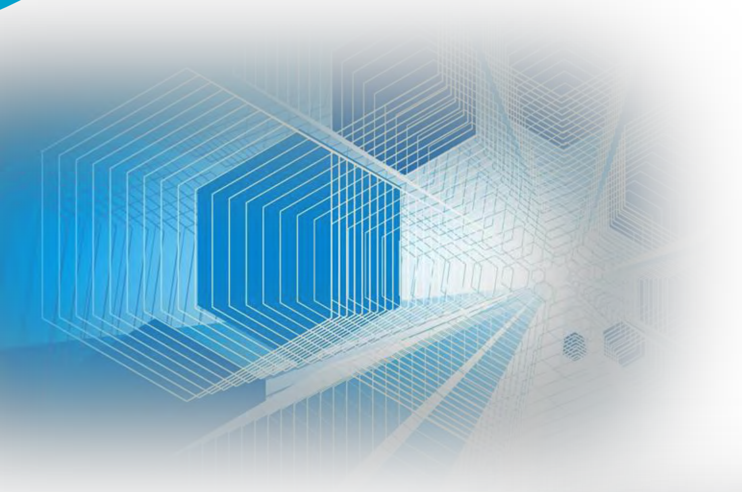
*Faculty of Engineering*

*Mansoura University*



# Postgraduate Studies Academic Regulations and Curriculum "Credit Hours System"

2020

# Faculty of Engineering – Mansoura University

# Postgraduate Studies Academic Regulations and Curriculum “Credit Hours System”

# 2020

بسم الله الرحمن الرحيم

# Work Team

**Faculty Administration**

| | |
|---|---|
| Prof. Mohamed Abd El Azim Mohamed | Faculty Dean and Professor at the Department of Electronics and Communications Engineering |
| Prof. Sherif Massoud Ahmed El-Badwy | Vice Dean for Postgraduate Studies and Research, and Professor at the Public Works Engineering Department |
| Prof. Mohamed Gamal Mohamed Mahdy | The Vice Dean for Education and Student Affairs and Professor at Structural Engineering Department |
| Prof. Sahar Sedki kaddah | The Vice Dean for community service and environmental development |

**Quality Assurance Unit**

| | |
|---|---|
| Prof. Ebrahim Abd El Ghafar Mohamed Badran | Director of the Quality Assurance Unit and Professor at the Electrical Engineering Department |
| Associate Prof. Mervat Mohamed Abou El Khier | Associate Professor, Department of Mathematics and Engineering Physics |

**Mathematics and Physics Engineering Department**

| | |
|---|---|
| Prof. Abed Mohamed Nasr | Former Vice President of Delta University for Graduate Studies, and Professor at the Department of Mathematics and Engineering Physics |
| Prof. Mohamed El-Metwally El-Gamal | Head of the Mathematics and Engineering Physics Department |
| Prof. Ebrahim Lotfy Hassan El Qala | Professor at the Department of Mathematics and Engineering Physics |
| Prof. Muhammad Al-Halawani | Professor of Chemical Engineering, Department of Mathematics and Engineering Physics |
| Associate Prof. Mohamed Sorour Abdel-Latif | Associate Professor, Department of Mathematics and Engineering Physics |
| Dr. Abas Hassan Mansour Abdul Qadir | Assistant Prof., Department of Mathematics and Engineering Physics |
| Dr. Mahmoud Hanafi Mahmoud | Assistant Prof., Department of Mathematics and Engineering Physics |

**Department of Power Mechanical Engineering**

| | |
|---|---|
| Prof. Ahmed Mohamed Hamed | Head of the Mechanical Power Engineering Department |
| Prof. Mohamed Nabil Sabry | Emeritus Professor, Department of Mechanical Power Engineering |
| Prof. Berg Ohanees Jeh Jian | Emeritus Professor, Mechanical Power Engineering Department |
| Associate Prof. El Shafaay Beder Mahmoud Zedan | Director of Mechatronics Program and Associate Professor, Mechanical Power Engineering Department |
| Associate Prof. Ahmed Abdalsalam | Assistant Prof., Department of Mechanical Power Engineering |
| Associate Prof. Muhammad Hassan Mansour | Assistant Prof., Department of Mechanical Power Engineering |
| Dr. Osama Mohamed Hamed | Assistant Prof., Department of Mechanical Power Engineering |

| | |
|---|---|
| Dr. Osama Youssef mokled | Assistant Prof., Department of Mechanical Power Engineering |
| Dr. Muhammad Rajab Al-Marghani | Assistant Prof., Department of Mechanical Power Engineering |
| Dr. Asmaa Ali Al-Awadi | Assistant Prof., Department of Mechanical Power Engineering |
| Dr. Muhammad Sameh Abdel-Ghani | Assistant Prof., Department of Mechanical Power Engineering |
| Dr. Muhammad Mustafa Tawfiq | Assistant Prof., Department of Mechanical Power Engineering |
| Dr. Ali Muhammad Hassan Radwan | Assistant Prof., Department of Mechanical Power Engineering |

**Department of Computers and Control Systems Engineering**

| | |
|---|---|
| Prof. Amira Yasin Heikal | Head of Computers and Systems Engineering Department |
| Prof. Hisham Ali Arafat | Professor, Department of Computers and Systems Engineering |
| Associate Prof. Amr Mohamed Thabet | Associate Prof., Department of Computers and Systems Engineering |
| Dr. Mahmoud Mohammed Saafan | Assistant Prof., Department of Computers and Systems Engineering |
| Dr. Mohamed Moawad Abdo Abdel Salam | Assistant Prof., Department of Computers and Systems Engineering |
| Dr.Hisham Helmy Gad | Assistant Prof., Department of Computers and Systems Engineering |
| Dr. Nahla Beshri Abdel Momen | Assistant Prof., Department of Computers and Systems Engineering |
| Dr. Ahmed Mohamed Abdel-Alim Ghanem | Assistant Prof., Department of Computers and Systems Engineering |
| Dr. Eman Mohamed El-Gendy | Assistant Prof., Department of Computers and Systems Engineering |

**Department of Production and Mechanical Design Engineering**

| | |
|---|---|
| Associate Prof. Noha Fouda Ibrahim Salama | Associate Prof., Department of Production Engineering and Mechanical Design |
| Prof. Ebrahim Mohamed Ebrahim Elewa Ammar | Emeritus Professor, Production Engineering and Mechanical Design Department |
| Prof. Abdou Abdel Fattah Abdel Samad | Professor, Department of Production Engineering and Mechanical Design and Dean of the Faculty of Industry and Energy, New Cairo University of Technology |
| Prof. Hassan Ali Sultan | Professor, Department of Production Engineering and Mechanical Design |
| Associate Prof. Tawakkul Enab | Associate Prof., Department of Production Engineering and Mechanical Design |
| Dr. Muhammad Ahmad Al-Qiran | Assistant Prof., Department of Production Engineering and Mechanical Design |
| Dr. Muhammad Gomaa Al-Khatib | Assistant Prof., Department of Production Engineering and Mechanical Design |
| Dr. Muhammad Hussain Al-Shafei | Assistant Prof., Department of Production Engineering and Mechanical Design |

| | |
|---|---|
| Dr. Mohammed Hamed Iraqi | Assistant Prof., Department of Production Engineering and Mechanical Design |

**Department of Electronics and Communications Engineering**

| | |
|---|---|
| Prof. Sherif Elsayed Sayed Ahmed Kishk | Director of the Center for Communications and Information Technology |
| Associate Prof, Nihal Fayez Arreed | Head of the Electronics and Communications Engineering Department |
| Associate Prof, Ahmed Abdel Rahman Al-Naqib | Associate Prof., Department of Communications and Electronics Engineering |
| Associate Prof. Hossam El Din Salah Moustafa Salah | Director of the Biomedical Engineering Program and Associate Professor, Electronics and Communications Engineering Department |
| Dr. Al-Saeed Ahmed Marzouq | Assistant Prof., Department of Communications and Electronics Engineering |
| Dr. Doaa Adel Tantawy | Assistant Prof., Department of Communications and Electronics Engineering |

**Department of Electrical Engineering**

| | |
|---|---|
| Prof. Sahar Sedki kaddah | Head of Electrical Engineering Department |
| Prof. Mohamed Abd El Moniem Tantawy | Emeritus Professor, Electrical Engineering Department |
| Prof. Magdy Mohamed El Saadawi | Emeritus Professor, Department of Electrical Engineering |
| Associate Prof, Ahmed Eid Musa Shaheen | Associate Prof., Department of Electrical Engineering |
| Dr. Elsaid Abu Al-Anwar | Assistant Prof., Electrical Engineering Department |
| Dr. Abd El Hady Tolba Mohamed Ghanem | Assistant Prof., Department of Electrical Engineering |
| Dr. Mohammed Al-Saied Rizk | Assistant Prof., Electrical Engineering Department |

**Department of Irrigation and Hydraulics Engineering**

| | |
|---|---|
| Associate Prof, Tharwat Eid Sarhan | Associate Prof., Department of Irrigation and Hydraulics Engineering |
| Associate Prof. Mohamed Tarek El Saied Shamaa | Emeritus Associate Professor, Irrigation and Hydraulics Engineering Department |
| Associate Prof, Hossam Abdel-Aziz Abdel-Gawad | Associate Prof., Department of Irrigation and Hydraulics Engineering |
| Dr. Reda Mahmoud Diab | Assistant Prof., Department of Irrigation and Hydraulics Engineering |
| Dr. Ahmed Abdel-Rahim Al-Adawi | Assistant Prof., Department of Irrigation and Hydraulics Engineering |
| Dr. Karim Adel Nassar | Assistant Prof., Department of Irrigation and Hydraulics Engineering |
| Dr. Amr Abbas Al-Zuhairi | Assistant Prof., Department of Irrigation and Hydraulics Engineering |

**Department of Structural Engineering**

| | |
|---|---|
| Prof. Ahmed Mahmoud Youssif Mohamed | Head of Structural Engineering Department |
| Prof. Salah El-Din Al-Saied Al-Mitwalli | Emeritus Professor, Structural Engineering Department |
| Prof. Emad El Saied Esmail El Beltagy | Professor, Structural Engineering Department |
| Associate Prof, Mohamed Attia Mohamed Abdel Rahman | Associate Prof., Structural Engineering Department |

**Department of Public Works Engineering**

| | |
|---|---|
| Prof. Hisham Khalil Abd El Fattah El Etribi | Head of Public Works Engineering Department |
| Associate Prof, Alaa Rashad Gabr | Associate Prof., Department of Public Works |
| Associate Prof. Mohamed Ahmed Abd El Hakim | Associate Professor, Public Works Engineering Department |
| Dr. Hany Mhanna | Assistant Prof., Department of Public Works |
| Dr. Ossama Al-Rawi | Assistant Prof., Department of Public Works |
| Dr. Ahmed Mohamed Metwally | Assistant Prof., Department of Public Works |
| Dr. Fawzy Hamed Fawzy Zarzoura | Assistant Prof., Public Works Engineering Department |
| Dr. Mohamed Zahran | Assistant Prof., Public Works Engineering Department |

**Department of Architecture Engineering**

| | |
|---|---|
| Prof. Lamis Saad Al-Jizawi | Head of the Architecture Engineering Department |
| Dr. Asmaa Rashad Nasr Al-Badrawid | Assistant Prof., Architecture Engineering Department |

**Textile Engineering Department**

| | |
|---|---|
| Prof. Fawkia Fahim Al Habiby | Head of Textile Engineering Department |
| Dr. Abdel Moneim Fahim Fouda | Assistant Prof., Textile Engineering Department |
| Dr. Rehab Abdel Khaleq Abdel Khaleq | Assistant Prof., Textile Engineering Department |
| Dr. Moaz Ahmed Sami Mustafa Al-Deeb | Assistant Prof., Textile Engineering Department |

**Faculty of Medicine**

| | |
|---|---|
| Prof. Basem Salama Abd el Halim | Professor of Community Medicine, Faculty of Medicine |

**Technical Committee**

| | |
|---|---|
| Ms. Marwa Muhammad Abdul-Ghani | Director of the Vice Dean's Office |
| Eng. Yahya Mohamed Abdul Majeed | Technical Office of the faculty Dean |

# Chapter One:

## General Regulations

## Introduction

It was established in 1974 after having been an Industrial Institution since 1957. The faculty has developed immensely through these years. It increased in size as well as in the number of advanced laboratories which serve the process of instruction and research. The faculty has become one of the leading faculties of engineering in Egypt through the research it presents that covers national and international issues.

The first regulation of postgraduate was issued by the faculty according to Ministerial Decree No. 1032 dated on 7/11/1984 by the academic year system. It was first updated by Ministerial Decree No. 4440 dated on 02/102/2014, by the credit hour system. The need to develop the faculty's postgraduate regulations has become evident to cope with the rapid scientific development, interdisciplinary fields, global practices, and international double and joint degrees. The following are the most important aspects of development in this bylaw:

1. Flexibility and harmony with international studying systems to facilitate mutual recognition and student exchange between the university and Egyptian and International universities. Also, adding and developing new postgraduate programs and interdisciplinary programs in line with what international systems offer and the Egyptian state vision 2030.
2. Updating the practical content of the courses and creating new courses to cope with the scientific development and the Egyptian state vision 2030.
3. Creating alternative ways for postgraduate students during the different stages of study, along with obtaining evidence of what has been studied.
4. Consistency with the preparation of study programs reference frame of Postgraduate Studies, Faculties of Engineering, issued by the Engineering, Technology and Industrial Studies Sector Committee 2020.

## The Faculty vision

Excellence and leadership locally and regionally and achieving a global position via cooperation of its students.

## The Faculty Mission

Faculty of Engineering, Mansoura University seeks to graduate highly qualified and distinguished engineers capable of competitive performance at national and regional levels in academic, research, and ethical aspects and capable of resolving society problems and increasing its resources within the constraints of the rules organizing our society.

## Article (1) Academic Departments

Faculty of Engineering, Mansoura University, consists of the following academic departments:
Mathematics and Engineering Physics.

1. Electrical Engineering.
2. Electronics and Communication Engineering.
3. Computer Engineering and Control Systems.
4. Mechanical Power Engineering.
5. Production Engineering and Mechanical Design.
6. Textile Engineering.
7. Structural Engineering.
8. Irrigation and Hydraulics Engineering.
9. Public Works Engineering.
10. Architecture Engineering.

These Scientific departments supervise the instruction of all the courses specified for graduate students (Diploma, Master and Doctorate Degrees), each in the respective field of specialization.

## Article (2) Academic Degrees

**A -**The Faculty of Engineering, Mansoura University, offers various postgraduate programs, whether specialized or Interdisciplinary Postgraduate Programs for different academic degrees. The available postgraduate programs vary between: Engineering Diploma (Basic and Advanced), Master of Science in Engineering and Doctor of Philosophy (PhD) in Engineering Sciences.

**B -** According to the reference frame for preparing study programs in the Faculties of Engineering (2020), academic degrees are defined as follows:

1. **Engineering Diploma (Basic and Advanced):** This study aims at developing scientific capabilities and development in the specialization and the field chosen by the student, using modern scientific techniques and methods by studying a number of advanced academic courses.

2. **Master of Science in Engineering:** This study aims at developing research capabilities, scientific thinking and development in the branch, field and subject chosen by the student based on the research plan of the faculty, by using modern scientific techniques and methods, studying a number of advanced academic courses, and conducting academic and applied scientific research through an integrated scientific thesis.

3. **Doctor of Philosophy (PhD) in Engineering Sciences:** This study aims at developing independent thought and the ability to develop, innovate, and add new knowledge to the branch, field, and subject chosen by the student, by following the scientific technical and research principles with a precise specialization and strengthening the research capabilities by conducting scientific research that adds new knowledge in the field of specialization.

## Article (3) Study System

**A-** Study follows the credit hour system which allows enrollment according to the rules set forth in Article (4). Grades are calculated according to Article (8); where one credit hour equals a number of contact hours as follows: one hour of lecture per week or two hours of tutorial per week or three hours Lab weekly. One hour of contact is divided into 50 minutes of actual teaching and 10 minutes of rest.

**B-** The number of weekly contact hours does not exceed **25** hours, so that the total student workload (**SWL**) is within 50 working hours, in case of full-time study.

**C-** The number of courses per semester ranges from **3** to **5** courses depending on the extent of the student's study devotion.

## Article (4) Times for Enrollment and Study

**A-** Enrollment takes place within four weeks before the start of any semester, after fulfilling the enrollment terms.

**B -** The academic year is divided into two main semesters in addition to the summer semester as follows:

- The first main semester (Fall semester): begins at the first of the fourth week of September and lasts for **15** weeks.
- The second main semester (spring semester): starts from the first of the third week of February and lasts for **15** weeks.
- Summer semester: starts from the first of July and lasts for eight weeks.

## Article (5) General Terms for Enrollment

A) Students should have a Bachelor of Science (BSc) degree in Engineering from one of the collages of engineering in an Egyptian university or an equivalent degree approved by the Supreme Council of the Universities.
B) Students should submit the required documents as specified by the Administration of Higher Studies and Research in the college.
C) Students should meet the prerequisites specified by the respective department council.
D) All students, with the exception of demonstrators, assistant lecturers and grant research students, should pay the assigned fees for each semester.
E) Enrollment is open twice a year at the beginning of each main semester and continues for four weeks. Registration for the summer semester, if available, takes place at the end of the second semester.

## Article (6) Course Enrollment

Enrollment in postgraduate studies follows the procedure below:

A. Obtaining the relevant department council or program management approval in case of Interdisciplinary Postgraduate Programs, and completing the documents required from the Faculty Administration of Higher Studies. Then, obtaining the approval of the college council based on the recommendation of the Higher Studies Committee.

B. The pertinent department council or program manager, in case of Interdisciplinary Postgraduate Programs, may-upon registration-determine the number of students admitted according to the capabilities available in the department and college.

C. The student may register in the main semester in courses ranging from **9** to **12** credit hours in case of part-time study. It is possible to enroll in courses with credit hours exceeding **12** hours in the case of full-time study with a maximum of **15** hours.

D. The maximum number of hours a student is allowed to register for the summer semester is **6** credit hours, and the minimum is **3** credit hours.

E. The available courses, for the student to enroll, in any semester depend on the number of students applying for enrollment, the specialized faculty members, and according to what is decided by the relevant department council / program administration.

## Article (7) Dropping, Addition, Withdrawal and Re-registration

A. After registration, the student may add or drop some courses. Failure to complete the necessary procedures when dropping a course leads to the student being considered failed in the course.

B. A student may change the courses in which he enrolled for others or drop some of them within the first two weeks after the beginning of the semester. This rule does not apply to the summer semester.

C. A student may drop a course without any academic effect until the end of the fourth week in the two main semesters. After this period, the only available alternative is withdrawal from the course. The courses dropped within the first four weeks of study shall not be listed in the transcript given to the student.

D. In case a student withdraws from a certain course after the fourth week and up to the twelfth in both main semesters and after the second week up to the sixth in the summer semester, the course is graded as a Withdrawal (W) which is considered a formal withdrawal.

E. Students are not allowed to take the final exam unless they attend at least 75% of the total teaching hours of the course. If the absence exceeds 25% of the assigned teaching hours, they are prohibited from attending the exam on the basis of a report submitted by the professor in charge of the course and after the approval of the Department Council and the Committee of Higher Studies and the Faculty Council. In their records, these students will be graded “FW” (Forced Withdrawal).

F. In all cases of withdrawal, fees are not returned to the student. Withdrawal is recorded in a special form. A student withdrawing from a certain course may request a re-enrollment.

G. In case a student does not attend without dropping a course, he/she shall get “Fail” as a grade.

H. A student is allowed a second chance of enrollment only once in case he/she fails a course or does not achieve the requested grade (C) or more. In this case, the student should comply with all the rules applicable regarding study, exams and fees. The final grade awarded should not exceed ($B^+$) when computing the grade point average (GPA).

I. Some or all of the courses can be taught remotely (electronically). Examinations can also be held electronically after approval of the relevant department council / program administration and approval of the Postgraduate Studies Committee, Faculty Council and University Higher Studies Council.

## Article (8) Grades

A) The grades are determined for the academic courses as stated in Table No. (1):

Table (1): Grade, percentage and GPA

| Grades | Percentage | GPA |
|---|---|---|
| $A^+$ | 95% or more | 4.0 |
| A | From 90% and less than 95% | 4.0 |
| $A^-$ | From 85% and less than 90% | 3.7 |
| $B^+$ | From 80% and less than 85% | 3.3 |
| B | From 75% and less than 80% | 3.0 |
| $B^-$ | From 70% and less than 75% | 2.7 |
| $C^+$ | From 65% and less than 70% | 2.3 |
| C | From 60% and less than 65% | 2.0 |
| D | From 50% and less than 60% | 1.0 |
| F | Less than 50% | 0 |

B) Upon his/her request, a student is given an approved course-grade transcript in Arabic or in English including the courses studied, the number of credit hours, the average grade and the accumulative average at the time of transcript issuance.

C) The following grades are issued under special circumstances and are not considered in calculating the grade point average (GPA) or the cumulative grade point average (GPA):

### (I) Incomplete Work:

This grade refers to a student's inability to complete the required coursework and take the final examination for unmanageable reasons deemed acceptable by the Department Council and approved by the Committee of Higher Studies and Faculty Council. This state is recorded in the student's data sheet at the Higher Studies Affairs Office (there must be one form for the student, another for the professor in which details concerning the reasons for not completing the work and the portion of the work required to modify the grade are mentioned.).

The student should consult the professor as to the work that needs to be done to complete the course within the first month of the following semester. This should not affect the number of the courses studied during the semester. In case the required tasks are not completed within this first month, a student gets an "FW" grade in the course.

### (W) Formal Withdrawal:

This grade is given to a student in case he/she withdraw from the course after giving an acceptable excuse within the times specified in Article (7-D) above. The student, in this case, should have completed the work required in the course up to the time of withdrawal.

### (FW) Forced Withdrawal:

Forced Withdrawal (FW) is a grade given to a student upon withdrawing from a course without having finished the work required at the time of withdrawal as mentioned in Article (7-E) above.

In the case of courses taught in more than one semester or thesis, one of the following grades are awarded:

**(IP) Advanced:**

This is a preliminary grade given at the end of the first semester.

(P) Pass: that is a student who took the course and passed it.

(NP) Not Passed: a student who took the exam but failed in it

(S) Satisfactory Performance: a student given a satisfactory performance in a project, a thesis/dissertation or similar courses

(US) Unsatisfactory Performance: a student failed to give a satisfactory performance in a project, a thesis/dissertation or similar courses

(NE) Non-Attendant: A student who attended the course but not the final exam.

**(AU) Audit:**

This is a grade given to a student who attended the course only as an audit without attending the examination. In case the audit attends 75% or more of the course, he/she is awarded this grade. However, the course in this case is considered a non- credit hour course.

## Article (9) Grade Point Average

Calculating the Grade point Average (GPA) is limited to the courses which the student had studied at Faculty of Engineering, Mansoura University. The Faculty Council, based upon the proposal of the relevant department council or program administration and approval of the University Studies Council, may allow the Postgraduate students to study some postgraduate courses in foreign universities associated with Mansoura University by dual mutual agreements or Memorandum of Understandings (MoU) with Mansoura University. These courses are counted within the degree-granting requirements. The student is allowed to transfer any number of these courses in which he succeeded with a grade of ($B^-$) at least or its equivalent to any of the graduate studies programs that he wishes to enroll in if these courses are within the requirements of the program. These courses are included in the calculation of the cumulative average of degrees, provided that no more than three years have passed since the date of enrollment in postgraduate programs.

**A-** The points of each course are calculated as the number of its credit hours multiplied by the metering of each credit hour.

**B-** The total points of the student at any stage are calculated as the sum of the points of all the courses he studied.

**C-** The cumulative average of points of any stage is calculated as the result of dividing the total points obtained by the student at this stage divided by the total number of hours of the courses that the student studied.

**D-** The student is not considered successful, and does not obtain the diploma unless he gets a cumulative grade point average of not less than **2.3** (**$C^+$**) in the basic diploma courses, and in the case of wanting to continue for the advanced engineering diploma, the cumulative average of points must not be less than **2.7** (**$B^-$**).

**E-** The cumulative average of the Basic Engineering Diploma courses should not be less than **3.0** (**B**) and the Advanced Engineering Diploma should not be less than 3.0 (**B**). An average score of not less than **2.7** (**$B^-$**) is required in any of the basic or Advanced Diploma courses if desired in order to complete the study to obtain a Master of Science in Engineering degree. The course in which the student obtains a grade lower than (**C**$^+$) for diploma, master's, or doctoral courses is not counted within the credit hours prescribed at this stage.

**F -** The student has the right to re-study the courses in which he previously passed with a grade lower than the required one only for the purpose of improving the **GPA** or achieving the requirements for obtaining a diploma, masters or PhD. The repetition is a study and an examination. The last grade is calculated for a maximum of (**B**$^+$) when calculating the average, provided that both grades are mentioned in his academic registered. The student also has the right to choose an alternative course for the course in which he did not achieve the required level unless the course is compulsory.

**G-** If a student has repeatedly failed twice in the same course, the student may be registered in another major once as a last opportunity.

## Article (10) Tuition Fees

What is determined by Mansoura University Council regarding tuition fees shall be complied with.

## Article (11) Academic Advisor

The Department Council appoints an academic advisor from Teaching Staff for each student upon enrollment for any academic degree to provide advice, guidance and scientific follow-up; and to continue with the student until the end of the Engineering Diploma (Basic and Advanced) study. While he is replaced by the main supervisor of the thesis in the event that the student applies to study a Master of Science degree in Engineering or a Doctor of Philosophy (PhD) degree in Engineering Sciences.

## Article (12) Study Duration

**A-** Study periods are limited to the number of major semesters permitted. The minimum and maximum duration of study in each degree, as well as the extension after the end of the maximum limit, shall be determined according to the following rules:

| Degree | Study Duration (one major semester) | | Maximum Conditional Extension Period (one major semester) |
|---|---|---|---|
| | Minimum | Maximum | |
| Basic Engineering Diploma | 1 | 2 | 1 |
| Advanced Engineering Diploma | 2 | 4 | 1 |
| Master of Science in Engineering (including basic and advanced diploma) | 4 | 6 | 2 |
| Doctor of Philosophy (PhD) in Engineering Sciences | 6 | 10 | 2 |

**B-** In case of study duration extension request, the student submits an application to the Department Council / the relevant program administration, and the student's eligibility is considered.

**C-** The durations set above are by imposing **25**-hour weekly contact hours. The maximum limit (up to a maximum of twice the duration) is increased for the above durations in case the student does not devote sufficient time to study at this rate.

## Article (13) Suspending Enrollment

Suspension of enrollment shall be in accordance with the controls established by the Council of Postgraduate Programs and Research at the university. The completion of its procedures is required before the end of the original registration duration, or registration stipulated in Article (**12**), and it is not for a previous period. The Faculty Council may, based upon the proposal of the relevant department council, suspend the registration of the registered student Postgraduate studies, in the following cases:

**A-** Sick cases, provided that the student submits the necessary sickness certificates approved by the university medical administration.

**B-** Accompanying the husband or wife to travelling abroad, provided that the student submits an evidence of this.

**C-** Summons for joining the armed forces, and submission of evidence.

**D-** Childcare leave provided that a certificate approved by the employer for workers or a birth certificate for the child is introduced.

**E-** Training scholarships and official assignments that the student is delegated to through his employer, provided that evidence is submitted.

**F-** Any other cases accepted by the Postgraduate Studies Committee and approved by the Faculty Council after the approval of the Department Council / Management of the relevant program.

**G-** A student may apply to suspend his enrollment to study a diploma in engineering sciences or a master's in engineering sciences after completing the basic engineering diploma stage, and obtain a certificate in the courses he studied, or after completing an advanced engineering diploma for students registered for a master’s degree and obtain a certificate with an advanced engineering diploma.

**H-** The student may apply to suspend his enrollment to study a Doctor of Philosophy (PhD) in Engineering Sciences after completing either of the two groups of doctoral courses (basic or advanced) and obtain a certificate in the courses he studied.

**I-** Enrollment suspension shall be for one academic year, and it may be extended for other periods with the approval of the Council of Postgraduate Studies and Research at the university, with a maximum of three years.

**J-** The student is not exempted from paying the prescribed fees during the suspension duration.

## Article (14) Registration Cancellation

The Postgraduate and Research Committee, upon the request of the Faculty Council, recommends canceling the student’s registration in the following cases:

**A-** The student failure at any of the courses twice or failing to obtain the minimum required for success upon completion of the courses.
**B-** Cases of breaching the study and examinations system, which are established according to an official investigation.

**C -** The student's lack of seriousness, his absence from study, and warning him with three notices. The duration between each notice and the next for him is fifteen days, after which the supervisors submit a report stating that the student is not serious about study.
**D-** Submitting a report from the Research judging committee (**MSc - PhD**) stating that he is not valid for the degree.
**E-** The student submitted a request to cancel the registration, and his request was approved after being approved by Prof. Vice President for Postgraduate Studies.
**F-** If the student is not awarded the academic degree during the period stipulated in the regulations (**Article 12**).
**G-** Failure to pay fees determined according to the rules regulating this.

## Article (15) Re-Enrollment

**A-** If the student's enrollment is canceled for one of the reasons mentioned in Article (**14**), the Faculty Council may, upon the proposal of the Postgraduate Committee, re-enroll him provided that at least one calendar year has passed from the date of the Faculty Council's approval of canceling his registration. The student must submit an application for re-registration on the specified dates, in accordance with Article (**4**) , and the general terms for registration in accordance with Article (**5**) and the terms for registration for each degree and set forth in this bylaw based upon the approval of the Department Council / the relevant program administration.

**B-** He, whose enrollment is suspended after the completion of one or both stages of the PhD courses, may be re-enrolled within a maximum duration of **12** months from the registration suspension. Otherwise, the student is forced to re-study the courses again. In all cases and for the choice of advanced PhD courses to be linked to the topic of the dissertation and the opinion of the supervisor. In case of changing the subject of the thesis or changing the principal supervisor during the re-registration stage, then the new department / program or principal supervisor shall have the right to request the study of additional advanced courses that suit the new situation.

## Article (16) Residency Requirements for International Students

International students must provide a proof of their residency in the Arab Republic of Egypt for at least two academic years.

## Article (17): Students and Foreign Teaching Staff

**A-** The Faculty Council may, upon the proposal of the department council / the relevant program administration, allow foreign students enrolled in foreign universities to study some postgraduate courses in the faculty. In case that the student successfully passes the course and his requirements, a statement is granted.

**B-** The Faculty Council may, upon the proposal of the department council / the administration of the relevant program, allow professors from distinguished foreign universities, to teach some postgraduate courses in the faculty. These courses can also be taught remotely, and exams are conducted electronically.

## Article (18): Course Coding System

**A-** The courses are coded by placing the code for the teaching department as shown in Table (**2**).

**B-** The course code consists of two parts. The first part is the code of the scientific department in letters. The second part consists of three numbers. The first of which represents the level of courses (**5-7**), followed by a number representing the course major (**1-9**), and the third number expresses a series of courses in the major of the same level (**1-9**).

**C-** In the case of courses that are not taught in the scientific departments, these courses are given a three-letter code for the interdisciplinary Programs.

***Table (2) Courses Code System***

| No. | Academic Department | Code |
|---|---|---|
| **1** | Mathematics and Engineering Physics | **BAS** |
| **2** | Electrical Engineering | **ELE** |
| **3** | Electronics and Communication Engineering | **ECE** |
| **4** | Computer and Control Systems Engineering | **CSE** |
| **5** | Mechanical Power Engineering | **MPE** |
| **6** | Production Engineering and Mechanical Design | **PDE** |
| **7** | Textile Engineering | **TXE** |
| **8** | Structural Engineering | **STE** |
| **9** | Irrigation Engineering and Hydraulics | **IRH** |
| **10** | Public Works Engineering | **PWE** |
| **11** | Architecture Engineering | **ARE** |

## Article (19) Courses

### Postgraduate courses are divided into:

**1.) 500- level Courses:** which are of an applied form, are taught mainly for students of the Basic Engineering Diploma. Courses from the bachelor's level (**400** level or less) may be taught as additional courses for diploma or master's students, but without being counted as credit hours.

**2.) 600- level Courses:** it is of an academic form. It is mainly taught for students of the advanced engineering diploma and Master of Science in. It can also be taught for students of PhD in philosophy, but with a maximum of two courses per student.

**3.) 700-level Courses:** it is mainly taught to students of the PhD in philosophy, and courses with a level of **700** can be taught to master's students, with a maximum of two courses per student.

## Article (20): Courses Marks Distribution

**A-** Each course is assigned grades for semester work in a percentage of the maximum score for the course determined by the scientific department / program according to the form of the course.

**B -** Each credit hour is allocated at least one hour for the written examination. The written examination time is not less than two hours and not more than three hours for any academic course. An exception may be made from the maximum number of some courses in the Architectural Engineering Department.

**C-** An oral examination is held in the course of the research seminar or research project, and a percentage of no less than **50%** of the total score of the course is specified in the regulation.

## Article (21): Courses Academic Content

**A-** The Faculty Council approves the academic content of postgraduate courses after being determined by the department council / the relevant program administration.

**B-** The faculty council can make some minor amendments and approve them without referring to the engineering sector committee, such as:

Adding courses to the elective course's basket **-** modification of course content that does not exceed **50% -** modification of course evaluation percentages **-** modification of the number of contact hours in a manner that does not affect the course's credit hour calculation.

## Article (22): Courses Equivalency

**A-** The Faculty Council, based upon the proposal of the department council / the management of the relevant program, may request the Council of Postgraduate and Research to calculate courses at the level of postgraduate in the same corresponding stage that the student has previously studied in the faculty or its equivalent from the Supreme Council of Universities. And the student has succeeded in them at a very good grade (**B**) At least during the three years preceding his enrollment in postgraduate studies provided that it has not been calculated for him. And he obtained a certificate or another academic degree according to study them provided that the number of hours of these courses does not exceed **6** credit hours. These courses are not included in the calculation of the cumulative average, and these hours are calculated from the total hours required.

**B-** The Faculty Council, upon the proposal of the department council / the relevant program administration, and university studies committee approval, may allow postgraduate students to study some postgraduate courses in foreign universities linked with Mansoura University by bilateral agreements of understanding. These courses are counted within the degree awarding requirements. The student is permitted to transfer any number of these courses in which he succeeded with a grade of (**B**) at least or its equivalent if these courses are within the requirements of the program. These courses are included in the calculation of the cumulative average of degrees, provided that no more than three years have passed since the date of enrollment in postgraduate programs.

## Article (23): Supervising Academic Thesis

- **A-** Based upon the proposal of the relevant department council / program administration and approval of the Postgraduate Committee, the Faculty Council appoints a principal supervisor for the student from among the professors or assistant professors in the college. One or two other members shall participate with him in supervising. One of them may be a professor provided that there is no relationship between the members of the committee or between one of them and the student by kinship or lineage up to the fourth degree.
- **B-** At the approval of the Faculty Council, it is permissible to participate in supervising master's and PhD thesis/dissertation at the level of professors or assistant professors from specialists outside the college. This is provided that the members of the supervisory body do not exceed three in the case of masters and five in the case of doctorate.
- **C-** For those who are enrolled in Master of Science degree, the exact major is determined. Also, the main supervisor is determined after completing the basic engineering diploma. The student, in consultation with the principal supervisor, determines the advanced engineering diploma courses that the master’s student should study.

**D-** For those who are enrolled in the PhD degree in Engineering Sciences, the Department Council / Program Administration determines a principal supervisor according to the research proposal specialization after the student succeeds in the basic PhD courses and submits the initial research proposal.

**E-** The Faculty Council may adjust the supervisory committee by reducing, adding or both. This is based upon the suggestion of the principal supervisor and the approval of : the relevant department council / program administration, the postgraduate committee and the approval of the amendment by The Vice President of the university of postgraduate studies and research without contradicting paragraph (a)of this article .

**F-** At the end of each academic year, the supervisors shall submit a report to the department / program administration council on the student's progress in his studies, and the principal supervisor may recommend continuing or canceling the enrollment.

## Article (24): Academic Thesis

The thesis is a partial, basic requirement for obtaining an academic degree (Master or PhD), which is registered every major semester or summer semester after completing the courses.

**1-** When the student finishes preparing the thesis and signing it from the supervisors, a public lecture will be held on the subject of the thesis. The lecture date will be determined upon the suggestion of the supervisors and the approval of the head of the department council / program administration.

**2-** After conducting the public lecture, the supervisors shall present to the department council / the concerned program administration in preparation of presentation to the college council with the following:

A. A report on the validity of the thesis of discussion, stating the exact title of the thesis in both Arabic and English and signed by the supervisory authority department / program administration, and provide evidence regarding the reasons for the required change). In case that a member of the Supervision Committee travels abroad, the traveling supervisor sends a letter, fax, or an email to the head of the department / program council or the faculty vice-president of postgraduate and research (within two weeks) indicating his approval of the authority report. If the reply does not arrive, the traveling supervisor is asked to send the report again. In case that his approval is not received within two weeks to submit the validity report, this is considered as an approval. In case that the opinions of the members of the student supervision committee differ, the non-approved supervisor writes a detailed report explaining the reason for his objection to not signing the validity report, and the scientific department / program studies the case and takes the appropriate decision.

B. Requesting a proposal to form a committee of discussion and judging the thesis from among three candidates, one of them is the supervisor (or supervisors with one vote) and the other two, one of whom is from outside the university.

C. A letter of publishing academic papers extracted from the thesis in specialized scientific journals approved by the department / program and in accordance with the rules determined by the University Council in this regard.

D. Four hard copies of the thesis, written in accordance with the instructions and rules for writing scientific theses in the faculty, to be delivered to the discussion and judgment committee.

**3-** After accepting the thesis from the discussion and judgment committee in a public discussion and making the necessary amendments if there were any, the student submits the required copies (paper and electronic) signed by the jury and supervisors committee and the head of the department / program council in charge. In addition to, the abstracts in Arabic and English approved by the supervisors, and a data form which is signed by the student and the supervisors to the Graduate Studies Department in the faculty for approval by the Vice-Dean for Postgraduate Studies and Research and the Dean of the faculty.

## Article (25): Research Judging Committee

**A-** The faculty council, based upon the proposal of the department / program administration council, shall form a committee to judge the dissertation from three members, one of them is the supervisor (or supervisors with one vote) in addition to two members from among the professors or assistant professors in Egyptian or foreign universities or those of their academic level Specialist. This is provided that at least one of them is from outside the university and the committee is headed by the oldest members. The Vice President for Postgraduate and Research approves the formation of the judging committee on the thesis after the approval of the faculty council. The discussion or judgment on the master's or PhD thesis does not take place until fifteen days have passed since the date of the university's approval to form the judging and discussion committee. This is provided that the discussion takes place during the authorized duration for the student to finish the public debate.

**B-** The committee, selected by the department council / program administration to judge the dissertation, is required that the dissertation to be in the major of their research specialization, and they have scientific production in this field.

**C-** The teaching staff shall not participate in the jury on the scientific thesis submitted by one of his relatives up to the fourth degree by relative or in-laws. It is also not permissible for members to participate in the jury who are related to some kind of kinship up to the fourth degree.

**D-** The discussion may occur at the presence of one of the representatives of the supervision committee in case that the attendance of the other supervisors is not possible.

**E-** It is permissible to use modern remote communication technologies such as (Video conference) or (Zoom, WebEx, Microsoft team, Skype) and so on in discussing the message of one or more members of the committee due to compelling circumstances that prevent them from attending the place of discussion. Likewise, in case of a referee member from outside the republic, the discussion may also take place without a member of the arbitration committee from outside the republic. This is provided that he is represented on the committee by one of the professors from the scientific department. In this case, the individual report is sufficient for the external arbitrator, provided that the report arrives before the public debate.

**F-** Each member of the jury submits an individual report on the dissertation. After receiving the individual detailed reports, a date for public discussion of the dissertation is set in case the individual reports agree to the discussion. The appointment shall be announced sufficiently in advance (at least **one** week), or the student is given a duration to amend what is stipulated in the individual reports as a condition for holding the public debate. After that, the committee submits a group report after discussing the student on the forms prepared by the Department of Graduate and Research for this purpose about the thesis and the outcome of the discussion, in preparation to introduce it to the University Council.

**G-** The committee may recommend in its collective report one of the following two recommendations:

**1-** Accept the message. It is given a "satisfactory" rating of **"S"**.

**2-** The letter was totally rejected, and the rating is given **"US"**.

In case that the committee recommends refusing the thesis, it may be returned to the student to complete what the committee deems shortage or modification. The student is given an opportunity (renewing the formation of the committee without changing the members of the committee) not exceeding six months from the date of the discussion. This is provided that it does not exceed the maximum limit for awarding the degree, whether for the master or PhD. In this case, the student is discussed again, and the committee submits a collective report to the department council / program administration concerned with the results of examining the thesis and discussion.

## Article (26): Interdisciplinary Programs

**A-** It is available to output interdisciplinary postgraduate programs based upon the proposal of the concerned scientific departments, and the approval of :the Postgraduate and Research Committee and the Faculty Council and the Council of Postgraduate Studies and Research in accordance with the basic rules for inter-degrees described in the 2020 progressive framework.

**B-** The Interdisciplinary studies are based upon a partnership or close cooperation between different academic departments and also with other faculties.

**C-** The Interdisciplinary postgraduate studies follow all academic grades in the articles of the current regulations.

**D-** The Faculty Council forms an academic council every year for each Interdisciplinary diploma, master's, or PhD. It has all the powers of the scientific department council to supervise the affairs of each of these degrees of an inter-nature under the chairmanship of the Vice-Dean for Postgraduate and Research and the membership of the heads of the relevant departments and a professor or assistant professor from these departments based upon the nomination of the scientific department council. It is permissible to include two teachers at most by a decision of the Faculty Dean based upon the proposal of the President of the Council (the Vice Dean for Postgraduate Studies and Research), after consulting the opinion of the Chairman of the relevant scientific department council.

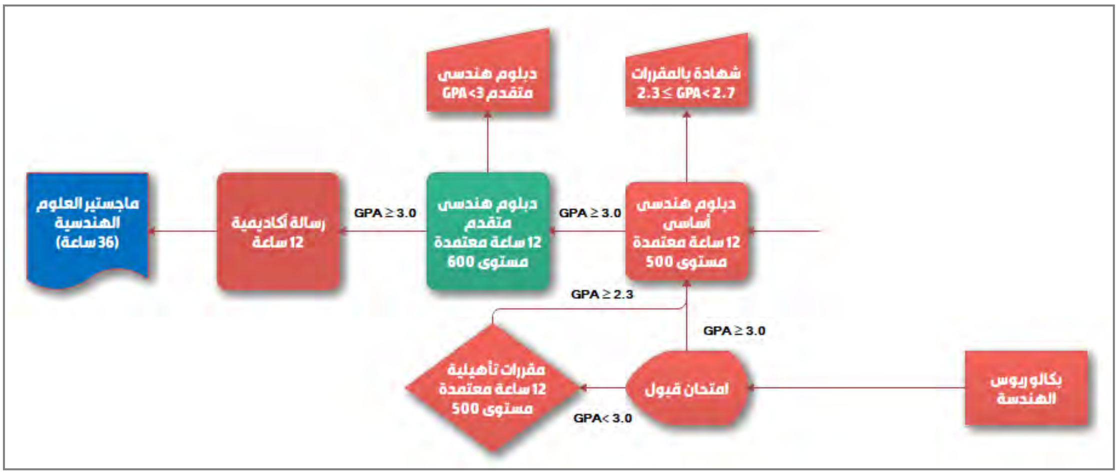
**E-** Students applying for a master's degree in the Interdisciplinary major, who do not have a bachelor’s degree in this major, shall study qualifying courses of not less than **12** credit hours and not more than **18** credit hours according to the schedules of specialization courses in the regulation or taught in other departments in the college or in one of the faculties of Mansoura University or recognized foreign universities. After they succeed in those courses with a grade of no less than (**C**$^+$), they are registered for the master's degree. These credit hours are not counted among the hours mentioned in Article (**31**) Paragraph **A**.

**F-** After completing the courses, the subject of the thesis is registered. Other advisors from other secondary specialties can be added to provide the required support that is focused on supporting the use of a specific method or tool required to conduct the research experiment, and they are not then from the Supervisors. Their names are added to the research papers resulting from the research and in the points where they were presented for support.

## Stages and Requirements for Obtaining Academic Degrees

### (1) Diploma in Engineering Sciences (24 credit hours as a minimum)

Mansoura University Council, upon the proposal of the Faculty of Engineering Council, shall grant a basic Engineering Diploma (Basic and Advanced) and an advanced engineering diploma in one of the disciplines shown in Table No. (**3**). The certificate is granted indicating the name of the diploma. It is possible to request the creation of new diplomas based upon the proposal of the department councils and the approval of the Postgraduate and Research Committee, the College Council and the approval of: the Council of Postgraduate and Research, and the University Council on that. New diplomas may be established with bodies outside the university to obtain a diploma in a specialized field or inter-fields. In case of the specialized diploma, the relevant department council sets the rules governing this diploma. The presentation is submitted to the Postgraduate Committee and then the Faculty Council for approval. In case of Interdisciplinary diplomas, a committee shall be formed to supervise the intermediate diplomas, headed by Prof. Vice Dean for Postgraduate Studies and Research and membership of representatives from relevant scientific departments.



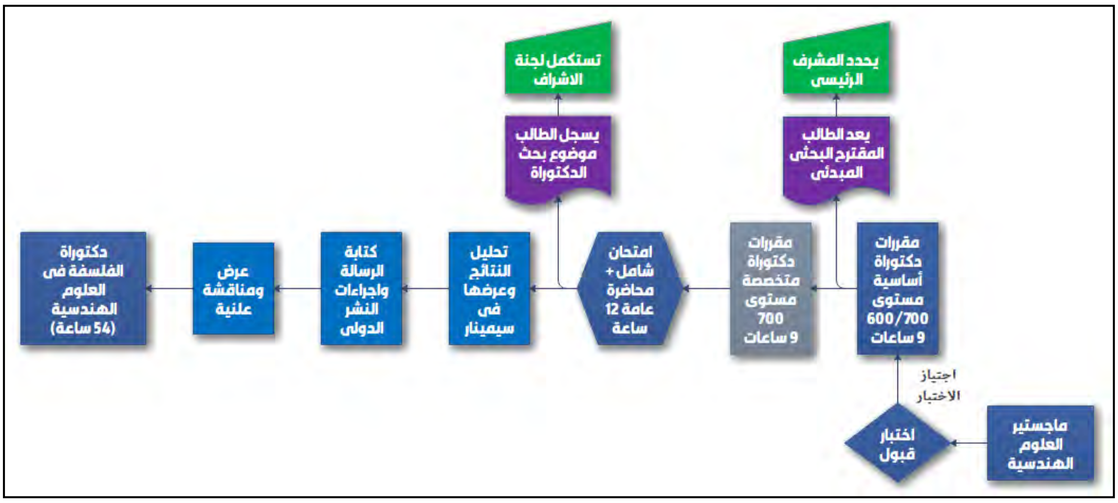




*Figure (1) Stages and requirements for postgraduate programs*

## Article (27): Basic Engineering Diploma

The courses of the Basic Engineering Diploma are studied as follows:

**A-** The student at this stage studies courses equivalent to **12** credit hours from level **500**.

**B-** The department / program council may assign the student, upon the request of the academic advisor, to study and pass some of the undergraduate courses (with a level of **400** or less) with a maximum of **12** credit hours, and these hours are not counted within the hours prescribed for the diploma.

**C-** The hours of any course the student studied are counted unless he obtains a grade of no less than **C**$^+$ (at least **2.3**).

**D-** The student obtains the basic engineering diploma in the major branch if he successfully completes the study of all the specified courses with a cumulative rate of not less than **2.3**. In case of desiring to continue for the advanced engineering diploma, the cumulative average of grades must not be less than **2.7**. If the student wants to apply for a master’s degree after obtaining an advanced engineering diploma, the cumulative average of grades is not less than **3.0** in.

## Article (28): Advanced Engineering Diploma *(24 Credit hours at least including basic Diploma)*

**A-** After the student succeeds in the first stage with an average grade of not less than **2.7**, he is entitled to join the next phase where the department / program council appoints a basic supervisor based upon the specialization and the student studies in this phase **12** optional credit hours of level **600**, and that is in coordination with the supervisor.

**B-** The courses are in the research and scientific fields of subspecialties in the various branches of engineering. The student may participate in work teams to prepare an applied research project that is evaluated at **3** credit hours out of the **12** hours. The relevant department council / program is assigned to supervise it (Article **29**).

**C-** The student obtains an engineering sciences diploma in the major branch if he successfully completes studying all the courses (not less than **24** credit hours).

**D-** The hours of any course studied by the student are not counted unless he obtains a grade of no less than **C**$^+$ (**2.3** at least) for obtaining an advanced engineering diploma, and in the event of a desire to continue to the Master of Science in Engineering, the average score should not be less than **3.0**.

## Article (29): Dissertation Project

**A-** The student, registered for the advanced engineering diploma, prepares a thesis project under the supervision of the department's faculty, preferably in the last semester.

**B-** The department council shall form a tripartite committee of examiners from among the teaching staff, and this committee discusses the student on the research project. If the student fails in the research project, he is given a second chance in the next semester of the examination and requires recording **3** credit hours for the research project.

***Table (3)***
***Majors of Engineering Science Diploma***

| No | Department | No | Department |
|---|---|---|---|
| 1 | **Electrical Engineering Department**<br>• Engineering Diploma in Electrical Engineering, Electrical Forces Major.<br>• Engineering Diploma in Electrical Engineering, in Renewable Energy Major.<br>• Engineering Diploma in Electrical Engineering, in Electrical Systems Protection Major. | 2 | **Electronics and Communications Engineering Department**<br>• Engineering Diploma in Electronics and Communications Engineering, in Electrical Communication Engineering Major.<br>• Engineering Diploma in Electronics and Communications Engineering, in Electronics Engineering Major.<br>• Engineering Diploma in Electronics and Communications Engineering, in Biomedical Electronics Engineering Major. |
| 3 | **Computer Engineering and Control Systems Department**<br>• Engineering Diploma in Computer Engineering and Control Systems, in Computer Engineering Major.<br>• Engineering Diploma in Computer Engineering and Control Systems, in Control Systems Major. | 4 | **Power Mechanical Engineering Department**<br>• Engineering Diploma in Mechanical Power Engineering in Refrigeration and Air Conditioning Engineering Major.<br>• Engineering Diploma in Mechanical Power Engineering within Power Station Engineering Major.<br>• Engineering Diploma Mechanical Power Engineering, in Hydraulic Machines Major.<br>• Engineering Diploma in Mechanical Power Engineering, in Combustion Engineering Major. |
| 5 | **Production Engineering and Mechanical Design Department**<br>• Diploma of Engineering Sciences in Design Engineering<br>• Diploma of Engineering Sciences in Manufacturing Engineering. | 6 | **Textile Engineering Department**<br>• Engineering Diploma in Textile Engineering, in Spinning and Weaving Engineering Major.<br>• Engineering Diploma in Textile Engineering, in Knitting and Clothing Engineering Major.<br>• Engineering Diploma in Textile Engineering, in Functional Textile Engineering Major. |
| 7 | **Structural Engineering Department**<br>• Engineering Diploma in Structural Engineering. | 8 | **Department of Irrigation and Hydraulics Engineering**<br>• Engineering Diploma in Irrigation and Hydraulics Engineering, in Irrigation and Drainage Engineering major.<br>• Engineering Diploma in Irrigation and Hydraulics Engineering, in port engineering and beach protection major.<br>• Engineering Diploma in Irrigation and Hydraulics Engineering in Water Resources Engineering major. |
| 9 | **Public Works Engineering Department**<br>• Engineering Diploma in Public Works Engineering Majoring in Transportation Engineering.<br>• Engineering Diploma in Public Works Engineering, Majoring in Highway and Airport Engineering<br>• Engineering Diploma in Public Works Engineering, Majoring in Sanitary and Environmental Engineering<br>• Engineering Diploma in Public Works Engineering, Majoring in Surveying Engineering. | 10 | **Architecture Department**<br>• Engineering Diploma in Architectural Engineering |
| | | 11 | **Interdisciplinary Programs**<br>• Engineering Science Diploma in Biomedical Engineering<br>• Engineering Science Diploma in Mechatronics Engineering |

## (2) Master of Science in Engineering (Minimum 36 Credit Hours)

Mansoura University Council, upon the proposal of the Faculty Council, grants a Master of Science degree in Engineering (specialized or Interdisciplinary), and the name of the scientific department / program, specialization, and thesis title shall be indicated in the certificate in Arabic and English.

### Article (30): Registration Requirements for master's degree

In addition to the conditions mentioned in Article (5), the student is required to be registered for the MSc Degree:

**A-** The Student must have a degree in engineering from one of the engineering faculties at the Egyptian universities, or an equivalent degree from any other scientific institute recognized by the Supreme Council of Universities after the certificate is equalized.

**B-** The department holds an admission Exam to determine the numbers of those admitted and to ensure that the appropriate scientific and academic background for the study is available.

**C-** In the case of the student in the admission Exam with a GPA of at least 3.0, he is entitled to enroll in a master's degree or diploma. In the event that he obtains a GPA of less than 3.0, he shall study 12 credit hours of qualifying courses of level 500. After passing these courses with a grade of no less than (C+), he is qualified to enroll in the MSc or a diploma.

**D-** The Faculty council may, upon the recommendation of the relevant department council, accept the student's enrollment for a master's degree if he has obtained a bachelor's degree in engineering with an acceptable grade. In addition to having obtained one of the advanced postgraduate diplomas from one of the engineering colleges recognized by the Supreme Council of Universities with an overall grade of at least good or a GPA of at least 3.0 in the same major.

**E-** Students, applying for a Master's Degree in Mathematics and Engineering Physics who do not hold a Bachelor of Science, shall take preparatory courses from level 500 that are not less than 12 credit hours and not more than 18 credit hours. After they succeed in these courses with a grade of no less than (C+), they can register for the Master of Science in Engineering degree. If the student has a Bachelor of Science in addition to a Bachelor of Engineering, he may be enrolled directly to the Master's Degree, subject to paragraphs (A and B) of this article as well as Article (5) in both cases.

**F-** Students applying for Master of Science degree in Engineering may be enrolled if they have a Bachelor of Engineering in fields other than the required major. This will be after they have completed the additional qualifying courses exam which is determined by the relevant department council (not less than 12 credit hours and not more than 18 credit hours) and their success in these courses with a grade of no less than (C+). These credit hours are not counted within the hours mentioned in Article (31)

## Article (31): Master's Degree Requirements

**A-** The student studies in the first stage **12** credit hours of level **500** which represent the basic engineering diploma. Then, in the second stage, he studies another **12** elective hours, thus completing the requirements for the advanced engineering diploma. In the final stage, the student conducts academic research and submits in the form of a master's thesis, which equals **12** credit hours.

**B-** After completing the basic engineering diploma courses with a grade point average of no less than 3.0, the framework of the precise specialization is determined, and a principal supervisor is determined.

**C-** The main advisor determines which courses should be studied in the advanced engineering diploma. These courses consist of **6** credit hours from optional courses within the framework of the specialization of the program in addition to **6** credit hours that can be chosen from other disciplines linked to the research point. These courses are of level **600** and two courses can be studied at a maximum of level **700**.

**D-** After completing the basic and advanced engineering diploma courses with a grade point average of no less than **3.0**. This is provided that at least one of the basic or advanced diploma courses has been obtained on a grade of **B**$^{-}$ or more (at least **2.7**). The subject of the thesis is registered, and there could be adding other supervisors according to the required specializations in the research, with a minimum of a second supervisor.

**E-** Hours of any course the student studied are not counted unless he attains a grade of **C**$^{+}$ or more (at least **2.3**).

**F-** The thesis duration shall be limited from the date of registration until the date of submitting the final copy, with a minimum of one year. It is allowed to extend it for another six months for reasons accepted by the relevant department / program council.

**G-** The relevant department council may require that the student pass, before registering the point, some of the courses that the supervisors specify for him from within: the department's courses of the bachelor's level or level **500**,or that are taught in other departments of the college or in one of the faculties of Mansoura University, Egyptian universities or recognized foreign universities. This is provided that they do not exceed a total of six (**6**) credit hours. These hours are not counted for the student as part of the credit hours mentioned in Paragraph (**A**) of this article, and they are not included in the calculation of the **GPA**, and these courses are necessary to complete the study and prepare the thesis.

**H-** The dissertation is evaluated by a committee formed by the department / program in accordance with Article (**25**) of these regulations.

**I-** The department council / management of the relevant program may agree to amend the field of research while fulfilling its requirements upon the request of the supervisors. This amendment shall be approved by the Faculty Council and the University's Postgraduate and Research Council, and this does not result in prejudice to the time periods stipulated in Article (**12**).

**J-** Those, who obtained the advanced engineering diploma with a grade point average of no less than **3.0** within a maximum period of **3** years from the date of obtaining the degree, may reapply to complete the study for a master's degree in engineering sciences. In this case, the advanced engineering diploma for a master's degree is merged using what was previously studied. The department council updates the list of supervisors in case they were previously identified, based on the new situation.

## Article (32): Master's Degree Awarding Terms

Based upon the recommendation of the Department Council / the relevant program administration and the postgraduate Studies and Research Committee, the Faculty Council recommends awarding a Master of Science in Engineering degree if the student fulfills the following conditions:

**A-** The passage of at least four major academic semesters from the start of enrollment or a full academic year from the date of the registration approval of the research point. This is provided that the duration of time is not less than two academic years from the date of registration for the master's degree in accordance with the executive regulations of the Universities Organization Law.

**B-** The student's success in all academic courses with an average of no less than **2.7** points for one course, provided that he has obtained in at least one of the basic or advanced diploma courses a grade of $B^-$ or more (at least **2.7**) and a **GPA** of no less than **3.0**.

**C-** Accepting the dissertation from the Judging and Discussion Committee with the recommendation to award the degree in accordance with Article (**25**) of these regulations.

## Article (33): Registration Transfer

If the student does not achieve an overall grade of at least **3.0** in the average total of the courses upon completion of the required courses for Master of Science in Engineering, he may apply for transferring the registration to the Engineering Diploma (Basic and Advanced). The transfer is made upon the approval of the relevant department / program administration, the postgraduate Studies Committee and the Faculty Council and University Postgraduate and Research Council.

## (3) Doctor of Philosophy (PhD) (54 credit hours as a minimum)

Mansoura University, upon the proposal of the Faculty Council, grants the degree of Doctor of Philosophy (PhD) in Engineering (specialized or Interdisciplinary). The name of the scientific department / program, specialization, and the title of the dissertation shall be indicated in the certificate in both Arabic and English.

### Article (34): Doctor of Philosophy (PhD) Degree Registration

In order to be registered for the degree of Doctor of Philosophy (PhD) in Engineering Sciences, the following is required:

**A-** The general conditions mentioned in Article (**5**) of these regulations.

**B-** He must have a Master of Science Degree in Engineering (MSc) in an appropriate specialty from one of the engineering faculties in Egyptian universities, or any equivalent degree from the Supreme Council of Universities.

**C-** To successfully pass the entrance exam.

### Article (35): Acceptance Examination

The entrance examination is held twice a year at the level of specialization at dates that allow approval of the examination result before the registration closes for the main semester. The examination is written or oral, or both, provided that the duration of the written examination is four hours in the subjects specified in the bachelor's and master's stages (levels **400**, **500** and **600**).Each department forms the examination committee, sets the conditions for the examination and determines the required degree for admission, no less than (**B-**), and the committee's decision in the case of the oral examination is the result of the entrance examination.

### Article (36): PhD Degree Requirements

**A-** The enrolled student studies no less than **18** credit hours of doctoral courses, and these courses are approved by the Department Council and the Graduate Studies Committee. These courses are divided into **9** credit hours, basic courses of level **600** and **700** (research does not exceed the number of courses from the level of **600** than two courses maximum) and **9** credit hours of specialized courses from level **700**. The student is considered successful in the course if he obtains an average score of not less than **3.0** and obtains a grade of (B-) or more (at least **2.7**) in one course.

**B-** The department council / management of the specialized program may require that the student pass, before registering the point, some of the courses that the supervisors specify for him from within: the department's courses of the bachelor's level ,or level **500** ,or that are taught in other departments in the college or in one of the colleges of Mansoura University or Egyptian universities or recognized foreign universities. This is provided they do not exceed a total of twelve (**12**) accredited hours. These hours are not calculated for the student within the credit hours mentioned in Paragraph (**A**) of this article. They are not included in the calculation of the **GPA**, and these courses are necessary to complete the study and prepare the thesis.

**C-** The student passes the main courses in which he was registered during two major semesters up to three major semesters.

**D-** At success in the basic courses of the PhD, the student submits the initial research proposal and the department / program management council assigns him a principal supervisor according to the specialization of the research proposal.

**E-** The student, in coordination with the supervisor, selects advanced doctoral courses, which consist of **9** credit hours from the level of **700**, which can be selected from the courses offered at Mansoura University or any other university associated with it. After the student has successfully passed the academic courses and a GPA of no less than 3.0 (B) otherwise, the student must register for additional courses or repeat some courses to improve the average grade.

**F-** The first stage in academic research (12 credit hours) is based on collecting information about the study background, reviewing the literature on the subject of study, collecting data, and ending with a public lecture (seminar) that is governed by the comprehensive examination committee. A committee shall be formed for the comprehensive examination in the two areas of major and minor specialization, consisting of five members (professors, assistant professors, or those of their scientific level), provided that one of them is the supervisor (or supervisors) and two members in each of the main and subspecialized fields, provided that the committee has at least one member from outside The university and the formation of this committee shall be approved by the Graduate Studies Committee and the College Board after taking the opinion of the Academic Department Council / Program Administration.

**G-** The student passes the comprehensive examination (written and orally) with no less than **70%** success. In the event of failure to pass the comprehensive examination, the student is entitled to another opportunity after eight weeks, upon the request of the supervisors and the approval of the department / program administration council. The comprehensive examination aims to measure the student's academic background, the extent of his understanding of the major specialization topics and the supporting subspecialties, and his ability to engage in systematic practical research, analysis and conclusion, and proposing appropriate solutions to engineering problems in his field of specialization.

**H-** After the student passes the comprehensive exam, supervisors will be added to the student according to the required specializations. Then, the thesis topic is registered within a duration not exceeding **12** months from the date of submitting the research proposal to the department council / the relevant program administration, the graduate studies committee and the college council. It is approved by the Council of Postgraduate and Research on the condition that it succeeds in the basic and advanced courses of the PhD and obtains a grade of B- or more (**2.7** At least) with a cumulative average of no less than **3.0**.

**I-** The relevant department council may, upon a request from the supervisors, approve the modification of the research field during the doctoral study. This may be done with or without changing the supervisors, and that amendment is approved by the postgraduate studies and research Committee, the Faculty Council, and the Postgraduate and Research Council. This amendment does not result in prejudice to the time periods stipulated in Article (**12**) of these regulations.

**J-** In the second stage of academic research (12 credit hours) the results are analyzed and presented down to results and proposals, and it ends with a general seminar.

**K-** After the research stage in the general seminar, the student is given a period of no less than 3 months to work on writing the thesis including all components of the scientific and academic thesis and also to complete the procedures for international publication of research emanating from the academic research, provided that at least one of them is in a specialized scientific journal that is peer-reviewed and indexed. It has a coefficient of impact or a regular international conference (more than 10 times) and organized by one of the main societies in the field of specialization and that the arbitration is based on the whole research and the condition of acceptance for publication is essential for submitting the final message for discussion. This final stage of writing is equivalent to 12 credit hours, so that the total number of credit hours is the minimum The Doctor of Philosophy degree is 54 credits.

**L**- The student is given only two chances to pass the academic courses, the general lecture, and the comprehensive exam.

## Article (37): The Public Lecture

**A-** The student gives a public lecture on the proposal of the research topic before a committee of specialized professors and the public, after successfully passing the course exam.

**B-** The supervisors notify the relevant council of the date of the public lecture and announce it in a clear place in the college.

**C-** The supervisors submit to the relevant department council a report of the student's performance in the general lecture and the opinion of the specialized committee. The lecture is the general lecture and the comprehensive examination is equivalent to **12** credit hours.

## Article (38): Awarding PhD Degree Terms

Based upon the recommendations of the relevant department council and the College of Postgraduate Studies and Research Committee, the Faculty Council recommends granting a PhD degree in the event that the student meets the following conditions:

**A-** Success in doctoral courses according to Articles (**36**) of these bylaws.

**B-** Passing the comprehensive test according to Article (**36**) of these regulations.

**C-** Presenting the public lecture stipulated in Article (**37**).

**D-** Submitting evidence of publishing or accepting publication of at least two scientific papers extracted from the thesis according to Article (**36I**).

**E-** Acceptance of the dissertation, which is based on presenting new and innovative scientific research and represents an addition to knowledge in the field of specialization from the jury, discussion and recommendation for awarding the degree.

**F-** Four main semesters have passed from the date of approval by the University of Postgraduate Studies and Research Council to register the research point. This is provided that the duration is not less than three academic years from the date of registration for the PhD degree in accordance with the executive regulations of the Universities Organization Law.

## Article (39): Studying English Language

For students studying for the degrees of "Master of Science in Engineering" and "Doctor of Philosophy in Engineering Sciences", proof of passing the (TOEFL) international test in English must be submitted with a score of at least 450 for the master’s degree and at least 500 for the doctorate (or equivalent to this exam) Of the internationally recognized English language exams), before enrollment or within a year from the date of enrollment, otherwise the enrollment shall be canceled.

## Article (40): Mutual Programs with other Universities

It is permissible to grant certificates or joint academic degrees with other universities in the system of dual programs or joint programs in accordance with the regulations determined by the University Council.

## Article (41): Transitional Provisions

This regulation applies to students enrolled in postgraduate studies from the date of issuance of the ministerial decision approving this bylaw. As for the students enrolled before this date, the internal regulations and the followed rules that complement them shall apply to them before the approval of this bylaw or the settlement of their status and their transfer to the new one, and the equivalence of the courses that they have succeeded in according to Article **38** of these regulations based on the proposal of the relevant department council and the approval of the college council.

*Where this regulation is in both Arabic and English, the Arabic version shall prevail.*

# Chapter Two:

## General Competencies for Postgraduate Programs

# 1. Diploma of Engineering Science

## General Attributes of Engineering Science Diploma

**The graduate of any engineering science Diploma program must be able to:**

1. Apply specialized knowledge that he gained in the professional practice.
2. Identify and suggest solutions for the professional Problems.
3. Use modern devices, tools and computer programs in professional practices.
4. Communicate using different modes, tools and language with various audiences and lead team works effectively.
5. Take good decisions in different professional aspects.
6. Master the good employment of different available resources.
7. Recognize his/her role in developing community and preserving environment.
8. Demonstrate a commitment to integrity, credibility and the rules of the profession.
9. Recognize the importance of developing himself and involve in the continuous learning.

## Competencies of Diploma Engineering Graduate

**The Diploma engineering graduate must be able to:**

1. Identify, formulate and solve specific problems in his professional field.
2. Utilize the analytical reading for researches and subjects related to specialization and write technical reports.
3. Assess the risks of the professional practice and make career decisions according to available data.
4. Communicate effectively- graphically, verbally and in writing- with a range of audiences using contemporary tools.
5. Function efficiently as an individual and as a member of multi-disciplinary and multicultural teams.
6. Acquire and apply new knowledge; and practice self, lifelong and other learning strategies.

# 2. Master of Science in Engineering

## General Attributes of MSc. of Science in Engineering

1- Master the basics and methodologies of scientific research.
2- Apply and utilize the analytical methods in field of specialization.
3- Integrate the specialized knowledge with related knowledge and apply it in the professional practice.
4- Display awareness of the ongoing problems and modern visions in area of specialization.
5- Identify and create solutions for the professional Problems.

6- Acquire suitable areas of professional skills and use recent technologies to improve his professional practice.
7- Communicate and lead team works effectively.
8- Take good decisions in different professional aspects.
9- Employ the available resources and achieve the highest benefit.
10- Demonstrate awareness of his role in community development and environmental preservation under the global and regional variables.
11- Show model attitudes and professionalism.
12- Develop himself in the academic and professional fields and practice the continuous learning.

## Competencies of MSc. of Science in Engineering Graduate

**The MSc. engineering graduate must be able to:**

1. Identify, formulate and solve specific problems with the lack of data by integrating knowledge of different fields.
2. Asses and develop the methods and tools existing in the area of specialization.
3. Asses the risks in the field of specialization and plan to improve the performance.
4. Write and evaluate technical reports, carry out a research study and write a scientific study for research problem.
5. Use creative, innovative and flexible thinking and acquire entrepreneurial and leadership skills to anticipate and make good decisions in different professional aspects.
6. Communicate effectively- graphically, verbally and in writing- with a range of audiences using contemporary tools.
7. Function efficiently as an individual and as a member of multi-disciplinary and multicultural teams.
8. Acquire and apply new knowledge; and practice self, lifelong and other learning strategies.

# 3. PhD of Engineering Science

## General Attributes of Engineering Science PhD

**The graduate of any engineering science PhD program must be able to:**

1. Master the basics and methodologies of scientific research.
2. Add knowledge in the field of specialization continuously.
3. Appraise and utilize scientific knowledge to continuously update in the field of specialization and relevant basic sciences.
4. Acquire excellent level of the special knowledge with the related knowledge to deduce and develop the relations between them.
5. Demonstrate in depth awareness of the ongoing problems and the modern theories in the field of specialization

6. Identify and create solutions for the professional Problems.
7. Acquire in depth an understanding of common areas of professional skills in the field of specialization.
8. Function effectively to develop the methods, tools, and techniques for professional dealings.
9. Use recent technologies to improve his professional practice.
10. Demonstrate leadership competencies including interpersonal and communication skills.
11. Master decision making capabilities in different situation.
12. Employ the available resources effectively, develop them and find new resources.
13. Demonstrate awareness of his role in community development and environmental preservation
14. Show model attitudes and professionalism.
15. Develop himself continuously and transfer his knowledge and experience to others.

**Competencies of PhD Engineering Science Graduate**

**The PhD engineering graduate must be able to:**

1. Identify, formulate and solve professional problems according to the available data.
2. Asses and develop the methods and tools existing in the area of specialization.
3. Asses the risks in the field of specialization and plan to improve the performance.
4. Practice research techniques and methods of investigation leading to the creation of new knowledge.
5. Discuss in high level of confidence based on proofs and evidences, write and evaluate scientific papers and technical reports.
6. Use creative, innovative and flexible thinking and acquire entrepreneurial and leadership skills to anticipate and make good decisions in different professional aspects.
7. Utilize contemporary technologies, codes of practice and standards, quality guidelines, health and safety requirements to serve the professional practice.
8. Communicate effectively- graphically, verbally and in writing- with a range of audiences using contemporary tools.
9. Function efficiently as an individual and as a member of multi-disciplinary and multicultural teams.
10. Acquire and apply new knowledge; and practice self, lifelong and other learning strategies.

# Chapter Three:

## Mathematics and Engineering Physics Department

# Master of Engineering Mathematics Program

***Program description***

The engineering mathematics master's degree prepares students for careers in science and engineering, where advanced methods in differential equations, nonlinear optimization, statistics, and computational mathematics play a significant role in technology development and innovation.

***Competencies for the program graduate***

In addition to generic competencies for the M.Sc. in engineering, the graduate of Master of Science in Engineering Mathematics must be able to:

1. Develop mathematical models appropriate for their area of specialization, explain the underlying assumptions that were used in constructing a model, and understand the limitations of a particular model.
2. Identify and apply appropriate analytical and numerical methodologies for investigating a model and develop and implement suitable numerical algorithms, as needed.

# Ph.D. of Engineering Mathematics Program

***Program description***

The overall goal of the PhD program in engineering Mathematics is to educate and inspire students to be experts and leaders in the interdisciplinary areas of science and engineering focusing on the intersection of algorithms, applications, and data.

***Competencies for the program graduate***

In addition to generic competencies for the Ph. D. program, the graduate of Engineering science Ph.D. in Engineering Mathematics must be able to:

1. Construct and implement models and simulations of physical and engineering situations and use these models/simulations to understand experimental or observational data.
2. Apply discipline-focused or methodology-focused topics in computational and data science to solve problems in the student's application domain of choice.
3. Conduct significant original research and present it in peer-reviewed articles, a written dissertation, and orally in a variety of venues .

# Engineering Mathematics Program

## List of level (500) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| BAS511 | Mathematical Physics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS512 | Linear Algebra | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS513 | Functional Analysis | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| BAS514 | Numerical Analysis | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS521 | Partial Differential Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS522 | Real Analysis | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| BAS523 | Complex Analysis | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS531 | Integral Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS532 | Discrete Mathematics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS533 | Probability and statistics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |

## List of level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| BAS611 | Fractional Calculus and Fractional Differential Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS612 | Symmetry Analysis of Differential Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS613 | Analytical Methods of constructing Exact Solutions of Partial Differential Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS614 | Research point | 1 | 4 | 0 | 5 | 3 | 10 | - | 70 | 30 * | - | 100 |
| BAS615 | Selected Topics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS621 | Approximation Theory | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS622 | Approximation using B-spline | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BAS623 | Numerical Linear Algebra | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS624 | Numerical Analysis of Partial Differential Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS625 | Finite Element Analysis | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS626 | Measure Theory | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS627 | Asymptotic Methods for Solving Differential Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS628 | Differential Equations with Nonlocal Conditions | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS631 | Introduction to Operations Research and Optimization | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS632 | Probability and Stochastic Processes | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS633 | Introduction to Dynamical Systems | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS634 | Analytic Mechanics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS635 | Introduction to Quantum Mechanics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| *Discussion | | | | | | | | | | | | |

## List of level (700) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical Exam | Written Exam | Total |
| BAS711 | Difference Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS712 | First Integrals and Conservation Laws | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS713 | Integral Transforms and Their Applications | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS714 | Selected Advanced topic | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS715 | Mathematical Modeling | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS716 | Introduction to Fuzzy Differential Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS721 | Advanced Functional Analysis | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS722 | Approximation using Wavelet | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS٧23 | Sinc Approximation Methods | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS724 | Advanced Finite Element Analysis | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS725 | Computational Fluid Dynamics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS731 | Linear Analysis of Differential Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BAS٧32 | Partial Differential equations with Moving Boundary | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS733 | Numerical Solutions of Integral Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS734 | Nonlinear Optimization | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS735 | Stochastic Differential Equations | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| BAS٧3٦ | Advanced Quantum Mechanics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |

# Summary of Courses Specification

## Level 500

| Course title | *Mathematical Physics* | | | | Course Code | BAS511 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

System of ordinary differential equations- Series solution of ordinary differential equations- Special functions (Gamma, Beta, and Bessel)- Legendre, Laguerre and Hermite polynomials- Fourier series and Fourier Integral- Partial differential equations (linear partial differential equations of first order, Cauchy type differential equation, Nonlinear partial differential equations of first order)- Application of partial differential equation (Method of separation of variables, Solution of one dimensional heat equation, wave equation and Laplace's equation, Steady-state heat flow)- Nonhomogeneous linear partial differential equations.

***References:***


1. ***B. Borden, J. Luscombe, Mathematical Methods in Physics, Engineering, and Chemistry, John Wiley & Sons, 2019.***
2. ***Ramana B., Higher Engineering Mathematics, Tata McGraw-Hill, 2015.***


| Course title | *Linear Algebra* | | | | Course Code | BAS512 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Matrices– Matrix operations, Reduced Echelon Form, Matrix inverse– Solving systems of linear equations, Describing the Solution, Gaussian elimination– vector spaces, Subspaces and Spanning Sets, Linear Independence, Basis and Dimension, Change of Basis– Inner product, Norm, Distance, standard deviation, Projection, Orthogonality– Gram–Schmidt algorithm– Determinants, Properties of Determinants, The Permutation Expansion, Determinants as Size Function– Eigenvalues and eigenvectors– Positive definite matrices– Computations with matrices, Matrix-matrix multiplication, Composition of linear functions, Matrix power, QR factorization, Linear and affine functions– Solving least squares problems, Least squares data fitting.

***References:***

1. ***Gilbert Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press; Fifth Edition (2016)***
2. ***David C. Lay, Steven R. Lay, Judi J. McDonald, Linear Algebra and Its Applications, , Pearson; 5 edition ( 2015)***

| **Course title** | ***Functional Analysis*** | | | | **Course Code** | **BAS513** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Introduction to metric spaces, Examples of some metrics on different sets– Open Set, Closed Set, Neighborhood, Convergence in a Metric Space, Cauchy Sequence, Completeness, Completeness Proofs– Vector Space– Normed spaces– Banach spaces– Further Properties of Normed Spaces– Finite Dimensional Normed Spaces and Subspaces, Compactness and Finite Dimension– Bounded and Continuous Linear Operators, Linear Operators and Functionals on Finite Dimensional Spaces, Normed Spaces of Operators– Dual Space– Inner product space– Hilbert space, Orthogonal Complements and Direct Sums, Representation of Functionals on Hilbert Spaces, Hilbert-Adjoint Operator, Banach Fixed Point Theorem.

***References:***

1. ***Markin, Marat V, Elementary functional analysis , de Gruyter, 2018***
2. ***Hans Wilhelm Alt, Linear Functional Analysis: An Application-Oriented Introduction, , Springer; 1st ed. 2016***

| **Course title** | ***Numerical Analysis*** | | | | **Course Code** | **BAS514** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Taylor's Theorem– Difference equations– Roots of nonlinear equations, Bisection , Newton's , Secant, and Fixed point methods– Solution of systems of linear algebraic equations– Matrix Algebra– LU and Cholesky factorization– Iterative and direct methods– Polynomial interpolation and curve fitting– Divided difference– Cubic spline interpolation– Hermite interpolation– Trigonometric interpolation– Numerical differentiation– Numerical integration– Gaussian quadrature– Trapezoidal and Simpson rules– Romberg integration– Adaptive quadrature– Multiple integrals– Numerical solution of ordinary differential equations– Taylor series, Euler and modified Euler, Rung-Kutta, Multistep, Shooting methods.

***References:***

1. ***James F. Epperson, An Introduction to Numerical Methods and Analysis, John Wiley & Sons Canada, Limited,2021.***
2. ***Alejandro L. Garcia, Numerical Methods for Physics, Create Space Independent Publishing Platform; Second, Revised (Python) edition, 2017.***

<table>
<tr><td>Course title</td><td colspan="4">Partial Differential Equations</td><td>Course Code</td><td>BAS521</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***Contents***

Nonhomogeneous Problems (Nonhomogeneous terms independent of time, Eigen-function expansion method, Time-varying end conditions)- The potential equation in polar coordinates- problems in several dimensions (Derivation of two dimensional heat equation in cartesian coordinates, Double Fourier series, Rectangular coordinates, Cylindrical coordinates , Spherical coordinates)- Poisson’s equation- Transmission line equations- Traveling wave solutions of linear and nonlinear partial differential equations- Some solutions of ( Sine-Gordon equation, Burger Equation)- Exact solutions of Homogeneous first-order linear and quasi-linear partial differential equation

***References:***


1. ***V. Henner, T. Belozerova, A. Nepomnyashchy, Partial Differential Equations: Analytical Methods and Applications, CRC Press, 2019.***
2. ***Nakhle H. Asmar, Partial Differential Equations with Fourier Series and Boundary Value Problems: Third Edition, Courier Dover Publications, 2017.***


<table>
<tr><td>Course title</td><td colspan="4">Real Analysis</td><td>Course Code</td><td>BAS522</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***Contents***

Preliminaries– The real numbers– Sequences and series (Limit theorems, Monotone sequences, The cauchy criterion) – Limits– Continuous functions (Continuous functions on intervals, Uniform continuity, Monotone and inverse functions) – Differentiation (The derivative, The mean value theorem, L’hospital’s rules, Taylor’s theorem) – The Riemann integral (Riemann integra, Riemann integrable functions, The darboux integral, The fundamental theorem of integration, Approximate integration) – Sequences of functions (Pointwise and uniform convergence, The trigonometric functions) – Infinite series (Absolute convergence, Series of functions) – The generalized Riemann integral ( Definition, Main properties, Improper integrals, Lebesgue integrals, Convergence theorems).

***References:***


1. ***Christopher Heil, Introduction to Real Analysis, Springer, 2019.***
2. ***Agarwal R., Fluat C. O’Regan D.: An Introduction to Real Analysis, CRC Press, 2018.***

| Course title | *Complex Analysis* | | | | | Course Code | BAS523 |
|---|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | | Credit hours | 3 |
| | 2 | | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | | |

***Contents***

Complex Numbers and the Complex Plane, Polar Form of Complex Numbers, Complex functions and Linear mapping– Analytic Complex function, Cauchy-Riemann Equations, harmonic functions– Elementary Complex Functions – Complex integration in the Complex Plane, Cauchy-Goursat Theorem , Independence of Path of integration, Cauchy's Integral Formulas and their Consequences– Taylor and Laurent series– Residue theorem and its applications– Conformal mapping– Applications of harmonic functions, Two-dimensional mathematical models (steady state temperature, electrostatics, fluid flow)– The Schwarz—Christoffel transformation.

***References:***

1. ***Nakhlé H. Asmar , Loukas Grafakos , Complex Analysis: Theory and Applications, Springer; 1st ed. 2018 .***
2. ***Ian Stewart, David Tall Complex Analysis, Cambridge University Press,2018***

| Course title | *Integral Equations* | | | | | Course Code | BAS531 |
|---|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | | Credit hours | 3 |
| | 2 | | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | | |

***Contents***

Classification of integral equations— Converting Volterra equation to ODE, Converting IVP to Volterra equations, Converting BVP to Fredholm integral equations— Solution techniques of Volterra integral equations (successive approximations method, Laplace transform method, Successive substitutions method, Adomian decomposition method) — Fredholm integral equations (successive approximations method, successive substitutions method, Adomian decomposition method) — Nonlinear integral equations (The method of successive approximations, Picard's method of successive approximations, Adomian decomposition method) — Integro-differential equations , Volterra integro-differential equations (Series solution method, Decomposition method, Converting to Volterra integral equations, Converting to initial value problems) — Fredholm integro-differential equations (Direct computation method, Decomposition method, Converting to Fredholm integral equations).

***References:***

1. ***D.C. Sharma, M. C. Goyal, Integral Equations, PHI Learning Pvt. Ltd., 2017.***
2. ***Abdul-Majid Wazwaz, A First Course in Integral Equations, World Scientific, 2015.***

| **Course title** | ***Discrete Mathematics*** | | | | **Course Code** | **BAS532** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Sets and Subsets, Operations on Sets, Sequences, Division in the Integers, Mathematical structures— Logic, Propositions and logical operations— Methods of proof— Mathematical induction— Counting, Permutations, Combinations, Pigeonhole principle— Elements of probability— Recurrence relations— Relations and digraphs, Equivalence relations, Computer representation of relations and digraphs, Operations on relations— Transitive closure— Growth of functions— Order relations and structures— Finite Boolean— Trees, Minimal spanning trees— Topics in graph theory, Coloring graphs— Semigroups and groups— Languages and finite-state machines, Finite-state machines, Groups and coding.

***References:***


1. ***A. Raigorodskii, Michael Th. Rassias, Discrete Mathematics and Applications, Springer International Publishing, 2020***
2. ***Susanna S. Epp, Discrete Mathematics with Applications, Cengage Learning; 5 edition, 2019.***


| **Course title** | ***Probability and Statistics*** | | | | **Course Code** | **BAS533** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Review of basic probability concepts— Set theory— Counting analysis— Probability rules— Bay's rule— Independent events— Random variables— Types of random variable— Discrete probability distributions (Binomial— Multi-nomial, Poisson, Negative Poisson, Geometric and Hyper geometric distributions)— Continuous probability distributions( Uniform , Exponential , Normal, Gamma , Beta and t-distributions) — Moment generating functions— Multiple random variables— Joint distribution— Covariance and correlation coefficients— Independent random variable— Functions of random variables— Central limit theory— Sampling theory— Estimating theory— Test of hypotheses and significance— One tail and two tail tests— Introduction to stochastic processes.

***References:***


1. ***Sheldon Ross, A First Course in Probability, Pearson, 2018.***
2. ***Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press, 2020***

## Level 600

<table>
<tr><td>Course title</td><td colspan="4">Fractional Calculus and Fractional Differential Equations</td><td>Course Code</td><td>BAS611</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***Contents***

Special functions used in fractional calculus (Gamma, Beta, Mittag-Leffler, Wright, Minardi and hypergeometric functions) — Laplace transforms of some special functions— fractional derivatives and fractional integrals, Riemann-Liouville frctional integral and derivative, Weyl fractional derivative, Caputo fractional derivative, Grunwald-Letnikov fractional derivative— Laplace transforms of fractional derivatives and integrals— Fourier transform of fractional derivatives and integrals—, Laplace transform and Fourier transform methods for solving fractional ordinary and partial differential equations— Series solutions of fractional ordinary differential equations— Euler and Grunwald-Letnikov methods for obtaining numerical solutions of fractional ordinary differential equations.

***References:***

1. ***D. Baleanu, K. Diethelm, E. Scalas, J. J. Trujillo. Fractional Calculus: Models And Numerical Methods (Vol. 5). World Scientific, 2017.***
2. ***C. Milici, G. Drăgănescu, J. T. Machado, Introduction to fractional differential equations (Vol. 25), Springer, 2019.***

<table>
<tr><td>Course title</td><td colspan="4">Symmetry Analysis of Differential Equations</td><td>Course Code</td><td>BAS612</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***Contents***

Lie groups of transformations and infinitesimal transformations— Invariance of Differential Equations — Lie's invariance Condition for differential equations— Symmetry analysis of ordinary differential equations—Contact symmetries and higher-order symmetries— Fundamental connections between integrating factors and symmetries of differential equations— Symmetry analysis of system of ordinary differential equations— symmetry analysis of partial differential equations— Invariant solutions of partial differential equations— Relation between the travelling wave transformation and symmetry analysis of partial differential equations— symmetry analysis of system of partial differential — Nonclassical symmetries of partial differential equations and compatibility.

***References:***

1. ***Daniel J. Arrigo, An Introduction : Symmetry Analysis of Differential Equations, John Wiley & Sons,2015.***
2. ***M. Sajjad Hashemi, D. Baleanu, Lie Symmetry Analysis of Fractional Differential Equations, CRC Press,2020.***

| Course title | *Analytical methods for Constructing Exact Solutions of Partial Differential Equations* | | | | Course Code | BAS613 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

The tanh methods— (G'/G) – expansion method— $\exp(-\Phi(\eta))$ expansion method— The functional variable method method— Elliptic functions and integrals— The simplest equation method— Integral bifurcation method— Equivalence between (G'/G) – expansion method and the tanh method— Equivalence between $\exp(-\Phi(\eta))$ expansion method and the tanh method—Non-traveling wave solutions of variable coefficient partial differential equations— Invariant subspace method for solving partial differential equations— Invariant subspace method for solving partial differential difference equations— Painleve analysis of ordinary differential equations, Painleve analysis of partial differential equations.

***References:***


1. ***Andrei D. Polyanin, Valentin F. Zaitsev, Handbook of Nonlinear Partial Differential Equations, Second Edition, CRC Press, 2016.***
2. ***Robert Conte, Micheline Musette, The Painlevé Handbook, Springer International Publishing, 2020.***


| Course title | *Research point* | | | | Course Code | BAS614 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 4 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 30 | 0 | 70 | - | | |

***Contents***

The student selects a research point in the field of engineering mathematics according to the department research plan.

***References:***

***According to selected research point.***

| Course title | *Selected topics* | | | | Course Code | BAS615 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

A study of some advanced special topics not covered by the regular courses in a branch of mathematics preferably related to the students' research topic.

***References:***

***According to the specific field.***

| Course title | *Approximation Theory* | | | | Course Code | BAS621 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

The approximation problem and the existence of best approximations— The uniqueness of best approximations— Approximation operators and some approximating functions— Polynomial interpolation— Divided differences— The uniform convergence of polynomial approximations— Best approximation in $C[a,b]$ — Chebyshev polynomials— Approximation in $L_1$ and $L_2$— The theory of minimax approximation— Least squares approximation— Properties of orthogonal polynomials— Approximation to periodic functions— The order of convergence of polynomial approximations— Interpolation by piecewise polynomials— Convergence properties of spline approximations— Natural and perfect splines— Optimal interpolation.

***References:***

1. ***Naokant Deo, Vijay Gupta, Ana Maria Acu, P. N. Agrawal, Mathematical Analysis I: Approximation Theory, Springer Nature, 2020.***
2. ***Lloyd N. Trefethen, Approximation Theory and Approximation Practice, Extended Edition, SIAM, 2019***.

| Course title | *Approximation using B-spline* | | | | Course Code | BAS622 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Introduction to Spline (Definitions and Properties of Spline and B-Spline) — Two point boundary value problems (linear and nonlinear) — Higher-Order Boundary Value Problems (linear and nonlinear) — Partial differential Equations (linear Heat and Wave equations, Nonlinear equations) — Integral, integro-differential equations (Fredholm and Volterra) — Higher-order Sturm-Liouville, Biharmonic problems— Triharmonic boundary-value problems— Navier–Stokes- Wiener–Hopf Equations— parabolic and hyperbolic partial differential equation with nonlocal boundary conditions— The time-dependent Emden-Fowler-type equations.

***References:***

1. ***Klaus Hollig, Jorg Horner, Approximation and Modeling with B-Splines, SIAM, 2015.***
2. ***El-Gamel M. and El-Shamy N.: B-spline and singular higher-order boundary value problems, SeMa J. 73(2016) 287-307.***

| Course title | *Numerical Linear Algebra* | | | | Course Code | BAS623 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Tridiagonal Systems— Symmetric Positive Definite Matrices— The Cholesky Decomposition— The Singular Value Decomposition (SVD)— Using the SVD to determine properties of a matrix— SVD and matrix norms— Geometric interpretation of the SVD— Review of the QR decomposition using Gram-Schmidt— The algebraic eigenvalue problem— Computation of selected eigenvalues and eigenvectors— Transformation to upper Hessenberg form— Schur's triangularization— Computing both eigenvalues and their corresponding eigenvectors— Sensitivity of eigenvalues to perturbations— Error estimation, Stability and conditioning— Direct and iterative methods for solving linear systems of algebraic equations— Some methods for large sparse systems— Methods for large dense systems.

***References:***


1. ***William Layton, Myron Mike Sussman, Numerical Linear Algebra, World Scientific, 2020.***
2. ***Larisa Beilina, Evgenii Karchevskii, Mikhail Karchevskii, Numerical Linear Algebra: Theory and Applications, Springer International Publishing AG, 2017.***


| Course title | *Numerical Analysis of Partial Differential Equations* | | | | Course Code | BAS624 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents:***

Classification of partial differential equations — Verification and validation— Finite difference method, Difference approximations and truncation errors— Application of boundary conditions— Matrix form— Multidimensional problems— Stability and convergence— Eigenvalues and condition number— Multigrid method — Parabolic partial differential equations— The advection reaction diffusion equation— Von Neumann stability— Explicit and implicit solutions , elliptic and hyperbolic partial differential equations— Finite element method— Strong form— Weak form— Sobolev spaces— Convergence analysis— The spectral method— Spectral method based on Fourier series, Discrete Fourier series and Chebyshev polynomials.

***References:***


1. ***Vitoriano Ruas, Numerical Methods for Partial Differential Equations: An Introduction, John Wiley & Sons, 2016.***
2. ***Martin J. Gander and Felix Kwok, Numerical Analysis of Partial Differential Equations Using Maple and MATLAB , SIAM, 2018.***

<table>
<tr><td>Course title</td><td colspan="4">Finite Element Analysis</td><td>Course Code</td><td>BAS625</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***<u>Contents</u>***

A direct physical approach to finite element method— Problems in linear elasticity and fields— the standard discrete system and origins of the finite element method— Weak forms and finite element approximation: 1-D problems— Variational forms and finite element approximation: 1-D problems— Field problems: Multidimensional finite element method, Shape Functions, Derivatives, and Integration— Elasticity: Two- and Three-dimensional finite elements, The patch test, Reduced integration, and Nonconforming elements— The time dimension: Semi-discretization of field and dynamic problems, Errors, Recovery Processes and Error Estimates— Adaptive finite element refinement.

***<u>References:</u>***

1. ***I. Koutromanos, Fundamentals of Finite Element Analysis: Linear Finite Element Analysis, Wiley, 2018.***
2. ***Singiresu Rao, The Finite Element Method in Engineering, , Butterworth-Heinemann, 2018.***

<table>
<tr><td>Course title</td><td colspan="4">Measure Theory</td><td>Course Code</td><td>BAS626</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***<u>Contents</u>***

History of Measure Theory— Lebesgue measure, Lebesgue integral— Abstract measure spaces— Some elements of the classical measure theory— Paradoxes in measure theory— Modes of convergence— Differentiation theorems— Outer measures— Pre-measures and product measures— Convergence theorems for set functions— One-dimensional diffusions and their convergence in distribution— Vector integration in Banach spaces and application to stochastic integration— Riesz theorem— Density topologies— Geometric measure theory: Selected concepts, Results and problems, Measures on algebraic-topological structures, Ergodic theory, Generalized derivatives, Real valued measurability, Some Set-Theoretic Aspects.

***<u>References:</u>***

1. ***Vladimir Kadets, A Course in Functional Analysis and Measure Theory, Springer, 2018.***
2. ***Piermarco Cannarsa, Teresa D'Aprile, Introduction to Measure Theory and Functional Analysis, Springer, 2015.***

<table>
<tr><td>Course title</td><td colspan="4">Asymptotic Methods for Solving Differential Equations</td><td>Course Code</td><td>BAS627</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***Contents***

Asymptotic expansions for definite integrals with small or large parameters— Laplace's method for definite integrals— Watson's Lemma, generalization for functions defined by contour integrals— Steepest descent method applications— Regular asymptotic expansions for functions depending on a small parameter— Solution of ordinary and partial differential equations with small parameters— Singular perturbation methods— Notion of the boundary layer method— Inner and outer solutions— Matching of the asymptotic expansions— Ordinary differential equations with singular perturbations— method of multiple scales— WKB Method.

***References:***


1. ***David Y. Gao, Vadim A. Krysko, Introduction to Asymptotic Methods, Taylor & Francis Limited, 2019.***
2. ***Alan W. Bush, Perturbation Methods for Engineers and Scientists, CRC Press LLC, 2019.***


<table>
<tr><td>Course title</td><td colspan="4">Differential Equations with Nonlocal Conditions</td><td>Course Code</td><td>BAS628</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***Contents***

Difference schemes— differential operator— Homogenous difference schemes with variable coefficients— Difference Green's function— Difference scheme for elliptic equations— Stability and convergence of Dirichlet difference problem— Time dependent equations with constant coefficients— Heat conduction equation with spatial variables— Stability theory of difference schemes— Operator difference schemes— Classes of stable two layer schemes— stable three layer schemes— Heat conduction equation with variable coefficients— Two point nonlocal conditions— Integral boundary conditions— Interface problem— System of difference equations— Elliptic and parabolic partial differential equation— Eigenvalue problem.

***References:***


1. ***Ronald E. Mickens, Nonstandard Finite Difference Schemes: Methodology and Applications, World Scientific Publishing Company, 2020.***
2. ***Qiang Du, Nonlocal Modeling, Analysis, and Computation, SIAM, 2019.***

| Course title | *Introduction to Operations Research and Optimization* | | | | Course Code | BAS631 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Operations research models— Solving the OR model— Queuing and simulation models— Modeling with linear programming— Graphical LP Solution— The simplex method and sensitivity analysis— Artificial starting solution— Computational issue in linear programming— Duality and post-optimal analysis— Transportation model— The assignment model— Network models— Minimal spanning tree algorithm— Shortest-route applications— Advanced linear programming— A Goal programming formulation— Integer linear programming — Heuristic and constraint programming , Metaheuristics , Application of metaheuristics to integer linear programs— Introduction to constraint programming— Deterministic dynamic programming— Deterministic inventory models , Introduction to nonlinear programming.

***References:***


1. ***Hamdy A. Taha, Operations Research: An Introduction , Pearson; 10 edition, (2016).***
2. ***Igor Griva, Stephen G. Nash, Linear and Nonlinear Optimization,, Orient Blackswan PVT Limited, (2017).***


| Course title | *Probability and Stochastic Processes* | | | | Course Code | BAS632 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Conditional Probability— Bayes' formula— Independent events— Introduction to random variables, Discrete random variables, Continuous random variables, Multiple random variables, Some special distributions— Moment generating function and characteristic function— Statistical estimation, Hypothesis testing, Correlation and regression, Analysis of variance— Introduction to stochastic processes, A brief introduction to: Point process— Counting process— Renewal rocess— Regenerative process— Poisson process— Markov chains— Brownian motion— Gaussian process— white noise process— Introduction to stochastic differential equations.

***References:***


1. ***P. Brémaud, Probability theory and stochastic processes, Springer, 2020.***
2. ***E. Bas, Basics of probability and stochastic processes, Springer, 2019.***

| **Course title** | ***Introduction to Dynamical Systems*** | | | | **Course Code** | **BAS633** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Free oscillators, Linear and nonlinear pendulum— Phase space and phase portraits, Fixed points, Stability, Liouville's theorem and conservation of areas in phase space— Van der Pol equation— Limit cycles— Forced pendulum— Resonance— Introduction to bifurcation theory, Saddle-node and Hopf bifurcation— Methods for analyzing periodic, Quasiperiodic and aperiodic systems— Poincare sections— Floquet matrices— Maps— Reduction of flows to maps— Strange attractors, Dissipation, Derivation of Lorenz attractor, Stability of Lorenz equations, Henon attractor, Quantitative analysis of strange attractors— Lyaponov exponents— Fractal dimension— Normal form theorem.

***References:***


1. ***S. H. Strogatz, Nonlinear dynamics and chaos with applications to physics, biology, chemistry, and engineering., CRC Press; 2 edition (2018).***
2. ***J. D. Meiss, Differential dynamical systems , SIAM-Society for Industrial and Applied Mathematics; Revised Edition (2017).***


| **Course title** | ***Analytic Mechanics*** | | | | **Course Code** | **BAS634** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Newton's laws of motion— Mechanical oscillations, Two-dimensional oscillators, Deriven damped oscillations— Conservation of energy and momentum— The calculus of variations, The Euler- Lagrange equation, Applications of the Euler- Lagrange equation— Lagrangian dynamics, Lagrange's equations, Generalized momenta and ignorable coordinates, Constraints and Lagrange's $\lambda -$ method, Non-holonomic constraints, Virtual work— Hamiltonian mechanics, Hamilton's canonical equations, Hamilton's equations for one-dimensional systems, Hamilton's equations for two-dimensional systems, Ignorable coordinates— Canonical transformations, Integrating the equations of motion, Poisson brackets, Hamilton-Jacobi theory.

***References:***


1. ***Samya Zain, Classical Mechanics: From Lagrangian to Newtonian Mechanics, Institute of Physics Publishing, 2019.***
2. ***P. C. Deshmukh, Foundations of Classical Mechanics, Cambridge University Press, 2019.***

| Course title | *Introduction to Quantum Mechanics* | | | | Course Code | BAS635 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Postulates of quantum mechanics— Operators, Eigen functions and Eigenvalues— Function Spaces— Dirac Formulation— Wave function— Time independent Schrodinger equation— Angular Momentum— Spin— Perturbation Theory— Variational Principle— The WKB approximation— Scattering— Time dependent Schrodinger equation— Stationary states— The free particle— Zeeman effect— The adiabatic theorem— Berry's phase— The Density Matrix— The Probability Density— The Coulomb interaction— Large order behavior of perturbation expansions— Properties of Jacobian elliptic function— The Liouville equation in classical mechanics— The Liouville equation in quantum mechanics— Two time correlation functions— Statistical operators— Quadratic Hamiltonians and their application— Tunneling— Superposition principle— Pauli spin matrices— Stark Effect.

***References:***


1. ***David Griffith, Darrell F. Schroeter, Introduction to Quantum Mechanics , Cambridge university Press, 2018.***
2. ***Leo P. Kadanoff, Quantum Statistical Mechanics, CRC Press, 2018.***


# Level 700

| Course title | *Difference Equations* | | | | Course Code | BAS711 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Difference calculus— Relationship between linear difference and differential equations— First order difference equations— Fundamental theorems for homogeneous linear difference equations— Inhomogeneous linear difference equations: method of undetermined coefficients and operator methods, Z-transform method— Systems of Linear ordinary difference equations— Linear partial difference equations: Lagrange's and separation-of-variables methods, simple symmetry methods for ordinary difference equations, extensions of basic symmetry methods, lattice transformations, some solution methods for partial difference equations and fractional difference equations— conservation laws for difference equations— Applications of difference equations.

***References:***


1. ***Ronald E. Mickens, Difference Equations: Theory, Applications and Advanced Topics, CRC Press, 2015***
2. ***Decio Levi, Raphaël Rebelo, Pavel Winternitz, Symmetries and Integrability of Difference Equations, Springer, 2017***

| **Course title** | *First Integrals and Conservation laws* | | | | | **Course Code** | **BAS712** |
|---|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | | |

***Contents***

Integrating factors for first-order differential equations— Integrating factors for nonlinear higher-order ordinary differential equations— Linearization of nonlinear ordinary differential equations— Equivalence transformation— Noether theorem— Adjoint equations to nonlinear differential equations— Symmetry of adjoint equations— Self-adjoint equations— Quasi-self-adjoint equations— Nonlinear self-adjoint equations— Lagrangians of differential equations— Non-local conservation laws— Construction of conservation laws using symmetries of differential equations— Partial Lagrangian— Symmetry analysis methods— Characteristic method— first integral of nonlinear ordinary differential system— direct method for First integral of nonlinear ordinary differential equation.

***References:***


1. ***Costas J. Papachristou, Aspects of Integrability of Differential Systems and Fields, Springer International Publishing, 2019***
2. ***P.G.L. Leach, Andronikos Paliathanasis, Noether's Theorem and Symmetry, MDPI, 2020***


| **Course title** | *Integral Transforms and Their Applications* | | | | | **Course Code** | **BAS713** |
|---|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | | |

***Contents***

Fourier transforms and their applications— Multiple Fourier transforms and their applications: Solutions of partial differential equations— Fourier cosine and sine transforms with applications— Laplace transforms and its applications: Solutions of integral equations, Solutions of difference and differential- difference equations— Applications of the joint Laplace and Fourier transforms— The double Laplace transforms with applications— Hankel transforms and their applications— Mellin transforms and their applications— Finite Fourier sine and cosine transforms and their applications— Finite Laplace transforms and their applications— Finite Hankel transforms and their applications.

***References:***


1. ***L. Debnath, D. Bhatta, Integral Transforms and Their Applications, CRC Press, Third edition, 2015***
2. ***Alexander D. Poularikas, Transforms and Applications Handbook, CRC Press, Third edition , 2018.***

| Course title | *Selected Advanced Topic* | | | | Course Code | BAS714 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

A study of some advanced special topics not covered by the regular courses in a branch of mathematics preferably related to the students' research topic

***References:***

***According to the specific field.***

| Course title | *Mathematical Modeling* | | | | Course Code | BAS715 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Basic concepts of mathematical modeling— Elementary mathematical models— Derivation of models using fundamental laws of nature: Conservation of the mass of substance, Conservation of energy, Conservation of the number of particles— Joint application of several fundamental laws— Models reduced from variational principles— Equations of motion— Variational principles and conservation laws in mechanics— Models from heat transfer— electrical circuits, biology and fluid mechanics — Study of the mathematical models— Dimensional analysis— Similarity variables— Nondimensionalization and Scaling— Perturbation methods.

***References:***

1. ***A.A. Samarskii, A.P. Mikhailov, Principles of Mathematical Modeling, CRC Press, 2018.***
2. ***Mark H. Holmes, Introduction to the Foundations of Applied Mathematics, Springer International Publishing, 2019***

| Course title | *Introduction to Fuzzy Differential Equations* | | | | Course Code | BAS716 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Fuzzy numbers and sets— Fuzzy arithmetic— Fuzzy functions— Fuzzy linear algebraic equations— Systems of fuzzy linear equations— Fuzzy differential equations— Fuzzy initial conditions— Analytical methods for solving fuzzy differential equations: Fuzzy center-based method, Method based on addition and subtraction of fuzzy numbers, Fuzzy center and fuzzy radius-based method, Double parametric-based method— Numerical methods for solving fuzzy differential equations: Euler-type methods, Max-Min Euler method, Average Euler method— Weighted residual methods— Collocation- type method— Galarkin- type method— The Adomian decomposition method.

***References:***


1. ***S. Chakraverty, S. Tapaswini & D. Behera, Fuzzy differential equations and applications for engineers and scientists. CRC Press, 2016.***
2. ***S. Chakraverty, S. Tapaswini & D. Behera. Fuzzy arbitrary order system: fuzzy fractional differential equations and applications. John Wiley & Sons., 2016.***


| **Course title** | ***Advanced Functional Analysis*** | | | | **Course Code** | **BAS721** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Zorn's lemma— Hahn-Banach theorem— Application to bounded linear functionals on C[a, b] — Riemann-Stieltjes integral— Adjoint operators— Reflexive spaces— Category theorem— Uniform boundedness theorem— Strong and weak convergence— Convergence of sequences of operators and functionals— Numerical integration and weak* convergence— Open mapping theorem— Closed linear operators— Closed graph theorem— Spectral theory of linear operators in normed spaces— Properties of resolvent and spectrum— Compact linear operators on normed spaces— Sequence of compact linear operators— Spectral properties of compact linear operators on normed Spaces.

***References:***


1. ***Eberhard Malkowsky, Vladimir Rakočević, Advanced Functional Analysis, CRC Press, 2019.***
2. ***Oleg G. Smolyanov, Vladimir I. Bogachev, Real and Functional Analysis, Springer Nature, 2020.***


| **Course title** | ***Approximation using Wavelet*** | | | | **Course Code** | **BAS722** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Introduction to wavelet (definitions and properties) – Types of wavelet (Haar wavelet and wavelet Galerkin methods) – Wavelet solution of Second order boundary value problems- Higher-order boundary value problems (linear and nonlinear) – Wavlet solution of Partial Differential Equation, Partial Integro-differential equations, System of Partial Differential Equations- The clamped plate eigenvalue problem- Biharmonic problems- Triharmonic boundary-value problems and Helmholtz equation, Nonlinear population density problem- Navier–Stokes- Wiener–Hopf equations, parabolic and hyperbolic partial Differential Equation with nonlocal boundary conditions, Higher order Sturm-Liouville problems.

***References:***


1. ***Lokenath Debnath, Firdous A. Shah, Lecture Notes on Wavelet Transforms, Birkhäuser, 2017.***
2. ***Lubos Pick, Alois Kufner, Oldřich John, Svatopluk Fucík, Vit Musil, Function Spaces, Walter de Gruyter GmbH, 2021.***

<table>
<tr><td>Course title</td><td colspan="4">Sinc Approximation Methods</td><td>Course Code</td><td>BAS723</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***Contents***

Introduction and Summary ( Analytic functions, Conformal mapping, Fourier series) — Sinc Interpolation— Sinc Quadrature— Numerical methods (Sinc-collocation, Sinc Convolution , sinc-Galerkin method) — Sinc solution of linear and nonlinear ODEs— Steady problems— Time-dependent problems— Solutions of PDEs via Sinc–Pack — Possion - Wave equation –Helmholtz equation- Nonlinear population density problem- Navier–Stokes- Wiener–Hopf equations— Parabolic partial differential equations with nonlocal boundary conditions— Higher order Sturm-Louville problems— Partial integero-differential equations— The clamped plate eigenvalue problem— Triharmonic boundary-value problems— Biharmonic problems.

***References:***

1. ***Frank Stenger, Handbook of Sinc Numerical Methods, CRC Press, 2016.***
2. ***El-Gamel M. and Abd El-Hady M. On using sinc-collocation approach for solving a parabolic PDE with nonlocal boundary conditions, J. Nonlinear Sci Appl. 14 (2021) 29-38.***

<table>
<tr><td>Course title</td><td colspan="4">Advanced Finite Element Analysis</td><td>Course Code</td><td>BAS724</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

***Contents***

Integral formulation and variational methods— Finite element analysis for one dimension and higher dimensions— Finite element error analysis— Patch test and incompatible Elements— Quadrilateral element with additional bending shape functions— Equations of elasticity in cylindrical coordinates— Multifield formulations for beam elements— Multifield formulations for analysis of elastic solids eigenvalue and time-dependent problems— Mixed formulation for nearly incompressible solids— Weak form for displacement-based formulation— Interpolation of functions— Numerical integration— Incompressible viscous and viscoelastic fluids— Numerical challenges of flow equations— Petrov-Galerkin formulations.

***References:***

1. ***J. N. Reddy, An introduction to the finite element method, , fourth edition, McGraw Hill Professional, 2018***
2. ***Darrell W. Pepper, The Intermediate Finite Element Method: Fluid Flow And Heat Transfer Applications, Routledge, 2017***.

| Course title | *Computational Fluid Dynamics* | | | | Course Code | BAS725 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Introduction to CFD, Development, Application, and Analysis— Essentials of Fluid Dynamics and Heat Transfer for CFD— Essentials of Numerical Methods for CFD— CFD for a Cartesian Geometry— Computational Heat Conduction— Computational Heat Advection— Computational Heat Convection— Computational Fluid Dynamics, Physical Law based Finite Volume Method— CFD for a Complex Geometry— Computational Fluid Dynamics on a Curvilinear Grid— Components of a CFD the simulation system— Mathematical models for fluid flow, Mathematical nature of the flow equations— Finite element method— The analysis of the numerical scheme— Time integration methods— Application to inviscid and viscous flows.

***References:***

1. ***Charles Hirsch, Numerical Computation of Internal and External Flows, Volume 2: Computational Methods for Inviscid and Viscous Flows, Butterworth-Heinemann, 2019.***
2. ***D. Anderson, John C. Tannehill, Richard H. Pletcher, R. Munipalli, V. Shankar, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis Group, 2020***.

| Course title | *Linear Analysis of Differential Equations* | | | | Course Code | BAS731 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Qualitative analysis for autonomous ordinary differential equation and systems of autonomous ordinary differential equations— Classifying equilibrium points and bifurcation points and Phase plane analysis in describing different solutions for systems— Linear stability analysis in partial differential equations (class of reaction diffusion systems) — Stability of propagating fronts in certain classes of differential equations— Modulation instability in differential equations and computing the gain— Minimal speed of front solutions— Patterned and uniformly translated front solutions in PDE— Introduction to pattern formation in PDEs (Turing Phenomenon).

***References:***

1. ***C.G. Lambe, C.J. Tranter, Differential Equations for Engineers and Scientists, Courier Dover Publications, 2018.***
2. ***Ching Shan Chou, Avner Friedman, Introduction to Mathematical Biology: Modeling, Analysis, and Simulations, Springer, 2016***

| **Course title** | ***Partial Differential Equations with Moving boundary*** | | | | **Course Code** | **BAS732** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Modeling of moving boundary problems, Single phase, Two phase— Classical Stefan problem— Nonlinear heat parameters— Linearized forms— Density change and convection— Multi-phase problems— Modeling of free boundary problems— classical formulation— Stream function— Formulation on fixed domain— Numerical techniques— Fixed finite difference grid— Variable time step— variable space grid— Finite elements— Method of lines— Front fixed methods— One dimensional problems— Body fitted curvilinear coordinates— Fixed domain method— Enthalpy method— Weak solutions— Explicit finite difference— Alternative forms— One phase Stefan problem— Two phase Stefan problem— Inverse Stefan Problems— Semi analytic method.

***References:***


1. ***William Schiesser, Moving Boundary PDE Analysis: Biomedical Applications in R, CRC Press, 2019***
2. ***S.C. Gupta, The Classical Stefan Problem: Basic Concepts, Modelling and Analysis with Quasi-Analytical Solutions and Methods, Elsevier, 2017***


| **Course title** | ***Numerical Solutions of Integral Equations*** | | | | **Course Code** | **BAS733** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Numerical Solution of Fredholm Integral Equations of the Second Kind— Projection methods (Collocation methods, Galerkin methods, Piecewise linear collocation, Trigonometric polynomial collocation, Piecewise linear Galerkin method, Galerkin method with trigonometric polynomials , The Nystrom method) — Numerical Solution of Singular Integral equations (Product integration method, The relationship of product integration and collocation methods) — Numerical solution of Volterra integral equations of the second kind (Nystrom and collocation method) — Numerical Solution of Volterra integral equations of the first kind (Nystrom method) — Numerical Solution of mixed integral equations of the second kind (Nystrom method) — Numerical solution of Fredholm integro-differential equations .

***References:***


1. ***Abdul-Majid Wazwaz, A First Course in Integral Equations, World Scientific, 2015.***
2. ***Hermann Brunner, Volterra Integral Equations: An Introduction to Theory and Applications, Cambridge University Press, 2017***

| Course title | *Nonlinear Optimization* | | | | Course Code | BAS734 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Unconstrained optimization, Optimality Conditions for Unconstrained Optimization— Gradient methods— Descent Directions Methods— Newton's method— Optimization over a convex set— Convex and concave Functions— directional derivative and subgradients— Quasi-convex and quasi-concave Functions— Optimality Conditions for Linearly Constrained Problems— Lagrange multiplier theory— Inequality Constraints— Lagrange Multiplier algorithms— Barrier and interior point methods— Penalty and augmented Lagrangian methods— Lagrange Multipliers with Optimal Sensitivity Properties— Sequential quadratic programming— Duality and convex programming— Dual methods— Scalarization methods— No-preference methods— Posteriori and priori methods, Interactive methods.

***References:***

1. ***Dimitri Bertsekas, Athena Scientific, Nonlinear Programming, 3rd edition , 2016.***
2. ***Richard W. Cottle, Mukund N. Thapa, Linear and Nonlinear Optimization, Springer, 2017***

| Course title | *Stochastic Differential Equations* | | | | Course Code | BAS735 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Classifications of Stochastic Differential Equations— Stochastic processes— Gaussian processes— white noise processes— Introduction to Itô calculus— Construction of the Itô integral— Explicit solutions to stochastic differential equations— Continuity in mean square sense— Differentiability in mean square sense— Solving stochastic differential equations in the mean square sense— Existence and uniqueness of the solution process— Introduction to the methods of solving stochastic differential equations includes an introduction to: Adomian decomposition method , Stochastic finite element method Mont Carlo simulation, Wiener Hermit expansion , Wiener Chaos expansion, Chaos polynomial generation, Statistical moments of the solution process.

***References:***

1. ***Carlos A. Braumann, Introduction to Stochastic Differential Equations with Applications to Modelling in Biology and Finance, Wiley, 2019***
2. ***S. Sarkka , A. Solin, Applied Stochastic Differential Equations, Cambridge University Press, 2019.***

| Course title | *Advanced Quantum Mechanics* | | | | Course Code | BAS736 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

***Contents***

Entanglement— Boson operators, Wick's theorem for Boson operators— Density operators— Solution of Schrodinger equation by normal ordering driven harmonic oscillators— Quantization of electromagnetic field— Interaction of radiation with matter— Quantum theory of damping (Langevin approach) — Time dependent Green's functions— Quantum cryptography— Quantum jumps— Bell inequality— Stochastic processes in quantum mechanics— Entanglement of mixed states— Quantum information— Quantum Entropy— No-Cloning theorem— Quantum Computation— Quantum teleportation— Jaynes-Cummings Model— Scattering theory— Born approximation— Feynman graphs, Feynman rules of calculations— Reduction of an operator to normal form— The Hamiltonian operator— Quantum theory of Laser— Statistical properties of Laser— Fokker Planck equation of Laser— Resonance fluorescence— Raman scattering— Propagation of light in vacuum— Hamiltonian of an atom in a radiation field— Solution of Fokker Planck equation.

***References:***

1. ***David Griffith, Darrell F. Schroeter, Introduction to Quantum Mechanics , Cambridge university Press, 2018.***
2. ***Leo P. Kadanoff, Quantum Statistical Mechanics, CRC Press, 2018.***

# Master of Engineering Physics Program

## Program description

The objective of the master's degree program in engineering physics is to produce graduates that able to enter the workforce and perform as productive, professional, ethically aware professionals in areas where traditional science and engineering disciplines overlap.

## Competencies for the program graduate

In addition to generic competencies for the M.Sc. in engineering, the graduate of Master of Science in Engineering Physics must be able to:

1- apply scientific and engineering principles to solving multidisciplinary problems in technological areas associated with Modern Physics.

2- Assimilate and synthesize existing knowledge in a specialized subfield of engineering physics and to critically analyze and evaluate research, their own and that of others in the field.

# Ph.D. of Engineering Physics Program

## Program description

Engineering physics Ph.D. program deals with the application of advanced physics to modern engineering challenges.

## Competencies for the program graduate

In addition to generic competencies for the Ph. D. program, the graduate of Engineering science Ph.D. in Engineering Physics must be able to:

1- Solve specific problems based on limited and contradictory information.
2- Participate in research development and innovation to create new knowledge.
3- Discuss in high level of confidence based upon proofs and evidences.

# List of level (500) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marking | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| BAS541 | Mathematical Physics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| BAS551 | Quantum Mechanics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 40 | 10 | 50 | 100 |
| BAS552 | Solid state physics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 40 | 10 | 50 | 100 |
| BAS553 | Atomic physics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 40 | 10 | 50 | 100 |
| BAS542 | Statistical Mechanics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| BAS561 | Optical electronics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS543 | Nuclear physics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 40 | 10 | 50 | 100 |
| BAS544 | Introduction to biophysics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 40 | 10 | 50 | 100 |
| BAS545 | Fundamental of Plasma physics | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 40 | 10 | 50 | 100 |
| BAS546 | Experimental physics | 2 | 0 | 3 | 5 | 3 | 6 | 2 | 30 | 20 | 50 | 100 |
| BAS547 | Computational physics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| BAS548 | Physics of Solar Cells | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 40 | 10 | 50 | 100 |

## List of level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marking | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| BAS651 | Advanced quantum mechanics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS652 | Applied Solid state physics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS641 | Advanced statistical mechanics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| BAS661 | Applied optics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS642 | Computational electromagnetics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| BAS643 | Applied mathematics | 2 | 2 | 0 | 4 | 3 | 10 | 3 | 50 | 0 | 50 | 100 |
| BAS662 | Photonics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS644 | Research point | 1 | 4 | 0 | 5 | 3 | 10 | - | 70 | 30 * | - | 100 |

*** Discussion**

## List of level (700) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marking | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical Exam | Written Exam | Total |
| BAS751 | Materials science | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS752 | Solid state electronics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS741 | Applied Spectroscopy | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS761 | Lasers and their Applications | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS753 | Quantum nanostructure physics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS762 | Nano photonics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| BAS742 | Selected Advanced topics for Ph.D. students | 1 | 4 | 0 | 5 | 3 | 10 | 3 | 40 | 20 | 40 | 100 |

## Summary of Courses Specification

# Level 500

| Course title | Mathematical physics | | | | Course Code | BAS541 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Functions of a complex variable ( complex numbers and arithmetic, the elementary functions, multivalued functions and conformal mapping) – Cauchy-Riemann equations ( Analytic and Harmonic functions) - Complex integration (Cauchy's theorem, Cauchy's integral formula, independence of path of integration, the maximum modulus principle, Taylor's theorem and Laurent's theorem and zeros and singularities) – The calculus of residues (the residue theorem, calculating residues, applications of residue theorem) – Fourier series and transforms – partial differential equations and boundary value problems – special functions (Gamma, Beta and Bessel functions).

**References:**

- ***Leslie Copley, "Mathematics for the Physical Sciences", De Gruyter Open Ltd, Warsaw/Berlin, 2014.***

| Course title | Quantum Mechanics | | | | Course Code | BAS551 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Black-body radiation - Compton effects, photoelectric effect, -Properties of matter - de Broglie wave nature of matter- The concept of wave function - particle-wave duality, free particle- function and Fourier transformations, uncertainty principle - time-dependent Schrödinger equation, continuity equation, current conservation, expectation value, - time- independent Schrödinger equation, energy quantization and eigenvalue problems -energy spectrum and wave functions- One-dimensional systems -free particle, potential step, various potential well problems, quantum tunneling, harmonic oscillator-Heisenberg principle, representations in quantum mechanics, occupation number representation for the harmonic oscillator - Introduction to the quantum physics of atoms and atomic nuclei.

**References:**

- ***Elisa Ercolessi , Valter Moretti , Manuel Asorey "From Classical Mechanics to Quantum Field Theory" World Scientific Publishing Co –2020.***
- ***James Lees "Quantum Theory", Flame Tree Press; Deluxe 2019.***

| Course title | Solid state physics | | | | Course Code | BAS552 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Crystal Structure of Solids - Elastic Properties of Solids - Lattice Vibrations-1 - Lattice Vibrations-2 - Free-Electron Theory of Metals - Electrons in Electric and Magnetic Fields - Transport Phenomena - Energy Bands in Crystalline Solids - Excitons, Plasmons, and Dielectric Screening in Crystals - Interacting Electronic-Nuclear Systems and the Adiabatic Principle - Lattice Dynamics of Crystals - Scattering of Particles by Crystals. The Fermi Surfaces – Semiconductors - Dielectric Properties of Nonconducting Solids - Ferroelectric Solids – Magnetism – Ferromagnetism – Superconductivity - Defects in Crystalline Solids - Amorphous Solids and Liquid Crystals - Physics of Nanomaterials.

**References:**

- ***Joginder Singh Galsin "Solid State Physics" Academic Press, 2019.***
- ***Giuseppe Grosso and Giuseppe Pastori Parravicini " Solid state physics " Elsevier, 2014.***

| **Course title** | **Atomic physics** | | | | **Course Code** | **BAS553** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | **3** |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | 10 | 0 | 40 | 50 | | |

**Contents**

The atomistic structure of matter, The quantum nature of physical laws, The dual nature of physical phenomena, The wavefunction, Quantum operators, Time evolution, Systems of identical particles, Matrix notation, Perturbation theory, The hydrogen atom, Hydrogenic atoms, Magnetic moments and interactions, Spin–orbit interaction, Other relativistic effects, Classifying the fine structure levels: the spectroscopic notation, Anomalous Zeeman and Paschen–Back effects, The action of an electric field, Emission and absorption of radiation, Microscopic theory of Einstein coefficients, Electric dipole selection rules for hydrogenic states, Forbidden transitions, The LASER.

**References:**

- ***Luciano Colombo, " Atomic and Molecular Physics ", IOP Publishing, Bristol, UK, 2019.***
- ***Mark Fox, " A Student's Guide to Atomic Physics", cambridge university press, 2018.***

| **Course title** | **Statistical Mechanics** | | | | **Course Code** | **BAS542** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | **3** |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | 10 | 0 | 40 | 50 | | |

**Contents**

The role of statistical mechanics - Interacting of many body systems – Phase diagrams – Thermodynamics properties and relations – Basic Principles – Examples (Non interacting Subsystems, Equipartition Theorem, Specific Heat-Finite-Level Scheme, Harmonic Oscillator, Free Rotator and Grüneisen Law) – Basic principles – Non interacting Gases – Mean-Field Approximation for the Free Energy, – Density Matrix Mean-Field Theory and Landau Expansions – Landau Theory for Two or More Order Parameters – Quantum Fluids – Superconductivity: Hartree–Fock for Fermions with Attractive Interactions – Qualitative Discussion of Fluctuations – The Cayley Tree – Exact Mappings – Series Expansions –The Ising Model: Exact Solutions, Monte Carlo, Real Space Renormalization Group, The Epsilon Expansion, Kosterlitz-Thouless Physics.

**References:**

- ***A. J. Berlinsky • A. B. Harris, "Statistical Mechanics ", Springer, 2019.***
- ***I. Willard Gibbs, " Elementary Principles in Statistical Mechanics: with The Rational Foundations of Thermodynamics ", The Perfect Library ,2015.***

| **Course title** | **Optical electronics** | | | | **Course Code** | **BAS561** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | **3** |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Electro-optic effect, electro-optic modulators, dispersion management in optical fibers, Attenuation in Optical waveguides and their applications. beam propagation and propagation media, light detection and detector, semiconductor science and light-emitting diodes (LED), energy band diagrams in an applied field, direct and indirect bandgap semiconductors, PN junction principles, PN junction band diagram, principles of light-emitting diodes, basic LED characteristics, LEDs for optical fiber communications, stimulated emission devices: optical amplifiers and lasers, Erbium-doped fiber amplifiers, stimulated emission, photon amplification, and lasers.

**References:**

- ***Optical Electronics: An Introduction, Jixiang Yan, De Gruyter, 2019.***
- ***Handbook of Optoelectronics: Enabling Technologies (Volume Two), John P. Dakin, Robert G. W. Brown, CRC press 2017.***

| Course title | Nuclear physics | | | | Course Code | BAS543 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Introduction – Bulk properties of nuclei (nuclear sizes, number density and Fermi momentum of nucleons and nuclear masses) – The nuclear force and two-body systems (the fundamentals of nuclear force, the general structure of nuclear force, the properties of Deuteron and the nuclear force, nucleon-nucleon scattering, microscopic considerations: Meson theory, QCD and effective interaction inside nucleus) – Interaction with electromagnetic field: electromagnetic moments (Hamiltonian of the electromagnetic interaction and electromagnetic multipole moments, electromagnetic multipole operators and properties of the electromagnetic multipole operators) – Shell structure – microscopic mean-field theory – The shapes of nuclei – nuclear decay and radioactivity – Synthesis of elements.

**References:**

- ***Noboru Takigawa, Kouhei Washiyama, "Fundamentals of Nuclear energy" Springer, 2017.***

| Course title | Introduction to biophysics | | | | Course Code | BAS544 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Dynamic Properties of Biological Processes - Kinetics of Enzyme Processes - Distributed Biological Systems - Chaotic Processes - Thermodynamics of Irreversible Processes in Biological Systems Near Equilibrium - Thermodynamics of Systems Far from Equilibrium - Physicochemical Principles of Biopolymer Structure- Intramolecular Dynamics of Proteins - Energy Migration and Electron Transport in Biological Structures - Mechanisms of Enzyme Catalysis - Physicochemical Features of Biological Membranes. Ionic Equilibria - Passive Transport of Substances Across Membranes - Channels and Carriers- Active Transport - Transport of Ions in Excitable Membranes - Primary Processes of Energy Transformation in Photosynthesis - Energy Transformation in Biological Membranes.

**References:**

- ***Armin kargol, "Introduction to cellular biophysics", Morgan& Claypool publishers,2019.***
- ***Andrey B.Rubin, "Fundamentals of Biophysics", Wiley, 2014.***

<table>
<tr><td>Course title</td><td colspan="4">Fundamental of Plasma physics</td><td>Course Code</td><td>BAS545</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>10</td><td>0</td><td>40</td><td>50</td></tr>
</table>

**Contents**

Introduction: What is plasma? – Fundamental Parameters – Plasma frequency – Plasma parameter – Magnetized plasmas – Plasma Beta – De Broglie wavelength – Charged particle motion - Collision – Boltzmann H-Theorem – Two-Body Coulomb Collisions – Collision times – Plasma Fluid Theory – Fluid equations – Entropy production – Braginskii equations – Cold-plasma equations – Langmuir sheaths – Waves in cold plasmas – Cold-Plasma Dielectric permittivity – wave polarization – Waves in unmagnetized plasma – Wave propagation through inhomogeneous plasma – Magnetohydrodynamic fluids – MHD shocks (parallel MHD shocks, perpendicular MHD shocks and oblique MHD shocks ) - Waves in warm plasmas (Landau Damping - plasma dispersion function – Harris instability).

**References:**


- ***Richard Fitzpatrick, "Plasma Physics: An Introduction", CRC Press,2014.***
- ***Gérard Belmont, Laurence Rezeau, "Introduction to plasma physics", ISTE Press Ltd, 2019.***


<table>
<tr><td>Course title</td><td colspan="4">Experimental physics</td><td>Course Code</td><td>BAS546</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>0</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>20</td><td>30</td><td>50</td></tr>
</table>

**Contents**

**Part1: Fundamentals** (Planning and carry out experiments – Presenting your results – Uncertainty and statistics – Scientific ethics) – **Part2: Tools of an experimentalist** (Analog electronics – Fundamentals of interfacing experiments with computers – Digital electronics – Data acquisition and experiment control with python – Basic optics techniques and hardware – Laser beams, polarization, and interference – Vacuum – particle detection – **Part3: Fields of physics** (Development and supervision of independent projects – Condensed matter physics – Biophysics – Non-linear, Granular, and fluid physics – Atomic and molecular physics – Photonics and fiber optics.

**References:**


- ***Walter Fox Smith, "Experimental physics: Principles and practice for the laboratory", CRC Press,2020.***


<table>
<tr><td>Course title</td><td colspan="4">Computational physics</td><td>Course Code</td><td>BAS547</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Some basic remarks – **Part 1**: **Deterministic methods** (Numerical differentiation – Numerical integration – The Kepler problem – Ordinary differential equation: Initial value problems – The double pendulum – Molecular dynamics – Numeric of ordinary differential equations: Boundary value problems – The one-dimensional stationary heat equation - The one-dimensional stationary SCHRÖDINGER equation – Partial differential equations) **- Part 2: Stochastic methods** (random number generators – Random sampling methods – A brief introduction to Monte-Carlo methods – Some basics of Stochastic processes – The random walk and diffusion theory – MARKOV- Chain Monte Carlo and the POTTS model – Data Analysis)

**References:**


- ***Benjamin A. Stickler, Ewald Schachinger, "Basic concepts in Computational physics", Springer,2016.***
- ***Mark E. J. Newman, "Computational physics", Createspace Independent Pub, 2012.***

| Course title | Physics of solar cells | | | | Course Code | BAS548 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Blackbody Radiation and Light - Light Absorption- Optical Transitions in Organic and Inorganic Semiconductors - Fundamental Model of a Solar Cell (Majority Carrier Injection Mechanisms, Majority Carrier Devices, Minority Carrier Devices, Fundamental Properties of a Solar Cell, Physical Properties of Selective Contacts in Solar Cells) - Recombination Current in the Semiconductor Diode - Radiative Equilibrium in a Semiconductor - Reciprocity Relations and the Photovoltage (The Reciprocity between LED and Photovoltaic Performance Parameters, Factors Determining the Photovoltage, External Radiative Efficiency, Photon Recycling ) - Basic Operation of Solar Cells.

**References:**

- ***Juan Bisquert, "The Physics of Solar Cells", CRC Press ,2018.***

## Level (600)

| Course title | Advanced quantum mechanics | | | | Course Code | BAS651 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Quantum states and wave functions, quantum measurements- Hilbert space, Dirac notation, Hermitian operators- Spin and angular momentum, the Bloch sphere, spin resonance- The quantum harmonic oscillator, coherent states- 3-D Time-independent perturbation theory, - Quantization and addition of angular momenta. Tensor operators. Symmetries and gauge transformations. Time-independent and time-dependent perturbation theory. Basic scattering theory. Applications in nuclear and particle physics**.** Composite systems and entanglement- Magnetism – superconductivity – superfluidity – Dissipative quantum mechanics –Relativistic quantum mechanics.

**References:**

- ***Wolfgang Scherer "Mathematics of Quantum Computing: An Introduction" Springer. 2019.***
- ***J. J. Sakurai and Jim Napolitano "Modern Quantum Mechanics" Cambridge University Press; 2 edition , 2017.***

| Course title | Applied solid state physics | | | | Course Code | BAS652 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Introduction to semiconductor Physics - Detectors and Generators of Electromagnetic Radiation - Superconductive Materials - Physics and Applications of the Nonlinear Optical Properties of Solids - Experimental X-ray Diffraction Techniques - Laue's Concept of X-ray Diffraction - Bragg's Concept of X-ray Diffraction - Computer-Controlled Single Crystal X-ray Diffractometer - X-ray Diffraction from a Polycrystalline Material. Structure Factor and Fourier Synthesis - The Phase Problem and Techniques of X-ray Structure Determination – Polymer crystallization and kinetics - Changing the Crystal Structure - Sampling and Crystal Mounting - Collimation of the Incident X-ray Beam - Calculating Crystal Density by Floatation Method.

**References:**
- ***Hendrik Bluhm , Thomas Brückel, Markus Morgenstern , Gero Plessen , and Christoph Stampfer "Advanced Solid State Physics: Electronic Properties" de Gruyter 2019.***
- ***Jacques Cazaux "Understanding Solid State Physics: Problems and Solutions", Jenny Stanford Publishing; 2016.***

| Course title | Advanced Statistical Mechanics | | | | Course Code | BAS641 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Classical Mechanics – Thermodynamics – Classical Statistical Mechanics – Various Statistical Ensembles - Simple Models of Adsorption - Thermodynamics of Interfaces - Statistical Mechanics of Inhomogeneous Fluids - Quantum Formulation - The principle of conservation of extension in phase – Application of the principle of conservation of extension in phase to the theory of errors - Application of the principle of conservation of extension in phase to the integration of the differential equation of motion - On the distribution in phase called canonical in which the index of probability is a linear function of the energy – Average values in a canonical ensemble of systems.

**References:**
- ***J. Willard Gibbs, "Elementary Principles in Statistical Mechanics ", Dover Publications, 2014.***
- ***Isamu Kusaka, "Statistical Mechanics for Engineers", Springer, 2015.***

| Course title | Applied optics | | | | Course Code | BAS661 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Thin film optics, Fresnel coefficients, reflection and transmission coefficients, reflection and polarization angle, internal/external reflection, evanescent wave, antireflection coatings and dielectric mirrors, optical fiber and plasmonic sensors, principles of plasmonic sensing, surface plasmon polaritons, electromagnetics properties of metals and volume plasmons, localized plasmons,
exciting surface plasmon polaritons at planar interfaces, polarization handling devices, semiconductor lasers, applications in communications including multiplexer-demultiplexer, polarization rotator, polarization splitter, photonic crystal fibers and modelling of different photonic devices using mode solver programs.

**References:**
- ***Applied Optics, Ronald Driggers, OSA 2018.***
- ***An Introduction to Applied Electromagnetics and Optics, Vladimir V. Mitin , Dmitry I. Sementsov, CRC press, 2016.***

| Course title | Computational electromagnetics | | | | Course Code | BAS642 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Classification of electromagnetics problems, Maxwell's equations, different types of boundary conditions, analytical methods (separation of variables), orthogonal functions, series expansion, numerical integration), coupled mode theory (Symetrical/ Asymetrical coupling), finite difference methods ( time domain/frequency domain, accuracy and stability, absorbing boundary conditions, lattice truncation conditions), method of moment, effective index method, Eigenvalue problems, modelling of insulator-metal-insulator structure, photonic devices based on photonic crystal fiber (PCF) such as polarization rotator, polarization splitter, multiplexer-demultiplexer and plasmonic sensors based on Comsol Multiphysics Software Package.

**References:**

- ***Computational Electromagnetics with MATLAB, Matthew N.O. Sadiku, CRC press 2018.***
- ***Advanced Computational Electromagnetic Methods and Applications, Wenhua Yu, Wenxing Li, Atef Z. Elsherbeni, Yahya Rahmat-Samii, Artech House 2015.***

| Course title | Applied mathematics | | | | Course Code | BAS643 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Review of complex variables – Linear differential equations (Linear dependence: Wronskian, the method of Frobenius and variation of parameters) – Linear algebraic equations, Determinants, and matrices ( the Cayley-Hamilton theorem, Sylvester's theorem, differentiation and integration of matrices, method of Peano- Baker, adjoint method and matrix solution of the Hill-Meissner equation) – Oscillations of linear mechanical oscillation – The calculus of finite differences and linear difference equations with constant coefficients – Transfer functions and impulse responses – The solution of two-dimensional potential problems by the method of conjugate functions – Approximate methods in applied mathematics – The analysis of nonlinear systems – Statistics and probability.

**References:**

- ***Louis A. Pipes and Lawrence R.Harvill "Applied mathematics for engineers and physicists " 3rd edition, 2014***

| Course title | Photonics | | | | Course Code | BAS662 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Light interaction with the material, Fresnel coefficients, refractive index and dispersion, group velocity and group index, magnetic field, irradiance, and poynting vector, antireflection coatings and dielectric mirrors, absorption of light and complex refractive index, characteristics of wave guiding through slab waveguides and optical fibers, dispersion, attenuation, polarization control, Light propagation in an anisotropic medium, birefringent optical devices, retarder plate, Soleil–Babinet Compensator and Wollaston prism, COMSOL® and Lumerical FDTD software will be used to simulate different photonic devices.

**References:**

- ***Photonics: An Introduction, Georg A. Reider, Springer 2016.***
- ***Fundamentals of Photonics, 3rd Edition, Bahaa E. A. Saleh, Malvin Carl Teich, Wiley 2019.***

| Course title | Research point | | | | Course Code | BAS644 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 4 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 30 (Discussion) | 0 | 70 | - | | |

**Contents**

A student should carry a research study about a topic related to his specialization under the supervision of a staff member.

**References:**

- *According to selected research point.*

## Level 700

| Course title | Material science | | | | Course Code | BAS751 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

What is Materials Science and Engineering, Classification of Materials, Functional Classification of Materials, Classification of Materials Based on Structure, Environmental and Other Effects, Materials Design and Selection, Classification of Polymers, Addition and Condensation Polymerization, Degree of Polymerization, Typical Thermoplastics, Structure—Property Relationships in Thermoplastics, Effect of Temperature on Thermoplastics, Mechanical Properties of Thermoplastics, Elastomers [Rubbers], Thermosetting Polymers, Adhesives, Polymer Processing and Recycling, Dispersion-Strengthened Composites, Particulate Composites, Fiber-Reinforced Composites, Characteristics of Fiber-Reinforced Composites, Manufacturing Fibers and Composites, Fiber-Reinforced Systems and Applications, Laminar Composite Materials, Examples and Applications of Laminar Composites, Sandwich Structures.

**References:**


- ***Kasap, Safa, Capper, Peter, Springer Handbook of Electronic and Photonic Materials, springer, 2017.***
- ***Donald R. Askeland, Wendelin J. Wright, " The Science and Engineering of Materials ", cengage learning, 2014.***


| Course title | Solid state electronics | | | | Course Code | BAS752 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Electrons, Bonds, Bands and Holes -Homogeneous Semiconductor at Equilibrium - Drift, Diffusion, Generation, Recombination, Trapping and Tunneling – Gauss' Law - Depletion Width - Forward Biased - The Diode Equation - Reverse Biased/Breakdown - Metal-Oxide-Semiconductor Capacitor (MOSC) - P/N and Other Junction Diodes - Metal-Oxide-Semiconductor and Other Field-Effect Transistors - Bipolar Junction Transistor and other Bipolar Transistor Devices – Power devices – Quantum effect and hot-electron devices – Active microwave devices - Photonic devices - LASER - Solar Cells

**References:**
- ***Manijeh Razeghi* "Fundamentals of Solid State Engineering" Springer, (4th edition), 2019**
- ***Papadopoulos, Christo "Solid-State Electronic Devices, An Introduction" Springer-Verlag New York, 2014***

| Course title | Applied spectroscopy | | | | Course Code | BAS741 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Sample Preparation and Sample Pretreatment, Basics of Optical Spectroscopy, Absorption of Light, Infrared Spectroscopy, Raman Spectroscopy, UV–vis Absorption and Luminescence, Instrumentation of Optical Spectroscopy, MIR Spectrometers, NIR Spectrometers, Terahertz Spectrometers, Raman Spectrometers, UV/vis Spectrometers, Fluorescence Spectrometers, Spectral Imaging Devices, Instrumentation for Nonlinear Vibrational Spectroscopy, Measurement Techniques, Transmission Measurements, Reflection Measurements, Spectroscopy with Polarized Light, Photoacoustic Measurements, Microscopic Measurements, Infrared Spectroscopic Imaging, Principles of Mass Spectrometry, Techniques and Instrumentation of Mass Spectrometry, Applications of Mass Spectrometry, Elemental Analysis, X-ray Fluorescence Analysis, Atomic Absorption Spectrometry (AAS), Atomic Emission Spectrometry (AES), Surface Analysis.

**References:**
- ***Siegfried Hofmann, "Surface and Interface Analysis", Wiley, 2016.***
- ***Prof. Dr. Günter Gauglitz Dr. David S. Moore, " Handbook of Spectroscopy: Second, Enlarged Edition", Wiley, 2014.***

| Course title | Lasers and their applications | | | | Course Code | BAS761 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Optical systems; Gaussian beams; Optical waveguides and resonant cavities; atomic radiation; stimulated emission and population inversion, photon amplification and laser principles, four-level laser system, stimulated emission rate and emission cross-section, gas lasers: the He-Ne laser, laser oscillations: threshold gain coefficient, pulsed lasers, principle of the laser diode, heterostructure laser diodes, quantum well devices, elementary laser diode characteristics, single frequency semiconductor lasers\ distributed Bragg reflector laser diodes, distributed feedback laser diodes, and external cavity laser diodes.

**References:**
- ***Lasers and Their Applications, Phoenix Walsh, ED-Tech press 2018.***
- ***Lasers- Fundamentals and Applications, Ajoy Ghatak K.Thyagarajan, Laxmi Publications; 2nd edition 2019.***

| Course title | Quantum nanostructure physics | | | | Course Code | BAS753 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Ground state and dipole response of quantum ring systems -Density Functional Theory - Single quantum rings under electric and magnetic fields -Vertically coupled quantum rings - Concentric

quantum rings.
Spin-orbit effects in quantum nanostructures - Quantum wells submitted to perpendicular magnetic field -Exchange-correlation effects in quantum wires submitted to in-plane magnetic fields.
Quantum wells with spin-orbit interaction under tilted magnetic fields - Theoretical and Computational Description of usual Nanosystems - Quantum Molecular Dynamics - Covalent Binding - Models for Many-body Potentials - The Monte Carlo Method
Analytical second-order perturbation theory solution for noninteracting quantum wires

**References:**

- ***Andrei D. Zaikin*** ***and Dmitry Golubev "Dissipative Quantum Mechanics of Nanostructures: Electron Transport, Fluctuations, and Interactions" Jenny Stanford Publishing; 1 edition ,2019.***
- ***Wolfram Schommers "Basic Physics of Nanoscience" Elsevier, 2018.***

| Course title | Nano photonics | | | | Course Code | BAS762 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Modal analysis of TE/TM symmetric and asymmetric slab optical waveguides, modal analysis of channel optical waveguides, mode expansion method, Multimode interference devices, electromagnetics properties of linear and nonlinear materials, isotropic and anisotropic materials, types of dielectrics; polar and non-polar materials, Lorentz model for dielectrics, Drude model for metals, bandgap calculations of photonic crystal structures, 1D FDTD formulation for calculating transmittance of 1D grating, principles and applications of plasmonic waveguides and metamaterials, electromagnetics of metals and volume plasmonics, dispersion relation of surface plasmon polariton

**References:**

- ***Nanophotonics, Arthur McGurn, Springer 2018.***
- ***Photonics, Volume 2: Nanophotonic Structures and Materials, David L. Andrews, Wiley 2015.***

| Course title | Selected advanced topics for Ph.D. students | | | | Course Code | BAS742 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 4 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 40 | 40 | | |

**Contents**

A supervisor selects advanced topics in specific field to prepare the Ph.D. student to identify the point of research.

**References:**

***According to the specific field.***

# Chapter Four:

## Electrical Engineering Department

# Diploma in Electrical Engineering Majoring in Electrical Power Systems

## Program description

The objective of this diploma degree program is to provide high quality, and flexibly delivered, postgraduate studies in electrical power systems. The Program enables the student to develop a comprehensive understanding of the electrical power systems. This provides a sound foundation to enter a professional role in industry or academia.

## Competencies for the diploma graduate

In addition to general competencies for the diploma in engineering the graduate of diploma in electrical engineering majoring in electrical power systems must be able to:

1- Demonstrate a comprehensive knowledge and understanding of advanced topics in the field of Electrical Power systems.

2- Demonstrate knowledge and understanding of the operation and control principles of electrical power systems.

3- Demonstrate a comprehensive knowledge and understanding of a number of key non-technical issues including policy, economics, system modeling, environmental issues and energy management associated to electrical power system.

4-Demonstrate a critical awareness of theoretical design concepts and their practical implementation within electrical power systems.

5- Use appropriate software packages and IT skills for modeling and simulation of electrical power systems.

6- Select and apply appropriate methods for developing electrical power solutions to practical problems

***Benchmark:* *Newcastle University***

*http://www.ncl.ac.uk/regulations/programme/2007-2008/school/eece.php*

# Diploma in Electrical Engineering Majoring in Renewable Energy

## Program description

The objective of this diploma degree program is to provide high quality, and flexibly delivered, postgraduate studies in renewable energy systems. The Programme is suitable for graduates from electrical engineering program and related programs and has been specifically designed to meet the needs of an expanding renewable energy industry.

## Competencies for the diploma graduate

In addition to general competencies for the diploma in engineering the graduate of diploma in electrical engineering majoring in electrical power systems must be able to:

1- Demonstrate a comprehensive knowledge and understanding of the origins and distribution of different renewable energy sources (solar, wind, hydro, wave, tidal and bioenergy) and storage/conversion systems

2- Demonstrate knowledge and understanding of the operation and control principles of electrical power distribution networks

3- Demonstrate a comprehensive knowledge and understanding of a number of key non-technical issues including policy, economics, system modeling, environmental issues and energy management.

4- Demonstrate a critical awareness of theoretical design concepts and their practical implementation within renewable energy systems.

5- Use appropriate software packages and IT skills for modeling and simulation of renewable energy systems.

6- Quantify resource potential and determine the appropriate renewable energy resource at a given site.

***Benchmark: Newcastle University***

*https://www.ncl.ac.uk/regulations/specs/2012-2013/AFRD/5160_3419_3045_MA_PGDip_PGCert_Renewable_Energy_Enterprise_and_Management.pdf*

# Diploma in Electrical Engineering Majoring in Power System Protection

## Program description

The objective of this diploma degree program is to provide high quality, and flexibly delivered, postgraduate studies in power system protection. This program will provide tools and skills to keep pace with the rapidly evolving power system protection technologies, covering the latest developments in all aspects of power system protection. It combines academic excellence with the development skills that are essential for an engineer in the field of power system protection.

## Competencies for the diploma graduate

In addition to general competencies for the diploma in engineering the graduate of diploma in electrical engineering majoring in electrical power systems must be able to:

1- Demonstrate a comprehensive knowledge and understanding of advanced topics in the field of power system protection.

2- Demonstrate knowledge and understanding of the operation and control principles of power system protection.

3- Demonstrate a comprehensive knowledge and understanding of a number of key non-technical issues including policy, economics, system modeling, and environmental issues associated to power system protection.

4- Demonstrate awareness of his role in managing protection systems and environmental preservation.

5- Use appropriate software packages and IT skills for modeling and simulation of power system protection.

6- Select and apply appropriate methods for developing solutions to practical problems of protection systems.

***Benchmark:*** ***Newcastle University***

*http://www.ncl.ac.uk/regulations/programme/2007-2008/school/eece.php*

# Master of Science in Electrical Engineering

## Program description

The objective of the master's degree program in Electrical Engineering is to provide research informed knowledge in a broad spectrum of specialist electrical topics with immediate application to industrial problems. These topics range from electrical supply through advanced systems control to high-speed electronics. This Program offers a flexible structure that enables both new graduates and more established engineers to tailor their learning experience to meet the needs for their future

## Competencies for the program graduate

In addition to general competencies for the MSc. engineering program the graduate of Master of Science in electrical engineering must be able to:

1- Demonstrate a comprehensive knowledge and understanding advanced topics in the field of Electrical Power: Power Electronics, State Space Analysis and Controller Design, Control of Electric Drives, Design of Modern Electrical Machines and Drives, Electrical Machines and Power Systems Operation

2- Evaluate computer aided design and analysis techniques appropriate to Electrical Power.

3- Identify a particular topic connected with Electrical Power studied in-depth as part of a research project

4- Apply appropriate methods for modelling and analyzing problems in Electrical Power

5- Use scientific principles in the modelling and analysis of engineering systems, processes and products

6- Select and apply appropriate methods for developing Electrical Power solutions to practical problems

7- Develop ideas and opinions and engineering solutions through the critical appraisal of information from a wide range of sources

8- Use software packages and measurement equipment relevant to Electrical Power

***Benchmark: Newcastle University***

*https://www.ncl.ac.uk/regulations/specs/2012-2013/SEEE/5059_MSc_Electrical_Power.pdf*

# Ph. D. Program in Electrical Engineering

## Program description

The Ph. D. program in Electrical Engineering is a research-oriented degree program. Its purpose is to advance the knowledge in the fields of Electrical Engineering and enable students of exceptional ability to undertake advanced study and original research. It prepares students for a research and/or teaching career in industry, research institutions, universities, and government. The program has a focus on state-of–art technology issues that cross boundaries of Electrical Power Systems, Renewable Energy Engineering's, Electrical Machines and Power Electronics applications, High Voltage Engineering and other related topics.

## Competencies for the program graduate

In addition to general competencies for the Ph. D. program the graduate of Ph. D. program in electrical engineering must be able to:

***Benchmark: University of Nevada, Las Vegas***

*https://www.unlv.edu/degree/phd-electrical-engineering*

1- Demonstrate a strong technical knowledge in their field of electrical engineering so that he can lead and direct engineering and scientific industry teams in his chosen field.

2- Demonstrate the ability to learn independently and generate new knowledge in his chosen field of electrical engineering.

3- Reach the highest academic level with the potential to become a leader and an authority in Electrical Engineering.

4- Demonstrate the ability to generate new knowledge by completing creative novel work and reporting on this work in a dissertation.

5- Apply scientific principles in integrating knowledge learned in previous courses into a dissertation.

# List of level 500 Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| ELE511 | Power System Planning | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ELE521 | Renewable Energy Sources | 2 | 0 | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| ELE512 | Power System Quality | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ELE513 | Advanced Power System Analysis | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ELE514 | Advanced Power System Control | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ELE551 | Numerical Analysis in Electrical Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ELE541 | Power Electronics (1) | 2 | 0 | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| ELE552 | Testing and Standard Specifications in Electric Power Systems | 2 | 0 | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| ELE553 | Digital Control Systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| COM511 | Digital Signal Processing | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ELE531 | Switchgear and Protection Equipment | 2 | 0 | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |

# List of level 600 Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| ELE611 | Smart Grids | 2 | 2 | | 5 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE612 | Optimal Operation of Electrical Power Systems | 2 | 2 | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE613 | Flexible AC Transmission Systems (FACTS) | 2 | 2 | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELE614 | High Voltage Engineering | 2 | 2 | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE651 | Computer Modeling and Simulation | 2 | 1 | 2 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| ELE641 | Power Electronics (2) | 2 | | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| ELE621 | Renewable Energy Systems | 2 | | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| ELE631 | Renewable Energy Protection Systems | 2 | 2 | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE661 | Design of Electrical Machines (1) | 2 | 2 | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE615 | High Voltage DC Transmission systems | 2 | 2 | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE632 | Distribution System Protection | 2 | 2 | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE662 | Transients in Electric Machines | 2 | 2 | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE652 | Research Study | 2 | 2 | | 4 | 3 | 8 | - | 50 | 50* | - | 100 |
| * Discussion | | | | | | | | | | | | |

## List of level 700 Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical Exam | Written Exam | Total |
| ELE711 | Power System Stability | 3 | | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE761 | Advanced Control of Electric Machines | 3 | | | 5 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE731 | Advanced Protection Systems | 3 | | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE751 | Numerical Methods for Electromagnetic Fields | 3 | | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE712 | Power System Deregulation | 3 | | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE762 | Design of Electrical Machines (2) | 3 | | | 5 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE713 | Power System Management | 3 | | | 4 | 3 | 8 | 3 | 50 | | 50 | 100 |
| ELE714 | Energy Storage Systems | 3 | | | 5 | 3 | 8 | 3 | 50 | | 50 | 100 |

# Summary of Courses Specification

## Level 500

| Course Title | Power System Planning | | | | Course Code | ELE511 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Objectives stages, and transition from planning to operation - Generating System Planning: Probabilistic models of generating units, Growth rate, Rate of generation capacity, Outage performance and evaluation of loss of load and loss of energy indices, Power supply availability assessment - Interconnected Systems: Multi area reliability analysis, Power pool operation, Quantification of economic and reliability benefits of pool operation - Demand/ Energy forecasting: Electricity consumption pattern, Peak demand and energy forecasting - Power System expansion planning: least cost optimization, Operation and maintenance costs of units - Design of Distribution Systems: conductor selection, Capacitor placement, Reconfiguration, Substation planning.

**References:**


- *Joe H. Chow, Juan J. Sanchez-Gasca Power System Modeling, Computation, and Control Wiley-IEEE Press, 2019.*
- *Grigsby, L.L., Power system stability and control. CRC press. 2016.*
- *Juergen Schlabbach and Karl-Hein Rofalski, "Power System Engineering: Planning, Design, and Operation of Power Systems and Equipment" 2nd Edition, Wiley 2014*


| Course title | Renewable Energy Sources | | | | Course Code | ELE521 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Advantages and Challenges of renewable energy, Solar Energy: solar radiation measurement, Photovoltaic (PV) Cells, Main components of PV power system, Solar thermal energy and ways to benefit from it- Wind Energy: wind speed measurement, Extraction of Power from Wind, Main components of wind energy conversion system, Types of wind turbines, Wind Turbine Aerodynamics, Characterizing Parameters of wind energy conversion system, Basic Control Aspects, Wind Data and Energy Estimation. wave energy - tidal energy - geothermal energy - biomass energy - hydrogen and fuel cells.

**References:**


- *A.Felix, M.Farret, Godoy Simoes, Integration of Renewable Sources of Energy, 2nd Edition, John Wiley & Sons,, 2017*
- *Krzysztof Mudryk, Sebastian Werle , "Renewable Energy Sources: Engineering, Technology, Innovation" springer 2017*
- *R. Wengenmayr, T. Buhrke, W. Brewer, "Renewable Energy"', Wiley, 2011.*

<table>
<tr><td>Course title</td><td colspan="4">Power System Quality</td><td>Course Code</td><td>ELE512</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Definition of Electric Power Quality, Sources for Electric Power Quality Deterioration in Power System, Classification of Power System Disturbances, Power Quality Standards and Guidelines, 3-phase unbalance (sources and effects), power quality monitoring, harmonics ( definition and calculation), effects of harmonics on users and networks, voltage sag and voltage swell, overvoltage and under voltage, flicker, interruption, nonlinear loads and their effects on power system quality, standard values for power quality indices, , different methods for power quality problems mitigation.

**References:**


- *J. Pinto , ''Power electronics and power quality'', Energies, 2020.*
- *A.. Zobaa, S. Aleem, M. Balci, "Power System Harmonics: Analysis, Effects and Mitigation Solutions for Power Quality improvement", IntecOpen, 2018*


<table>
<tr><td>Course title</td><td colspan="4">Advanced Power System Analysis</td><td>Course Code</td><td>ELE513</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Network Formulation, Power System Components definition – Representation of Power System Components, Introduction to Power System Analysis; Admittance Model of Power System Elements; Kron's Reduction; Power Flow Analysis: Gauss-Seidel method, Newton-Raphson method, Fast-Decoupled power flow; Programming Consideration for Large Systems; Balanced and Unbalanced Radial Power Flow, AC-DC Power Flow, Harmonic Power Flow, Continuation Power Flow; Steady-State Voltage Stability; Loss Allocation Methods; Network Congestion (concepts, causes, indices); Available Transfer Capability; Contingency Analysis; Z-Bus Formulations; Fault Analysis using Z-Bus.

**References:**


- *P.S.R. Murty, Power Systems Analysis, 2nd Edition, Butterworth-Heinemann, June 2017*
- *Thomas, Glover, J. Duncan Power System Analysis and Design, 6th Edition, Cengage Learning 2018.*


<table>
<tr><td>Course title</td><td colspan="4">Advanced Power System Control</td><td>Course Code</td><td>ELE514</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Importance of power system control – Operating states of electrical power system – Elements of Power Systems Control – power system state variables - Generator control: concept and methods, generator control loops – frequency control: concept and methods- frequency control loop– voltage control concept and methods– control in active power flow in electrical power network - control in reactive power flow in electrical power network Automatic generation control in single and multi-area systems – interchange of power and energy in multi-area system.

**References:**
- *Kwatny, Harry G., Miu-Miller, Karen, "Power System Dynamics and Control", springer 2016*
- *Grigsby, L.L., Power system stability and control. CRC press. 2016..*

| Course title | Numerical Analysis in Electrical Engineering | | | | Course Code | ELE551 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

## Contents

Numerical methods for solution of differential equations, recursive methods, determination of optimal solution methods; numerical methods of electric system calculations, prediction of curve behavior, linear model of electric system, characteristic equation, stability of electric systems; numerical electromagnetic analysis using the finite difference time domain method (FDTD), finite element method (FEM) for solving the differential form of Maxwell's equations; numerical electromagnetic analysis using the partial element equivalent circuit (PEEC) for solving the mixed-potential integral equation (MPIE) for the free space; and applying the electromagnetic transients (EMT) software such as EMTP-RV and PSCAD for the numerical analysis of electromagnetic transients.

**References:**
- *Timothy Sauer, Numerical Analysis, Pearson Education, 2018*
- *A., Ametani, ''Numerical Analysis of Power System Transients and Dynamics (Energy Engineering)'' IET, 2015*
- *Stanislaw Rosloniec, Fundamental Numerical Methods for Electrical Engineering, Springer Berlin Heidelberg, 2008*

| Course title | Power Electronics (1) | | | | Course Code | ELE541 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Introduction and background - Protection of electronics switches and determination of their values – Single face rectifier circuits (uncontrolled - controlled) – Three phase rectifier circuits (uncontrolled - controlled) - AC current regulators - AC voltage regulators- Single and three phase inverters and their types and theory of operation - DC choppers, types and theory - Applications of frequency converters with static loads - Methods of improving power factor – Single and three phase AC choppers with phase control**.**

**References:**
- *B. Issa, H. Ahmad, ''Power electronics: circuit Analysis and Design'' Springer, 2017.*
- *Muhammad H. Rashid, Power Electronics Handbook, 4th Edition, Elsevier Inc., 2018*

| Course title | Testing and Standard Specifications in Electric Power Systems | | | | Course Code | ELE552 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Testing fundamentals and maintenance methods based on Egyptian and international standards (IEC, BS, NFPA Standards). Measuring techniques and methods, different types of drawings, testing tools. Instruments and methods required for testing. The offline and online condition monitoring for maintenance. The troubleshooting procedures and analysis. The safety issues and procedures required for testing. Inspecting and testing of various electrical equipment and installations. The limits for different equipment tests. Insulation resistance tests, polarization index test, Hi-Pot test, Dissipation power factor test and online testing for the insulation. oil tests and how to assess its quality. Testing of different earthing types.

**References:**


- *P80-Guide for Safety in AC Substation Grounding, IEEE Standard Association, 2017*
- *2030.3-2016 - IEEE Standard Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications, IEEE Standard Association, 2016*
- *BS 7671- Requirements for Electrical Installations IEE Wiring Regulations Seventeenth Edition, 2105*


| Course title | Digital Control Systems | | | | Course Code | ELE553 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | | 50 | 50 | | |

**Contents**

Introduction to digital control - Linear Difference Equations and the z-Transform - Discrete time systems - Modeling of digital controls systems - Stability of digital control systems - Digital control systems design - State space representation of digital control systems - Properties of discrete state-space models - State feedback digital control - Proportional, derivative and integral control systems- Introduction to optimal digital control - State Estimation in the Presence of Noise - Introduction to System Identification - Practical applications.

**References:**


- *R. G. Jacquot, Modern Digital Control Systems: CRC Press, 2019.*
- *A. Veloni, N. Miridakis, Digital Control Systems: Theoretical Problems and Simulation Tools, 1st Ed., CRC Press, 2017*


| Course title | Digital Signal Processing | | | | Course Code | COM511 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Study of signal processing systems - analog switching circuits - analog switching circuits - types of processors - pulsing circuits – pulse width modulation circuits - programming of signal processors Discrete-time signals and systems concepts- Signal representations in vector spaces - Linear inverse problems - Computing the solutions to least-squares error problems- Multi-rate Digital Signal processing - Linear Prediction and Optimum Linear Filters - Power Spectral Estimation- Parametric Method of Power Spectrum- Estimation Speech Signal Processing - DSP Hardware and Implementation Technologies.

**References:**


- *P. M. Parker, ‘‘Digital signal processors DSP’’, ICON Group International, Inc., 2020.*
- *Orhan Gazi, Understanding Digital Signal Processing, Springer, 2017*

<table>
<tr><td>Course title</td><td colspan="12">Switchgear and Protection Equipment</td><td>Course Code</td><td>ELE531</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="4">Lectures</td><td colspan="4">Tutorial</td><td colspan="4">Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="4">2</td><td colspan="4">2</td><td colspan="4">-</td></tr>
<tr><td rowspan="2">Course grades</td><td colspan="3">Oral</td><td colspan="3">Practical</td><td colspan="3">S. work</td><td colspan="3">Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td colspan="3">-</td><td colspan="3">20</td><td colspan="3">30</td><td colspan="3">50</td></tr>
</table>

**Contents**

Static Comparators as Relays, Numerical Protection, Carrier Aided Protection of Transmission Lines, Principle of Unit Protection, Feeder Protection (Cable and Overhead Lines), Management of protection systems, Lightning and switching Over-Voltage Protection and Insulation Coordination, Leakage-Current and Earth Fault Protection, Circuit Breaker Technologies, Low-Voltage Switchgear, Medium Voltage Switchgear, Applications of Low Voltage Switchgear, Application of Medium Voltage Switchgear, Control and Interlocking Schemes for Medium Voltage Switchgear, Protection Schemes for Medium Voltage Switchgears, Integrated Protection for Substation, Erection and Commissioning of Switchgear, Operation and Maintenance and Testing of Switchgears, International Codes for Drawings of Circuits for Protective Relaying, Microprocessor-Based Digital Protection.

**References:**


- *Na Vikraman, A Textbook of Protection and Switchgear, Independently Published, 2020*
- *V. K. Sachan, ''Electrical Switchgear, Protection & Energy Management: Principles, Designs & Applications', Smt. Jay Devi Sachan Memorial Publication House, 2019*


## Level 600

<table>
<tr><td>Course title</td><td colspan="12">Smart Grids</td><td>Course Code</td><td>ELE611</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="4">Lectures</td><td colspan="4">Tutorial</td><td colspan="4">Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="4">2</td><td colspan="4">2</td><td colspan="4">-</td></tr>
<tr><td rowspan="2">Course grades</td><td colspan="3">Oral</td><td colspan="3">Practical</td><td colspan="3">S. work</td><td colspan="3">Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td colspan="3">-</td><td colspan="3">-</td><td colspan="3">50</td><td colspan="3">50</td></tr>
</table>

**Contents**

Introduction to the Smart Grid concept, Problems associated to conventional electric systems, Definitions and general considerations for a Smart Grids, Characteristics of Smart Grid, Smart Grid technologies, Smart Grid Elements, Smart Grid Control techniques, Smart Grid communication system and its cyber security, Smart Grid Operations: control and management functions, operations architectures and information models, Power system protection under Smart Grid environment, Application of Smart Grid concept to distribution networks, integration of electric vehicles with Smart Grid, Smart Grid and energy storage systems, Smart transmission grid.

**References:**


- *K S MANOJ, "Smart Grid: Concepts To Design", Notion Press, 2019*
- *Thomas, Mini S., and John Douglas McDonald. Power system SCADA and smart grids. CRC press, 2017.*

<table>
<tr><td>Course title</td><td colspan="4">Optimal Operation of Electrical Power Systems</td><td>Course Code</td><td>ELE612</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Fundamentals of optimization techniques - Classification of optimization techniques- Classical optimization techniques: (Lamda iteration method, Linear programming, Quadratic programming) - Modern optimization techniques: (Genetic Algorithm, Particle Swarm Optimization, Fuzzy logic, ........) - Applications of optimization techniques in electrical power systems - Optimization in traditional power systems - Optimization in modern power systems: optimization of stochastic renewable energy systems, optimal operation of distributed energy, optimization of electric vehicles integrated with power systems, incorporating demand response in the optimization problem, optimization of energy storage integrated with power systems.

**References:**


- *Antonio J. Conejo , et al., Electric Energy Systems: Analysis and Operation, CRC Press 2016.*
- *Jizhong Zhu, "Optimization of Power System Operation"2nd Edition Wiley – IEEE press 2015*


<table>
<tr><td>Course title</td><td colspan="4">Flexible AC Transmission Systems (FACTS)</td><td>Course Code</td><td>ELE613</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>70</td></tr>
</table>

**Contents**

Concepts and general system considerations, Voltage Source Converters, Static Shunt Compensators, Static Series Compensators- Static Voltage and Phase Angle Regulators, modeling of FACTS components, controllers of flexible systems, coordination of flexible systems, effect of controllers on performance and response of the flexible system, Unified power Flow Controller (UPFC), Special purpose FACTS, Modeling of Multi-Functional Single Converter FACTS in Power Flow Analysis, Modeling of FACTS-Devices in Optimal Power Flow Analysis, Autonomous Systems for Emergency and Stability Control of FACTS, Wide Area Control of FACTS.

**References:**


- *B. Andersen, S. Nilsson , Flexible AC Transmission Systems. Springer International Publishing, 2020.*
- *S. Bhowmick, Flexible AC Transmission Systems (FACTS): Newton Power-Flow Modeling of Voltage-Sourced Converter-Based Controllers, CRC Press 2016*


<table>
<tr><td>Course title</td><td colspan="4">High Voltage Engineering</td><td>Course Code</td><td>ELE614</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Review to generation and measurements of different types of high voltages (high dc, ac, and impulse voltage) - Operation, design and construction of impulse generators - Electrostatic fields and field stress control-Breakdown of gaseous insulation - Corona discharges -Breakdown in liquids and solid insulating materials - Breakdown of composite insulation -Nondestructive insulation test techniques - Dielectric loss and capacitance measurements - Partial-discharge measurements- Insulation strength characteristics and insulation coordination, Fencing, earthing and shielding of electrical power system in high voltage systems, Design and testing of external insulation.

**References:**


- *Ayman El-Hag , High Voltage Engineering and Applications,: Mdpi AG Publisher, April 2020.*
- *Farouk A.M. Rizk, Giao N. Trinh, High Voltage Engineering, CRC press 2018..*

| Course title | Computer Modeling and Simulation | | | | Course Code | ELE651 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | ١ | ٢ | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Introduction to modelling - Use of models for design, real time training and optimization - Types of model, Physical equations of systems - Constraint equations, Time domain solutions: steady state and dynamic - Formation of lumped parameter models - Analogies with electrical and mechanical systems. Conversion into transfer function models. Model validation - Block diagram representation: modelling of control loop elements, integration of process & control models - Simulation; discrete and continuous system simulation, selection of numerical integration routines, Choice of step length and run time, Setting up initial and boundary conditions, State space modelling of multivariable systems.

**References:**

- *Andreas Tolk, Tuncer Ören, The Profession of Modeling and Simulation: Discipline, Ethics, Education, Vocation, Societies, and Economics, John Wiley and sons Inc., 2017*
- *B. Guilfoos and S. I. Gordon, Introduction to Modeling and Simulation with MATLAB® and Python, CRC Press, 2017*

| Course title | Power Electronics (2) | | | | Course Code | ELE641 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | | ٣ | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Three Phase Inverters - Multi level inverter – Cycloconverters - Switched mode power converters - uninterruptible power systems (UPS) - Active filters in power systems - Static Shunt Compensators - Static Series Compensation - Static Voltage and Phase Angle Regulators - Combined Compensators - High voltage DC transmission systems - Digital excitation systems for synchronous generators - Energy storage systems (super capacitors - batteries - superconductors - fuel cells) - Design of inductor, transformer for power electronic applications.

**References:**

- *F. Blaabjerg, T. Dragicevic and P. Davari, "Applications of Power Electronics", MDPI AG Publisher, 2019*
- *Simone Buso, Paolo Mattavelli, Digital Control in Power Electronics, 2nd Edition, Morgan & Claypool Publishers, 2015*

| Course title | Renewable Energy Systems | | | | Course Code | ELE621 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Renewable Energy: Advantages and Challenges - Grid-connected, standalone and hybrid renewable energy - Solar Energy: sizing, Design, and modeling of PV array and the factors influencing on it, Control and Regulation of PV cell voltage, power electronics components for PV Systems -stand alone and grid connected PV system- Wind Energy: Types of wind turbine generator systems (induction, synchronous, and doubly-fed induction generator), modeling and control aspects. Distributed generation feature, sizing, location and impacts on system performance, smart grid technology.

**References:**

- *G Rigatos Gerasimos, Intelligent Renewable Energy Systems: Modelling and Control, Springer, 2016.*
- *Muhammad Rashid "Electric Renewable Energy Systems " Elsevier 2015*

| Course title | Renewable Energy Protection Systems | | | | Course Code | ELE631 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

Contents

Protection considerations for renewable resources – Adaptive protection - Protection issues of distributed energy resources - Impact of distributed energy resources on protection system: Protection failure, Loss of coordination - Protection schemes for distribution systems with distributed energy resources - Protection equipment for distributed energy resources networks - Recent technological trends in distributed energy resources protection – Lightning protection for renewable energy generation systems – Influence of grounding system design on mitigation of lightning strikes on wind farms systems.

References:


- *Ali Hooshya, Protection of Renewable Energy Systems, Lap Lambert Academic Publishing, 2015*
- *Taha Selim Ustun, Smart grid Protection Principles with Advanced Communication & Control, Lap Lambert Academic Publishing, 2019*
- *Pengwei Du, Ross Baldick, Aidan Tuohy, Integration of Large-Scale Renewable Energy into Bulk Power Systems: From Planning to Operation, Springer 2017.*


| Course title | Design of Electrical Machines (1) | | | | Course Code | ELE661 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction: Major considerations in Electrical Machine Design - Choice of Specific Electrical and Magnetic loadings – Thermal Considerations – Standard Specifications. DC Machines: Output Equations – Main Dimensions - Magnetic circuit calculations - Real & Apparent flux densities– Design of Armature, commutator and brushes – performance prediction using design values. Design of DC machines using finite element method. Transformers: Output Equations – Main Dimensions - KVA output for single and three phase transformers –Operating characteristics -Regulation – Design of Tank - cooling of Transformers. . Design of transformers using finite element method.

**References:**


- *K.M. Vishnu Murthy, Computer Aided Design of Electrical Machines, StreetLib SRL, 2019*
- *Lei, Gang, Zhu, Jianguo, Guo, Youguang, Multidisciplinary Design Optimization Methods for Electrical Machines and Drive Systems, Springer, 2016.*
- *Pyrhonen, Juha, Tapani Jokinen, and Valeria Hrabovcova. Design of rotating electrical machines. John Wiley & Sons, 2013.*


| Course title | High Voltage DC Transmission Systems | | | | Course Code | ELE615 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction to DC and AC power transmission technology, Configurations of DC transmission system, Applications of DC transmission, HVDC converters: types and characteristics, Converter faults and Converter protection against over-currents and over voltages, Smoothing reactors, Transient over voltages in DC line, Protection of DC line, DC breakers, Monopolar operation, bipolar operation, Effects of proximity of AC and DC transmission lines, Reactive power control, Power flow analysis in AC/DC systems, multi-terminal HVDC systems, DC circuit breakers, integration of offshore wind farms via HVDC links.

**References:**

- *H. Zhou, 'Ultra-high Voltage AC/DC Power Transmission', Springer, 2018.*
- *Dragan Jovcic, High Voltage Direct Current Transmission: Converters, Systems and DC Grids, 2nd Edition, John Wiley and sons Inc., 2019*

| **Course title** | **Distribution System Protection** | | | | **Course Code** | **ELE632** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | **3** |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | - | - | 50 | 50 | | |

## Contents

Fault Calculation in distribution system, over voltages protection, protection of distribution transformers, protection of distribution substations, protection of busbars, protection of loads, protection of distribution feeder, auto reclosures and their applications in distribution network, improving voltage using voltage regulators, monitoring performance of distribution networks, Impact of distributed generation on protection systems in distribution networks, Protection of distributed generators and renewable energy systems; distribution transformer protection; protecting of medium voltage distribution lines against lightning-induced overvoltages; earth leakage protection.

**References:**

- *Juan Manuel Gers, Distribution Systems Analysis and Automation, 2nd Edition, IET Digital Library, 2020.*
- *V. K. Sachan, ''Electrical Switchgear, Protection & Energy Management: Principles, Designs & Applications ', Smt. Jay Devi Sachan Memorial Publication House, 2019.*

| **Course title** | **Transients in Electric Machines** | | | | **Course Code** | **ELE662** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | **3** |
| | 2 | | 2 | | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | - | | 50 | 50 | | |

**Contents**

Electromagnetic induction and energy conversion in electric machines; Electromagnetic transients in transformers (Transformer inrush current, over-excitation of transformers, Ferro resonance phenomenon, sudden short circuit, and internal faults); Starting and braking of rotating electric machines; modeling of rotating AC machines in *dq* axes; high frequency modeling of electrical rotating machines and transformers; Transients in DC and AC drives with power electronic switches; Electrometrical transient of electric rotating machines; Applications of the finite element method (FEM) for optimum machine design with transients conditions..

**References:**

- *Ion Boldea, Induction Machines Handbook: Transients, Control Principles, Design and Testing, CRC Press, 2020.*
- *Jan A Melkebeek, Transient Phenomena in Electrical Machines, Springer, 2018*
- *K. T. Chau. Electric Vehicle Machines and Drives: Design, Analysis and Application. Wiley-IEEE Press, 2015.*

| **Course title** | **Research Study** | | | | **Course Code** | **ELE652** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | **Tutorial** | | **Practical** | **Credit hours** | **3** |
| | 2 | 2 | | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | - | - | 50 | 50(discussion) | | |

**Contents**

A student should carry a research study about a topic related to his specialization under the supervision of one of the staff members.

**References:**

## Level 700

| Course title | **Power System Stability** | | | | Course Code | ELE711 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 3 | - | | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

Contents

Basics of stability of the electric power system – problems resulting from the instability of the system - system disorders that cause instability - transient stability - System Response to Small Disturbances- voltage stability – voltage collapse criteria- active power versus voltage curve, reactive power versus voltage curve as voltage stability measure, The Effect of Excitation on Stability - frequency stability - system stability of multiple machines - means of enhancing the stability of the power system - impact of renewable sources on system stability.

**References**:


- *Vijay Vittal, James D. McCalley, Paul M. Anderson, A. A. Fouad- "Power System Control and Stability", 3rd Edition-Wiley-IEEE Press, 2019.*
- *Kenneth Okedu, Power System Stability, InTecOpen, 2019*


| **Course title** | **Advanced Control of Electric Machines** | | | | **Course Code** | **ELE761** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | **Tutorial** | | **Practical** | **Credit hours** | **3** |
| | 3 | - | | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | - | | 50 | 50 | | |

**Contents**

Dynamic representation of induction machines - principle of induction control - principle of directional control - direct and indirect directional control – speed and current sensor fault-tolerant-control of the induction motor drive, stator faults monitoring and detection in vector controlled induction motor drives- open-circuit fault diagnostic methods for controlled induction motor drives - sensitivity of variables in indirect control of induction machines - compensation of sensitivity of variables operating by weakening the field - directional control in permanent magnet synchronous machines.

**References:**


- *Masmoudi, Ahmed, Control Oriented Modelling of AC Electric Machines, Springer, 2018*
- *Jacek Kabziński, "Advanced Control of Electrical Drives and Power Electronic Converter", Springer 2017.*
- *J. Pyrhonen, V. Hrabovcova, R. Scott Semken, Electrical Machine Drives Control: An Introduction, 1st Edition, Wiley; 2016*

<table>
<tr><td>Course title</td><td colspan="4">Advanced Protection Systems</td><td>Course Code</td><td>ELE731</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Organization of physical components in integrated protection systems - Relaying and control system - Applications of relays for transient waves - Protection of systems against lightning strikes, surge and transient states - Applications of microprocessors and sub-automation - Transmission-assisted distance protection - Adaptive protection system - Modern protection systems for intelligent power systems including high penetration of renewable energy resources - Technologies and applications of smart microgrid protection using Internet of Things - Lightning protection for wind energy conversion systems.

**References:**


- *J. Ekanayake,J. Karunanayake , V. Terzija "Modern Power System Protection", Wiley, 2020.*
- *Z. Q. Bo et al., Protection and Control of Modern Power Systems, Springer, 2016*


<table>
<tr><td>Course title</td><td colspan="4">Numerical Methods for Electromagnetic Fields</td><td>Course Code</td><td>ELE751</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">3</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td></td><td>50</td><td>50</td></tr>
</table>

**Contents**

Review and Introduction to Numerical Analysis: electrostatics and magneto statics; solution method classification, Integral equation methods: boundary integral equations (2D and 3D); weighted residual method and system construction; One- and two-dimensional finite differences: iterative solution; cavity field computations; field mapping, equipotential surfaces; One- and two- dimensional finite element method: linear and quadratic shape functions, meshing; system construction and assembly; element matrix for the wave equation; boundary condition enforcement/condensation of boundary conditions; using the finite difference time domain method (FDTD), finite element method (FEM) for Maxwell's equations; using the partial element equivalent circuit (PEEC) for the mixed-potential integral equation (MPIE)

**References:**


- *Matthew N. Sadiku, Numerical Techniques in Electromagnetics with MATLAB, 3rd Edition, CRC Press, 2015.*
- *Lawrence N. Dworsky, Introduction to Numerical Electrostatics Using MATLAB, Wiley-IEEE Press, 2014*
- *Atef Z. Elsherbeni, Veysel Demir, The Finite-Difference Time-Domain Method for Electromagnetics with MATLAB® Simulations, 2nd Edition, Scitech Publishing, 2015*

<table>
<tr><td>Course title</td><td colspan="4">Power System Deregulation</td><td>Course Code</td><td>ELE712</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">3</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Traditional Regulated Structure of Electric systems, Definition of deregulation, History and evolution of deregulation, Competition at the Wholesale Generation Level, Distributed generation and energy storage, Generation and Transmission in a deregulated Industry, Power distribution in deregulated industry, Retail sale in fully deregulated industry, Loss allocations in deregulated power system-Service reliability and aging infrastructure, System blackouts and operational complexity regulation and Deregulation, Open access transmission - cost pricing components of transmission systems - incremental transmission based on cost pricing, power distribution in Deregulated industry.

**References:**

- *P. S. Varma, S. Velamury, Power System Deregulation, LAP LAMBERT Academic Publishing, 2017*
- *A. Creti, F. Fontini, "Economics of Electricity: Markets, Competition and Rules", Cambridge University Press, 2019.*

<table>
<tr><td>Course title</td><td colspan="4">Design of Electrical Machines (2)</td><td>Course Code</td><td>ELE762</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">3</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction to Electrical Machine Design - Windings of Electrical Machines - Main Dimensions of a Rotating Machine - Choice of Specific Electrical and Magnetic loadings – Thermal Considerations - Standard Specifications. Induction Motors: output equation - Design of rotor bars & slots – Design of wound rotor -Magnetic leakage calculations - Design of induction motors using finite element method - Synchronous Machines: output equations – choice of loadings – Design of salient pole machines– Armature design – Design of rotor– Determination of full load field mmf – Design of synchronous machines using finite element method

**References:**

- *V. Rajini and V. Nagarajan, Electrical Machine Design: Pearson Education India, 2018.*
- *Alexander Gray, Electrical Machine Design: The Design and Specification of Direct and Alternating Current Machinery, Forgotten Books Publisher, 2018*

<table>
<tr><td>Course title</td><td colspan="4">Power System Management</td><td>Course Code</td><td>ELE713</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">3</td><td></td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>٥٠</td><td>٥٠</td></tr>
</table>

**Contents**

Introduction, Design, Structure, and Operation of an Electricity Market , Pricing, Modeling, and Simulation of an Electricity Market, Evaluation of an Electricity Market , Transmission Planning , Under Electricity Market Regime, Electricity Market under a Future Grid, Meshed Networks and Congestion, Retail Competition: Supplying Electricity to Final Consumers, Assessing the Benefits of Retail Competition, Optimal Investment in Power Generation, Energy-Only Markets vs. Markets with Capacity Remuneration Mechanisms, Analysis of Capacity Remuneration Mechanisms, Global

Warming and the Electricity Markets, The Integration of Renewable Energy Sources in the Electricity System.

**References:**

- *J. Lin, F. Magnago "Electricity markets : theories and applications", IEEE Press series on power engineering, Wiley 2017.*
- *Cretì, F. Fontini, "Economics of Electricity: Markets, Competition and Rules", Cambridge University Press, 2019*

| Course title | Energy Storage Systems | | | | Course Code | ELE714 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 3 | | - | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction, Modeling of Energy Storage Systems for Power System Operation and Planning, Day-Ahead Schedule and Bid for a Renewable Energy Generation and Energy Storage System Union, Refined Bidding and Operating Strategy for a Renewable Energy Generation and Energy Storage System Union, Unit Commitment with Energy Storage System, Optimal Power Flow with Energy Storage System, Power System Secondary Frequency Control with Fast Response Energy Storage System, Integration of Large-Scale Energy Storage System into the Transmission Network, Optimal Planning of the Distributed Energy Storage System.

**References:**

- *Zechun Hu , " Energy Storage for Power System Planning and Operation ", Wiley 2020 .*
- *Fu-Bao Wu, Bo Yang, Ji-Lei Ye, Grid-Scale Energy Storage Systems and Applications, Academic Press, 2019*
- *Michael Sterner, Ingo Stadler, "Handbook of Energy Storage: Demand, Technologies, Integration", Springer, 2019*

# Chapter Five:

## Electronics and Communications Engineering Department

## Fundamental Diploma in Electronics and Communication (ECE) Engineering

### Program description

The Fundamental Diploma degree program in Electronics and Communication Engineering (ECE) is generally of 12 credits, intended to provide students with deepen knowledge and skills of the basic concepts and theories, leading directly to a specific job or a registration in advanced diploma degree in the field of Electronics and Communication Engineering (ECE).

### Competencies for the program graduate

In addition to the competencies for all fundamental diploma's engineering programs, Fundamental **Diploma of electronics and communication engineering** graduate must be able to:

1- Apply scientific and engineering principles to solving multidisciplinary problems in technological areas associated with electronics and communications
2- Provide opportunities to students to help upgrade their conceptual knowledge, by enhancing the information sources like Library, internet access facilities, etc.

## Advanced Diploma in Electronics and Communication Engineering

### Program description

The advanced diploma degree program in electronics and communication engineering is generally of 12 credits, intended to provide students with deepen knowledge and skills involving analysis, systems implementation, operation, production, and maintenance of the various applications in the field of Electronics and Communications Engineering, leading directly to a specific job or a registration master's degrees.

### Competencies for the program graduate

In addition to the competencies for all advanced diploma's engineering programs and the fundamental Diploma Degree engineering programs, advanced diploma of electronics and communication engineering graduate must be able to:

1. Provide practical exposure to the students through modern laboratories with continuous up gradation.
2. Create technical awareness among the students through special lectures from eminent resource persons, through industrial visits and in plant training.
3. Provide opportunity to improve students' skills and competencies through participation in seminar, technical paper presentation and project works within the campus and at reputed companies

| Fundamental and Advanced Diploma Benchmark | | | |
|---|---|---|---|
| **Degree** | **University Details** | **Description** | **Link** |
| **Diploma** | Institute of management and engineering studies, India | Diploma in electronics and communication | shorturl.at/eqFSW |

## Master of Electronics and Communication Engineering Program

### Program description

The objectives of the master's degree program is acquire advanced knowledge on current telecommunications and electronic systems with the latest skills for their design, development and maintenance in order to establish the graduates in successful careers or advanced studies in electronics and communication engineering, with the ability to engage in lifelong learning in the field of electronics and communication engineering.

### Competencies for the program graduate

In addition to the competencies for all master's engineering programs, Master of electronics and communications engineering program graduate must be able to:

1- The ability to design components, devices, and systems to meet specified needs in the field of electronics and communications engineering, within the given constraints
2- The ability to professionally identify, formulate and solve problems in the field of electronics and communications
3- The ability to use the techniques, skills, and tools of modern engineering effectively in the practice of electronics and communications

| Master Benchmarks | | | |
|---|---|---|---|
| **Degree** | **University Details** | **Description** | **Link** |
| **Master** | University of Siena, Italy | Master in electronics and communication | shorturl.at/sHMQZ |
| | University of Louisville, USA | Master's in electrical and computer engineering | shorturl.at/nGH45 |

## Ph.D. of Electronics and Communications Engineering Program

Electronics and communications Ph.D. program aims to provide in-depth training in the field of electronics and communications leading to a doctoral dissertation, with emphasis on original thinking, professional behavior, ethical conduct, communications skills, broad analytic understanding of advanced experimental, theoretical and computational methods, and ability to conduct independent research. The program aims at providing students with the opportunity to develop their professional knowledge and expertise to qualify for leadership positions in teaching, research, and industry.

### Competencies for the program graduate

In addition to the competencies for all PhD engineering programs, **PhD of Electronics and Communications (ECE) engineering program** graduate must be able to:

1- Solve specific problems in the field of electronics and communications based on limited and contradictory information.

2- Generate new ideas and approaches to resolve problems in the field of electronics and communications
3- Professionally express and present ideas and methods
4- Qualify for leadership positions in academia in teaching and/or research in the field of electronics and communications
5- Qualify for leadership positions in industrial research and development (R&D)

| PhD Benchmark | | | |
|---|---|---|---|
| **Degree** | **University Details** | **Description** | **Link** |
| **Ph.D.** | Harvard University | PhD in electrical engineering | shorturl.at/sxCU1 |
| | American University, Cairo, Egypt | PhD in electronics and communication | shorturl.at/esyJO |
| | Brno University of Technology, Czech | PhD in electronics and communication | shorturl.at/ahmrG |

**List of level (500) Courses**

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **BAS511** | Advanced probability theory | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **ECE512** | Programming application | 2 | 0 | 2 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE521** | Digital communication systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE531** | Digital integrated circuits | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE513** | Advanced engineering mathematics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **ECE541** | Advanced digital signal processing | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE551** | Microwave Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE513** | Technical writing and communication skills | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

## List of level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **ECE635** | Selected topics in Electronics | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE 625** | Selected topics in Communications | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE611** | Research Project | 1 | 4 | 0 | 5 | 3 | 8 | - | 70 | 30 * | - | 100 |
| **ECE621** | Advanced wireless Communications | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE622** | Advanced Communications Networks | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE623** | Advanced Cellular Communications | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE624** | Advanced Optical Communications | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE631** | Analog Integrated Circuit Design | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE632** | Advanced Optical Electronics | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE633** | Nanoelectronics | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE634** | Solid State Electronics | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE651** | Advanced Antenna Systems | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE652** | Nanophotonics | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE641** | Advanced Digital Image Processing | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE642** | Pattern Recognition and Machine Learning | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| **ECE612** | Research skills and ethics | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 50 | 0 | 50 | 100 |
| **ECE653** | Numerical methods in electromagnetics | 2 | 2 | 0 | 4 | 3 | 8 | 2 | 40 | 10 | 50 | 100 |
| *** Discussion** | | | | | | | | | | | | |

## List of level (700) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **ECE 711** | Advanced Optimization methods | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE 751** | Millimeter wave technology | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE 721** | Network security | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE 741** | Advanced data analysis | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE 752** | Quantum optics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE 731** | Photonics integrated circuits | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE 732** | Advanced integrated circuits design | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE 722** | Advanced wireless communications networks | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **ECE 712** | Selected advanced topics in Electronics and Communications Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |

# Summary of Courses Specification

## Level (500)

| **Course title** | **Advanced probability theory** | | | | **Course Code** | BAS 511 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Introduction to Probability Theory; Random Variables; Probability Density Function; Mixed Distributions; Parametric Models for Random Variables; Gaussian Random Variable (Normal); Log-Normal Random Variable; Exponential Random Variable (One-Sided); Laplace Random Variable (Double-Sided Exponential); Binomial Approximation; Poisson Approximation; Gaussian Approximations; Independent Random Variables; Random Vectors; Random Variable Transformations; Transformations of Random Vectors; Expectation and Integration; Expectation for Discrete Sample Spaces; Expectation for Continuous Sample Spaces; Conditional Expectation; Variance, Covariance, and Correlation; Correlation and Covariance Matrices; Types of Random Processes; Stochastic Convergence, Calculus, and Decompositions; Central Limit Theorem; Systems, Noise, and Spectrum Estimation; Sufficient Statistics and Parameter Estimation.

**References:**

- *John J. Shynk "Probability, Random Variables, and Random Processes: Theory and Signal Processing Applications", John Wiley & Sons, 2013*
- *Richard Durrett, "Probability: Theory and Examples", Cambridge Series in Statistical and Probabilistic Mathematics, 4th Edition.*

| **Course title** | **Programming application** | | | | **Course Code** | ECE512 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Engineering Problem Solving; Computing Software; Matlab Technical Computing Environment; Computational Limitations; Mathematical Functions; Accuracy and Precision; Script M-Files; Errors and Debugging; Trigonometry and Complex Numbers; Arrays and Array Operations; Array Plotting Capabilities; Signal Representation, Processing, and Plotting; Functions of Two Variables; Plotting Functions; Data Analysis; Random Number Generation; Relational and Logical Operators; Flow Control and loops; Selection Statements in User-Defined Functions; Speech Signal Analysis; Vectors, Matrices and Linear Algebra; Solutions to Systems of Linear Equations; Applied Problem Solving: Robot Motion; Curve Fitting and Interpolation; Integration and Differentiation; Strings, Time, Base Conversion and Bit Operations; Solving Algebraic and Transcendental Equations; Calculus; Linear Algebra.

**References:**

- *Stephen Chapman, "Matlab Programming for Engineers",4th* Edition, Thomson, 2008.
- *Stephen J. Chapman, "MATLAB Programming with Applications for Engineers", Cengage Learning, 2013*

| **Course title** | **Digital communication systems** | | | | **Course Code** | ECE521 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Fourier Analysis of Signals and Systems; Probability Theory and Bayesian Inference; Stochastic Processes; Information Theory; Source-coding Theorem; Lossless Data Compression Algorithms; Channel-coding Theorem; Information Capacity Law; Sampling Theory; Quantization and its Statistical Characterization; Prediction-Error Filtering for Redundancy Reduction; Differential Pulse-Code Modulation; Delta Modulation; Line Codes; Optimum Receivers Using Coherent Detection; Phase-Shift Keying Techniques Using Coherent Detection; Frequency-Shift Keying Techniques Using Coherent Detection; Noncoherent Orthogonal Modulation Techniques; Differential Phase-Shift Keying; Signaling over Band-Limited Channels; Intersymbol Interference; Ideal Nyquist Pulse for Distortionless Baseband Data Transmission; Signaling over Fading Channels; Statistical Characterization of Wideband Wireless Channels; Spread Spectrum Signals; Code-Division Multiple Access .

**References:**

- ***J. G. Proakis, Digital Communications, 4th edition, McGraw Hill, 2001***
- ***S. Haykin, Communication Systems, 4th edition, Wiley, 2001.***

| **Course title** | **Digital integrated circuits** | | | | **Course Code** | ECE531 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Quality Metrics of a Digital Design; Manufacturing CMOS Integrated Circuits; Design Rules; The Contract between Designer and Process Engineer; Packaging Integrated Circuits; The Diode Design; The MOSFET Transistor Design; Circuit Simulation; Interconnect Parameters — Capacitance, Resistance, and Inductance; Electrical Wire Models; SPICE Wire Models; Static CMOS Inverter; Performance of CMOS Inverter: The Dynamic Behavior; Power, Energy, and Energy-Delay; Static CMOS Design; Dynamic CMOS Design; Static Latches and Registers Design; Dynamic Latches and Registers Design; Pipelining: An approach to optimize sequential circuits; Non-Bistable Sequential Circuits; Cell-Based Design Methodology; Array-Based Implementation Approaches; Capacitive Parasitics; Resistive Parasitics; Inductive Parasitics ; Advanced Interconnect Techniques.

**References:**

- *J. Rabaey, A. Chandrakasan and B. Nikolic," Digital Integrated Circuits: A Design Perspective," 2nd Edition, Prentice Hall, 2003.*
- *Neil Weste and David Harris," CMOS VLSI Design: A Circuits and Systems Perspective, 3rd or 4th Edition.*

| Course title | Advanced engineering mathematics | | | | Course Code | ECE513 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Mathematical Modeling and Engineering Problem Solving; Overview of Programming and Software; Approximations and Round-Off Errors; Truncation Errors and the Taylor Series; Bracketing Methods (Graphical Methods, The Bisection Method, The False-Position Method); Open Methods (Simple Fixed-Point Iteration, The Newton-Raphson Method, Systems of Nonlinear Equations); Computing with Polynomials; Root Location with Software Packages; Case Study: Design of an Electric Circuit; Gauss Elimination; Nonlinear Systems of Equations; Gauss-Jordan; LU Decomposition and Matrix Inversion; Error Analysis and System Condition; Linear Algebraic Equations with Software Packages; Application of Linear Algebraic Equations to Currents and Voltages in Resistor Circuits; One-Dimensional Unconstrained Optimization; Multidimensional Unconstrained Optimization; Constrained Optimization; Maximum Power Transfer for a Circuit; Least-Squares Regression; Interpolation.

**References:**

- *Steven C. Chapra, Raymond P. Canale, " Numerical Methods for Engineers," 7th Edition, McGraw-Hill Education, 2015.*
- *Steven Chapra, "Applied Numerical Methods with MATLAB for Engineers and Scientists," McGraw-Hill Higher Education, 2006*

| Course title | Advanced digital signal processing | | | | Course Code | ECE541 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Discrete-Time Signals; Discrete-Time Systems; Analysis of Discrete-Time Linear Time-Invariant Systems; Discrete-Time Systems Described by Difference Equations; Implementation of Discrete-Time Systems; Correlation of Discrete-Time Signals; The z-Transform and Its Application to the Analysis of LTI Systems; Frequency Analysis of Discrete-Time Signals; Frequency-Domain Characteristics of Linear Time-Invariant Systems; Frequency Response of LTI Systems; Linear Time-Invariant Systems as Frequency-Selective Filters; Inverse Systems and Deconvolution; Sampling and Reconstruction of Signals; Properties of the DFT; Linear Filtering Methods Based on the DFT; Structures for FIR Systems; Structures for IIR Systems; Design of FIR Filters; Design of IIR Filters From Analog Filters; Frequency Transformations; Multirate Digital Signal Processing; Applications of Multirate Signal Processing; Digital Filter Banks; Linear Prediction and Optimum Linear Filters; Adaptive Filters.

**References:**

- *Proakis & Manolakis," Digital Signal Processing: Principles, Algorithms and Applications," 4$^{th}$ Edition, Prentice Hall, 2003.*
- *Simon Haykin," Modern Filters," Macmillan Publishing Company, 1989.*

<table>
<tr><td>Course title</td><td colspan="4">Technical writing and communication skills</td><td>Course Code</td><td>ECE 513</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td colspan="2">0</td><td>50</td><td>50</td></tr>
</table>

**<u>Contents:</u>**
Studying skills- active reading- Optimal writing- Technical writing- References-Web design- Printing- Proposals- Articles- Thesis- Conference publication.

**<u>References:</u>**
- *Adair, John. Effective Communication. London: Pan Macmillan Ltd., 2003. ❑ Ajmani, J. C. Good English: Getting it Right... .*
- *Hasson, Gill. Brilliant Communication Skills. Great Britain: Pearson. Education, 2012. ❑ Hughes, Shirley... .*
- *Raman, Meenakshi & Sangeeta Sharma. Technical Communication: Principles and Practice.*

<table>
<tr><td>Course title</td><td colspan="4">Microwave Engineering</td><td>Course Code</td><td>ECE 551</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td colspan="2">10</td><td>40</td><td>50</td></tr>
</table>

**<u>Contents:</u>**
Analysis carrier modulation circuits – Planar microwave circuits - Microwave waveguides - Power comparators and dividers – Microwave filters- Non-magnetic elements – Microwave integrated circuits noise in microwave circuits – Amplifier design – Mixers – Oscillators.

**<u>References:</u>**
- *Frank Gustrau, RF and Microwave Engineering, Fundamentals of wireless communications*

**<u>Level (600)</u>**

<table>
<tr><td>Course title</td><td colspan="4">Research skills and ethics</td><td>Course Code</td><td>ECE 612</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td colspan="2">0</td><td>50</td><td>50</td></tr>
</table>

**<u>Contents:</u>**
Effective reading – Best writing methodology – technical writing – references – web writing – abstract, papers, and thesis writing – presenting in conference – Latex - Basic principles of scientific research ethics and copyrights

**<u>References:</u>**
- *Hansrudi Lenz, Scientific ethics and publishing conduct, Feb 2014*

| Course title | Numerical methods in electromagnetics | | | | Course Code | ECE 653 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

**Contents:** Vector space – Approximation methods – spectral analysis methods – moments methods and its application in antennas and wave guides – Finite elements method and its applications in wave propagation – Surface elements method – Difference method in time domain and its applications.

**References:**

*1) Mattew N. O. Sadiku, Numerical Electromagnetics with MATLAB, 3rd. ed. 2020*

*2) C. Neal Stewart Jr., Research Ethics for Scientists: A Companion for Students, John Wiley & Sons, Ltd, sep. 2011.*

| Course title | Research Project | | | | Course Code | ECE612 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 2 | 2 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 30 | | 70 | 0 | | |

**Contents**

Study and research in the field electronics and communications including a documented report, a simulation of results, and a presentation – Fields of study include but not limited to: Wireless communications – Cellular communications - Optical communications – Radio Communications – Satellite communications - Wireless sensor networks - Computer networks – Network security – Software defined radio- cognitive networks - Analog integrated circuit design – Digital integrated circuit design – Advanced circuit design – Nanoelectronics – Optoelectronics – Biomedical electronics – Solid state electronics – Photonics – Nanophotonics – Antenna and wave propagation – Microwave – Information theory – Digital signal processing – Image processing – Medical image analysis – Internet of things (IOT) – Energy harvesting – Deep learning – Quantum computations – Pattern recognition and machine learning

**References:**

- ***Egyptian Knowledge Bank: Books, Journals, Theses, and proceedings***
- ***Google Scholar: Books, Journals, Theses, and proceedings***
- ***IEEE transactions and conferences***

| Course title | Analog Integrated Circuit Design | | | | Course Code | ECE631 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Integrated circuit devices and modeling - Processing and layout - Frequency response of electronic Circuits - Feedback amplifiers - Wide-frequency-band amplifiers - Basic operational amplifier design and compensation - Biasing – Referencing – Regulators – Bipolar devices and circuits- Noise analysis and modeling – Linearity analysis and modeling- Design and construction of comparator circuits – Sample-and-hold circuits – Translinear circuits – Continuous-time filters- Differential amplifier circuits – Discrete-time signals – Switched capacitor circuits – Data converter fundamentals – Nyquist rate digital to analog (D/A) converters - Nyquist rate analog to digital (A/D) converters – Oversampling converters –Phase locked loops – CMOS devices and circuits – Simulation of analog circuits - Introduction to analog IC design software tools – Advances in analog IC design

**References:**

- *Baker, R. Jacob. CMOS: circuit design, layout, and simulation. John Wiley & Sons, 2019.*
- *Martins, Ricardo, Nuno Lourenço, and Nuno Horta. Analog Integrated Circuit Design Automation. Springer, 2017.*
- *Gray, Paul R., and Robert G. Meyer. "Analysis and design of analog integrated circuits." (2017).*
- *Johns, David A., and Ken Martin. Analog integrated circuit design. John Wiley & Sons, 2008.*

| **Course title** | **Advanced Optical Electronics** | | | | **Course Code** | ECE632 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Rays and optical beams – Propagation, modulation, and oscillation in optical dielectric waveguides and optical fibers - Optical resonators – Interaction of radiation and atomic systems – Theory of laser oscillation – Specific laser systems – Dispersion in fibers - Nonlinear optics - Integrated Detectors- photo-diode - Carrier fusion - Opto-electric modulation of laser beams - Errors and SNR in optical systems - Analysis of optical amplifiers- Devices and materials of liquid crystals - Solar cells – Opto-electronics integrated circuits - Interaction of light and sound – laser applications - Semiconductor lasers: theory and applications – quantum wall laser - Phase conjugate optics: theory and applications – Simulation of optoelectronic circuits - Introduction to software tools related to optoelectronic - Advances in optoelectronics

**References:**

- *Jixiang Yan, Optical Electronics: An Introduction, Series: De Gruyter Textbook Together with Tsinghua University Press, 2019, DOI: https://doi.org/10.1515/9783110500608*
- *Yoshimura, Tetsuzo. Optical Electronics: Self-Organized Integration and Applications. CRC Press, 2012.*
- *Amnon Yariv and Pochi Yeh, Photonics: Optical Electronics in Modern Communications (The Oxford Series in Electrical and Computer Engineering) 6th Edition, 2007*
- *Yariv, Amnon. Optical electronics. Saunders College Publ., 1991.*

| **Course title** | **Nanoelectronics** | | | | **Course Code** | ECE633 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Fundamentals of nanoelectronics- Nano CMOS modeling – Nano CMOS technology – Nanocapacitors – Terahertz systems and devices - Electron tunneling devices- Single electron transistors- Nanoelectronics using super conductors – Quantum electronic devices- Quantum cellular automata - Molecular electronics - Quantum mechanical aspects – Nanodefects – Nanolayers –Nanoparticles – Memristors – Resistive switches – Nanomemories – Graphene preparation and properties - Graphene devices – Graphene nanotube applications – Carbon nanotube transistor modeling - Carbon nanotube transistor fabrication – Random carbon nanotube network transistors – Nanoredundant systems – Nanowire fabrication – Nanowire applications – Nanowire transistors – Nanomagnetic logic – Spintronics – Introduction to nanomedics - Nanodevice modeling - Simulation of nanoelectronic circuits - Introduction to software tools related to nanoelectronics - Advances in nanoelectronics

**References:**


- *Raza, Hassan. Nanoelectronics Fundamentals: Materials, Devices and Systems. Springer, 2020.*
- *Ismail, Razali, Mohammad Taghi Ahmadi, and Sohail Anwar, eds. Advanced nanoelectronics. CRC Press, 2018.*
- *Puers, Robert, Livio Baldi, Marcel Van de Voorde, and Sebastiaan E. Van Nooten, eds. Nanoelectronics: Materials, Devices, Applications, 2 Volumes. John Wiley & Sons, 2017.*
- *Morris, James E., and Krzysztof Iniewski, eds. Nanoelectronic device applications handbook. CRC Press, 2017.*
- *Weiner, R. (Ed.). (2005). Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices. Wiley-VCH.*


| **Course title** | **Solid-state Electronics** | | | | **Course Code** | ECE634 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Electronic structure of atoms – The carbon atom – Crystalline properties of solids – Periodic structures – Wave motion of electrons in materials - Introduction to quantum mechanics- Electron and energy band structures in crystals - Carrier theory- Negative resistance- Homogeneous semiconductor at equilibrium- Drift, diffusion, generation, recombination, trapping and tunneling - Field effect transistors - bipolar junction transistors- Metal oxide semiconductor (MOS) devices- High field and short channel effects- Device model and its effect on analog and digital circuits- Solar energy harvesting – Applications of solid state electronics - Simulation of solid state electronic circuits - Introduction to software tools related to solid state electronics - Advances in solid state electronics

**References:**


- *Van der Ziel, Aldert. Solid state physical electronics. Prentice Hall, 2018.*
- *Papadopoulos, Christo. "Solid-State Electronic Devices." Undergraduate Lecture Notes in Physics, New York, NY: Springer New York (2014).*
- *Razeghi, Manijeh. Fundamentals of solid state engineering. Springer Berlin Heidelberg, 2006.*
- *Tang, Chung Liang. Fundamentals of quantum mechanics: for solid state electronics and optics. Cambridge University Press, 2005.*
- *Streetman, B.G. and Banerjee, S., 1995. Solid state electronic devices (Vol. 4). Englewood Cliffs, NJ: Prentice hall.*

| **Course title** | **Advanced Digital Image Processing** | | | | **Course Code** | ECE641 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Fundamentals of digital image processing – Introduction to basic mathematical tools used in digital image processing – Intensity transformation and spatial filtering – Using fuzzy techniques in digital image processing – Filtering in frequency domain – Image restoration and reconstruction – Wavelet and other image transforms – Color image processing – Image compression and watermarking – Morphological image processing – Image segmentation – Edge detection – Active contours – Image registration – Feature extraction – Image pattern classification - Medical imaging modalities – Image processing and parallel programming using python – Simulation of digital image operations and processing techniques - Practicing software tools to analyze and process digital imaging - Advances in digital image processing

**References:**


- *Chityala, Ravishankar, and Sridevi Pudipeddi. Image processing and acquisition using Python. CRC Press, 2020.*
- *Gonzalez, Rafael C., Richard Eugene Woods, and Steven L. Eddins. Digital Image Processing Using MATLAB 3rd edition, 2020.*
- *Gonzalez, Rafael C., Richard Eugene Woods, Digital Image Processing (4th Edition) 4th Edition, 2017*


| **Course title** | **Pattern Recognition and Machine Learning** | | | | **Course Code** | ECE642 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Supervised Learning - Unsupervised Learning – Machine learning – Neural networks in pattern recognition – Deep learning – Convolutional Neural networks - Linear Regression - Weighted Least Squares - Logistic Regression - Netwon's Method – Statistical pattern recognition - Generalized Linear Models - Laplace Smoothing. Support Vector Machines - Support Vector Machines. Kernels - Neural Networks - K-Means. GMM (non EM) - Expectation Maximization - Principal Component Analysis - Pattern recognition and machine learning techniques for image processing and analysis - Image recognition problem – Spatial recognition – Search techniques – Feature extraction - Artificial intelligence –Machine vision – Pattern recognition and machine learning using python – Simulation of pattern recognition and machine learning techniques - Practicing software tools for pattern recognition and machine learning - Advances in pattern recognition and machine learning

**References:**


- *Alpaydin, E. (2020). Introduction to machine learning. MIT press.*
- *Fu, King-Sun. Applications of pattern recognition. CRC press, 2019.*
- *Mohri, Mehryar, Afshin Rostamizadeh, and Ameet Talwalkar. Foundations of machine learning.*

*MIT press, 2018.*
- *Raschka, Sebastian, and Vahid Mirjalili. Python machine learning. Packt Publishing Ltd, 2017.*
- *Fukunaga, K. (2013). Introduction to statistical pattern recognition. Elsevier.*
- *Bishop, C. M. (2006). Pattern recognition and machine learning. springer*

| **Course title** | **Selected topics in Electronics** | | | | **Course Code** | ECE 635 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Course content will be selected each semester from current developments in the field of electronics engineering. Nanotechnology for Electronics, Biosensors, and Emerging Technologies, Wide Bandgap Semiconductor Electronics and Devices, High Performance Logic and Circuits for High-Speed Electronic Systems, High Performance Materials and Devices for High-Speed Electronic Systems. Scaling and Integration of High-Speed Electronics and Optomechanical Systems. Physics and Modeling of Tera- and Nano-Devices

**References**:

- *Bakir, M.S., King, C., Sekar, D., Thacker, H., Dang, B., Huang, G., Naeemi, A. and Meindl, J.D., 2008, September. 3D heterogeneous integrated systems: Liquid cooling, power delivery, and implementation. In 2008 IEEE Custom Integrated Circuits Conference (pp. 663-670). IEEE.*
- *Viveros, R.D., Zhou, T., Hong, G., Fu, T.M., Lin, H.Y.G. and Lieber, C.M., 2019. Advanced one-and two-dimensional mesh designs for injectable electronics. Nano letters, 19(6), pp.4180-4187.*
- *Borlase, S. ed., 2016. Smart grids: infrastructure, technology, and solutions. CRC press.*
- *Peng, C., Sun, H., Yang, M. and Wang, Y.L., 2019. A survey on security communication and control for smart grids under malicious cyber attacks. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 49(8), pp.1554-1569.*

| **Course title** | **Selected topics in Communications** | | | | **Course Code** | ECE 625 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Course content will be selected each semester from current developments in the field of communication engineering Signal Modeling for Audio-Visual Communication. Scene Analysis for Audio-Visual Content. Machine learning for audiovisual processing. Efficient data representation and Sparse Models for Audio-visual communication. The selection of topics might depend somewhat on the interests of the participants, but will typically include: Statistic modeling and analysis of fading channels, MIMO systems, space-time coding, multiple-access techniques in cellular systems, opportunistic and cooperative transmission schemes, interference-limited wireless networks, and link adaptation in wireless systems.

**References:**
- *Karthika, R. and Balakrishnan, S., 2015. Wireless communication using Li-Fi technology. SSRG International Journal of Electronics and Communication Engineering (SSRG-IJECE), 2(3), pp.32-40.*
- *Vahdat-Nejad, H., Ramazani, A., Mohammadi, T. and Mansoor, W., 2016. A survey on context-aware vehicular network applications. Vehicular Communications, 3, pp.43-57.*

| Course title | Advanced wireless Communications | | | | Course Code | ECE 621 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

***Contents***

This course provides knowledge on a number of advanced topics in wireless communication and related technologies. Students will gain an in-depth understanding of topics such as wireless channel characterization and characteristics, modeling, channel amplitude estimation, and digital modulation techniques. Complex topics such as fading and diversity techniques (such as time, place, and frequency), interference, error control coding, and power control will be visited. Other advanced topics covered include multi-carrier modulation, propagation spectrum, antenna arrays, smart antenna technologies, multiple I / O systems.

**References**:
- *Savo G. Glisic, Advanced Wireless Communications: 4G Technologies, ISBN: 978-0-470-86777-27 April 2004*
- *Karun Rawat, Patrick Roblin, Shiban Kishen Koul, Bandwidth and Efficiency Enhancement in Radio Frequency Power Amplifiers for Wireless Transmitters, April 2020*

| Course title | Advanced Communications Networks | | | | Course Code | ECE 622 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

***Contents:***

The objective of this course is to develop an understanding of some basic techniques used for modeling and analyzing communication networks. The course will address the development of analytical tools and conceptual models in describing the protocols used in existing networks. However, some of the existing protocols will be used to clarify the concepts. These analytical tools are used to analyze the performance of different networks. Also the content will focus on topics such as structuring computer networks - OSI model - data link layer - SS7 protocol - high speed networks - quality of service - Internet Protocol - distribution protocols - wide networks - software defined networks - network security

**References:**
- *D. Bertsekas and R. Gallager, Data Networks, Prentie Hall, 2nd edition, 1992*
- *B. Hajek, Notes for ECE 567: Communication Network Analysis, available on-line*

*Selected Journal Articles and supplementary notes.*

| **Course title** | **Advanced Cellular Communications** | | | | **Course Code** | ECE 623 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

***Contents:***

Mobile communication systems are among the fastest growing sectors of the global economy, and massive developments are expected to lead in the next decade. Modern mobile communication systems use advanced wireless communication technologies and network technologies / protocols to provide high quality and high-quality services for a variety of mobile applications. The course aims to cover a number of key advanced concepts that are used either in modern mobile communications systems or are expected to be published in the future. The topics will address the description and analysis of UMTS, LTE and LTE-Advanced Networks: Learning outcomes of the topic: - The ability to analyze, design and implement the latest structures and protocols and communication interfaces for mobile communication systems. - The ability to analyze, model and apply advanced mobile technology.

**References**


- *Rony Kumer SAHA, Advanced mobile communications, July 2016*


| **Course title** | **Advanced Optical Communications** | | | | **Course Code** | ECE 624 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

***Contents:***

Advanced techniques and methods that enhance the overall performance and productivity of the optical transmission system, and trade-offs in the system engineering process. Topics include advanced color dispersion compensation, PMD compensation, and nonlinear management. Spectral efficiency limits will be described as well as techniques to achieve them, such as turbo equation, forward error correction and encoded coding. Advanced modulation formats, such as various multilevel configurations and OFDM, and restrictive coding techniques suitable for dealing with nonlinear fibers. The physics underlying parameter amplification, as well as their application to optical renewal, wavelength transformation and multi-band switching. Other topics include soliton and soliton transport managed by dispersions and detectors - photodiode - carrier fusion - laser - electrophoresis optical modulation - errors and SNR in optical systems - optical amplifier analysis - liquid crystal devices and materials - solar cells - opto-electronics integrated circuits

**References:**


- *Milorad Cvijetic, Advanced Optical Communication Systems and Networks, 16 Dec 2020*


| **Course title** | **Advanced Antenna Systems** | | | | **Course Code** | ECE 651 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

The advanced techniques required to analyze the antenna systems are studied in detail. Fourier transforms are reviewed and applied to the antenna theory and array distribution. The method of time differences is studied and used to solve basic integral equations using different basic functions. Green functions of the patch antennas are formulated in terms of Sommerfeld-like integrals. Technologies such as saddle point integration are offered. Topics covered include computational electromagnetism, leakage and surface waves, mutual coupling, and Floquet patterns. The course topics also address the method of placement and application in wired antennas - micro-chip antennas - microwave-wave antennas - analysis and construction of antenna arrays - separate matrices and aperture antenna - synthetic and lace antenna antennas - deviations and correction method - waveguide antennas antennas

***Reference:***

- *Henrik Asplund David Astely Peter von Butovitsch Thomas Chapman Mattias Frenne Farshid, Ghasemzadeh Måns Hagström Billy Hogan George Jöngren Jonas Karlsson Fredric Kronestedt Erik Larsson, advanced antenna systems, june 2020.*
- *Mohammad Abdul Matin, Modern Antenna Systems, 2017*

| **Course title** | **Nanophotonics** | | | | **Course Code** | ECE 652 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Introduction to nanophotonics - nanophotonics properties of engineered materials (insulators, semiconductors, and metals). Determination of the near field and its applications - Devices (laser - detectors - sensors) - Basics of Maxwell's equations, light interaction with materials, study of dispersion and electromagnetic properties of nanostructures. It also includes the study of photon structures, optical fibers with photon structures, nanophotonic circuits, optical minerals and manufactured materials with negative refractive factors such as meta materials and nanoparticles. This course also covers the latest research findings in nanophotonics.

**References:**

- *Paras N. Prasad, Nanophotonics, March 2004*
- *Sergey V. Gaponenko, Introduction to nanphotonics, 2012*

## Level (700)

| **Course title** | **Advanced Optimization Methods** | | | | **Course Code** | ECE 711 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Convex sets, convex functions, Examples of discrete and continuous optimization problems: classification and learning problems (least squares, LASSO, SVM), maximum flows and minimum cuts, maximum cut, minimum independent set, Optimality conditions for general and convex problems , Gradient descent for smooth and strongly convex functions , Prediction using expert advice: majority algorithms, multiplicative weights update algorithm, Applications of multiplicative weights update framework, online optimization and learning, Introduction to discrete optimization, Submodular functions and optimization, Projection, separating hyperplanes, polyhedral sets, Karush-Kuhn-Tucker conditions - Lagrangian duality - Semi-definite programming - Computational complexity - Approximation algorithms– stochastic optimization – multi-objective optimization - Evolutionary Optimization Algorithms.

**References:**
- *Yang, X.S., 2018. Optimization techniques and applications with examples. John Wiley & Sons.*
- *Boyd, S., Boyd, S.P. and Vandenberghe, L., 2004. Convex optimization. Cambridge university press.*

| Course title | Millimeter Wave Technology | | | | Course Code | ECE 751 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Introduction to Millimeter-Wave Technology- Characteristics of millimeter wave communications - Guiding Structures and interconnects at millimeter-wave frequencies -Millimeter wave bands – Millimeter Wave Propagation-Antennas at MM-Wave Frequencies: Design of millimeter-wave feeds, metasurface antennas, horn antennas, and low-profile antennas - Millimeter Wave Components-Passive components: diplexers, ortho-mode transducers, quadrature hybrids, and other structures at millimeter wave- Active components: millimeter wave mixers and frequency multipliers using GaAs Schottky diodes-Design and fabrication of millimeter-wave components-Direct conversion receiver Millimeter Wave Devices-Millimeter channel modeling – Millimeter-Wave Systems-Noise and Link Budget-Millimeter waves antenna design – massive MIMO – millimeter waves design issues – Directional transmission- Modeling and analysis for mmW technology, Gradient descent for smooth and strongly convex functions , Prediction using expert advice: majority algorithms, multiplicative weights update algorithm, Applications of multiplicative weights update framework, online optimization and learning, Introduction to discrete optimization, Submodular functions and optimization, Projection, separating hyperplanes, polyhedral sets, Karush-Kuhn-Tucker conditions - Lagrangian duality - Semi-definite programming - Computational complexity - Approximation algorithms– stochastic optimization – multi-objective optimization - Evolutionary Optimization Algorithms.

**References:**
- *Rappaport, T.S., Heath Jr, R.W., Daniels, R.C. and Murdock, J.N., 2015. Millimeter wave wireless communications. Pearson Education.*
- *Va, V., Shimizu, T., Bansal, G. and Heath Jr, R.W., 2016. Millimeter wave vehicular communications: A survey. Foundations and Trends® in Networking, 10(1), pp.1-118.*
- *Liu, D., Pfeiffer, U., Grzyb, J. and Gaucher, B. eds., 2009. Advanced millimeter-wave technologies: antennas, packaging and circuits. John Wiley & Sons*

| Course title | Network Security | | | | Course Code | ECE 721 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Foundations of Network Security- Advanced TCP/IP- IP Packet Structure and Analysis- Routing and Access Control Lists- Securing Windows- Securing Linux- Security on the Internet and World Wide Web- Attack Techniques- Network Defense Fundamentals- Designing and Configuring Firewall Systems- Configuring VPN's- Designing an IDS- Analyzing Intrusion Signatures- Performing a Risk Analysis- Creating a Security Policy- Cryptography Fundamentals - Strong Authentication- Digital Signatures- PKI Standards- PKI Fundamentals- Biometrics Fundamentals- Sign-On Solutions- Secure E-Mail Implementation- File Encryption Solutions- PKI Solutions and Applications- Legal Issues of

Network Security- Network Forensics- Physical Security- Business Continuity Planning (BCP) and Disaster Recovery Planning (DRP)- security issues for IOT- Law, Investigations and Ethics.

**References:**

- *Forouzan, B.A., 2007. Cryptography & network security. McGraw-Hill, Inc.*
- *Network Security: Current Status and Future Directions, Christos Douligeris, Dimitrios N. Serpanos – 2007.*
- *Network Security, Firewalls and VPN, J. Michael Stewart – 2013*

| **Course title** | **Advanced Data Analysis** | | | | **Course Code** | ECE 741 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Review of Statistics Basics-Data collection - Statistical intervals - Hypothesis testing - linear regression and correlation - Design of experiments with single or several factors – big data analytics – Big data tools-Data Summarization and Visualization-Linear and Nonlinear Regression-Model Selection-Classification, Logistic Regression- Clustering-Decision Trees-graphical models-Exploring Data with Graphs-Comparing Several Means: ANOVA-Analysis of Covariance (ANCOVA)- Factorial ANOVA-Causal Modeling: Path Analysis and Structural Equation Modeling. Graph structure learning - Graph mining -Graph modeling-Time series analysis Spatial time series analysis-Massive Data Analytics: parallel algorithms -Massive Data Analytics: online learning algorithms-Massive Data Analytics: locality sensitive hashing-Parallel programming. Applications of Data analysis in machine learning and pattern recognition-Natural language processing.

**References:**

- *Advanced Statistical Methods for the Analysis of Large Data-Sets, Agostino Di Ciaccio, Mauro Coli, Jose Miguel Angulo Ibanez – 2012.*
- *Dietrich, D., 2015. Data science and big data analytics: Discovering, analyzing, visualizing and presenting data. John Wiley & Sons*

| **Course title** | **Quantum Optics** | | | | **Course Code** | CE 752 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

the quantum description of optics, lasers, and coherent optical processes-quantum nature of light-notion of a photon- photon detection processes- coherent and squeezed states of the radiation field, lasers, and nonlinear optics- single-frequency lasers-single-photon sources-photon counters-optical cooling-squeezed states generators- quantum computing-teleportation-cryptography-Classical and quantic description of electromagnetic radiation-Radiative transitions-Einstein's coefficients, transition rates - Width and shape of spectral lines-Lasers and masers; oscillations, modes and properties-Photon statistics-"Bunching" and "antibunching" of photons-Coherent states-Interaction of light with matter-Superposition of coherent states and density matrix- Resolution of time-dependent Schrodinger's equation-Resonant processes-Weak field and Einstein's coefficients-String field: Rabi's oscillations, dampening-Atoms in cavities-Optical cavities, coupling atom/cavity-Weak limit and spontaneous emission, Purcell's effect-Quantum electrodynamics of the strong coupling and experimental results-Applications Doppler cooling-Magneto-electric traps.

**References:**

- *Ficek, Z. and Wahiddin, M.R., 2014. Quantum optics for beginners. CRC Press.*
- *Fox, M., 2006. Quantum optics: an introduction (Vol. 15). OUP Oxford.*

<table>
<tr><td>Course title</td><td colspan="4">Photonics Integrated Circuits</td><td>Course Code</td><td>ECE 731</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td colspan="2">10</td><td>40</td><td>50</td></tr>
</table>

**Contents**

Fundamental concepts and operating principles of silicon photonics devices and circuits-Design of primary passive and active silicon photonics devices, circuits and interconnect-optical waveguide theory- Optical switching technologies -Optical transceiver technologies-Design of photonic integrated devices-Photonic integrated devices manufacturing -Theory and techniques for photonic integrated devices-photonic integrated circuits (PICs) for telecomm and data comm-material systems, especially silicon photonics and indium phosphide photonics-main steps in producing a PIC-pros and cons of PICs-silicon photonics design requirements and challenges for emerging applications, such as neural networks and LIDAR. Photonic Applications using Simulation tools from Lumerical Inc- Application of silicon photonics in high-performance computing-Lumerical MODE, FDTD, INTERCONNECT (simulations) and Klayout for chip layout design and verification.

**References:**

- *Coldren, L.A., Corzine, S.W. and Mashanovitch, M.L., 2012. Diode lasers and photonic integrated circuits (Vol. 218). John Wiley & Sons.*
- *Chrostowski, L. and Hochberg, M., 2015. Silicon photonics design: from devices to systems. Cambridge University Press*

<table>
<tr><td>Course title</td><td colspan="4">Advanced Integrated Circuits Design</td><td>Course Code</td><td>ECE 732</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td colspan="2">10</td><td>40</td><td>50</td></tr>
</table>

**Contents**

introduction to CMOS devices and circuits -Compact modeling for circuit simulations - Quantitative evaluations of performance -Intuitive approaches to design - Treatment of advanced MOS and bipolar technologies - Archtypical analog blocks such as broadband gain stages and transimpedance amplifiers – radio frequency IC design-Designing emerging nanoelectronic devices-Future computers. The memory and logic architectures- Analytical and approximate treatments of signal integrity and timing issues, as well as power consumption. Effects of device scaling on device and circuit performance-Low resistance contacts to nanoscale devices-Future technology evolution such as SOI, nanowires and graphene-Interconnect technology such as metal interconnects and low-k dielectrics-3D heterogeneous integration.

**References:**

- *Baschirotto, Andrea, Pieter Harpe, and Kofi AA Makinwa, eds. Next-Generation ADCs, High-Performance Power Management, and Technology Considerations for Advanced Integrated Circuits: Advances in Analog Circuit Design 2019. Springer Nature, 2019.*
- *Gray, P.R., Hurst, P.J., Lewis, S.H. and Meyer, R.G., 2009. Analysis and design of analog integrated circuits. John Wiley & Sons.*
- *Pavlidis, V.F., Savidis, I. and Friedman, E.G., 2017. Three-dimensional integrated circuit design. Newnes.*

| Course title | Advanced Wireless Communications Networks | | | | Course Code | ECE 722 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Wireless channel models – spectral efficiency and implementation complexity, power efficiency and green communication - multiple antenna techniques- diversity and multiplexing gains- multiple-input multiple-output (MIMO) systems - OFDM – space division multiple access - 4G networks – 5G networks – Ad hoc networks- Wireless application protocol-Mesh networks-Mobile IP and mobile IPv6 -Mobile security-Emerging wireless systems and wireless references technologies: cognitive radio, SDR, WRAN, etc- network monitoring and efficient resource management- power allocation and control- Routing protocols for Wireless Networks- Wireless radio resource management (RRM)- rate adaptation-handover- Performance analysis of remotely hosted communications, metric interpretation, QoS metrics and techniques based on requirements of delay sensitive wireless Internet applications.

**References:**

- *Glisic, S.G., 2004. Advanced wireless communications. Wiley-InterScience.*
- *Bliss, D.W. and Govindasamy, S., 2013. Adaptive wireless communications: MIMO channels and networks. Cambridge University Press.*
- *Kyriazakos, S., Soldatos, I. and Karetsos, G., 2008. 4G Mobile & Wireless Communications Technologies. River Publishers.*
- *Osseiran, A., Monserrat, J.F. and Marsch, P. eds., 2016. 5G mobile and wireless communications technology. Cambridge University Press.*

| Course title | Selected topics in Electronics and Communications Engineering | | | | Course Code | ECE 712 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 10 | | 40 | 50 | | |

**Contents**

Li-Fi based Wireless Communication- vehicular network applications-internet of things (IOT)-Ingestible electronics- HAM communication- Next generation backscatter communication: systems, techniques, and applications- Multimedia Big Data Computing for IoT Applications- Cloud Computing Trends- Flexible and stretchable antennas- LEO/MEO intersatellite optical wireless communication systems- spectrum sharing scheme for the next generation communication systems- Multi-tier computing networks- Towards Deep Integration of Electronics and Photonics- High-speed electronics for silicon photonics transceivers- Biomedical electronics powered by solar cells-Deep learning for health care challenges- Carbon nanotubes: An effective platform for biomedical electronics- nanoscale devices- 3D heterogeneous integrated circuits- Injectable Electronics- Smart Grids Technologies- cyber-attacks in smart grids.

**References:**

- *Gubbi, J., Buyya, R., Marusic, S. and Palaniswami, M., 2013. Internet of Things (IoT): A vision, architectural elements, and future directions. Future generation computer systems, 29(7), pp.1645-1660.*
- *Steiger, C., Abramson, A., Nadeau, P., Chandrakasan, A.P., Langer, R. and Traverso, G., 2019. Ingestible electronics for diagnostics and therapy. Nature Reviews Materials, 4(2), pp.83-98.*
- *Wulff A. (2019) Ham Nets, Volunteering, and More. In: Beginning Radio Communications. Apress, Berkeley, CA.*

- *Liu, W., Huang, K., Zhou, X. and Durrani, S., 2019. Next generation backscatter communication: systems, techniques, and applications. EURASIP Journal on Wireless Communications and Networking, 2019(1), pp.1-11.*
- *Tanwar, S., Tyagi, S. and Kumar, N., 2020. Multimedia Big Data Computing for IoT Applications. Springer Singapore.*
- *Varghese, B. and Buyya, R., 2018. Next generation cloud computing: New trends and research directions. Future Generation Computer Systems, 79, pp.849-861.*
- *Xie, Z., Avila, R., Huang, Y. and Rogers, J.A., 2020. Flexible and stretchable antennas for biointegrated electronics. Advanced Materials, 32(15), p.1902767.*
- *Rashed, A.N.Z., Tabbour, M.S.F. and Natarajan, K., 2020. Performance enhancement of overall LEO/MEO intersatellite optical wireless communication systems. International Journal of Satellite Communications and Networking, 38(1), pp.31-40.*
- *Attiah, M.L., Isa, A.A.M., Zakaria, Z., Abdulhameed, M.K., Mohsen, M.K. and Ali, I., 2019. A survey of mmWave user association mechanisms and spectrum sharing approaches: an overview, open issues and challenges, future research trends. Wireless Networks, pp.1-28.*
- *Yang, Y., 2019. Multi-tier computing networks for intelligent IoT. Nature Electronics, 2(1), pp.4-5.*
- *Pshenichnyuk, I.A., Kosolobov, S.S. and Drachev, V.P., 2019. Towards Deep Integration of Electronics and Photonics. Applied Sciences, 9(22), p.4834.*
- *Bauwelinck, Johan, Peter Ossieur, Gunther Roelkens, Michael Vanhoecke, Joris Lambrecht, Hannes Ramon, Laurens Breyne et al. "High-speed electronics for silicon photonics transceivers." In Integrated Photonics Platforms: Fundamental Research, Manufacturing and Applications, vol. 11364, p. 113640I. International Society for Optics and Photonics, 2020.*
- *Wangatia, L.M., Yang, S., Zabihi, F., Zhu, M. and Ramakrishna, S., 2020. Biomedical electronics powered by solar cells. Current Opinion in Biomedical Engineering, 13, pp.25-31.*
- *Wang, F., Casalino, L.P. and Khullar, D., 2019. Deep learning in medicine—promise, progress, and challenges. JAMA internal medicine, 179(3), pp.293-294.*
- *Deshmukh, M.A., Jeon, J.Y. and Ha, T.J., 2020. Carbon nanotubes: An effective platform for biomedical electronics. Biosensors and Bioelectronics, 150, p.111919.*
- *Anantram, M.P., Lundstrom, M.S. and Nikonov, D.E., 2008. Modeling of nanoscale devices. Proceedings of the IEEE, 96(9), pp.1511-1550.*

# Chapter SIX:

## Computer and Control Systems Engineering Department

## Diploma in Computer and Control Systems Engineering (Specialist in Computer Engineering)

**Program description**

The program introduces the fundamentals, techniques and advanced in the field of computer engineering. The objective of the diploma in Computer Engineering Program have the following Objectives: **1)** Students will have excessive and long vision careers in computer engineering arenas or will be intelligent to successfully pursue advanced degrees. **2)** Students will able to offer the solutions of inexpensive problems by applying computer engineering theory and practices. **3)** Participate in life-long learning through the successful completion of advanced degree(s), continuing education, and/or engineering certification(s)/licensure or other professional development.

**Competencies for the program graduate**

In addition to generic competencies for the Engineering science Diploma, the graduate of Engineering science Diploma in Computer and Control Systems Engineering (Specialist in Computer Engineering) must be able to:

1) The ability to deal with the daily practical needs of life.
2) The ability to analyze data, apply technical tools, and reach the required results.
3) The ability to lay a strong foundation for innovative learning and creative ideas for operating systems
4) Understand (use of database management systems for effective data management, logarithm basics and applications, data structuring)
5) Understand the knowledge and skills needed in building a business in the field of computer engineering and the interfaces of computer peripheral devices.

## Diploma in Computer and Control Systems Engineering (Specialist in Control Systems Engineering)

**Program description**

The objective of the diploma in control Engineering Program have the following Objectives 1) To provide sound foundation in the mathematical, scientific and engineering fundamentals to formulate, solve and analyze problems related to Instrumentation and Control Engineering. 2) To prepare graduates for employment in core / IT industries who are socially responsible and integrated with professional and ethical skills. 3) To prepare graduates to involve in research, higher studies and / or to become entrepreneurs in the long run.

**Competencies for the program graduate**

In addition to generic competencies for the Engineering science Diploma, the graduate of Engineering science Diploma in Computer and Control Systems Engineering (Specialist in Control Systems Engineering) must be able to:

1- Apply scientific and engineering principles to solving multidisciplinary problems in technological areas associated with Modern control theory.
2- Assimilate and synthesize existing knowledge in a specialized subfield of control engineering and to critically analyze and evaluate research, their own and that of others in the control engineering systems

3- Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
4- Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
5- Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

For the Diploma **in Computer and Control Systems Engineering (Specialist in Computer Engineering)**
Student have to select from courses in level 500 the courses in the domain 51*, 52*,54*

For the Diploma **in Computer and Control Systems Engineering (Specialist in Control Systems Engineering)**
Student have to select from courses in level 500 the courses in the domain 51*, 53*,54*

## M.Sc. in program Computer and Control Systems Engineering

**Program description**

This program provides a balanced perspective of both hardware and software elements of computing and Automatic control systems, and their relative design trade-offs and applications. It will build on your knowledge in mathematics, science, and engineering to ensure students have a sound foundation in the areas needed for a career in this field. The objective of the Program of M.Sc. in program Computer and Control Systems Engineering is to:

1. Produce specialized computer and/or control engineering expertise through which advanced technologies and their applications
2. Produce researchers who can investigate problems in different application domains (computing or controlling) and creatively develop and evaluate computational solutions.
3. Equip graduates with a strong foundation for further research and discovery work.

**Competencies for the program graduate**

In addition to generic competencies for the M.Sc. in engineering, the graduate of Master of Science in Computer and Control Systems Engineering must be able to:

1. Have an extensiveness of knowledge in different current and advanced computer and control engineering topics.
2. Use appropriate tools and variety of sources to evaluate multiple points of view for analyzing and integrating information to conduct critical reasoned arguments.
3. Be capable of self-learning and comprehending emerging scientific and engineering trends in order to be able to propose specific improvements.
4. Have the scientific and technical knowledge and skills necessary to allow identifying appropriate computing and control problems and formulate corresponding research plans to develop and evaluate computations techniques and models to solve problems in any related discipline.

5. Have the ability to use appropriate techniques, skills, and tools necessary for computing and control practice.

## Ph.D. in Computer and Control Systems Engineering

**Program description**

The Doctor of Philosophy (Ph.D.) program in Computer and Control Systems Engineering is a research-oriented degree program. The objective of this program is to prepare exceptionally qualified individuals for research careers in academia and industry. The program is designed for students who offer evidence of exceptional scholastic ability, intellectual creativity, and research motivation. Its purpose is to advance the knowledge in the fields of computer and control Engineering and enable students of exceptional ability to undertake advanced study and original research. It prepares students for a research and/or teaching career in industry, research institutions, universities, and government. The program has a focus on state-of–art technology issues that cross boundaries of Computer Engineering, Microcontroller, and Communications protocol & Signal Processing.

**Competencies for the program graduate**

In addition to generic competencies for the Ph. D. program, the graduate of Engineering science Ph.D. in Computer and Control Systems Engineering must be able to:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
4. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
5. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

# List of level (500) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| CSE 511 | Advanced Digital Logic Design | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 35 | 15 | 50 | 100 |
| CSE 512 | Advanced Engineering Statistics | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 30 | 10 | 60 | 100 |
| CSE 513 | Technical English | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 40 | 10 | 50 | 100 |
| CSE 514 | Data Structures and Algorithms | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 35 | 15 | 50 | 100 |
| CSE 515 | Advanced Programming | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 35 | 15 | 50 | 100 |
| CSE 516 | Introduction to Computer Design and Architecture | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 35 | 15 | 50 | 100 |
| CSE 517 | Computer Networks | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 35 | 15 | 50 | 100 |
| CSE 518 | Computers Operating Systems | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 35 | 15 | 50 | 100 |
| CSE 519 | Artificial Intelligence and Machine Learning | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 521 | Computer Architecture | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 522 | Computer Systems Performance Evaluation | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 523 | System Analysis and Design | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 524 | Databases Systems | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 525 | Computer Graphics | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 526 | Internet of Things (1) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 527 | Natural Language Processing | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE531 | Introduction to Automatic Control Engineering | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 35 | 15 | 50 | 100 |
| CSE532 | Modern Trends of Control | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE533 | Microprocessor Systems Application | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE534 | Programmable Logic Controllers | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE535 | Mechatronics (2) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE536 | Digital control (1) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE537 | Computer Controlled Systems (1) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE538 | Modern Control Systems | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE541 | Mechatronics (1) | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 35 | 15 | 50 | 100 |
| CSE542 | Systems Engineering | 1 | 1 | 2 | 4 | 2 | 5 | 3 | 35 | 15 | 50 | 100 |
| CSE543 | Advanced Computer Applications | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 544 | Diploma Research Project | 2 | 0 | 3 | 5 | 3 | 6 | * | 50 | - | 50 | 100 |

* Defense

# List of level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| CSE 621 | Software Engineering | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 622 | Data Security and Protection | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 623 | Advanced Computer Architecture (1) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 624 | Distributed Operating Systems (1) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 625 | Distributed Database Systems (1) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 626 | Information Systems | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 627 | Multimedia | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 628 | Computer Networks' Design and Programming | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 629 | Selected Topics in Computer Engineering | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 641 | Image Processing and Computer Vision | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 642 | Cyber Security (1) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 631 | Genetic Algorithms | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 632 | Advanced Computer-controlled Systems (1) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 633 | Design of Adaptive Control Systems (1) | 2 | 1 | 2 | 5 | 3 | 6 | 3 | 35 | 15 | 50 | 100 |
| CSE 634 | Design of Modern Control Systems (1) | 2 | 1 | 2 | 5 | 3 | 7 | 3 | 35 | 15 | 50 | 100 |
| CSE 635 | Design of Optimal Control Systems (1) | 2 | 1 | 2 | 5 | 3 | 7 | 3 | 35 | 15 | 50 | 100 |
| CSE 636 | Design of Self-tuning Control Systems (1) | 2 | 1 | 2 | 5 | 3 | 7 | 3 | 35 | 15 | 50 | 100 |
| CSE 637 | Neural Networks and Fuzzy Logic | 2 | 1 | 2 | 5 | 3 | 7 | 3 | 35 | 15 | 50 | 100 |
| CSE 638 | Nonlinear Control Systems | 2 | 1 | 2 | 5 | 3 | 7 | 3 | 35 | 15 | 50 | 100 |
| CSE 639 | Selected Topics in Control Systems | 2 | 1 | 2 | 5 | 3 | 7 | 3 | 35 | 15 | 50 | 100 |
| CSE 643 | Internet of Things (2) | 2 | 1 | 2 | 5 | 3 | 7 | 3 | 35 | 15 | 50 | 100 |
| CSE 644 | Research Topic in (computer or Control) ** | 2 | | 3 | 5 | 3 | 8 | * | 50 | | 50 | 100 |

* Defense

** Student have to select the course which suitable for the research Topic

## List of level (700) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| CSE 721 | Computer Architecture (2) | 2 | 1 | 2 | 5 | 3 | 8 | 3 | 35 | 15 | 50 | 100 |
| CSE 722 | Distributed Operating Systems (2) | 2 | 1 | 2 | 5 | 3 | 8 | 3 | 35 | 15 | 50 | 100 |
| CSE 723 | Distributed Database Systems (2) | 2 | 1 | 2 | 5 | 3 | 8 | 3 | 35 | 15 | 50 | 100 |
| CSE 724 | Image Processing | 2 | 1 | 2 | 5 | 3 | 8 | 3 | 35 | 15 | 50 | 100 |
| CSE 725 | Computer Game Architecture and Virtual Reality | 2 | 1 | 2 | 5 | 3 | 8 | 3 | 35 | 15 | 50 | 100 |
| CSE 726 | Parallel and Distributed Computing | 2 | 1 | 2 | 5 | 3 | 9 | 3 | 35 | 15 | 50 | 100 |
| CSE 727 | Advanced Topics in Computer Engineering | 2 | 1 | 2 | 5 | 3 | 9 | 3 | 35 | 15 | 50 | 100 |
| CSE 728 | Cyber Security (2) | 2 | 1 | 2 | 5 | 3 | 9 | 3 | 35 | 15 | 50 | 100 |
| CSE 729 | Big Data Concepts | 2 | 1 | 2 | 5 | 3 | 9 | 3 | 35 | 15 | 50 | 100 |
| CSE 731 | Advanced Computer-controlled Systems (2) | 2 | 1 | 2 | 5 | 3 | 9 | 3 | 35 | 15 | 50 | 100 |
| CSE 732 | Adaptive Control Systems Design (2) | 2 | 1 | 2 | 5 | 3 | 9 | 3 | 35 | 15 | 50 | 100 |
| CSE 733 | Modern Control Systems Design (2) | 2 | 1 | 2 | 5 | 3 | 10 | 3 | 35 | 15 | 50 | 100 |
| CSE 734 | The Design of Optimal Control Systems (2) | 2 | 1 | 2 | 5 | 3 | 10 | 3 | 35 | 15 | 50 | 100 |
| CSE 735 | Design of Self-tuning Control Systems (2) | 2 | 1 | 2 | 5 | 3 | 10 | 3 | 35 | 15 | 50 | 100 |
| CSE 736 | Selected Topics in Control Systems Engineering | 2 | 1 | 2 | 5 | 3 | 10 | 3 | 35 | 15 | 50 | 100 |
| CSE 737 | Robust Multivariable Control | 2 | 1 | 2 | 5 | 3 | 10 | 3 | 35 | 15 | 50 | 100 |
| CSE 738 | Robot Modeling and Control | 2 | 1 | 2 | 5 | 3 | 10 | 3 | 35 | 15 | 50 | 100 |
| CSE 739 | Applied Kalman Filtering | 2 | 1 | 2 | 5 | 3 | 10 | 3 | 35 | 15 | 50 | 100 |
| CSE 741 | Distributed Machine Learning and Big Data | 2 | 1 | 2 | 5 | 3 | 10 | 3 | 35 | 15 | 50 | 100 |
| CSE 742 | Introduction to Reinforcement Learning | 2 | 1 | 2 | 5 | 3 | 10 | 3 | 35 | 15 | 50 | 100 |

# Summary of Courses Specification

## Level 500

| CSE 511 | **Course Code** | **Advanced Digital Logic Design** | | | | | **Course title** |
|---|---|---|---|---|---|---|---|
| 2 | **Credit hours** | ---- | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 1 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Principles of digital design - a review of methods for the design of combinational logic and sequential circuits, reducing the logic state - preference allocation case - logical design methods for computer applications - design of progressive digital logic. modern design technologies with Quartus software and programmable chips the role HDLs have played in design methodology -Basic Micro-architectural blocks (Mux/Demux, decoders, FSMs, Counters, MACs, Memories)

**References:**

- B. LaMeres, *"Introduction to Logic Circuits & Logic Design with VHDL Brock, 1st edition"* Switzerland, Springer, 2017.

| CSE 512 | **Course Code** | **Advanced Engineering Statistics** | | | | | **Course title** |
|---|---|---|---|---|---|---|---|
| 2 | **Credit hours** | ---- | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 1 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 60 | | ٣٠ | | 10 | |

**Contents**

Continuous Random Variables and Probability Distributions - Joint Probability Distributions and Random Samples - Statistical Intervals Based on a Single Sample - Inferences Based on Two Samples - The Analysis of Variance. Model building and validation, data collection, data analysis and data interpretation form the core of sound engineering practice

**References:**

- D. Montgomery and G. Runger, *"Applied Statistics and Probability for Engineers, 7th edition,"* Hoboken, Wiley, 2018.

| CSE 513 | **Course Code** | **Technical English** | | | | | **Course title** |
|---|---|---|---|---|---|---|---|
| 2 | **Credit hours** | ----- | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 1 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 40 | --- | ١٠ | |

**Contents**

Selected texts in engineering topics for training on fast reading and accurate reading - Report writing - scientific communication - Development of linguistic communication through discussions and abstracts writing - Analysis, interpretation and critique of writing - Reading texts from multiple books - Focused review of long writings, which includes research and experience in presentation. vocabulary growth, comprehension and expression of the main idea. -reading skills such as pre-reading. - development of sentence structure and sentence variety to the paragraph level. Students - the paragraph form, including expression of the main idea in technical sentences

**References:**

A. Downing, *"English Grammar: A University Course, 3rd edition,"* London and New York, Routledge, 2015.

| CSE 514 | Course Code | Data Structures and Algorithms | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 2 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 1 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Fundamentals of data structures, algorithms, and data types - data structures such as arrays, lists, tree, graph, comparison between representation, sequential and interconnected, trees, representation and dealing with lists and trees (branches), organizing of files on external devices, data columns, stacks, queues, times of arrival and different types of files , research methods, advanced sequencing and algorithm analysis, algorithms include implementation, coordination and research. Restructuring and programming performed using one programming language developed in Computer Engineering. Graphs: terminology and graphs as types of abstract data. Application graphs and analysis of all points of the graph.

**References:**

- N. Karumanchi, *"Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles, 5th edition,"* M. Tech, IIT Bombay Founder, CareerMonk, 2017.

| CSE 515 | Course Code | Advanced Programming | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 2 | Credit hours | ---- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 1 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Object-oriented programming - the basics of object-oriented programming, fundamentals of structural programming - arrays - loops - functions and procedures, objects, inheritance. Programming model for servers, and Internet protocols - designing and building servers aspects: Performance - Fault Tolerance, security - Web programming - peer-to- peer, basics of the World Wide Web - server security - HTML programming language- Java programming language. parameterization and inheritance to promote reuse networking and multithreading - Compose more complex programs from simpler parts - implement GUIs. (Algorithms and Implementation

**References:**

- T. Mailund, *"Advanced Object-Oriented Programming in R: Statistical Programming for Data Science, Analysis and Finance,"* Aarhus N, Denmark, Apress, 2017

| CSE 516 | Course Code | Introduction to Computer Design and Architecture | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 2 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 1 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to computing - the physical components of computers - specifications for computer components - operating systems, computer software - infrastructure of the computer - the operating unit, the arithmetic and logic unit, control unit, micro-programming control, organizing input / output - computer communications, assembly programming language, representation of data, machine calculations, types and formats of instructions - representation of characters, timing, input and output operations, fragmented codes, the concept of complex, structure of instructions and addressing methods - real-time applications - division and linking programs, interrupts.

**References:**

- R. Trobec, B. Slivnik P. Bulić, and B. Robič, *"Introduction to Parallel Computing From Algorithms to Programming on State-of-the-Art Platforms,"* Switzerland, Springer, 2018.

| CSE 517 | Course Code | Computer Networks | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 2 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 1 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

A review of the principles of digital data – OSI model – structures of computer networks - topology - examples of networks - local area networks - network management – advanced network technologies - data link layer - protocols - high-speed networking - quality of service - Internet Protocols - local and wide area networks - data transmission - network structures, Links packages - communication protocols - centralized and distributed devices - the basics of network design - networking software - (client / server) system - remote systems - load and balance distribution wireless computer networks - methods of data transformation in networks - .

**References:**

- M. O'Leary, *"Cyber Operations: Building, Defending, and Attacking Modern Computer Networks, 2nd edition,"* Towson, MD, USA, Apress, 2019.

| CSE 518 | Course Code | Computers Operating Systems | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 2 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 1 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Definition and nature of operations - managing concurrent processes - Privacy Computing - distributed operating systems - systems – processors and processes and their management - design criteria for operations – interfacing of input/output and their organization. - The purposes and functions of a operating systems - the concept of multiple programming - operating multi- management - numbering and memory fragmentation - operational management, prevention of failure, mutual exclusion and use semaphores , scheduling work , Device Manager , Files' I/O , relative study to some systems (such as UNIX , VMS , etc. ...) - Introduction to distributed operating systems

**References:**

- E. Nemeth, G. Snyder, T. Hein, et. al., *"Unix and Linux System Administration Handbook,"* Boston, Addison-Wesley, 2018

| CSE 519 | Course Code | Artificial Intelligence and Machine Learning | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Features of intelligence - AI search - level of intelligence - AI problems -intelligent agent - knowledge classification - search techniques - types of search algorithms - blind search - depth first search - breadth first search -iterative deepening - finding best solution -heuristic functions - probability in AI - Bayes rule - dependence - Bays network- Machine learning paradigms – Different learning algorithms.

**References:**

- W. Ertel, *"Introduction to Artificial Intelligence, 2nd edition,"* Switzerland, Springer, 2017.
- R. Neapolitan and X. Jiang, *"Artificial Intelligence With an Introduction to Machine Learning, 2nd edition,"* Boca Raton, CRC Press, 2018.

| CSE 521 | **Course Code** | **Computer Architecture** | | | | | **Course title** |
|---|---|---|---|---|---|---|---|
| 3 | **Credit hours** | ### | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to processor architecture - performance evaluation - instruction types and formats, information flow and control - dynamic branching prediction - dynamic scheduling, the design of the processor- the structure of memory- design of memory- virtual memory. Factors that depends upon the design of computer systems, the definition and operation of computer systems, analytical methods, computer systems, alternative economics of the computer, performance evaluation, operational requirements, modern development in manufacturing of computer circuits – manufacturing and applications of multiprocessor systems

**References:**

- A. Elahi, *"Computer Systems Digital Design, Fundamentals of Computer Architecture and Assembly Language,"* New Haven, CT, USA, Springer, 2018

| CSE 522 | **Course Code** | **Computer Systems Performance Evaluation** | | | | | **Course title** |
|---|---|---|---|---|---|---|---|
| 3 | **Credit hours** | ### | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

The main concepts and techniques needed to plan the capacity of computer systems, predict their future performance under different configurations, and design new applications that meet performance requirements. The course is mainly based on the use of analytic queuing network models of computer systems. These techniques are applied to study the performance of centralized, distributed, parallel, client/server systems, Web server and e-commerce site performance. The course also discusses performance measuring tools for operating systems such as Unix and Windows. The course provides the students with hands-on experience in performance evaluation through a project. The concept and applications of software performance engineering are also covered.

**References:**

- N. Powers, D. Frangopol, R. Al-Mahaidi, and C. Caprani, *"Maintenance, Safety, Risk, Management and Life-Cycle Performance of Bridges,"* London, UK, CRC Press/Balkema, 2018

| CSE 523 | **Course Code** | **System Analysis and Design** | | | | | **Course title** |
|---|---|---|---|---|---|---|---|
| 3 | **Credit hours** | ### | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

A review of the life cycle of the system - system requirements - data collection and analysis, organizing and documentation of data - practical analysis – logical design – system organization - the design of entrances and exits - the design of data files and databases – designing of computer programs - programming and testing - system maintenance and mangament ..

**References:**

- A. Dennis, B. Wixom, and D. Tegarden, *"Systems Analysis & Design: An Object-Oriented Approach with UML, ٧th edition,"* Hoboken, Wiley, 201٩

| CSE 524 | Course Code | Databases Systems | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Ways and methods of data processing - the concept of databases - the concept of database systems and its components and types - design database systems - the components of database management systems. Patterns of relational algebra - query language standard - EER model - the study of the application of database management packages. Database models - Database Management Systems - Design rules - normalization – relationships models and entities - queries - confidential and security - overcoming the problems of databases - the simultaneous operation of the procedures in the database applications

**References:**

- A. Taylor, *"SQL For Dummies, 9th edition,"* Hoboken, Wiley, 2019

| CSE 525 | Course Code | Computer Graphics | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction - methods and ways of programming computer graphics – application of a language for drawing - The perception of images- color representation and coordinate systems- mathematical study of 2D systems – image transformation – image enhancement - layered diagrams and special effects - image retrieval - image compression - reconfiguring images using projections - image analysis, introduction to the problems of transforming landscapes, Introduction to identify shapes (Bayesian method , extracting features and classifying it)

**References:**

- S. Guha, *"Computer Graphics Through OpenGL: From Theory to Experiments, 3rd edition,"* Boca Raton, CRC Press, 2019

| CSE 526 | Course Code | Internet of Things (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to IoT – IoT hardware platforms and operating systems – Wireless communication technologies for IoT – IP-connected smart objects and networks – Embedded web services and web of things – Tracking industrial networks – Other relevant standardization bodies and protocols- interactions of embedded systems with the physical world - the core hardware components most commonly used in IoT devices - the interaction between software and hardware in an IoT -. Describe the role of an operating system to support software in an IoT device

**References:**

- B. Tripathy and J. Anuradha, *"Internet of things (IoT): technologies, applications, challenges and solutions,"* Boca Raton, CRC Press, 2018

| CSE 527 | Course Code | Natural Language Processing | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Language Processing and Python- Accessing Text Corpora and Lexical Resources- Processing Raw Text – writing structured programs -. Categorizing and Tagging Words-Learning to Classify Text-Extracting Information from Text- Analyzing Sentence Structure, natural language processing tools - compilers and interpreters, building NLP using python. Probabilistic language modeling and its applications. Markov models. N-grams. Estimating the probability of a word, and smoothing. Generative models of language. Their application to building an automatically-trained email spam filter, and automatically determining the langua

**References:**

- D. Rao and B. McMahan, *"Natural Language Processing with PyTorch: Build Intelligent Language Applications Using Deep Learning,"* Sebastopol, O'Reilly Media, 2019.

| CSE 531 | Course Code | Introduction to Automatic Control Engineering | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 2 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 1 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Review of systems' representation and their properties (transfer function and state variables) and root locus and the response in the frequency domain. Design using root locus and in the frequency domain with the use of MATLAB to solve some examples. Devising the transfer functions of SISO systems to achieve the dynamic and static attributes - Various examples of open loop systems that contain both poles and zeros.

**References:**

K. Vamvoudakis and S. Jagannathan, *"Control of Complex Systems: Theory and Applications,"* Butterworth-Heinemann, Elsevier, 2016

| CSE 532 | Course Code | Modern Trends of Control | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

A brief explanation of various topics in modern control systems such as: LQR – self-tuning controllers – control systems design using fuzzy logic and neural networks. Deadbeat response-pole assignment with state and with output feedback. Use of observer. Introduction to advanced control topics: optimal control. Adaptive control systems. System identification of dynamic systems, least squares, Theory and implementation for system estimation -.Types of dynamical systems are common in applications: those for which the time variable is discrete and those for which the time variable is continuous.

**References**:

W. Mitkowski, J. Kacprzyk, K. Oprzędkiewicz, and P. Skruch (eds.), *"Preview Trends in Advanced Intelligent Control, Optimization and Automation,"* Proceedings of KKA 2017—The 19th Polish Control Conference, Kraków, Poland, Springer, Volume 577, 2017.

| CSE 533 | Course Code | Microprocessor Systems Application | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to computers –computer structure - solid components of the Computer - basics of the assembly language - Programming-links of computer system-synchronization in computer-the county-interrupt routines- Programmable chips - data acquisition systems-applications of closed loop systems-development tools-case studies of sudden crash- The internal structure and design of peripheral devices. Memory system design and analysis. The use and structure of development tools such as (cross) assemblers or compilers, monitor programs, simulators, emulators

**References:**

- Alan D. George, *"Microprocessor-based Parallel Architecture for Reliable Digital Signal Processing Systems,"* Boca Raton, CRC Press, 2017.

| CSE 534 | Course Code | Programmable Logic Controllers | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Parts of programmable logic controllers –PLC programming languages (Ladder diagram - Sequential Function Chart - Structured Text) - Timers - Counters - Master Control - Jump Control - Shift Register - Data Handling and Manipulation - Analog I/O - how to choose a PLC for a specific system – applications in control systems- Describe the personal protective equipment (PPE) used by technicians when working on electrical systems. (OCC)- lockout/tagout process and the need to inspect a PLC system - I/O chassis, Input module, Output module, sensor & actuator, wire the proper I/O field wiring and create a Control Logix routine necessary to exercise the I/O devices

**References:**

- D. Hanssen, *"Programmable Logic Controllers,"* Pondicherry, India, Wiley, 2015.

| CSE 535 | Course Code | Mechatronics (2) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Process Controllers (ON-OFF Controllers - PID Controllers - Pneumatic Controllers - Digital controller - adaptive controllers (- CNC Machine and Robotics -design of mechatronic systems- Real-time operating systems, requirements of real-time systems, deadlock, resource management, priority, pre-emption 14 Hard real-time scheduling algorithms: Rate monotonic and earliest deadline first, schedulability tests, real-time communication: introduction, necessity, hard and soft real-time, network topologies and main non-real-time protocols.

**References:**

- K. Deng, Z. Yu, S. Patnaik, and J. Wang, *"Recent Developments in Mechatronics and Intelligent Robotics,"* Proceedings of International Conference on Mechatronics and Intelligent Robotics (ICMIR2018), Switzerland, Springer, Volume 856, 2019.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 536 | **Course Code** | **Digital Control (1)** | | | | | **Course title** |
| 3 | **Credit hours** | ### | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to the analysis and design of discrete-time feedback control systems. -Z-transformation – comparison between Z-transformation and Laplace – difference equations – comparison between Z and S-planes – stability analysis – root locus – Lyapunov – self tuning controllers -discrete equivalent systems, transient specifications, steady-state tracking errors, stability, controller design, quantization effects

References:

- C. Phillips, H. Nagle, and A. Chakrabortty, *"Digital Control System Analysis & Design, 4th edition (Global Edition),"* England, Pearson, 2015

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 537 | **Course Code** | **Computer Controlled Systems (1)** | | | | | **Course title** |
| 3 | **Credit hours** | ### | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to the use of computers in control systems - Software and hardware components in computer control systems - Open and closed loop in computer-controlled systems – applications -Analyze observability and controllability of linear discrete-time control systems. -.Design digital control systems using pole placement state space approach. -.Design digital control systems using optimal control approach. -.Analyze stability of singular points of non-linear discrete-time systems

**References:**

C.L. Phillips and H.T. Nagle, Digital System Control Analysis and Design" Prentice Hall, 3rd Ed, 2017

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 538 | **Course Code** | **Modern Control Systems** | | | | | **Course title** |
| 3 | **Credit hours** | ### | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

State space representation of time invariant systems – eigen values – transfer functions to state space and vice versa – canonical form – solving state space equations - controllability and observability – duality - MISO systems - Lyapunov theory – Optimal control methods;, linear quadratic regulator, dynamic programming, Pontryagin's minimum principle. Robust feedback control of dynamical systems; controller design using linear matrix inequalities (LMIs). Adaptive control. Model-based predictive control (MPC) design. Model-free controller design. State observers; Combined controller-observer compensators; Fault detection and isolation (FDI) using observers..

**References:**

- R. Dorf and R. Bishop, *"Modern Control Systems, 12th edition,"* England, Pearson, 201٧

| CSE 541 | Course Code | Mechatronics (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 2 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 1 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Fundamentals laws and principles of mechanical engineering; introduction to problem layout and problem solving methods; simplified engineering modeling and analysis of mechanical systems; collection, manipulation and presentation of engineering data Measuring devices and sensors, displacement sensors, heat, speed, torque, Introduction to electronic devices (PN junction - Transistor - SCR - DIAC - TRIAC - OPTOCOUPLER). Pneumatic systems, Valves, all kinds of motor (Stepper - DC - AC - Induction Motor). Speed Control, Digital Systems, logic gates, Interfacing and data Acquisition systems.

**References:**

- F. Qiao, S. Patnaik, and J. Wang (eds.), *"Recent Developments in Mechatronics and Intelligent Robotics,"* Proceedings of the International Conference on Mechatronics and Intelligent Robotics (ICMIR2017), Switzerland, Springer, Volume 1, 2018

| CSE 542 | Course Code | Systems Engineering | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 2 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 1 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to discrete systems- Z-transform - difference equations – Zero and first order hold- Fourier transform- Discrete-time Fourier transform - Fast Fourier transform – introduction to digital and analog signal processing of continuous time signal, Matrices and operations on them- system engineering process and its benefits to customers, users, managers, and maintainers, with the concepts reinforced

**References:**

- N. Nise, *"Control Systems Engineering 7th Ed – Nise,"* California State Polytechnic University, Pomona, Wiley, 2015

| CSE 543 | Course Code | Advanced Computer Applications | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

The basics of designing programming languages – building commands – rules of construction and appearance of programming languages – memory management – local and global \variables - comparison of different programming languages – rules of languages – similarities between languages – subroutines and interfacing between inputs and output – I/O commands – conditional statements – program control statements – loops- functions and inheritances - arithmetic, logic operations and algorithms – definition of variables –arrays and pointers – applications on some programming languages.

**References:**

- D. Wyld, J. Zizka, and D. Nagamalai (eds.), *"Advances in Computer Science, Engineering and Applications,"* Proceedings of the Second International Conference on Computer Science, Engineering and Applications (ICCSEA 2012), New Delhi, India, Springer, Volume 2, 2012.

<table>
<tr><td>CSE 544</td><td>Course Code</td><td colspan="5">Diploma Research Project</td><td>Course title</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Credit hours</td><td rowspan="2">-----</td><td rowspan="2">Prerequisites</td><td>Practical</td><td>Tutorial</td><td>Lectures</td><td rowspan="2">Teaching hours</td></tr>
<tr><td>2</td><td>1</td><td>2</td></tr>
<tr><td rowspan="2">100</td><td rowspan="2">Total grads</td><td colspan="2">Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Course grades</td></tr>
<tr><td colspan="2">50 Defense</td><td>50</td><td></td><td></td></tr>
<tr><td colspan="8"><u>Contents</u><br>The student must select a research topic in his field under the supervision of the one of department's staff.</td></tr>
</table>

## Level 600

| CSE 621 | Course Code | Software Engineering | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Software Development processes: Waterfall models, Agile methods, Rapid application development - System modeling using UML: Context models, Interaction models, Structural models, Behavioral models, Model-driven engineering - System architecting and design: Architectural design decisions, Architectural views, Architectural patterns, Application architectures – Testing: Development testing, Test-driven development, Release testing, User testing – Software Maintenance: Evolution processes, Understanding software evolution, Making changes to operational software systems, Legacy system management, Making decisions about software change - Quality Assurance & Configuration Management, recent trends in software development - Software project management.

**References:**

- R. Mall, *"Fundamentals of Software Engineering, 4th edition,"* Haryana, PHI Learning, 2014.

| CSE 622 | Course Code | Data Security and Protection | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Safety of computer systems - security – methods of access control – data encryption – Miracle-Hillman and security protocols –RSA and RSA – encryption algorithms - checking the privileges and the different ways to perform - privacy - computer viruses - firewalls - assessment and analysis of the different security methods - different applications that need security and confidentiality of data - business applications - e-commerce - smart cards - ATMs - Application protection systems - data protection during transmission and storage - local and global information - encryption and decryption - operating systems - databases and how to secure them as well as networking.

**References:**

- T. Johnson, *"Cyber-security Protecting Critical Infrastructures from Cyber Attack and Cyber Warfare,"* Boca Raton, CRC Press, 2015.

| CSE 623 | Course Code | Advanced Computer Architecture (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Synchronous logic circuits – sequential digital circuits – CPU and its theory of operation – memory structure – SRAM and DRAM - Bus system - control unit – Microprogram control - input/output control - assembly language programming - types of commands- program linking – interrupt – DMA – cache memory. performance of multicore processors using SPEC benchmarks -the several advanced optimizations to achieve cache performance-virtual memory and virtual machines -storage systems, RAID, I/O performance, and reliability measure

**References:**

- H. El-Rewini and M. Abd-El-Barr, *"Advanced Computer Architecture And Parallel Processing,"* Hoboken, New Jersey, Wiley Interscience, 2005

| CSE 624 | Course Code | Distributed Operating Systems (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Basics of distributed operating systems - deadlock protection, multiprocessor scheduling, computer system modeling, and virtual memory management from the operating systems viewpoint. structural building of distributed systems - operating systems that are based on tracks and switches – distribution processes and tasks - process in distributed systems – scheduling – communication between processes on distributed systems – synchronization – communication protocols in distributed systems.

**References:**

- Silberschatz, G. Gagne, and P. Galvin, *"Operating System Concepts, 10th edition,"* Palatino, Wiley, 2018.
- J. Schönwälder, *"Operating Systems - Computer Networks and Distributed Systems,"* JACOBS University, 2013.

| CSE 625 | Course Code | Distributed Database Systems (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | | | | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

The development of database applications - centralized systems and distributed systems – systems based on networks – basics of distributed database systems - relationship between database systems - important considerations in distributed database systems – handling inquiries – monitoring synchronization techniques - methods in supporting the transactions and how to recover them – Security and privileges Emerging data management issues including parallel and streaming data management, NoSQL and New SQL data management on the cloud will also be covered. - Experimental DDBMS. design and implement a distributed database query processing and optimization engine, capsulated into a web service to meet the requirements of the remote service call- The delivered service is subject to the benchmark

**References:**

(1) M. Özsu and P. Valduriez, *"Principles of Distributed Database Systems, 4th edition,"* Switzerland, Springer, 2020.
(2) S. Rahimi and F. Haug, *"Distributed Database Management Systems: A Practical Approach,"* Hoboken, Wiley, 2010

| CSE 626 | Course Code | Information Systems | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Organizations and Information Technology - Concepts of Enterprise Information Systems, Concepts of Business Processes - Types of Enterprise Information Systems - Building and Management of Enterprise Information Systems - Procurement Processes - Fulfillment Processes - Production Processes - Integrated Processes - issues and trends in managing information systems infrastructure and services -. the Information Systems and processes involved in utilizing the Internet for interacting with consumers - Information Systems as they relate to enhancing business intelligence and processes -the processes involved in developing and securing Information Systems

**References:**

*(1)* J. Świątek, L. Borzemski, and Z. Wilimowska (edits), *"Information systems architecture and technology-Part II,"* Proceedings of 38th International Conference on Information Systems Architecture and Technology (ISAT-2017), Switzerland, Springer, Volume 656, 2018.

*(2)* L. Borzemski, J. Świątek, and Z. Wilimowska (edits), *"Information Systems Architecture and Technology-Part I,"* Proceedings of 39th International Conference on Information Systems Architecture and Technology (ISAT 2018), Switzerland, Springer, Volume 852, 2019

| CSE 627 | Course Code | Multimedia | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction - types of multimedia - advantages and disadvantages - hardware and software components - applications on multimedia systems - Current advances in storage and display screens and printing devices - audio and video conferencing – integration between different types of signals - the interaction between human and computer, cards dealt for video and audio - physical and programmed methods for image compression - the basics of multimedia - Introduction to virtual reality.

**References:**

M. Collins, *"Pro HTML5 with CSS, JavaScript, and Multimedia: Complete Website Development and Best Practices,"* California, Apress, Berkeley, CA, 2017

| CSE 628 | Course Code | Computer Networks' Design and Programming | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Digital commination systems components and understanding -Control protocols in transmission - architecture of computer networks – OSI protocols - (TCP / IP) protocols - Integrated Services Digital Networks (ISDN) - Broadband Integrated Services Digital Network (B-ISDN) – ATM networks peer-to-peer networks, the client-server model, network operating systems, and an introduction to wide-area networks-The network and implementation tools may vary to meet current development trends

**References:**

Olivier Bonaventure , "Computer Networking : Principles, Protocols and Practice Release 0.25 " , 2018

| CSE 629 | Course Code | Selected Topics in Computer Engineering | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Advanced and recent topics on computer engineering and computer information systems not covered by other courses.

**References:**

- Abdallah, *"Advanced Multicore Systems-On-Chip: Architecture, On-Chip Network, Design,"* Singapore, Springer, 2017
- I. Alsmadi, *"The NICE Cyber Security Framework: Cyber Security Intelligence and Analytics,"* Switzerland, Springer, 2019.

| CSE 641 | Course Code | Image Processing and Computer Vision | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction-digital image representation-mathematical tools for image processing-image enhancement-image processing in frequency domain-image denoising-image segmentation - Image formation-image processing-feature detection-segmentation-feature based alignment-structure from motion-stereo correspondence-3D reconstruction -Image Enhancement, Image Restoration, Wavelets and Multiresolution Processing, Image Compression, Morphological Image Processing, Image Segmentation, Representation and Description, and Object Recognition

**References:**

H. Singh, *"Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python,"* New York, Apress, 2019

| CSE 642 | Course Code | Cyber Security (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | | | | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Cyber security Fundamentals: Cyberspace, Definition of Cyber security, Need for Cyber security, Hacking - Types of Malware: Worms, Viruses, Spyware, Trojans - Cyber Security Breaches: Phishing, Identity Theft, Harassment, Cybers talking - Types of Cyber Attacks: Password Attacks, Denial of Service Attacks , Passive Attack, Penetration Testing - TwoStep Verification – Mobile Protection – Social Network Security, Prevention Software: Firewalls, Virtual Private Networks, Anti Virus & Anti Spyware.

**References:**

I. Alsmadi, *"The NICE Cyber Security Framework: Cyber Security Intelligence and Analytics,"* Switzerland, Springer, 2019.

| CSE 631 | Course Code | Genetic Algorithms | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Basics of optimization, optimization problems, population based algorithms, Brief Overview of Evolutionary Computation, Genetic Algorithms (Theory and Advanced Operators), Genetic representation, search operators, selection schemes, crossover and mutation methods, operations on real-valued representations, fitness functions, particle swarm optimization, Evolution Strategies, constraint handling in optimization problems, real life application of optimization Algorithms, introduction of Multi-objective Evolutionary Algorithms- calculus-based computation- localized behavior patterns that prevent easy passage to desired global properties- parallelized at the conceptual level

**References:**

F. Buontempo, *"Genetic Algorithms and Machine Learning for Programmers: Create AI Models and Evolve Solutions,"* Frances Buontempo, 2019

| CSE 632 | Course Code | Advanced Computer-controlled Systems (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction of using computers in control systems - studying stability of the systems - design of compensators - improving the performance of control systems with computers - digital PID controllers, design of digital controllers, state-space models, observability and controllability, pole placement design, optimal design methods, nonlinear discrete-time systems, digital control of biomedical systems, digital control of wind power systems, 1 case studies

**References:**

F. Giri, *"AC Electric Motors Control: Advanced Design Techniques and Applications,"* United Kingdom, Wiley, 2013.

| CSE 633 | Course Code | Design of Adaptive Control Systems (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction - methods of adaptive control – model reference systems - systems based on way to Lyapunov method - systems with high gain - using neural networks in control systems - the design of control systems using a fuzzy logic - Adaptive Control in the Presence of Input Constraints - Direct MRAC for Nonlinear systems with Matched Structured Nonlinearities - Robustness of MRAC: Parameter Drift - Adaptive Control in the Presence of Uniformly Bounded Residual Nonlinearity - Disturbance Rejection - Input-to-State Stability

**References:**

W. Levine, "The Control Systems Handbook: Control System Advanced Methods, Second Edition (Electrical Engineering Handbook)," Boca Raton, CRC Press, 2011.

| CSE 634 | Course Code | Design of Modern Control Systems (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Controllability - observability – duality - control systems design using Lyapunov - design using regression method – design using Krasovka method - Optimal control methods;, linear quadratic regulator, dynamic programming, Pontryagin's minimum principle. Robust feedback control of dynamical systems; controller design using linear matrix inequalities (LMIs). Adaptive control. Model-based predictive control (MPC) design. Model-free controller design. State observers; Combined controller-observer compensators; Fault detection and isolation (FDI) using observers.

**References:**

- R. Dorf and R. Bishop, *"Modern Control Systems, 12th edition,"* New Jersey, Pearson, 2011.

| CSE 635 | Course Code | Design of Optimal Control Systems (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Design using different properties - controller design – compensator design - comparison between optimal and self-tuning controllers - comparison between the optimal and adaptive controllers- Optimization techniques, Hamilton calculus of variation - Linear Quadratic Regulator, Linear Quadratic Tracking - Optimal control via output feedback - State estimator, LQG/LTR- Minimum-time optimal control, Robustness design - The application of optimal control to the real plant

**References:**

D. Subbaram Naidu , "Optimal Control Systems (Electrical Engineering Series)", 1st Edition" CRC press 2020

| CSE 636 | Course Code | Design of Self-tuning Control Systems (1) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction - Different types of self-tuning control systems – merits and demerits of self-tuning – automatic model identification - PID controllers – auto tuning of PID controllers using model identification - Self-tuning PID Controllers - Algebraic Methods for Self-tuning Controller Design - Self-tuning Linear Quadratic Controllers - Computer-aided Design for Self-tuning Controllers - Application of Self-tuning Controllers- Criteria Used for Ending Adaptation of a Particular Subsystem

**References:**

*(1)* A. Marco, *"Gaussian Process Optimization for Self-Tuning Control,"* ETSEIB, 2015

*(2)* V. Bobál, J. Böhm, J. Fessl, and J. Macháček, *"Digital Self-tuning Controllers: Algorithms, Implementation and Applications (Advanced Textbooks in Control and Signal Processing),"* Germany, Springer, 2005

| CSE 637 | Course Code | Neural Networks and Fuzzy Logic | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction-neural model- ANN applications -activation functions - building logic gates- multilayered feedforward neural networks - back-propagation algorithm-momentum back-propagation algorithm - training examples – radial basis functions- Introduction in fuzzy logic and reasoning - fuzzy control - linear fuzzy PID - nonlinear fuzzy PID - self organizing fuzzy controller- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine Competitive NEURAL NETWORKS - . Special NEURAL NETWORKS - Cognitron and Neocognitron - Architecture, training algorithm and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems

**References:**

*(1)* J. Keller, D. Liu, and D. Fogel, *"Fundamentals of Computational Intelligence: Neural Networks, Fuzzy Systems, and Evolutionary Computation,"* Canada, Wiley, 2016.

*(2)* P. Melin, O. Castillo, and J. Kacprzyk (eds.), *"Design of Intelligent Systems Based on Fuzzy Logic, Neural Networks and Nature-Inspired Optimization,"* Switzerland, Springer, Volume 601, 2015.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 638 | **Course Code** | **Nonlinear Control Systems** | | | | | **Course title** |
| 3 | **Credit hours** | ----- | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to Nonlinear Systems - Analysis of Nonlinear Systems: Linearization, Describing functions - stability of Nonlinear Systems: Nyquist method - phase plane analysis- Phase plane analysis, Lyapunov stability, Input-to-state stability, Input-Output stability, and Passivity analysis- Nonlinear control design, including Lyapunov-based control, Energy-based control, Cascaded control, Passivity-based control, Input-Output linearization, and Backstepping

**References:**

R. Vepa, *"Nonlinear control of robots and unmanned aerial vehicles: an integrated approach,"* Boca Raton, CRC Press, 2017.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 639 | **Course Code** | **Selected Topics in Control Systems** | | | | | **Course title** |
| 3 | **Credit hours** | ------ | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Advanced and new topics in control systems engineering that are not handled in any other subjects in control system engineering.

**References:**

Norman S. Nise , " Control Systems Engineering" , 8th Edition , wiley , 2019

Katsuhiko Ogata ,"Modern Control Engineering", Fifth Edition , Prentice Hall, 2016

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 643 | **Course Code** | **Internet of Things (2)** | | | | | **Course title** |
| 3 | **Credit hours** | ------ | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to data analytics - fog and edge Computing - data analytics architectures - IoT considerations for industry - IoT for connected and smart cities - security analysis of IoT networks - privacy and security issues for IoT systems- relationship between IoT, cloud computing, and big data- how IoT differs from traditional data collection systems - Combining IoT Data with Static Data - Scripting and Programming with IoT Dat- Machine Learning / Artificial Intelligence

**Reference**

G. R. Kanagachidambaresan, R. Maheswar, V. Manikandan, K. Ramakrishnan , "Internet of Things in Smart Technologies for Sustainable Urban Development", springer , |Feb 21, 2020

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 644 | **Course Code** | **Research Topic** | | | | | **Course title** |
| 3 | **Credit hours** | ----- | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | ٥٠ | | 50 | | | |

**Contents**

The student selects a research topic in the field in which he enrolled under the supervision of department's staff.

## Level 700

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 721 | **Course Code** | **Computer Architecture (2)** | | | | | **Course title** |
| 3 | **Credit hours** | ### | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | | | | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to programmable logic FPGA – programmable switching technologies of FPGA - Different techniques in programming FPGA - reprogramming and reconfiguring the chip – using hardware description languages HDL to construct combinational and sequential logic – Finite state machine using FPGA – FSM with data path – System on Chip technologies. Overview of digital design with Verilog HDL, hierarchical modeling, modules and ports, Gate-level modeling, dataflow and behavioral modeling, tasks and functions, timing and delays, switch-level modeling, user-defined primitives, programming language interface, logic synthesis with VHDL.

**References:**

*A. Elahi, "Computer Systems Digital Design, Fundamentals of Computer Architecture and Assembly Language," New Haven, CT, USA, Springer, 2018.*

J. Dumas II, *"Computer architecture: fundamentals and principles of computer design,"* Boca Raton, CRC Press, 2017

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 722 | **Course Code** | **Distributed Operating Systems (2)** | | | | | **Course title** |
| 3 | **Credit hours** | ### | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Network operating systems - the interaction of processes and tasks in distributed systems - Memory organization and scheduling in distributed systems - Synchronization in the implementation of the operations of the players distributed - simultaneous operation and its problems - design considerations - Study process for cases of distributor organization - the evolution of network systems and the adoption of most applications - Review of most modern network systems - advanced study for local networks and extended - Digital Communications - Protocols and nature of the relationship between the different layers – cloud operating systems – examples of cloud operating systems.

**References:**

- (1) M. Özsu and P. Valduriez, *"Principles of Distributed Database Systems, 4th edition,"* Switzerland, Springer, 2020.
- (2) S. Rahimi and F. Haug, *"Distributed Database Management Systems: A Practical Approach,"* Hoboken, Wiley, 2017.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CSE 723 | **Course Code** | **Distributed Database Systems (2)** | | | | | **Course title** |
| 3 | **Credit hours** | ### | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Recent trends in distributed database systems - the fundamental differences in the problems of centralized and distributed databases - data distribution - operating the central and operating distributor - run queries in an environment of distributed databases - how to adopt the software on the input - how to structure the inputs to build programs on these inputs - understand inputs and how to process it - the basics of writing programs - distinct local structures and definitions of the data - the different types of data and how compaction - the use of a modern languages

**References:**
- (1) M. Özsu and P. Valduriez, *"Principles of Distributed Database Systems, 4th edition,"* Switzerland, Springer, 2020.
- (2) S. Rahimi and F. Haug, *"Distributed Database Management Systems: A Practical Approach,"* Hoboken, Wiley, 2017.

| CSE 724 | Course Code | Image Processing | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Image transformation - the definition and properties 1D and 2D transformation - Fourier transform - cosine transformation - Walsh – Hadamart transformation - Covert Lov transformation – image enhancement: spatial filter – frequency spectrum - image restoration: Description of the model of deformation – inverted transformation -sampling and quantization, image acquisition, basic relationships between pixels, imaging geometry -. Image transforms: discrete Fourier transform, discrete cosine transform, , Hotelling transform.- detection of discontinuities, thresholding, region-oriented segmentation, the use of motion analysis in segmentation

**References:**

*(1)* H. Singh, *"Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python,"* New York, Apress, 2019.

*(2)* J. Kinser, *"Image operators image processing in Python,"* Boca Raton, CRC Press, 2019.

| CSE 725 | Course Code | Computer Game Architecture and Virtual Reality | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Game Theory Motivation and Background – Software architecture for computer games – 2D and 3D rendering – Event driven programming – Game engines – Introduction to Virtual Reality – Virtual Reality (Input Devices – Output Devices) – Computing Architectures for Virtual Reality (OpenGL Introduction – 2D drawing – Shading) – Modelling OpenGL 3D drawing – Animation – Lights -Stereoscopic perception and rendering - Head mounted display optics and electronics - Inertial measurement units: gyros, accelerators, magnetometers -Sensor fusion: complementary filter, Kalman filter -Human perception: visual, audio, vestibular, tactile

**References:**

*(1)* B. Arnaldi, P. Guitton, and G. Moreau, *"Virtual Reality and Augmented Reality: Myths and Realities,"* London, Wiley, 2018.

*(2)* T. Jung, *"Augmented Reality and Virtual Reality: The Power of AR and VR for Business,"* Switzerland, Springer, 2019

| CSE 726 | Course Code | Parallel and Distributed Computing | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

The use of parallelism to achieve high performance - parallelism within the central processing unit – parallel processing in multiprocessors environment - physical components of the data flow machines – new parallel architectures - the new advances in parallel processing - models and structures parallel data - examples of applications of the current in parallel and distributed systems- Distributed Systems, MapReduce, Clusters - Distributed File Systems, Security - Distributed Shared Memory, Peer-to-Peer

**References:**
- F. Xhafa, F. Leu, M. Ficco, and C. Yang, *"Advances on P2P, Parallel, Grid, Cloud and Internet Computing,"* Proceedings of the 13th International Conference on P2P, Parallel, Grid, Cloud and Internet Computing (3PGCIC-2018),

| CSE 727 | Course Code | Advanced Topics in Computer Engineering | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ----- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Advanced and modern topics in computer engineering do not exist in other courses such as IoT – Cloud computing – Fog computing.

**References:**

Y. Wenli, *"Information Technology and Computer Application Engineering,"* Proceedings of the International Conference on Information Technology and Computer Application Engineering (ITCAE 2013), Boca Raton, CRC Press, 2014

| CSE 728 | Course Code | Cyber Security (2) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Critical Cyber Threats: Critical Cyber Threats, Cyber terrorism, Cyber warfare, Cyber espionage - Defense Against Hackers: Cryptography, Digital Forensics, and Intrusion Detection - Data Mining for Cyber Security, cyber security governance, and case study- The techniques appropriate to provide basic protection of a small computer and/or small network - basic incident response techniques - Identify potential threats to wireless networks - a risk analysis for a network in a small business or clinic

**References:**
- I. Alsmadi, *"The NICE Cyber Security Framework: Cyber Security Intelligence and Analytics,"* Switzerland, Springer, 2019.
- M. Lehto and P. Neittaanmäki (edits.), *"Cyber Security: Analytics, Technology and Automation,"* London, Springer, Volume 78, 2015

| CSE 729 | Course Code | Big data Concepts | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Big Data Definition, Big data Multi-V-model, Challenges of Big Data, Technologies of big data, Cloud Computing, IOT, Hadoop, Big Data Generation, Acquisition, Storage and Analysis, Architecture for Big Data Analysis, Tools for Big Data Mining and Analysis- methods that are foundations for artificial intelligence and cognitive networks - methods to optimize the analytics based on different hardware platforms, such as Intel & Power chips, GPU, FPGA, - the future challenges of Big Data, especially on the onging Linked Big Data issues which involves graphs, graphical models, spatio-temporal analysis, cognitive analytics.

**References:**

- T. Erl, W. Khattak, and P. Buhler, *"Big Data Fundamentals: Concepts, Drivers & Techniques,"* Indiana , Prentice Hall, 2016.

| CSE 731 | Course Code | Advanced Computer-controlled Systems (2) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | | | | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to RTOS - RT kernel architectures - Scheduling-control of shared resources-shared resources and contention issues- inter-task communication - memory usage and management-multiprocessor systems-distributed system-testing and debugging of multitask software-using RTOS in critical systems- Hierarchical implementation of computer control- apply modern control principles in various areas of industry - Robotics & Autonomous Systems- cascade control, feed forward control, multi-loop control utilising de-couplers, Smith Predictor.- Multi-loop interaction analysis using Relative Gain Array

**References:**

*(1)* F. Giri, *"AC Electric Motors Control: Advanced Design Techniques and Applications,"* United Kingdom, Wiley, 2013.

*(2)* A. Glumineau, *"Sensorless AC Electric Motor Control: Robust Advanced Design Techniques and Applications,"* London, Springer, 2015

| CSE 732 | Course Code | Adaptive Control Systems Design (2) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction – designing variable structures systems - changing structures design using neural networks - design using logic value system and the changing structure -Parameter Convergence, Persistent Excitation- Robust Adaptive Control disturbances - Robust Adaptive Control time varying parameters -Robust Adaptive Control unmodeled dynamics - Improving Transient Response in Adaptive Control - Adaptive Control of Nonlinear Plants, time-delay systems -Applications of Adaptive Control

**References:**

**(1)** W. Levine, *"The Control Systems Handbook: Control System Advanced Methods, Second Edition (Electrical Engineering Handbook),"* Boca Raton, CRC Press, 2011.

**(2)** W. Levine, *"The Control Handbook, Second Edition: Control System Fundamentals, Second Edition (Electrical Engineering Handbook),"* Boca Raton, CRC Press, 2011

| CSE 733 | Course Code | Modern Control Systems Design (2) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Advanced methods of using Lyapunov theory in designing controllers for nonlinear systems - Krasovka method for the design of the controllers - governors in systems design variables case - the study of the stability systems for the presence of disorders - feedback control systems characteristics - Decomposition of system into controllable and uncontrollable parts - The performance of feedback control systems –Deadbeat response-pole assignment with state and with output feedback - The Design of feedback control systems – Stability of the feedback control systems – Frequency response methods- The Design of state variable feedback control systems

**References:**

- R. Dorf and R. Bishop, *"Modern Control Systems, 12th edition,"* England, Pearson, 2011.
- T. Mills, *"Applied Time Series Analysis: A Practical Guide to Modeling and Forecasting,"* United Kingdom, Academic Press, Elsevier, 2019

| CSE 734 | Course Code | The Design of Optimal Control Systems (2) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Review of modern approach of control system. Calculus of extremes and single stage decision Constrained extrems and lag range multipliers. Variational calculus and EulerLagrange Eq. Mathematical Modeling of optimization problem. The maximum principle.The Hamiltonian – Jacobi theory. Linear regulator problems. Minimum time problem. The discrete maximum principle Discrete linear quadratic problem. Adaptive control systems. Model reference adaptive control. Self-tuning adaptive control systems. Stability, problem in adaptive control systems Advanced applications on the analysis and design of optimal controllers -stability analysis of optimal controllers.

**References:**

- D. Subbaram Naidu , "Optimal Control Systems (Electrical Engineering Series)", 1st Edition" CRC press 2020

| CSE 735 | Course Code | Design of Self-tuning Control Systems (2) | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ### | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Advanced applications on the analysis and design of self-tuning controllers -stability analysis of self-tuning controllers - Combined systems and signal model – Residual and prediction error - Using recursive estimation - Initializing the estimator - computational alternative to recursive estimation – Convergence analysis for recursive algorithm – Self-tuning controller – Multistage predictive control – Self – Tuning multiple stage – Frequency domain self Tuning - Vibration control algorithm – Self Tuning adjustment mechanism

**References:**

- A. Marco, *"Gaussian Process Optimization for Self-Tuning Control,"* ETSEIB, 2015.
- M. Jelali, *"Control Performance Management in Industrial Automation: Assessment, Diagnosis and Improvement of Control Loop Performance,"* London, Springer, 2013.

| CSE 736 | Course Code | Selected Topics in Control Systems Engineering | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

It deals with advanced and modern topics in control systems engineering that are not covered by other courses.

**References:**
*(1)* D. Nenchev, A. Konno, and T. Tsujita, *"Humanoid Robots: Modelling and Control,"* United Kingdom, Elsevier, 2019.
*(2)* L. Keviczky, R. Bars, J. Hetthéssy, and C. Bányász, *"Control engineering,"* Singapore, Springer, 2019

| CSE 737 | **Course Code** | **Robust Multivariable Control** | | | | | **Course title** |
|---|---|---|---|---|---|---|---|
| 3 | **Credit hours** | ---- | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Basic design principles, Fundamental limitations in achievable control performance, Multivariable frequency domain design and loop shaping, Linear quadratic theory, Youla-parametrization, H-Infinity and H-2 performance analysis of control systems, Model reduction, μ-analysis and synthesis.- the computational tools for control systems available in Robust Control Toolbox (MATLAB).

**References:**
- D. Crolla, *"Automotive Engineering: Powertrain, Chassis System and Vehicle Body, 1st edition,"* USA, Elsevier, 2009.

| CSE 738 | **Course Code** | **Robot Modeling and Control** | | | | | **Course title** |
|---|---|---|---|---|---|---|---|
| 3 | **Credit hours** | ------ | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Robot modeling, kinematics, dynamics, Path and trajectory planning, Robot control, PID-based control, Computed torque, Adaptive control, Force control, Vision based control, Tools (such as Robotics Toolbox, Modelica, Mathematica, RobotStudio), Programming in Rapid (ABB's language for robot programming)- Robot features, sensors, manipulators.- Application areas. State of Robotics research and adoption. -. Robotic hardware systems. - Sensors, sensor data interpretation and sensor fusion. -. Configuration spaces. - Position estimation. - Intelligent systems. - Spatial mapping. - Human-Robot Interaction basics. Implicit vs Explicit interaction. - HRI experimentation design.- Intelligent interaction. - Multi-agent systems.

**References:**
- S. Cubero, *"Industrial Robotics: Theory, Modelling and Control,"* Advanced Robotic Systems International, 2007.

| CSE 739 | **Course Code** | **Applied Kalman Filtering** | | | | | **Course title** |
|---|---|---|---|---|---|---|---|
| 3 | **Credit hours** | ------ | **Prerequisites** | **Practical** | **Tutorial** | **Lectures** | **Teaching hours** |
| | | | | 2 | 1 | 2 | |
| 100 | **Total grads** | **Final Exam** | | **S. work** | **Practical** | **Oral** | **Course grades** |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Detailed treatment of Kalman Filtering Theory and its applications, including some aspects of stochastic control theory. Least square estimation - Estimation of a constant – Recursive least squares estimation - Wiener filtering - propagation of states and covariances - The discrete time Kalman filter- One-step Kalman filter equations - The continuous-time Kalman filter – Discrete time and continuous-time white noise - Derivation of the continuous-time Kalman filter - The steady-state continuous-time Kalman filter – Extended Kalman Filter. Topics include state-space models with random inputs, optimum state estimation, filtering, prediction and smoothing of random signals with noisy measurements, all within the framework of Kalman filtering. Additional topics are nonlinear filtering problems, computational methods, and various applications such as global positioning system, tracking, system control, and others. Stochastic control problems include linear-quadratic-Gaussian problem and minimum-variance control.

**References:**

- M. Grewal and A. Andrews, *"Kalman Filtering: Theory and Practice with MATLAB, 4th edition"* New Jersey, Wiley, 2015

| CSE 741 | Course Code | Distributed Machine Learning and Big Data | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------ | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Introduction to Big data using Apache Spark- Principles of Distributed Machine Learning- Distributed Linear Regression- Distributed Logistic Regression- Principal Component analysis- Neuroimaging analysis via PCA.

**References:**

H. Luu, *"Beginning Apache Spark 2: With Resilient Distributed Datasets, Spark Sql, Structured Streaming and Spark Machine Learning Library,"* California, USA, Apress, 2018

| CSE 742 | Course Code | Introduction to Reinforcement Learning | | | | | Course title |
|---|---|---|---|---|---|---|---|
| 3 | Credit hours | ------- | Prerequisites | Practical | Tutorial | Lectures | Teaching hours |
| | | | | 2 | 1 | 2 | |
| 100 | Total grads | Final Exam | | S. work | Practical | Oral | Course grades |
| | | 50 | | 35 | 5 | 10 | |

**Contents**

Reinforcement Learning basics - Temporal Difference Learning (TD) - Convergence: TD control and Bellman Equations- Advanced Algorithmic Analysis (AAA)- Messing with Rewards - confidence-based exploration- Partially observed MDPs- Game theory- Coordinating and communication and Coaching (CCC).

**References:**

- R. Sutton and A. Barto, *"Reinforcement Learning: An Introduction, 2nd Edition,"* London, England, The MIT Press, 2018

### : Request determined by the academic advisor and Dept. Committee

# Chapter Seven:

## Mechanical Power Engineering Department

# Diploma in Mechanical Power Engineering Majoring in Refrigeration and Air-conditioning Engineering

## Program description

The objective of this diploma degree program is to provide high quality of theoretical and practical aspects of refrigeration and air-conditioning engineering. The program enables students to learn in depth and apply principles of refrigeration systems and advanced cooling techniques. This provides a sound foundation to enter a professional role in industry or academia.

## Competencies for the diploma graduate

In addition to generic competencies for the diploma in engineering, the graduate of diploma in mechanical engineering must be able to:

1- Demonstrate the underlying foundational knowledge required to conceive, design, manufacture and operate air conditioning systems.

2- Demonstrate knowledge and understanding of the essential components of controlling refrigeration systems.

3- Demonstrate a comprehensive knowledge with clear, concise, accurate and readily available information related to policy, economics, system modeling, environmental issues and energy management associated to refrigeration and air conditioning systems.

4-Demonstrate a critical awareness of theoretical design concepts and their practical implementation within cooling systems.

5- Select and apply appropriate methods of improving mechanical systems efficiencies and adapting appropriate solutions to practical problems

***Benchmark: British Columbia Institute of Technology (BCIT)***

*https://www.bcit.ca/study/programs/635ddiplt#details*

# Diploma in Mechanical Power Engineering Majoring in Power Stations

## Program description

The objective of this diploma degree program to gain the fundamental knowledge required to work in the field of power plants. The program enables students to learn in depth and apply principles of energy systems and energy resources. This provides a sound foundation to enter a professional role in industry or academia. The program is suitable for graduates from mechanical engineering program and related programs and has been specifically designed to meet the needs of an expanding energy industry.

## Competencies for the diploma graduate

In addition to generic competencies for the diploma in engineering, the graduate of diploma in mechanical engineering must be able to:

1- Demonstrate a comprehensive knowledge and understanding of the origins and distribution of different renewable energy sources (solar, wind, hydro, wave, tidal and bioenergy), as well as conventional energy including hydro, gas turbine and nuclear energy.

2- Demonstrate a critical awareness of applying quality control and quality assurance procedures to meet organizational standards and requirements

3- Apply mathematics and fundamentals of mechanical engineering to analyze and solve mechanical problems as well as design, maintain and repair the mechanical components of power plants.

4- Demonstrate a critical awareness of theoretical design concepts and their practical implementation within energy systems.

5- Use current and emerging technologies to support the implementation of mechanical engineering projects in accordance with health and safety regulations, as well as standard practices and procedures.

6- Quantify resource potential and determine the appropriate energy resource at a given site.

***Benchmark: Sheridan College***

*https://academics.sheridancollege.ca/programs/mechanical-engineering-technician*

# Diploma in Mechanical Power Engineering Majoring in in Hydraulic Machinery

## Program description

The objective of this diploma degree program is to gain the fundamental knowledge required to work in the field of hydraulic machinery, besides the basic math and science. The program is suitable for graduates from mechanical engineering program and related programs and has been specifically designed to meet the needs in controlling and operating pipelines networks and hydraulic machines.

## Competencies for the diploma graduate

In addition to generic competencies for the diploma in engineering, the graduate of diploma in mechanical engineering must be able to:

1- Demonstrate the underlying foundational knowledge required to conceive, design, manufacture and operate hydraulic machines.

2- Demonstrate knowledge and understanding of the essential components of hydraulic control systems.

3- Demonstrate a comprehensive knowledge with clear, concise, accurate and readily available information related to policy, economics, system modeling, environmental issues and energy management associated to hydraulic and fluid machines.

4-Demonstrate a critical awareness of theoretical design concepts and their practical implementation within hydraulic systems.

5- Use high-level software packages and IT skills for modeling and simulation the performance of hydraulic components.

6- Select and apply appropriate methods of improving mechanical systems efficiencies and adapting appropriate solutions to practical problems

***Benchmark: British Columbia Institute of Technology (BCIT)***

*https://www.bcit.ca/study/programs/635ddiplt#details*

# Diploma in Mechanical Power Engineering Majoring in in Combustion Engineering

## Program description

The objective of this diploma degree program is to provide high quality of theoretical and practical aspects of combustion engineering. The program enables students to learn in depth and apply principles of internal and external combustion engines. This provides a sound foundation to enter a professional role in industry or academia.

## Competencies for the diploma graduate

In addition to generic competencies for the diploma in engineering, the graduate of diploma in mechanical engineering must be able to:

1- Demonstrate the underlying foundational knowledge required to conceive, design, manufacture and operate mechanical engines.

2- Demonstrate a critical awareness of applying quality control and quality assurance procedures to meet organizational standards and requirements

3- Demonstrate a comprehensive knowledge with clear, concise, accurate and readily available information related to policy, economics, system modeling, environmental issues and energy management associated to combustion process.

4- Demonstrate a critical awareness of theoretical design concepts and their practical implementation within mechanical power systems.

5- Use high-level software packages and IT skills for modeling and simulation of the combustion process and mechanical engines.

6- Select and apply appropriate methods of improving mechanical systems efficiencies and adapting appropriate solutions to practical problems

***Benchmark:* *British Columbia Institute of Technology (BCIT)***

*https://www.bcit.ca/study/programs/635ddiplt#details*

# Master of Science in Mechanical Engineering

## Program description

The objective of the master's degree program in mechanical engineering is to provide research informed knowledge in a broad spectrum of specialist mechanical topics with immediate application to industrial problems. These topics involve energy production, cooling techniques, micro- and nano-fluids applications This Program offers a flexible structure that enables both new graduates and more established engineers to tailor their learning experience to meet the needs for their future

## Competencies for the program graduate

In addition to generic competencies for the M.Sc. in engineering, the graduate of Master of Science in mechanical engineering must be able to:

1- Demonstrate the ability to apply acquired scientific knowledge to real life mechanical engineering problems.
2- Demonstrate the ability to carry out experiments or use computation skills in a research-intensive job dealing with mechanical engineering fields.
3- Use appropriate computer aided design and analysis techniques to provide solutions to practical problems related to mechanical systems.
4- Identify an in-depth knowledge of a certain topic related to mechanical engineering fields as part of a research project
5- Apply and integrate knowledge and skills acquired in other disciplines to explain complex systems and select appropriate methods for modelling mechanical systems.
6- Develop current research and best practices in energy systems.
7- Use software packages and measurement equipment relevant to mechanical systems.

***Benchmark: Queen's University***

*https://www.queensu.ca/sgs/sites/webpublish.queensu.ca.sgswww/files/files/Program%20DLEs/MEME_MASc.pdf*

# Ph. D. program in Mechanical Engineering

## Program description

The Ph. D. program in mechanical engineering is a research-oriented degree program. It aims to advance the knowledge in the fields of mechanical engineering and enable students of exceptional ability to undertake advanced study and original research. It prepares students for a research and/or teaching career in industry, research institutions, universities, and government. The program has a focus on state-of–art technology issues that cross boundaries of Power Systems, Renewable Energy Engineering's, Hydraulic Machines, thermofluids and Microfluidics applications, and other related topics.

## Competencies for the program graduate

In addition to generic competencies for the Ph. D. program, the graduate of Ph. D. program in mechanical engineering must be able to:

1- Demonstrate a strong technical knowledge in mechanical systems and develop the research skills needed to plan and conduct research.

2- Demonstrate the ability to learn independently and make an original contribution to knowledge in the chosen field of mechanical engineering.

3- Reach the highest academic level with the potential to become a world leading industry professionals and researchers in mechanical engineering fields.

4- Demonstrate the ability to generate new knowledge by completing creative novel work and writing a thesis.

5- Apply scientific principles in integrating knowledge learned in previous courses into a dissertation.

***Benchmark: The University of Manchester***

*https://www.manchester.ac.uk/study/postgraduate-research/programmes/list/03061/phd-mechanical-engineering/programme-details/#course-profile*

## List of level 500 Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| MPE511 | Thermodynamics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| MPE512 | Fluid Mechanics | 2 | 0 | 3 | 5 | 3 | 9 | 3 | 30 | 20 | 50 | 100 |
| MPE513 | Heat and Mass Transfer | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| MPE514 | Refrigeration Cycles and Systems | 2 | 0 | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| MPE515 | Internal Combustion Engines | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| MPE516 | Hydraulic Machines | 2 | 0 | 3 | 5 | 3 | 9 | 3 | 30 | 20 | 50 | 100 |
| MPE517 | Gas Dynamics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

## List of level 600 Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| MPE611 | Measurements and Instrumentation | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| MPE612 | Research Project | 2 | 0 | 3 | 5 | 3 | 10 | 3 | 30 | 70 | 0 | 100 |
| MPE613 | Computer Applications in mechanical systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| MPE614 | Statistical Thermodynamics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| MPE621 | Solar Heating and Cooling | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| MPE622 | Air Conditioning Systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| MPE623 | Maintenance of Refrigeration and Air Conditioning Equipment | 2 | 0 | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MPE624** | **Selective Topics in Air Conditioning Engineering** | 2 | 0 | 3 | 5 | 3 | 10 | 3 | 30 | 20 | 50 | 100 |
| **MPE625** | **Heat Exchangers** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| **MPE626** | **Cooling and Heating** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| **MPE627** | **Non-conventional Refrigeration systems** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE628** | **Drying** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE631** | **Energy Conversion** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE632** | **New and Renewable Energy** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE633** | **Solar Power** | 2 | 0 | 3 | 5 | 3 | 7 | 3 | 30 | 20 | 50 | 100 |
| **MPE634** | **Wind Power** | 2 | 0 | 3 | 5 | 3 | 7 | 3 | 30 | 20 | 50 | 100 |
| **MPE635** | **Nuclear Power** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| **MPE636** | **Modern Power Plants** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE637** | **Economics of Power Plants** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE641** | **Laminar and Ideal Flow** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| **MPE642** | **Turbulence Theory** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| **MPE643** | **Open Channel Flow** | 2 | 0 | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **MPE644** | **Two-Phase Flow** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE645** | **Water Desalination** | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **MPE646** | **Pipelines and Networks** | 2 | 0 | 3 | 5 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **MPE647** | **Hydropower Plants** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| **MPE648** | **Maintenance of Hydraulic Circuits** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| **MPE649** | **Selective Topics in Hydraulic Machines** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE651** | **Pollution** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| **MPE652** | **Furnaces and Combustion** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE653** | **Fuels and Oils** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |
| **MPE654** | **Maintenance of Combustion Engines** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE655** | **Selective Topics in Combustion** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MPE656** | **Engines Performance** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE657** | **Oils and Lubrication Methods** | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | 0 | 50 | 100 |

## List of level 700 Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical Exam | Written Exam | Total |
| **MPE711** | **Non-conventional cooling systems** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE712** | **Energy efficient buildings** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE713** | **Mini- and microchannel heat transfer** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE714** | **Microelectromechanical systems** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE715** | **Microfluidics** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE716** | **Emerging Desalination Technologies** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE717** | **Advances in Wastewater Treatment** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE718** | **Evaporators and Condensers** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE719** | **Design of Heat Transfer Equipment** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE721** | **Mechatronics** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE722** | **Automatic Control Systems** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE723** | **Boundary Layer Theory** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **MPE724** | **Pumps and Compressors** | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

# Summary of Courses Specification

## Level (500)

| Course title | Thermodynamics | | | | Course Code | MPE511 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction to Thermodynamics – Microscopic State of Matter – The Zeroth Laws of Thermodynamics – The First Laws of Thermodynamics – The Second Laws of Thermodynamics – Closed Systems – Open Systems – The Definition of Entropy – Exergy Destruction – Exergy Analysis – The Reversibility – The Microscopic Definition of Work and Heat – The Macroscopic Properties – Ideal Gases Mixture – Specific Heat Relations of Ideal Gases – Carnot Cycle – Carnot Heat Engine – Gas Power Cycles (Otto, Diesel, Stirling and Ericsson, and Brayton Cycle) – Vapor and Combined Power Cycles – Combined Gas–Vapor Power Cycles.

**References:**


- ***Cengel, Yunus A., and Michael A. Boles. Thermodynamics: An engineering approach, 2015.***
- ***Bejan, Adrian. Advanced engineering thermodynamics. John Wiley & Sons, 2016.***


| Course title | Fluid Mechanics | | | | Course Code | MPE512 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Introduction and Basic Concepts – Pressure and Fluid Statics – Dimensional Analysis and Modeling – Rheological Behaviour of Newtonian and non-Newtonian fluid– Equation of Motion of Compressible and Incompressible Fluids – Navier-Stokes Equations – Approximate Solutions of the Navier-Stokes Equation – Viscous Flow – Laminar and Turbulent Flow (Analysis, Measurement, and visualization) – Steady and Unsteady Flow – Fluid Vortices – Flow in Nozzles and Diffusers – Two-Dimensional Flow for Ideal Fluid – External Flow (Drag and Lift) – Internal Flow – Buoyancy-Driven Flows – Aerodynamics – Biofluid Mechanics – Irrotational Flow – Flow Past Immersed Bodies.

**References:**


- ***Pritchard, Philip J., and John W. Mitchell. Fox and McDonald's introduction to fluid mechanics. John Wiley & Sons, 2016.***
- ***Yunus, A. Cengel. Fluid Mechanics: Fundamentals and Applications (Si Units). McGraw Hill Education, 2017.***

| Course title | Heat and Mass Transfer | | | | Course Code | MPE513 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Basic Concepts of Heat Transfer (Conduction, Convection, and Radiation) – Relationship to Thermodynamics – Steady and Unsteady Conduction – One- and Two-Dimensional, Steady-State Conduction – Conduction with Thermal Energy Generation – Transient Conduction – Free and Forced Convection – Forced Convection (External ND Internal Flow) – Thermal Boundary Layer – Heat Transfer from Extended Surfaces – Radiation – Heat Transfer with Change in Phase (Boiling, Condensation, and Freezing) – Heat Exchangers – Principles of Mass Transfer – Symmetry between Heat and Mass Transfer – Applications (Cooling Towers – Air Washers – Wet Cooling Coils – Humidifiers – Industrial Drying).

**References:**


- ***Bergman, Theodore L., Adrienne Lavine, Frank P. Incropera, and David P. Dewitt. Fundamentals of heat and mass transfer. New York: John Wiley & Sons, 2017.***
- ***Yunus, A. Cengel. Heat and mass transfer: fundamentals and applications. McGraw-Hill Education, 2019.***


| Course title | Refrigeration Cycles and Systems | | | | Course Code | MPE514 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

The Refrigeration Cycle (Vapor Compression Cycles) – Refrigerants – Heat Pumps and Integrated Systems – Fundamentals of Absorption Refrigeration Systems – Single, Double, Triple, and Quadruple Effect Absorption Refrigeration System – Refrigeration by Steam Nozzles – Air Refrigeration – Air Conditioning Methods and Applications – Thermoelectric Cooling – Gas Liquefaction – Ice Production – Salt Coolers – Defrosting – Cooling Towers – Expansion Valves – Component Selection and Balancing – Distributed Cooling and Heating – Cold Storage and Refrigeration Load Estimation – Refrigeration Installation and Construction – Food Refrigeration and Freezing – Industrial Applications Refrigeration Maintenance and Control Systems.

**References:**


- ***Hundy, Guy F. Refrigeration, air conditioning and heat pumps. Butterworth-Heinemann, 2016.***
- ***Tomczyk, John, Eugene Silberstein, Bill Whitman, and Bill Johnson. Refrigeration and air conditioning technology. Nelson Education, 2016.***
- ***Dincer, Ibrahim. Refrigeration systems and applications. John Wiley & Sons, 2017.***

| Course title | Internal Combustion Engines | | | | Course Code | MPE515 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction and Basic Concepts of Internal Combustion Engines – Internal Combustion Engines Classification – Engine Design and Operating Parameters – Thermochemistry of fuel-air mixtures – Gas exchange processes – Ideal models of engine cycles – Petrol Engines – Diesel Engines – Gas Engines – Combustion in Petrol and Diesel Engines – Overcharging – Fuel Injection – Engines Performance and Tests – Combustion in Spark-Ignition Engines – Combustion in Compression-Ignition Engines – Engine Heat Transfer – Modeling real engine flow and combustion processes – Engine Friction and Lubrication – Exhaust Analyzing and Air Pollution Control.

**References:**


- ***Heywood, John B. Internal Combustion Engine Fundamentals. New York: McGraw-Hill, 2018.***
- ***Ferguson, Colin R., and Allan T. Kirkpatrick. Internal Combustion Engines: Applied Thermosciences. John Wiley & Sons, 2015.***


| Course title | Hydraulic Machines | | | | Course Code | MPE516 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Basic Concepts – Hydraulic Circuit Design and Analysis – Hydraulic Machines Turbines – Hydraulic Engines – Centrifugal Pumps – Reciprocating Pumps – Pump Casing – Leakage – Impellers and Rotors – Impeller Friction and Mechanical Losses – Inspection and Repair Guidelines for Rotors– Axial Propulsion – Pumps Performance – Pump Control and Valves – Pipe Flow Systems – Compressors Classification – Selection Factors for Process Compressors – Compressor Operation and Capacity Control – Operating Characteristics of Turbocompressors – Reciprocating Compressors – Rotating Compressors – Compressor Performance Testing – Instrumentation Controls – Surveillance Monitoring and Troubleshooting – Bearings Stability and Vibration Guidance – Maintenance Techniques.

**References:**


- ***Goyal, M. K. Fluid and Hydraulic Machines. Prentice Hall India Pvt., Limited, 2015.***
- ***Subramanya, K. Fluid Mechanics and Hydraulic Machines: Problems and Solutions, 2e. McGraw-Hill Education, 2018***

| Course title | Gas Dynamics | | | | Course Code | MPE517 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 0 | 50 | 50 | | |

**Contents**

Basic Concepts of Compressible Flow – Steady Ideal Compressible Flows – One-Dimensional Isentropic Flow Shock and Expansion Waves – Multi-Dimensional Compressible Flow – Flow with Friction and Heat Transfer – High Temperature Gas Dynamics – Inviscid Hypersonic Flows – Hypersonic Viscous Interactions – Small Perturbation Theory – Applications of Small Perturbation Theory – Radiative Gas Dynamics – Method of Characteristics – Waves in Compressible Flows – Unsteady Flow in Ducts – Numerical Procedures of Solution – Standing Normal Shocks – Moving Shocks – Oblique Shocks – Expansion Waves Applications of Shock Physics – Case Studies.

**References:**

- ***Emmons, Howard W. Fundamentals of gas dynamics. Princeton University Press, 2015.***
- ***Zucker, R. D., and O. Biblarz. Fundamentals of Gas Dynamics. Wiley, 2019.***

## Level (600)

| Course title | Measurements and Instrumentation | | | | Course Code | MPE611 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Basic Concepts – Theory and Performance of Measurement and Control Devices – Measurements Methods (Pressure, Temperature, Flow Rate, Thermal Transport Property, Viscosity) – Linear Control Systems – Logic Circuits (Hydraulic, Pneumatic, Electronic) – Balance, Tuning, and Calibration of Measurement and Control Devices – Control Using Computer – Experimental Results Analyzing – Hydraulic Machines Applications – Measurement Calibration – Torsion Pendulum Experiments- Turbine Engine Component Measurement – Voltage Dividers – Power and Energy in Electric Circuits – bservables Measured in Fluorescence – The Perrin–Jabłoński Diagram, Instrumentation, Light Source, Monochromator, Light Detectors.

**References:**

- ***Morris, A. S., and R. Langari. Measurement and Instrumentation: Theory and Application. Elsevier Science, 2015.***
- ***Rajput, R. K. Mechanical Measurements & Instrumentation. SK Kataria and Sons, 2015.***

| **Course title** | **Research Project** | | | | **Course Code** | MPE612 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | - | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 70 | - | 30 | 0 | | |

**Contents**

The student studies (researches on) a subject related to mechanical engineering under the supervision of one of the department staff members – Getting started – How to structure your research report – Writing your literature review- Choosing your research methodology – Research strategies – case studies, action research and surveys – Gathering your data – interviews and observations – Gathering your data – documents and questionnaires- Analysis of qualitative data- Analysis of quantitative data – Some final advice – writing literature – graphing and presentation of results.

**References:**

- ***Bell, J. Doing Your Research Project: A Guide for First-Time Researchers. McGraw-Hill Education, 2014***
- ***Thomas, G. How to Do Your Research Project: A Guide for Students. SAGE Publications, 2017.***

| **Course title** | **Computer Applications in mechanical systems** | | | | **Course Code** | MPE613 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Data Structures Fundamentals – Algorithmics Including Execution, Sorting, and Searching – Data Types – Data Structures – Structures and Programming are done Using C++ Language with Applicable Examples – Computer applications in Energy Management Activities and Approaches – computer Functions – System Implementation – Energy Conservation Opportunities – Trends in Computer-Based Energy Management Systems – Energy Management Organization – Energy Conservation Opportunities through Better Control-Philosophy of Control for Energy Processes – Design Procedure for an Advanced Control System – Applying Optimization Techniques – Review of Experimental Search Methods- The Pattern Search Method – Three Optimization Techniques Commonly Energy Management Solutions – computer applications in Cooling Towers and refrigeration Management Systems – Basic Operation of a Refrigeration Machine.

**References:**

- ***kanetkar, Y. Computer System and Programming in C: Learn the Fundamentals of C Programming. BPB Publications, 2018.***
- ***Steven Chapra, "Applied Numerical Methods with MATLAB: for Engineers & Scientists", 4th edition, McGraw-Hill Education, 2017.***

<table>
<tr><th>Course title</th><th colspan="4">Statistical Thermodynamics</th><th>Course Code</th><th>MPE614</th></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction – Microscopic State of Matter – The Entropy – The Statistical Analysis – The Statistical Analysis of Entropy – Entropy Change due to the Microscopic Effects – The Microscopic Definition of Work and Heat – The zeroth, and first Laws of thermodynamics, including the concepts of heat capacity and enthalpy – Exploration of the second law of thermodynamics – Properties examination using the third law of thermodynamics – Thermodynamic potentials and phase changes in substances. The final part of the unit explores the kinetic theory of gases and statistical mechanics. Classical treatment of energy distribution to include the effects of quantum mechanics, deriving the distribution functions of blackbody radiation and matter that are subject to either Bose-Einstein or Fermi-Dirac statistics.

**References:**


- ***Hertel, P. Quantum Theory and Statistical Thermodynamics: Principles and Worked Examples. Graduate Texts in Physics. Springer International Publishing, 2017.***
- ***Daily, J. W. Statistical Thermodynamics: An Engineering Approach. Cambridge University Press, 2018.***


<table>
<tr><th>Course title</th><th colspan="4">Solar Heating and Cooling</th><th>Course Code</th><th>MPE621</th></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Solar Energy and Radiation – Geometry and Intensity of Solar Radiation – Calculating the Solar Radiation on Horizontal and Inclined Surfaces – Solar Radiation Collectors – Solar Energy Applications – Coolants – Absorption Cooling System – Thermoelectric Cooling – Direct and Indirect Solar Heating – Passive Solar Building – Solar Water Heating – Solar Space Heating – Solar Thermal Applications (such as Agricultural Product Dryers, Solar Ovens, and Water Desalination) – Grid-connected Photovoltaics – Stand-alone Photovoltaics – Larger Scale Applications such as Concentrating solar power – Adsorption and Absorption Cooling Cycles.

**References:**


- ***Dincer, Ibrahim. Refrigeration systems and applications. John Wiley & Sons, 2017.***
- ***Karellas, S., T. C. Roumpedakis, N. Tzouganatos, and K. Braimakis. Solar Cooling Technologies. Energy Systems. CRC Press, 2018.***

| Course title | Air Conditioning Systems | | | | Course Code | MPE622 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Human Comfort – Industrial Conditioning Purposes – Psychrometric Processes – Cooling Load – Heating Load – Air Distribution and Vents – Ducts Sizing – Window Units – Split Units – Portable Units – Central Air Conditioning – Fan and Coil Units – Dual Duct System – Air Conditioning Applications – Heating cycle – Absorption chillers – double-effect direct-fired absorber – Air purge unit – Capacity control and part-load operation – Coefficient of performance – Condensing temperature controls – Cooling water entering temperature – Cooling water temperature control – Corrosion control – Crystallization controls – Difference between absorption and centrifugal chillers – Evaporating temperature – Evaporator and refrigerant pump – Flow of solution and refrigerant – Generators – Heat exchangers – Heat removed from absorber and condenser.

**References:**


- ***Hundy, G. F. Refrigeration, Air Conditioning and Heat Pumps. Elsevier Science, 2016.***
- ***Kandelousi, M. S. HVAC System. IntechOpen, 2018.***
- ***Bearg, D. W. Indoor Air Quality and Hvac Systems. CRC Press, 2019.***


| Course title | Maintenance of Refrigeration and Air Conditioning Equipment | | | | Course Code | MPE623 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 0 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Chilled Water Production Units (Compressors – Evaporators – Condensers – Expansion Devices – Pumps – Control Devices) – Air Handling Units (Supply and Exhaust Air Grilles – Filters – Cooling Coils – Heating Coils – Humidifiers – Fans) – Ducts – Cooling Towers – Insulators – Control Devices – Diagnosing Refrigeration and Air Conditioning Equipment Problems – Methods of Refrigeration and Air Conditioning Equipment Maintenance – Maintenance overview – Maintaining the cooling system – Maintaining insulated panels and vapour control sealing – Condensation control outside the cold store enclosure – Frost-heave control – Cold store panel insulation – Insulation for refrigeration pipes – Cold store maintenance schedule – Refrigerated vehicles – Refrigerated vans – Refrigerated rigid bodies – Refrigerated semi-trailer – Refrigerated containers.

**References:**


- ***Eric Kleinert, HVAC and Refrigeration Preventive Maintenance, 2015.***
- ***Ibrahim Dincer, Refrigeration Cycles and Systems, 2017.***

| Course title | Selective Topics in Air Conditioning Engineering | | | | Course Code | MPE624 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Advanced topics in air conditioning engineering which are not covered by other courses in the field of Mechanical Engineering such as (Filters, Cooling Coils, Heating Coils, Humidifiers, Fans) – Ducts – Cooling Towers – Insulators – Control Devices – Diagnosing Refrigeration and Air Conditioning Equipment Problems-Dual Duct System – Air Conditioning Applications – Heating cycle, Absorption chillers, double-effect, and direct-fired- Thermoelectric Cooling – Direct and Indirect Solar Heating – passive solar building – solar water heating-solar space heating – other solar thermal applications.

**References:**


- ***Eric Kleinert, HVAC and Refrigeration Preventive Maintenance, 2015.***
- ***Kreith, F., S. K. Wang, and P. Norton. Air Conditioning and Refrigeration Engineering. CRC Press, 2018.***
- ***Althouse, A. D., C. H. Turnquist, A. F. Bracciano, G. M. Bracciano, and D. C. Bracciano. Modern Refridgeration and Air Conditioning. Goodheart-Willcox Company, Incorporated, 2019.***


| Course title | Heat Exchangers | | | | Course Code | MPE625 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction and Basic Concepts – Heat Exchangers Classification – Thermal and Hydraulic Design of Heat Exchangers – Shell and Tubes Exchangers – Boilers – Condensers and Cooling Towers – Radiators – Heat Exchanger Test and Effectiveness – Fouling in Heat Exchangers – Materials Used in Heat Exchangers Fabrication – Uses of Heat Exchangers – Heat Exchanger Selection – Construction of Heat Exchangers – Classification of Heat Exchangers – Tubular Heat Exchanger – Plate Heat Exchangers – Extended Surface Exchangers – Regenerative Heat Exchangers – Classification according to Transfer Process – Indirect Contact Heat Exchangers – Direct Contact – Micro Heat Exchanger – Printed Circuit Heat Exchanger – Perforated Plate Heat Exchanger as Cryocoolers – Scraped Surface Heat – Graphite Heat Exchanger.

**References:**


- ***Balik, M. Heat Exchangers: Basics Design Applications. Scitus Academics, 2017.***
- ***Ranganayakulu, Chennu, and Kankanhalli N. Seetharamu. Compact heat exchangers: Analysis, design and optimization using FEM and CFD approach. John Wiley & Sons, 2018.***

| Course title | Cooling and Heating | | | | Course Code | MPE626 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Weather conditions- thermal comfort conditions- Vapor Compression Cooling System – Vapor Compression Cycle Components – Condensers and Cooling Towers – Commercial Cooling and Freezing Methods – Cooling Using Absorption Cycles – Heat Pumps – Solar Heating – Heating by Steam, Hot Water, and Hot Air – Heating by Electrical Heaters – Heat Losses- Cooling Loads – Heating Systems- Steam Systems – Domestic Services – Ventilation- Air Conditioning- Pumps and Fans- Sound – Labor Rates – Heating systems- Steam heating systems – solar heating systems – Properties of steam and air – Heat and thermal properties of materials – thermal insulation – vacuum glazing – vacuum insulation panels.

**References:**


- ***Kandelousi, M. S. HVAC System. IntechOpen, 2018.***
- ***Dincer, Ibrahim, and Tahir Abdul Hussain Ratlamwala. Integrated absorption refrigeration systems: comparative energy and exergy analyses. Springer, 2016***


| Course title | Non-conventional Refrigeration systems | | | | Course Code | MPE627 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction and Basic Concepts – air cooling cycles- aircraft air refrigeration cycles-Vapor Compression Cooling System – Vapor Compression Cycle Components – types of evaporators- types of condensers- types of compressors- types of capillary rubes- compound refrigeration cycles- Condensers and Cooling Towers Vortex Refrigeration System- Pulse tube refrigeration-vortex tube-Solar refrigeration- Thermoelectric Cooling – Direct and Indirect Solar Heating- passive building cooling Electrocaloric refrigeration- solar water heating- solar space heating- ground source heat pumps-adsorption cooling systems- absorption cooling systems-descant wheel cooling- thermoelectric refrigeration and magnetic refrigeration.

**References:**


- ***Dincer, Ibrahim, and Tahir Abdul Hussain Ratlamwala. Integrated absorption refrigeration systems: comparative energy and exergy analyses. Springer, 2016.***
- ***J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, 4th Edition, John Wiley & Sons, Inc., New York, 2006.***

| Course title | Drying | | | | Course Code | MPE628 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Mass Transfer Basics – Mass Transfer by Unstable Convection Basics – needs for drying-Drying Methods – Drying Equipment – Calculations of Drying Period Rate – Drying by Freezing Organic Materials – Use of Drying Fields. Drying of fruits, vegetables, sugar, biomass, and coal- Spreadsheet-aided dryer design- Indirect and pneumatic drying-Drying of fish and seafood, grain, herbal medicines, and tea-Drying of nanosize products, enzymes, and textiles- Dewatering and drying of wastewater treatment sludge-Heat pump drying and industrial crystallization-Solid–liquid separation for pretreatment.

**References:**


- ***Kudra, Tadeusz, and Arun S. Mujumdar. Advanced drying technologies. CRC press, 2009.***
- ***Arun S. Mujumdar, Handbook of Industrial Drying,2015***


| Course title | Energy Conversion | | | | Course Code | MPE631 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

General Principles of Energy Conversion and Management - Energy Classifications – Power and Energy Measurement Units and Techniques - Primary Energy Measurement Units - Production of Thermal Energy – Fossil-Fuel Systems – Production of Mechanical Energy – Production of Electrical Energy – Direct Energy Conversion Devices for thermic, Thermo-Ionic, Magnetohydrodynamic, Photovoltaic Energy – Principles and Theories of Chemical and Mechanical Energy Storage Devices - Heat Exchange and Recovery in Process and Facilities - Basic Principles of Heat Exchanger Operation - Waste and Energy Recovery .

**References:**


- ***Goswami, D. Yogi, and Frank Kreith, eds. Energy conversion. CRC press, 2007.***
- ***Petrecca, Giovanni. Energy Conversion and Management. Springer, 2014.***
- ***Geradus Blokdyk, Energy Conversion and management: A complete guide. Emereo Pty Limited, 2020.***


| Course title | New and Renewable Energy | | | | Course Code | MPE 632 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Global and Regional Energy Challenges - Principles of Renewable Energy - Solar Radiation and the Greenhouse Effect - Solar Water Heating - Other Solar Thermal Applications - Photovoltaic Power Technology (PV) -

Hydropower - Wind Resource - Wind Power Technology - Biomass Resources from Photosynthesis - Bioenergy Technologies - Wave Power - Tidal-current and Tidal-range Power - Ocean Gradient Energy: OTEC and Osmotic Power - Geothermal Energy - Energy Systems: Integration, Distribution and Storage - Using Energy Efficiently - Economies of Renewable Energy.

**References:**


- ***Boyle, Godfrey. Renewable energy. 2004.***
- ***Twidell, John, and Tony Weir. Renewable energy resources. Routledge, 2015.***


| Course title | Solar Power | | | | Course Code | MPE 633 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Introduction – Environmental Characteristics – Solar Energy and Radiation – Geometry and Intensity of Solar Radiation – Calculating the Solar Radiation on Horizontal and Inclined Surfaces – Flat Plate Solar Collectors – Heliostat Solar Collectors – Parabolic Trough Solar Collectors – Parabolic Dish Solar Collectors – Performance of Solar Collectors – Solar Water Heating Systems – Solar Space Heating and Cooling – Industrial Process Heating – Chemical Applications – Solar Dryers – Solar Desalination Systems – Photovoltaic Power Systems – Solar Thermal Power Systems – Solar Energy Storage – Design and Modeling Of Solar Power Systems – Solar Energy Economics.

**References:**


- ***Kalogirou, Soteris A. Solar energy engineering: processes and systems. Academic Press, 2013.***
- ***Sukhatme, Suhas P., and J. K. Nayak. Solar energy. McGraw-Hill Education, 2017.***


| Course title | Wind Power | | | | Course Code | MPE 634 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Definitions and Technical Terminology – General Characteristics of Wind Resource – Characteristics of the Atmospheric Boundary Layer – Wind Measurement and Instrumentation – Wind Data Analysis and Resource Estimation – Regional Wind Resource Assessment – Wind Prediction and Forecasting – Wind Energy Production Estimation Using Statistical Techniques – Wind Turbines Types – Wind Turbines Components and Operation Characteristics – Aerodynamics of Wind Turbines – One-dimensional Momentum Theory and the Betz Limit – Airfoils Design Main Concepts – Blade Design for Modern Wind Turbines Calculating the Power Generated from Wind Turbines – Wind Farms – Environmental Effects of Wind Turbines – Economics of Power Generation by Wind.

**References:**


- ***Burton, Tony, et al. Wind energy handbook. Vol. 2. New York: Wiley, 2001.***
- ***Manwell, James F., Jon G. McGowan, and Anthony L. Rogers. Wind energy explained: theory, design and application. John Wiley & Sons, 2010.***
- ***Shambhu Ratan Awasthi. Wind power: Practivcal aspects. TERI press, 2018.***


| **Course title** | **Nuclear Power** | | | | **Course Code** | MPE 635 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Nuclear Energy Basics – The Demand for Energy – Importance of Nuclear Energy – Generating Electricity by Nuclear Power Plants – Nuclear Fission – Radioactivity – Power Plants of Fission Reactors (Pressurized Water Reactors – Boiling Water Reactors – Gas-Cooled Reactors – Pressurized Heavy Water Reactors) – Power Plants of Fast Neutron Reactors – Reactor Design – Atomic Energy and Construction Law –Interface Between Plant and Structural Engineering – Planning and Design Requirements – Extraordinary Actions Involved When Designing Nuclear Installations – Safety Concept and Design – Design Instructions for Concrete, Reinforced and Pre-Stressed Concrete Structures – Design Instructions for Steel Components – Ageing Management of Buildings.

**References:**


- ***Stuart, Sam. Nuclear Power Generation: Modern Power Station Practice. Elsevier, 2013.***
- ***Meiswinkel, Rüdiger, Julian Meyer, and Jürgen Schnell. Design and construction of nuclear power plants. John Wiley & Sons, 2013.***
- ***Breeze, Paul. Nuclear Power. Academic Press, 2016.***


| **Course title** | **Modern Power Plants** | | | | **Course Code** | MPE 636 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction – Power Plants Classification – Power Plant Planning and Design – Thermodynamics Cycles for Power Plants – Steam Power Plants – Gas Power Plants – Combined Cycle Plants – Fossil Fuels – Coal and Limestone Handling – Combustion Processes – Steam Generators – Steam Turbines – Gas Turbines – Heat Exchangers – Fans – Pumps – Circulating Water Systems – Cycle Performance Impacts – Power Plant Atmospheric Emissions Control – Water Treatment – Liquid and Solid Waste Treatment and Disposal – Plant Control Systems – Resource Recovery – Basics of Nuclear Plants Operation – Hydraulic Plants – Renewable Energy Plants

**References:**


- ***Drbal, Larry, Kayla Westra, and Pat Boston, eds. Power plant engineering. Springer Science & Business Media, 2012.***

- ***Sarkar, Dipak. Thermal power plant: design and operation. Elsevier, 2015.***


| **Course title** | **Economics of Power Plants** | | | | **Course Code** | MPE 637 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction – Load Curves – Economic Load Sharing – Different Types of Power Plants – Layout of Power Plants – Plant Location – Cost Analysis – Selection of Type of Generation – Selection of Boilers – Selection of Prime Movers – Selection of Size and Number of Generation Units – Economics in Power Plant Selection – How to Reduce Power Generation Cost – Power Plants Useful Life – Economics of Hydro-Electric Power Plants – Economics of Cogeneration plants – Tariff for Electrical Energy – Objective and Requirements of Tariff – General Tariff Form.

**References:**


- ***Hegde, R. K. Power plant engineering. Pearson, 2014.***
- ***Rajput, R. K. Power system engineering. Firewall Media, 2006.***
- ***Haas, Reinhard, Lutz Mez, and Amela Ajanovic. The Technological and Economic Future of Nuclear Power. Springer Nature, 2019.***


| **Course title** | **Laminar and Ideal Flow** | | | | **Course Code** | MPE 641 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Basic Definitions - Pressure – Equation of motion – Continuity Equation – Energy Equation and Impulse Equation – Eulerian Description – Introduction to Lagrangian Description – Particle Paths – Equilibrium in Fluids – Inviscid Flow – Bernoulli's Equation – Potential Flow – Potential Flow around Bodies in Two and Three Dimensions – Pressure Equation for Irrotational Flow – Vorticity Equation – Navier-Stokes Equations of Motion – Laminar Flow through Circular Cross Section – Laminar Flow between Two Parallel Plates – Stokes Law – Measuring the Viscosity – Flow through Porous Medium (Darcy Law) – Liquefaction.

**References:**


- ***Pritchard, Philip J., and John W. Mitchell. Fox and McDonald's introduction to fluid mechanics. John Wiley & Sons, 2016.***
- ***Yunus, A. Cengel. Fluid Mechanics: Fundamentals and Applications (Si Units). Tata McGraw Hill Education Private Limited, 2010.***

| Course title | Turbulence Theory | | | | Course Code | MPE 642 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Spatial Eulerian Description – fundamental properties of the solutions for a Single Incompressible Fluid – Rotation and Vorticity in the Spatial Description – Lamb Vector Dynamics for incompressible Fluids – Material/ Lagrangean Description – Rotation and Vorticity in the Material Description – Velocity Gradient Tensor in the spatial Description – Working Definition of turbulence – Asymptotic Properties of Turbulence Flow – Number of Degrees of Freedom for Turbulence Flow – Homogenous Turbulence flow – Periodic Pipe Flow Domain – Open and non-Compact Domain – Phase and Test Function Spaces – Phase Space for the Turbulence Measure: Incompressible Fluids and Homogeneous Boundary Conditions.

**References:**


- ***Wolfgang Kollmann. Navier-Stokes Turbulence: Theory and Analysis. Springer Nature, 2019.***
- ***Stanisic, M. M. The mathematical theory of turbulence. Springer Science & Business Media, 2012.***


| Course title | Open Channel Flow | | | | Course Code | MPE 643 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Types of Liquid Flow – Classifications of Flows – Velocity Distribution – One-Dimensional Method of Flow Analysis – Pressure Distribution – Pressure Distribution in Curvilinear Flows – Flow with Small Water-Surface Curvature – Equation of Continuity – Energy Equation – Linear Momentum Equation – Energy Depth Relations - Specific Energy – Alternative Depth and Critical Depth – Introduction for Uniform Flow – Chezy Equation – Darcy Friction Factor in pipe Flow and Open Channels- Shear stress Distribution and Different Resistance Formulas – Uniform Flow Computations – Gradually Varied Flow Theory – Different Equations and Classification of Flow Profiles – Gradually Varied Flow Computations.

**References:**


- ***Chaudhry, M. Hanif. Open-channel flow. Springer Science & Business Media, 2007.***
- ***K Subramanya. Flow in open channels. McGraw-Hill Education, Apr 20, 2019 - Technology & Engineering - 676 pages***

| Course title | Two-Phase Flow | | | | Course Code | MPE 644 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction and Basic Concepts of multiphase Flow – Equations of Motion – Interaction with Turbulence – introduction of single Particle Motion – Unsteady Effects – Particle Equation of Motion - Overview of Computational – Direct Numerical Simulation of Gas-Liquid Flows – the Lattice Boltzmann Method – Immersed Boundary Method – Eular Lagrange Method – Gas-Liquid Flow in Ducts – Fluid-Solid Flow in Ducts – Compressible Multiphase Flow - Dispersed Flows: Hydrodynamic Forces on a Single Sphere Immersed in a Fluid – Modeling Methods for Particle-Laden Flows, Granular Flows, Separated Flows and Interface Tracking Methods.

**References:**

- ***Brennen, Christopher Earls, and Christopher E. Brennen. Fundamentals of multiphase flow. Cambridge university press, 2005.***
- ***Prosperetti, Andrea, and Grétar Tryggvason, eds. Computational methods for multiphase flow. Cambridge university press, 2009.***
- ***Efstathios Michaelides, Clayton T. Crowe, John D. Schwarzkopf. Multiphase Flow Handbook, Second Edition, 2016.***

| Course title | Water Desalination | | | | Course Code | MPE 645 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction – Seawater Desalination for Freshwater Production – Conventional Thermal Processes - Single-Effect Evaporation - Multiple-Effect Distillation (MED) - Single-Effect Mechanical Vapour Compression (MVC) - Multi-Stage Flash Desalination (MSF) - Reverse Osmosis and Forward Osmosis Desalination - Design, Operating and Performance Parameters of Thermal Units – Membranes for Desalination - Membrane Desalination Technology - Membrane Materials and Modules - Microfiltration and Ultrafiltration – Commercial Desalination Technologies – Nuclear Desalination - Solar Thermal Processes - Membrane Distillation for Solar Desalination – Solar Energy for Water Desalination.

**References:**

- ***El-Dessouky, Hisham T., and Hisham Mohamed Ettouney. Fundamentals of saltwater desalination. Elsevier, 2002.***
- ***Schorr, Michael, ed. Desalination: Trends and Technologies. BoD–Books on Demand, 2011.***

| **Course title** | **Pipelines and Networks** | | | | **Course Code** | MPE 646 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 0 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | 20 | 30 | 50 | | |

**Contents**

Introduction and System Configurations – Flow Hydraulics and Network Analysis – Cost and Design Considerations – Network synthesis – Transportation of Solids through Pipelines – Basic Principles of Surface Resistance – Form Resistance – Pipe Flow Problems – Equivalent Pipe – Pipe Network Analysis – Head losses in a pipe link – Analysis of Water Transmission Lines - Pipe network Geometry – Analysis of Branched Network – Analysis of Looped Network - Multi-input Source Water Network Analysis – Flow Path Description – General Principles of Networks Synthesis ( Constraints and Formulation of the Problems ).

**References:**

- ***Verde, Cristina, and Lizeth Torres. Modeling and Monitoring of Pipelines and Networks. Springer, 2017.***
- ***Swamee, Prabhata K., and Ashok K. Sharma. Design of water supply pipe networks. John Wiley & Sons, 2008.***

| **Course title** | **Hydropower Plants** | | | | **Course Code** | MPE 647 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Basic Concepts –Hydropower Resources, Hydropower Sites and Types of Hydropower Plants – Dams and Barrages – Hydropower Turbines – Hydropower Generators and its Types– Small, Mini and Micro Hydropower Plant Design – Tidal Power – Storage Hydropower Plant Design – Hydropower Plants and the Environment – Cost of Electricity from Hydropower Plants – Hydrological Statistics for Regulating Hydropower – Assessment of Impact of Hydropower Dams Reservoir Outflow on the Downstream River Flood Regime – Discharge Measurement Techniques in Hydropower Systems with Emphasis on the Pressure – Sediment Management in Hydropower Dam – Reservoir Operation Applied to Hydropower Systems.

**References:**

- ***Ming Jun Tang. Hydropower: Practice and Application. Scitus Academics LLC, 2016 - Water-power - 298 pages.***
- ***Paul Breeze. Hydropower., 2018.***

| Course title | Maintenance of Hydraulic Circuits | | | | Course Code | MPE 648 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction to Hydraulic Systems – Properties of Hydraulic Fluids – Pressure and Flow Measurements – Different Types of Hydraulic Pumps - Principles and Operation of Hydraulic Pumps – Pumps Performance and Maintenance – Hydraulic Motors and its Basic Concepts – Hydraulic Motor Performance – Hydraulic Cylinders and its Construction – Control Components in Hydraulic System – Hydraulic Accessories ( Reservoir System – Filters and Strainers – Accumulators – Heat exchangers – Piping and Hoses ) – Hydraulic Circuit Design and Analysis – System and Equipment Performance Test – Applications (Hydraulic Jacks – Loaders – Winches – etc...) – Identifying Hydraulic Circuits Problems and Methods for Maintenance.

**References:**


- ***Doddannavar, Ravi, Andries Barnard, and Jayaraman Ganesh. Practical hydraulic systems: operation and troubleshooting for engineers and technicians. Elsevier, 2005.***
- ***Gupta, Ram S. Hydrology and hydraulic systems. Waveland Press, 2016.***


| Course title | Selective Topics in Hydraulic Machines | | | | Course Code | MPE 649 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Advanced topics in hydraulic machines which are not covered by other courses in the field of Mechanical Engineering.

**References:**

| Course title | Pollution | | | | Course Code | MPE 651 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

The science of air pollution-Pollution sources –life cycle assessment of air pollution-The risk of air pollution-Inherent properties of air pollutants- Methods of measuring air pollutants- Air pollution Hazards- Air pollution impacts on ecosystems-Respiratory effects of air pollutants- Air Pollution Spreading and Control Strategy – Environment Conditions and the Effects on Pollution – Controlling air pollution from sources-Calculating the Average Annual Concentration of Pollutants in the Exhaust – Applying and interpreting air quality monitoring data- Air pollution modelling and prediction-Chimneys Heights Calculation.

**References:**

- ***Vallero, Daniel A. Fundamentals of air pollution. Academic press, 2014.***
- ***de Nevers, Noel. Air Pollution Control Engineering. Waveland Press, 2016.***

<table>
<tr><td>Course title</td><td colspan="4">Furnaces and Combustion</td><td>Course Code</td><td>MPE 652</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Air standard cycles and their analysis-reactive systems- combustion with air- adiabatic combustion temperature- fuel-air cycles and their analysis- actual combustion cycles- Basics of Combustion Laws – Combustion Kinetics – Flame Types – Flame Temperature – Flame Stability – effect of engine variables on the flame speed- effect of spark timing on the actual cycle of SI engines- power and efficiency of the actual cycles- Knocking and Detonation – Combustion Thermodynamics – Combustion and Pollution- Combustion in spark ignition engines-factors affecting spark lag- factors affecting combustion- cyclic variation.

**References:**

- ***H. N. Gupta, "Fundamentals of Internal Combustion Engines", PHI Learning Pvt. Ltd., 2012***
- ***Glassman, Irvin, Richard A. Yetter, and Nick G. Glumac. Combustion. Academic press, 2014.***
- ***Williams, Forman A. Combustion theory. CRC Press, 2018***

<table>
<tr><td>Course title</td><td colspan="4">Fuels and Oil</td><td>Course Code</td><td>MPE 6٥3</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td></td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction – Fuel Types and Properties – liquified petroleum gas- Naphtha- Gasoline grades and specification- kerosene grades, specification, and applications- Diesel fuels- Residuals fuel oils- bitumen composition and applications- petroleum coke types- lubricating oil blending- classification of lubricating oil- Calorific Value of Fuels – Fuel Alternatives – Combustion System Components – Fuel Systems (Liquid – Gas – Solid) – Lubrication Oils Types and Properties – Lubrication Systems- synthetic oils- turbine oil- lubrication gases- used oil Re-fining- petroleum wax manufacture, properties, and applications- Metalworking fluids- cutting oils.

**References:**

- ***SurinderParkash, "Petroleum Fuels Manufacturing Handbook: Including Specialty Products and Sustainable Manufacturing Techniques", McGraw-Hill Companies, Inc., 2010***
- ***Turns, S. R. An Introduction to Combustion: Concepts and Applications. Mcgraw-Hill Series in Mechanical Engineering. McGraw-Hill, 2012.***
- ***Francis, Wilfrid. Fuels and Fuel Technology: A Summarized Manual in Two Volumes. Elsevier, 2016.***

| Course title | Maintenance of Combustion Machines | | | | Course Code | MPE 654 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Petrol Engines – Diesel Engines – Gas Engines – reciprocating engines- combustion diagnosis- engine combustion- reacting kinetic- combustion in the real working process- Combustion in Petrol and Diesel Engines – Overcharging – Fuel Injection – charging of internal combustion engine- Engines Performance and Tests – Identifying Internal Combustion Engines Problems and Methods for Maintenance-exhaust aftertreatment- total combustion system analysis-phenomenological combustion models- injection process simulation- optical diagnosis techniques- pressure trace analysis and loss distribution- piezoelectric measurement chain-ignition maps- selection of the measurement location-TDC assignment.

**References:**


- ***Merker, Günter P., Christian Schwarz, and Rüdiger Teichmann, eds. Combustion engines development: mixture formation, combustion, emissions and simulation. Springer Science & Business Media, 2011.***
- ***Benson, Rowland S., and Norman Dan Whitehouse. Internal combustion engines: a detailed introduction to the thermodynamics of spark and compression ignition engines, their design and development. Vol. 1. Elsevier, 2013.***
- ***Baumgarten, Carsten. Mixture formation in internal combustion engines. Springer Science & Business Media, 2006.***
- ***Law, Chung K. "Combustion Physics." 2016***


| Course title | Selective topics in Combustion | | | | Course Code | MPE 655 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Advanced topics in combustion which are not covered by other courses in the field of Mechanical Engineering.

**References:**

--

| Course title | Engines Performance | | | | Course Code | MPE 656 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Internal Coefficients of Internal Combustion Engines – specific fuel consumption- brake mean effective pressure- specific power output- exhaust smoke and other emissions- power and mechanical efficiency- mean effective pressure and torque- fuel to air ratio- thermal efficiency- Indicated power- effective power- Road load power-stroke volume- engine speed-specific weight-– Measurements Related to Internal Combustion Engines Performance. Discharge coefficient- flow coefficient-Engine manifold filling dynamics- Mathematical formulation of static engine system design-- Improving the Performance of Internal Combustion Engines – Combustion and its Stages.

**References:**


- ***Guzzella, Lino, and Christopher H. Onder. "Introduction to modeling and control of internal combustion engine systems." (2010).***
- ***Williams, Forman A. Combustion theory. CRC Press, 2018.***
- ***Joseph Wood Kershaw, "Elementary Internal Combustion Engines", Longmans, Green, and Co., 2012.***


| **Course title** | **Oil and lubricants** | | | | **Course Code** | MPE 657 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Lubrication Methods (Hydrodynamic – Hydrostatic) – Mechanical Parts Lubrication (Flat Bearings – Rolling Bearings – Gears – Chains – Slides – Wire Ropes) – oils and Lubricants Types (Solid Lubricants – Gaseous Lubricants – Oil Type Test) –lubricating oils blending- classification of lubricating oils- lubricating greases-metal catalyst lubricant degradation-high temperature lubricant degradation-bulk oil oxidation test-thin film oxidation test-autoxidation of lubricating oil- mechanism of primary antioxidation- oxidation inhibition-Lubrication Systems (Oil and Lubricant Lubrication Systems – Test System – Alerting and Protection Methods – Changing Oil Periods and Tests).

**References:**


- ***SurinderParkash, "Petroleum Fuels Manufacturing Handbook: Including Specialty Products and Sustainable Manufacturing Techniques", McGraw-Hill Companies, Inc., 2010***
- ***Leslie R. Rudnick, "Lubricant Additives: Chemistry and Applications", CRC Press, 2nd edition, 2009***
- ***Francis, Wilfrid. Fuels and Fuel Technology: A Summarized Manual in Two Volumes. Elsevier, 2016.***


## Level (700)

| **Course title** | **Non-conventional cooling systems** | | | | **Course Code** | MPE711 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction to solar energy – Geometry and Intensity of Solar Radiation – Calculating the Solar Radiation on Horizontal and Inclined Surfaces – Solar Radiation Collectors – Solar Energy Applications – Coolants – Absorption Cooling System Absorption cooling systems- Adsorption cooling systems–solar air conditioner-

Desiccant wheel cooling– evaporative cooling system – thermoelectric coolers- radiant cooling systems- passive solar building- solar water heating- solar space heating- other solar thermal applications (such as cooling and desalination)- grid-connected photovoltaics- stand-alone photovoltaics. It also introduces the reader to larger scale applications such as concentrating solar power- adsorption and absorption cooling cycles.

**References**:

- ***GuptIoan Sarbu and Calin Sebarchievici, "Solar Heating and Cooling Systems, 2016***
- ***Sotirios Karellas, Tryfon C Roumpedakis, Nikolaos Tzouganatos, Konstantinos Braimakis, Solar Cooling Technologies (Energy Systems), 2018***
- ***Flath Julia, Selke Tim, Life Cycle Analysis of a Solar Air Conditioning System Paperback, 2012***

| **Course title** | **Energy efficient buildings** | | | | **Course Code** | MPE712 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | - | 50 | | |

**Contents**

Recommendations and standards– ZEB and NZEB (definitions, design methodologies, good practices and case studies)- Passive houses and bioclimatic architecture, buildings simulation tools, Building envelope, efficient thermal insulation of buildings, Innovative and advanced insulation materials and systems, Innovative and advances glazing materials (electrochromic, thermochromic, selective coatings), Adaptive Facades, Building integrated PV, Solar thermal energy for building applications, Ground source heat pumps, Efficient heat and cooling distribution in buildings, Efficient lighting systems, Costs-benefits analysis of buildings renovation.

**References**:

- ***Umberto Desideri Francesco Asdrubali, Handbook of Energy Efficiency in Buildings,2018***
- ***Jessica Granderson, Mary Ann Piette, Ben Rosenblum, Lily Hu, George Hernandez, Daniel Harris, Paul Mathew, Phillip Price, Geoffrey Bell, Srinivas Katipamula, Energy Information Handbook: Applications for Energy-Efficient Building Operations,2013***

| **Course title** | **Mini- and microchannel heat transfer** | | | | **Course Code** | MPE713 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | - | 50 | | |

**Contents**

Introduction- Single-phase gas flow in microchannels with heat transfer- Single-phase liquid flow in minichannels and microchannels- Single phase electrokinetic flow in microchannels- Flow boiling in minichannels and microchannels-Condensation in minichannels and microchannels-Biomedical applications of microchannel flows. Heat Transfer in Minichannels and Microchannels CPU Cooling Systems- electric vehicle thermal management- micro heat exchangers-nanofluids-3D metal printing-heat pipes-microelectronic cooling-micro pin fin cooling-micro porous media heat sinks- finned heat sinks-jet impingement heat sinks.

**References**:

- ***Satish Kandlikar, Srinivas Garimella, Dongqing Li, Stephane Colin, Michael R. King, Heat Transfer and Fluid Flow in Minichannels and Microchannels, 2015.***
- ***Frank P. Incropera, David P. DeWitt, Theodore L. Bergman, Adrienne S. Lavine, Fundamentals of Heat and Mass Transfer 6th Edition, 2006.***

| Course title | Microelectromechanical systems | | | | Course Code | MPE714 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | | | 50 | | |

**Contents**

Introduction to MEMS devices - Scaling of micromechanical devices – Mechanical properties of MEMS Materials- Flow Physics- Integrated simulation for MEMS- Molecular Based Microfluidics simulation models- Electromechanical transducers - Magneto-mechanical MEMS sensors – Hydrodynamics of small scale Internal gaseous flows – Burnett simulations of flows in microdevices – Liquid flow in microchannels – lubrication in MEMS – Physics of thin liquid films – Bubble and Drop transport in microchannels – Fundamental of control theory – Model based flow control for distributed architectures – soft computing in control.

**References**:

- ***Gad-el-Hak, Mohamed, ed. MEMS: introduction and fundamentals. CRC press, 2005.***
- ***Tilli, Markku, Mervi Paulasto-Krockel, Matthias Petzold, Horst Theuss, Teruaki Motooka, and Veikko Lindroos, eds. Handbook of silicon based MEMS materials and technologies. Elsevier, 2020.***

| Course title | Microfluidics | | | | Course Code | MPE715 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | **3** |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | **100** |
| | - | - | - | 50 | | |

**Contents**

Introduction to Microfluidics – Development of microfluidics components – oriented microfluidics systems- Physics at the micrometric scale - Fabrication techniques for Microfluidics - Microfluidics for external flow control - Microfluidics for Internal Flow Control - Droplet-based microfluidics - Digital microfluidics- Fundamental concepts and physics in microfluidics – Microfluidics devices – Numerical simulation in microfluidics and introduction of the related software – Fundamental of digital microfluidic systems – Microfluidic for chemical analysis – Microfluidic devices for the isolation of circulating tumor cells – Microfluidic for disease diagnosis.

**References**:

- ***Nguyen, Nam-Trung, Steven T. Wereley, and Seyed Ali Mousavi Shaegh. Fundamentals and applications of microfluidics. Artech house, 2019.***
- ***Kakaç, Sadık, B. Kosoy, D. Li, and A. Pramuanjaroenkij, eds. Microfluidics based microsystems: fundamentals and applications. Springer, 2010.***

| Course title | Emerging Desalination Technologies | | | | Course Code | MPE716 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Adsorption desalination Principles - Adsorption desalination process design - Forward osmosis desalination principles and feasibility - Membrane distillation Principles, configurations, and applications - Membrane distillation process design and implementation - Desalination by pervaporation - Humidification-dehumidification desalination. Sustainable desalination by permeate gap membrane distillation technology – A spray assisted low-temperature desalination technology – nanocomposite membranes – Electrochemically active carbon nanotubes membrane filter for desalination – Valorization of reverse osmosis brines – Thermal applications of desalination of shale gas wastewater – Sea water desalination for crop irrigation.

**References:**

- ***Gude, Gnaneswar. Emerging Technologies for Sustainable Desalination Handbook. Butterworth-Heinemann, 2018. Wang, Lawrence K., et al., eds. Membrane and desalination technologies. Vol. 13. Springer Science+ Business Media, LLC, 2008.***

| Course title | Advances in Wastewater Treatment | | | | Course Code | MPE717 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Primary treatment – Rotating belt sieve technology - Biological nutrient removal with membranes – Overall MBR and CAS UCT systems performance – Biological P removal kinetics – Anoxic Batch test - Moving bed biofilm reactor (MBBR) technology – Membrane system reactor sizing considerations - Integrated Fixed-Film Activated Sludge (IFAS) Process – membrane based process - Aerobic granular sludge - Organic micropollutant control – organic micropollutant removal - Anaerobic digestion processes - structure and composition of aerobic granules - Greenhouse gas emissions from membrane bioreactors.

**References:**

- ***Henze, Mogens, et al., eds. Biological wastewater treatment. IWA publishing, 2008.***
- ***Mannina, Giorgio, et al., eds. Advances in Wastewater Treatment. iwa publishing, 2018.***

| Course title | Evaporators and Condensers | | | | Course Code | MPE718 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction and Basic Concepts – Heat Exchangers Classification – Thermal and Hydraulic Design of Heat Exchangers construction and operation of heat exchangers – Boiling and Evaporation – Condensation – Shell and Tubes Exchangers – Boilers – thermal and hydraulic performance in condensers and evaporators - Condensers and Cooling Towers – Industrial applications – material and manufacturing – Basic design methods - Fouling, corrosion, erosion in Heat Exchangers – Materials Used in Evaporators and Condensers Fabrication – Uses of Evaporators and Condensers – Evaporators and Condensers Selection -Extended design and operation issues.

**References:**


- ***Sundén, Bengt, and Raj M. Manglik. Plate heat exchangers: design, applications and performance. Vol. 11. Wit Press, 2007.***
- ***Kakaç, Sadik, ed. Boilers, evaporators, and condensers. John Wiley & Sons, 1991.***
- ***Ranganayakulu, Chennu, and Kankanhalli N. Seetharamu. Compact heat exchangers: Analysis, design and optimization using FEM and CFD approach. John Wiley & Sons, 2018***


| **Course title** | **Design of Heat Transfer Equipment** | | | | **Course Code** | MPE719 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction and Basic Concepts – Heat Exchangers Classification Geometry of construction – Thermal and Hydraulic Design of Heat Exchangers heat transfer mechanism in heat exchangers – Shell and Tubes Exchangers – Boilers – Condensers and Cooling Towers – Radiators – Heat Exchanger Test and Effectiveness – Fouling in Heat Exchangers – Materials Used in Heat Exchangers Fabrication – Uses of Heat Exchangers – Design of Heat Exchangers Networks – Design correlations for condensers and evaporators –Compact heat exchangers – operation features of heat exchangers – Operation of heat exchanger subject to fouling.

**References:**


- ***Kakac, Sadik, Hongtan Liu, and Anchasa Pramuanjaroenkij. Heat exchangers: selection, rating, and thermal design. CRC press, 2020.***
- ***Hesselgreaves, John E., Richard Law, and David Reay. Compact heat exchangers: selection, design and operation. Butterworth-Heinemann, 2016.***
- ***Kröger, Detlev G. Air-cooled heat exchangers and cooling towers. Vol. 1. PennWell Books, 2004.***


| **Course title** | **Mechatronics** | | | | **Course Code** | MPE721 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction and Basic Concepts – Electromechanical Systems Introduction and General Concepts – Electrical and Electronic Components and Mechanical Logic Gates-Sequential Control-Temporary Counters Operating Amplifiers and Controllers-Senses-Triggers-Semiconductors for Computer Control Capability.

**References:**

- ***Shetty, Devdas, and Richard A. Kolk. Mechatronics system design, SI version. Cengage Learning, 2010.***
- ***Preumont, André. Mechatronics. Springer, 2006.***
- ***De Silva, Clarence W. Mechatronics: an integrated approach. CRC press, 2004.***

| **Course title** | **Automatic Control Systems** | | | | **Course Code** | MPE722 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Basic Concepts – Control Devices Theory and Performance – Modeling with structural analysis- Modeling paradigms for mechatronic systems –Linear Control Systems – Applications in Control – Logic Circuits (Hydraulic – Pneumatic – Electronic) – Balance and Tuning Control Devices – Control Using Computer – Applications (Temperature Control – Pressure – Humidity – Velocity – etc…)– elements of modeling – Simulation issues – Functional realization : Multi body dynamics – The generic mechatronic transducer – Electrostatic transducer – Piezoelectric transducer – Electromagnetically acting transducers – Digital information processing – Control theoretical aspects – Stochastic dynamic analysis – Design evaluation: System budgets.

**References:**

- ***Manring, Noah D., and Roger C. Fales. Hydraulic control systems. John Wiley & Sons, 2019.***
- ***Walters, Ronald B. Hydraulic and electric-hydraulic control systems. Dordrecht, The Netherlands: Kluwer academic publishers, 2000.***

| **Course title** | **Boundary Layer Theory** | | | | **Course Code** | MPE723 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Basic Laws of Viscous Fluid Motion – Features of viscous flow – Fundamental of boundary layer theory – Laminar Boundary Layer – Field equations for flows of Newtonian fluids – Properties of the equation of motion Exact solution of the Navier stokes equations – General properties and exact solutions of the boundary layer equations for plane walls – thermal boundary layer with and without coupling with the velocity field– Boundary layer control – Axisymmetric and three dimensional boundary layers – unsteady boundary layers– Turbulent Boundary Layer – Laminar Flow Models.

**References:**

- ***Schlichting, Hermann, and Klaus Gersten. Boundary-layer theory. Springer, 2016.***
- ***Sobey, Ian John. Introduction to interactive boundary layer theory. Vol. 3. Oxford University Press on Demand, 2000.***

<table>
<tr><td>Course title</td><td colspan="4">Pumps and Compressors</td><td>Course Code</td><td>MPE724</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Essentials of fluid mechanics – Introduction and basic considerations –Centrifugal Pumps – components of centrifugal pumps – fundamental of Energy transfer in centrifugal pumps – Axial and radial thrusts in centrifugal pumps – common problems in centrifugal pumps – Pump Casing – Leakage – Impeller Friction and Mechanical Losses – Axial flow pump – Axial Propulsion – Pumps Performance – Pump Control and Valves – Displacements pumps – Compressors Classification – Reciprocating Compressors – Rotating Compressors – Introduction to Fans and compressors – Centrifugal fans – Compressors Performance – multiphase flow pumping – pump selection guidelines.

**References:**


- ***Badr, Hassan M., and Wael H. Ahmed. Pumping machinery theory and practice. John Wiley & Sons, 2015.***
- ***Brown, Royce N. Compressors: Selection and sizing. Gulf Professional Publishing, 1997.***

# Chapter Eight:

## Production Engineering and Mechanical Design Department

# Diploma of Engineering Science in Design Engineering

## Program Description

The objective of this diploma program is to provide high quality of theoretical and practical aspects of design engineering. The program enables students to pursue a specialization in design engineering; provide an incentive to take more courses in design, participating in more design projects; and improve their employment prospects to design engineering applications. This provides a sound foundation to enter a professional role in industry or academia.

## Competencies for Program Graduate

In addition to generic competencies for the Engineering science Diploma, the graduate of Engineering science Diploma in Engineering Science in Design Engineering must be able to:

1. Demonstrate the underlying foundational knowledge required to conceive the engineering design systems.
2. Demonstrate knowledge and understanding of the essential components of an integrated design engineering system.
3. Demonstrate a comprehensive knowledge with clear, concise, accurate and readily available information related to policy, economics, system modeling issues and this is necessary to achieve optimal design solutions for products, systems, processes, and services.
4. Demonstrate a critical awareness of theoretical design concepts and their practical implementation within design engineering systems.
5. Use high-level software packages and IT skills for modeling and simulation of design engineering systems.
6. Select and apply appropriate methods of improving design engineering systems efficiencies and adapting appropriate solutions to practical problems.

***Benchmark: University of Adelaide***

*https://www.adelaide.edu.au/degree-finder/2019/gdeng_gdengmech.html*

# Diploma of Engineering Science in Manufacturing Engineering

**Program Description**

The objective of this diploma program is to offer high quality, up-to-date, and internationally recognized education for manufacturing engineering. To nurture student rational thoughts, intellectual capabilities, engineering and design knowledge foundation. This provides a sound foundation to enter a professional role in industry or academia.

**Competencies for Program Graduate**

In addition to generic competencies for the Engineering science Diploma, the graduate of Engineering science Diploma in Engineering Science in Manufacturing Engineering must be able to:

1. Demonstrate the underlying foundational knowledge required to conceive, design, manufacture and operate industrial engineering techniques.
2. Demonstrate knowledge of mechanics, design, manufacturing processes and materials.
3. Design and manufacture high quality products using state-of-the–art technology and methods.
4. Demonstrate awareness of the local and global context, in which, manufacturing engineering is practiced, locally and globally, including economic and business practices, societal needs, and considerations of public health, safety, environment, culture and ethics.
5. Not only possess the technical skills required, but who also continue to educate themselves and who will have the intellectual resources they will need to prosper in a society.
6. Demonstrate broad knowledge of modern computational, engineering design, materials and manufacturing, industrial engineering, power, mechatronics and experimental methods in manufacturing engineering.

***Benchmark: German University in Cairo (GUC)***
*https://www.guc.edu.eg/en/academic_programs/programs/program_details.aspx?programId=38*

# Master of Science in Engineering – Design and Manufacturing Engineering

**Program Description**

The objective of the master's degree program in design and manufacturing engineering is to provide the students with extended research-oriented knowledge and offer them the proper opportunities to get involved in many topics. These topics include mechanical design, materials engineering, manufacturing engineering, and industrial engineering. This program establishes a flexible and versatile framework that enables both new graduates and engineers to cultivate and utilize their learning experiences to meet the needs for their future.

**Competencies for Program Graduate**

In addition to generic competencies for the M.Sc. in engineering, the graduate of Master of Science in Engineering—Design and Manufacturing Engineering must be able to:

1. Possess the basic knowledge and understanding of aspects intervening with this research field.
2. Demonstrate the ability to apply obtained knowledge to real-world engineering problems and analyze them in a scientific-reasonable way.
3. Use the appropriate CAD/CAM/CAPP/FEA tools to model, design, develop materials and products, as well as optimizing their fabrication, application, and efficiency.
4. Show self-reliance to conduct literature survey about any topic or sub-topic that will face him/her during the thesis work progress.
5. Develop skills in industrial design, prototyping, and testing prototypes through simulation and advanced design principles.
6. Learn how to use newly-gained knowledge to investigate new and emerging manufacturing technologies.
7. Develop current research and best practices in industrial and manufacturing systems.
8. Possess software skills and experiences targeted at dealing with diverse aspects that emerge in this research field.

***Benchmark: Queen's University***

*https://www.ncl.ac.uk/postgraduate/modules/mec8095/*

# Doctor of Philosophy in Design and Manufacturing Engineering

**Program Description**

The Ph.D. program seeks to align course work with cutting edge and advised research for helping the students to build high professionalism and provide original contributions in the field of design and manufacturing. By achieving that, it is expected that the students will be qualified to be technical leaders in industry, academia, and research organizations.

**Competencies for Program Graduate**

In addition to generic competencies for the Ph. D. program, the graduate of Engineering science Ph.D. in Design and Manufacturing Engineering must be able to:

1. Demonstrate an in-depth understanding of the core and advanced topics in design and manufacturing engineering.
2. Demonstrate the capability to conduct research in the related cutting-edge fields by identifying and formulating the relevant problems and introducing solutions by the integrating the interdisciplinary principles of mathematics, sciences, and design and manufacturing engineering.
3. Demonstrate the ability to learn independently and work creatively in individual and as part of a research team.
4. Demonstrate high communications skills, which can be implemented by writing thesis as well as manuscripts for peer reviewed journals and be able to articulate research in conferences and workshops.
5. Demonstrate commitment to the principles of ethics, responsibilities, and norms of design and manufacturing engineering practices.
6. Show success in finding employment in the desired sector whether in academia, or national research centers, or industry.

***Benchmark: Ohio State University***

*https://asccas.osu.edu/sites/default/files/2017_GraduateLearningOutcomes.pdf*

# List of level (500) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| PDE511 | Stress and Strain Analysis | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE512 | Principles of Fracture Mechanics | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE513 | Mechanical Design | 2 | 2 | — | 4 | 3 | 6 | 3 | 50 | – | 50 | 100 |
| PDE514 | Machine Design (1) | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE515 | Machine Design (2) | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE516 | Machine Design (3) | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE517 | Die Design | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE521 | Principles of Tribology | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE522 | Engineering Fluids in Manufacturing | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE523 | Fundamentals of Mechanical Vibration | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE524 | Maintenance of Mechanical Systems | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE531 | Principles of Mechatronics | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE541 | Materials Engineering | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE542 | Analysis of Material Systems | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE551 | Forming Engineering | 2 | 2 | 3 | 6 | 4 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE552 | Heat Treatment | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE553 | Machining Engineering | 2 | 2 | 3 | 6 | 4 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE561 | Principles of Metrology | 1 | — | 3 | 4 | 2 | 8 | 3 | 25 | 25 | 50 | 100 |
| PDE571 | Engineering Statistics | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE572 | Quality Engineering | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE581 | Facility Management | 2 | 2 | — | 3 | 3 | 5 | 3 | 50 | – | 50 | 100 |
| PDE582 | Operations Management | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE583 | Product Design | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE584 | Work Study | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |

# List of level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| PDE611 | Elasticity and Plasticity | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE612 | Mechanics of Materials | 2 | 2 | — | 3 | 3 | 5 | 3 | 50 | – | 50 | 100 |
| PDE613 | Fundamentals of Fracture Mechanics | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE614 | Optimum Design | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE615 | Machine Tools (1) | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE616 | Machine Tools (2) | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE617 | Cutting Tools Engineering | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE618 | Manufacturing Tools Engineering | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE621 | Fundamentals of Tribology | 2 | 2 | — | 3 | 3 | 5 | 3 | 50 | – | 50 | 100 |
| PDE622 | Fault Analysis and Control | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE623 | Tribology of Metal Cutting | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE624 | Analysis and Control of Mechanical Vibration | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE631 | Manufacturing Automation | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE632 | Virtual Manufacturing | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE633 | Fundamentals of Robotics | 2 | — | 3 | 5 | 3 | 9 | 3 | 25 | 25 | 50 | 100 |
| PDE634 | Fundamentals of Mechatronics | 2 | — | 3 | 5 | 3 | 9 | 3 | 25 | 25 | 50 | 100 |
| PDE635 | Micro- and Nano-Electromechanical Systems | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE636 | Digital and Statistical Signal Processing | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE637 | Machine Learning Engineering | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE638 | Fundamentals of Fuzzy Control | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE639 | Finite Element Method | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE641 | Engineering Materials (1) | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE642 | Engineering Materials (2) | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE643 | Composite Materials | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE644 | Fundamentals of Polymer Science | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE645 | Special Applications of Polymers | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE646 | Materials Selection for Manufacturing | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE651 | Composites Manufacturing | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE652 | Sheet Metal Forming | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE653 | Mechanics of Sheet Metal Forming | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE654 | Die Design for Sheet Metal Forming | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE655 | Manufacturing Engineering | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE656 | Metal Cutting | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE657 | Plastics Engineering | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PDE658 | Metal Welding | 2 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE659 | Die Casting Engineering | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE661 | Optical Metrology | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE662 | Quality of Measurements | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE671 | Operations Research | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE672 | Decision Support Frameworks | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE673 | Fundamentals of Monte Carlo Methods | 2 | 2 | — | 3 | 3 | 5 | 3 | 50 | – | 50 | 100 |
| PDE674 | Reliability Engineering | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE675 | Design of Experiments | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE676 | Total Quality Management | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE677 | Lean Six Sigma Methodology | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE681 | Work Design | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE682 | Logistics and Supply Chain Management | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE683 | Design of Material Handling Systems | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE684 | Design of Manufacturing Processes | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE691 | Fundamentals of Biomaterials | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE692 | Biomedical Engineering (1) | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE693 | Biomedical Engineering (2) | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE694 | Occupational Safety and Health | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |

## List of level (700) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical Exam | Written Exam | Total |
| PDE711 | Machinery Design for Fatigue | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE721 | Corrosion Engineering | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE722 | Condition-Based Monitoring of Machinery | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE723 | Hydraulic Systems Engineering | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE724 | Vibration of Continuous Systems | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE725 | Random Vibration of Mechanical Systems | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE726 | Engineering Noise Control | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE731 | Additive Manufacturing | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE732 | Intelligent Energy Field Manufacturing | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE733 | Analysis and Control of Robotic Systems | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE734 | Digital Signal Processing | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |
| PDE741 | Mechanics of Composite Materials | 1 | 2 | — | 3 | 2 | 5 | 3 | 50 | – | 50 | 100 |
| PDE742 | Modeling and Analysis of Materials | 2 | 2 | — | 4 | 3 | 7 | 3 | 50 | – | 50 | 100 |
| PDE751 | High Integrity Die Casting | 1 | 2 | 3 | 6 | 3 | 12 | 3 | 25 | 25 | 50 | 100 |

# Summary of Courses Specification

## Level (500)

| Course title | Stress and Strain Analysis | | | | | Course Code | PDE511 |
|---|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | | Credit hours | 2 |
| | 1 | | 2 | - | | | |
| Course grades | Oral | Practical | S. work | Final Exam | | Total grades | 100 |
| | - | - | 50 | 50 | | | |

**Contents**
Introduction; Theory of stress and strain; Methods of measurement and analysis of stress and strain; Equilibrium integration and configuration equations; Failure theory; Bending; Torsion in prismatic bars; Two-direction solutions for Cartesian, circular, and curved axes; Composite voltage theory; Stress concentration; Energy method; Thermal elasticity; Viscous elasticity; Optical elasticity; Numerical methods; Essential software; Applications; Recent topics.

**References:**

- R.L. Mott and J.A. Untener, Applied Strength of Materials, 6th Edition, Taylor & Francis Group, LLC, 2017.


| Course title | Principles of Fracture Mechanics | | | | | Course Code | PDE512 |
|---|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | | Credit hours | 2 |
| | 1 | | 2 | - | | | |
| Course grades | Oral | Practical | S. work | Final Exam | | Total grades | 100 |
| | - | - | 50 | 50 | | | |

**Contents**
Introduction; Linear elastic fracture mechanics; Elastic–plastic fracture mechanics; Dynamic and time-dependent fracture; Fracture mechanisms in metals and nonmetals; Fracture testing; Fatigue crack propagation; Environmentally assisted cracking; Computational fracture mechanics; Essential software; Applications; Recent topics.

**References:**

- E.E. Gdoutos, Fracture Mechanics: An Introduction, 3rd Edition, Springer Nature Switzerland AG, 2020.


| Course title | Mechanical Design | | | | | Course Code | PDE513 |
|---|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | | Credit hours | 3 |
| | 2 | | 2 | - | | | |
| Course grades | Oral | Practical | S. work | Final Exam | | Total grades | 100 |
| | - | - | 50 | 50 | | | |

**Contents**
Introduction; Fundamentals of mechanical design; Engineering tolerances; Materials in mechanical design; Design of mechanical systems; Design of mechanical elements; Tool design; **Mechanical Design Process:** Total design, Design planning, Design for 'X', Axiomatic design, Modular design, Rapid prototyping, Design costing. Information and knowledge support technology for mechanical design; Failures and failure analysis of mechanical elements and systems; (Standard for Exchange of Product model) STEP-based design; Reverse engineering; Essential software; Applications; Case studies in machine tool design; Recent topics.

**References**:

- *J.A. Collins et al., Mechanical Design of Machine Elements and Machines, 2nd Edition, A Failure Prevention Perspective, John Wiley & Sons, Inc., 2010.*
- *Grous, Applied Mechanical Design, ISTE Ltd., 2018.*
- *R.L. Mott et al., Machine Elements in Mechanical Design, 6th, Pearson Education, Inc., 2018.*
- *P.R.N. Childs, Mechanical Design Engineering Handbook, 2nd Edition, Elsevier Ltd., 2019.*
- *R.G. Budynas and J.K. Nisbett, Shigley's Mechanical Engineering Design, 11th Edition, McGraw-Hill Education, 2020.*
- *R.L. Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, 6th Edition, McGraw-Hill Education, 2020.*

| **Course title** | **Machine Design (1)** | | | | **Course Code** | PDE514 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Fundamentals of materials mechanics; Columns; Elements of Power Transmission Systems: Drives (belts, chains, ropes, pulleys, sprockets, power screws, and gears), Couplings, Clutches. Safety, reliability, and maintenance considerations in machine design; Machine design documentations, and configuration management; Accelerated testing of machines and their elements; Life cycle assessment and costing of machines; Essential software; Applications; Case studies; Recent topics.

**References**:

- *J.A. Collins et al., Mechanical Design of Machine Elements and Machines, 2nd Edition, A Failure Prevention Perspective, John Wiley & Sons, Inc., 2010.*
- *Grous, Applied Mechanical Design, ISTE Ltd., 2018.*
- *R.L. Mott et al., Machine Elements in Mechanical Design, 6th, Pearson Education, Inc., 2018.*
- *P.R.N. Childs, Mechanical Design Engineering Handbook, 2nd Edition, Elsevier Ltd., 2019.*
- *R.G. Budynas and J.K. Nisbett, Shigley's Mechanical Engineering Design, 11th Edition, McGraw-Hill Education, 2020.*
- *R.L. Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, 6th Edition, McGraw-Hill Education, 2020.*

| **Course title** | **Machine Design (2)** | | | | **Course Code** | PDE515 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Fundamentals of materials mechanics; Shafts; Spindles; Bearings and supports; Gear trains; Gear boxes; Cylinders; Pistons and piston rings; Connecting rods; Crankshafts; Camshafts and rocker arms; Balance shafts; Flywheels, governors, and gyroscopes; Design documentations; Essential software; Applications; Case studies; Recent topics.

**References**:

- *J.A. Collins et al., Mechanical Design of Machine Elements and Machines, 2nd Edition, A Failure Prevention Perspective, John Wiley & Sons, Inc., 2010.*
- *Grous, Applied Mechanical Design, ISTE Ltd., 2018.*

- *R.L. Mott et al., Machine Elements in Mechanical Design, 6th, Pearson Education, Inc., 2018.*
- *P.R.N. Childs, Mechanical Design Engineering Handbook, 2nd Edition, Elsevier Ltd., 2019.*
- *R.G. Budynas and J.K. Nisbett, Shigley's Mechanical Engineering Design, 11th Edition, McGraw-Hill Education, 2020.*
- *R.L. Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, 6th Edition, McGraw-Hill Education, 2020.*

| **Course title** | **Machine Design (3)** | | | | **Course Code** | PDE516 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**
Introduction; Fundamentals of materials mechanics; Frames; Housings; Engine blocks; Axles; Tanks; Flanges; Fasteners; Joints; **Elements of Joints:** Detachable joints (threaded fasteners, keys, pins, snap fitters, and splines), Permanent joints (riveted, welded, and bonded). Bushes; Gaskets and sealants; Springs; Dashpots; Brakes; **Hydraulic Systems of Machines:** Pumps, Compressors, Valves, Pipes, and hoses, Filters, and Pressure vessels. Design documentations; Essential software; Applications; Case studies; Recent topics.

**References:**
- *J.A. Collins et al., Mechanical Design of Machine Elements and Machines, 2nd Edition, A Failure Prevention Perspective, John Wiley & Sons, Inc., 2010.*
- *Grous, Applied Mechanical Design, ISTE Ltd., 2018.*
- *R.L. Mott et al., Machine Elements in Mechanical Design, 6th, Pearson Education, Inc., 2018.*
- *P.R.N. Childs, Mechanical Design Engineering Handbook, 2nd Edition, Elsevier Ltd., 2019.*
- *R.G. Budynas and J.K. Nisbett, Shigley's Mechanical Engineering Design, 11th Edition, McGraw-Hill Education, 2020.*
- *R.L. Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, 6th Edition, McGraw-Hill Education, 2020.*

| **Course title** | **Die Design** | | | | **Course Code** | PDE517 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**
Introduction; Presses details; Forming terminology; Stamping process design; Engineering design for dies; Metal sheering processes; Shearing dies; Bending dies; Forming dies; Drawing dies; Hydraulic and rubber dies; Pressure dies; Progressive dies; Compound dies; Ferrous and nonferrous die metals; Stamping metals; Economic considerations; Numerical and simulation methods; Essential software; Applications; Recent topics.

**References:**
- *V. Boljanovic and J.R. Paquin, Die Design Fundamentals, 3rd Edition, Industrial Press Inc., 2006.*
- *I. Suchy, Handbook of Die Design, 2nd Edition, I. Suchy. Published by McGraw-Hill, 2006.*
- *J.G. Nee (ed.), Fundamentals of Tool Design, 6th Edition, Society of Manufacturing Engineers, 2010.*
- *V. Boljanovic, Sheet Metal Forming Processes and Die Design, 2nd Edition, Industrial Press Inc., 2014.*

| **Course title** | **Principles of Tribology** | | | | **Course Code** | PDE521 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**
Introduction; Engineering surfaces; Hertzian contact; Elliptical hertzian contact; Rough surfaces contact; Actual contact area; Metals friction; Solid Lubricants; Wear mechanisms; **Lubrication Systems:** Mixed, Hydrodynamic, and Elastic hydrodynamic. **Rynolds' Equations:** First order and Second order. Polymers tribology; Ceramics tribology; Composites tribology; Applications; Recent topics.

**References:**
- *J.P. Davim (ed.), Tribology in Manufacturing Technology, Springer-Verlag Berlin Heidelberg, 2012.*
- *M. Qiu et al., Bearing Tribology: Principles and Applications, National Defense Industry Press, Beijing and Springer-Verlag Berlin Heidelberg, 2017.*
- *S. Wen and P. Huang, Principles of Tribology, 2nd Edition, Tsinghua University Press, 2018.*

| **Course title** | **Engineering Fluids in Manufacturing** | | | | **Course Code** | PDE522 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**
Introduction; Evolution of types and usage techniques of engineering fluids; Cooling fluids; Lubrication fluids; Using fluids in metal forming and machining, and other manufacturing processes; Metallurgical, chemical, and mechanical considerations; Tool wear and part distortion and their relation with cooling fluid; Selection criteria, recycling, and disposal of fluids in manufacturing processes; Health and occupational considerations; Applications; Recent topics.

**References:**
- *J.P. Davim (ed.), Tribology in Manufacturing Technology, Springer-Verlag Berlin Heidelberg, 2012.*
- *M. Torbacke et al., Lubricants Introduction to Properties and Performance, John Wiley & Sons Ltd., 2014.*
- *W. Dresel and T. Mang, Lubricants and Lubrication, Wiley-VCH Verlag GmbH & Co. KGaA, 2017.*
- *D.M. Pirro et al., Lubrication Fundamentals, 3rd Edition, CRC Press, Talyor & Francis group, 2017.*
- *J.P. Byers, Metalworking Fluids: Manufacturing Engineering and Materials Processing, 3rd Edition, Taylor & Francis Group, LLC 2018.*

| **Course title** | **Fundamentals of Mechanical Vibration** | | | | **Course Code** | PDE523 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**
Introduction; Classification of mechanical vibration; Systems and models of mechanical vibration; Sources of machines' vibration; Measuring devices for vibration; Interpretation of vibration records; Acceptance limits of machine vibration; **Methods of Vibration Control:** Equilibrium, Linear deviation, Resonance, Isolation. Fault diagnosis and prognosis based on vibration; Essential software; Applications for vibration analysis; Recent topics.

**References:**
- *D.J. Inman, Engineering Vibration, 4th Edition, Pearson Education, Inc., 2014.*
- *M. Géradin and D.J. Rixen, Mechanical Vibrations: Theory and Application to Structural Dynamics, 3rd Edition, John Wiley & Sons, Ltd., 2015.*
- *A.B. Palazzolo, Vibration Theory and Applications with Finite Elements and Active Vibration Control, John Wiley & Sons, Ltd., 2016.*
- *Y. Mori, Mechanical Vibrations: Applications to Equipment, ISTE Ltd., 2017.*
- *A.A. Shabana, Theory of Vibration: An Introduction, 3rd Edition, Springer International Publishing AG, part of Springer Nature, 2019.*
- *S.S. Rao, Mechanical Vibrations, 6th Edition in SI Units, Pearson Education, Inc., 2018.*
- *B. Balachandran and E.B. Magrab, Vibrations, 3rd Edition, Balakumar Balachandran and Edward B. Magrab, 2019.*

<table>
<tr><td>Course title</td><td colspan="4">Maintenance of Mechanical Systems</td><td>Course Code</td><td>PDE524</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Lectures</td><td colspan="2">Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>1</td><td colspan="2">2</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; Design of mechanical systems; Engineering mistakes in mechanical systems; Types and forms of damage and fracture; Damage and fracture models; Surface and tribological failures; Volumetric failures; Role of fatigue and creep in failures; Functional failures; Failure analysis; Fault diagnosis and prognosis; Measurement methods; Monitoring of machine performance; Nondestructive tests; Methods and tools of mechanical maintenance; Vibration damping; Techniques of surface failure treatment; Maintenance types; Management and information systems for maintenance; Essential software; Applications; Case studies; Recent topics.

**References:**
- *C. Scheffer (ed.), Practical Machinery Vibration Analysis and Predictive Maintenance, IDC Technologies, 2004.*
- *H.P. Bloch and F.K. Geitner, Machinery Component Maintenance and Repair, 3rd Edition, Elsevier Inc., 2005.*
- *R.R. Knotek and J. Stenerson, Mechanical Principles and Systems for Industrial Maintenance, Pearson Education, 2006.*
- *R. Manzini et al., Maintenance for Industrial Systems, Springer-Verlag London Ltd., 2010.*
- *J. Clade and M. Brumbach, Industrial Maintenance, 2nd Edition, Cengage Learning, 2013.*
- *J. Yan, Machinery Prognostics and Prognosis Oriented Maintenance Management, John Wiley & Sons Singapore Pte. Ltd., 2015.*
- *T. Kanti Agustiady and E.A. Cudney, Total Productive Maintenance: Strategies and Implementation Guide, Taylor & Francis Group, LLC, 2016.*

<table>
<tr><td>Course title</td><td colspan="4">Principles of Mechatronics</td><td>Course Code</td><td>PDE531</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Lectures</td><td colspan="2">Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>1</td><td colspan="2">2</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; Architectures of mechatronic systems; Electric circuits and components; Semiconductor electronics; Systems' responses; Analog signal processing using operational amplifiers; Digital circuits;

Microcontroller programming and interfacing; Data acquisition; Sensors; Actuators; Control of mechatronic systems; Measurements and errors analyses in mechatronic systems; Implementation of mechatronic systems; Essential hardware and software; Applications; Case studies; Recent topics.

**References:**


- *W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 6th Edition, Pearson Education Limited, 2015.*
- *E. Brusa (ed.), Mechatronics: Principles, Technologies and Applications, Nova Science Publishers, Inc., 2015.*
- *D.G. Alciatore, Introduction to Mechatronics and Measurement Systems, 5th Edition, McGraw-Hill Education, 2019.*


| Course title | Materials Engineering | | | | Course Code | PDE541 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Types of materials; Structure of materials; **Properties of Materials:** Mechanical, Electrical, Magnetic, Optical, Thermal, Chemical, Metallurgical, Biological, Tribological. Change of properties; Corrosion; Degradation; Transport properties; Imperfections in solids; Diffusion; Deformation and strengthening mechanisms; Materials testing; Failures and failure mechanics of products; Reliability of material systems; Phase diagrams; Phase transformations; Thermodynamics of condensed phases; Kinetic processes; Synthesis, fabrication, and processing of materials; **Treatment of Materials:** Surface and heat treatment, Coating, Reinforcement. Materials selection and design; Numerical methods; Essential software; Engineering and industrial applications; Health and safety systems in materials engineering; Economic and environmental issues in materials engineering; Recycling of materials; Recent topics.

**References:**


- *D.R. Askeland and W.J. Wright, The Science and Engineering of Materials, 7th Edition, Cengage Learning, 2016.*
- *A. Tiwari et al., Advanced Engineering Materials and Modeling, Scrivener Publishing LLC., John Wiley & Sons, Inc., 2016.*
- *W.D. Callister, JR. and D.G. Rethwisch, Materials Science and Engineering: An Introduction 10th Edition, John Wiley & Sons, Inc., 2018.*
- *S. Trolier-McKinstry and R.E. Newnham, Materials Engineering: Bonding, Structure, and Structure–Property Relationships, Materials Research Society, 2018.*
- *K. Kumar et al. (eds.), Micro and Nano Machining of Engineering Materials: Recent Developments, Springer Nature Switzerland AG, 2019.*
- *A.V. Vakhrushev and A.K. Haghi, Composite Materials Engineering: Modeling and Technology, Apple Academic Press, 2020.*
- *W.F. Smith, Foundations of materials science and engineering, 6th Edition, McGraw-Hill Education, 2019.*
- *M. Ashby et al., Materials: Engineering, Science, Processing and Design, 4th Edition, Butterworth-Heinemann, Elsevier Ltd., 2019.*
- *L. Burstein, A MATLAB® Primer for Technical Programming in Materials Science and Engineering, Woodhead Publishing, Elsevier Inc., 2020.*

| Course title | Analysis of Material Systems | | | | Course Code | PDE542 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 1 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**
Introduction; An overview of material systems development; Structure of materials; Types and applications of materials; **Behavior of Engineering Materials:** Mechanical, Thermomechanical, Electrical. Destructive and nondestructive testing of materials; Modeling of material systems; Defect analysis of engineering materials; Failure analysis of engineering materials; Corrosion and degradation monitoring; Quality control of materials; Materials protection; Environmental analysis of materials; Numerical methods in analysis of material systems; Essential software; Applications; Recent topics.

**References:**


- *R. Smith, Smart Material Systems: Model Development, SIAM, Society for Industrial and Applied Mathematics, 2005.*
- *D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley & Sons, 2007.*
- *M.F. Ashby and D.R.H. Jones, Engineering Materials 2: An Introduction to Microstructures and Processing, 4th Edition, M.F. Ashby and D.R.H. Jones. Published by Elsevier Ltd., 2013.*
- *R.C. Hibbeler, Mechanics of Materials, 10th Edition in SI Units, R.C. Hibbeler. Published by Pearson Education, Inc., 2018.*
- *D.R.H. Jones and M.F. Ashby, Engineering Materials 1: An Introduction to Properties, Applications and Design 5th, D.R.H. Jones and M.F. Ashby. Published by Elsevier Ltd., 2019.*
- *M. Ashby et al., Materials: Engineering, Science, Processing and Design, 4th Edition, Butterworth-Heinemann, Elsevier Ltd., 2019.*
- *F.P. Beer et al., Mechanics of Materials, 8th Edition, McGraw-Hill Education, 2020.*
- *A. Bedford and K.M. Liechti, 2nd Edition, Mechanics of Materials, Springer Nature Switzerland AG, 2020.*
- *L. Burstein, A MATLAB® Primer for Technical Programming in Materials Science and Engineering, Woodhead Publishing, Elsevier Inc., 2020.*


| Course title | Forming Engineering | | | | Course Code | PDE551 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 4 |
| | 2 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**
Introduction; Theory and fundamentals of forming; Evolution of forming technology and processes; Processes and techniques of forming; **Solidification Processes:** Metal casting, Glass working, Plastics shaping, Rubbers shaping, Polymers shaping. Ceramics shaping; Powdering processes; **Metal Forming Processes:** 'Forging, Rolling, Extrusion, and Bending', 'Wire, Bar, and Tube' working, 'Sheet material' working. **Joining Processes:** Welding, Brazing, Soldering, Bonding, Fastening. Composites forming processes; Hydroforming; Micro forming; Mechanics of forming processes; Modeling, simulation, and optimization of forming processes; Measurements in forming; Heat treatment; Surface treatment; Tribology in forming; Design and management of forming systems; Design of forming tools, equipment, and dies; Reliability analysis of forming products, processes, and systems; Design for forming; Safety and Health aspects; Contemporary technology in forming; Simulation of forming processes; Essential software; Workshop applications for forming.

**References:**


- *A.M. Habraken, Material Forming Processes, Kogan Page Ltd., 2003.*

- *M.P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 5th Edition, John Wiley & Sons, Inc., 2013.*
- *P.D. Rufe (ed.), Fundamentals of Manufacturing, 3rd Edition, Society of Manufacturing Engineers, 2013.*
- *J.P. Davim (ed.), Modern Manufacturing Engineering, Springer International Publishing, 2015.*
- *R.S. Hingole, Advances in Metal Forming: Expert System for Metal Forming, Springer-Verlag Berlin Heidelberg, 2015.*
- *R.G. Narayanan and J.S. Gunasekera (eds.), Sustainable Material Forming and Joining, Taylor & Francis Group, LLC, 2019.*
- *K. Gupta (ed.), Materials Forming, Machining and Post Processing, Springer Nature Switzerland AG, 2020.*


| **Course title** | **Heat Treatment** | | | | **Course Code** | PDE552 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; **Thermal Properties of Materials:** Metallic and Nonmetallic. Basics of heat treatment; Heat treatment units; Heat treatment techniques; Heat treatment processes; Development of heat treatment systems; Benefits and difficulties of heat treatment; Design and management of heat treatment systems; Heat treatment of metallic products; Heat treatment of nonmetallic products; Heat treatment of steel and alloy steels; Heat treatment of tool steels; Heat treatment of cast irons; **Heat Treatment of Alloys:** Ferrous and Nonferrous. Heat treatment of castings; Heat treatment of rotational parts of machines; Thermochemical treatment of metals; Using laser in heat treatment; Deformation reduction; Heat treatment effects on materials properties; Safety systems for heat treatment; Quality control of heat treatment processes; Simulation of heat treatment processes; Essential software; Applications; Recent topics.

**References:**


- *G.E. Totten (ed.), Steel Heat Treatment Handbook—Steel Heat Treatment: Metallurgy and Technologies, Taylor & Francies Group, LLC, 2007.*
- *T.V. Rajan et al., Heat Treatment: Principles and Techniques, 2nd Edition, PHI Learning Private Limited New Delhi, 2011.*
- *F. Czerwinski (ed.), Heat Treatment: Conventional and Novel Applications, InTech, 2012.*
- *W.E. Bryson, Heat Treatment: Master Control Manual, Carl Hanser Verlag, Munich, 2015.*
- *S.K. Mandal, Heat Treatment of Steels, McGraw Hill Education (India) Private Ltd., 2016.*


| **Course title** | **Machining Engineering** | | | | **Course Code** | PDE553 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 4 |
| | 2 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Theory and fundamentals of machining; Evolution of machining technology and processes; Processes and techniques of machining; Mechanical machining processes; Electro, chemical, and electrochemical machining processes; Thermal machining processes; Hybrid machining processes; Micro- and Nano-Machining; Precision machining; Machining of threads, gears, and camshafts; Machining of crankshafts; Cutting machines; Cutting tools; Mechanics of machining processes; Modeling, simulation, and optimization of machining processes; Measurements in machining; Cutting tribology; Design and management of machining systems; Design for machining; Reliability analysis in machining; Health and safety aspects; Contemporary technology in machining; Simulation of machining processes, Essential software; Machining workshop applications.

**References:**


- *H. El-Hofy, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, The McGraw-Hill Companies, 2005.*
- *H. Youssef and H. El-Hofy, Machining Technology: Machine Tools and Operations, Taylor & Francis Group, LLC, 2008.*
- *A. Overby, CNC Machining Handbook: Building, Programming, and Implementation, McGraw-Hill Companies, Inc., 2011.*
- *J.P. Davim (ed.), Machining and Machine Tools: Research and Development, The editor and contributors, Published by Woodhead Publishing Ltd., 2013.*
- *M.P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 5th Edition, John Wiley & Sons, Inc., 2013.*
- *J.P. Davim, Nontraditional Machining Processes: Research Advances, Springer-Verlag London, 2013.*
- *S.Y. Liang and A.J. Shih, Analysis of Machining and Machine Tools, Springer, 2016.*
- *A.P. Markopoulos and J.P. Davim (eds.), Advanced Machining Processes: Innovative Modeling Techniques, Taylor & Francis Group, LLC, 2018.*
- *K. Kumar et al. (eds.), Micro and Nano Machining of Engineering Materials: Recent Developments, Springer Nature Switzerland AG, 2019.*
- *J.R. Walker and B. Dixon, Machining Fundamentals 10th Edition, The Goodheart-Willcox Company, Inc., 2019.*
- *K. Gupta (ed.), Materials Forming, Machining and Post Processing, Springer Nature Switzerland AG, 2020.*
- *A.M. Sidpara and G. Malayath, Micro Electro Discharge Machining: Principles and Applications, Taylor & Francis Group, LLC, 2020.*
- *H. Youssef and H. El-Hofy, Non-Traditional and Advanced Machining Technologies, 2nd Edition, Taylor & Francis Group, LLC, 2021.*


<table>
<tr><td>Course title</td><td colspan="4">Principles of Metrology</td><td>Course Code</td><td>PDE561</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">2</td></tr>
<tr><td colspan="2">1</td><td>-</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; Standards and comparators; Limits, fits, tolerances, and gauges; Design of limit gauges; Design of engineering tolerances; Straightness and flatness measurement; Roundness measurement; Surface roughness measurement; Fine measurement for flat and circular surfaces; Coordinate measurement; Fine measurement instruments and calibration; Angular measurements; Screw thread measurements; Gear measurements; Machine tool testing; Optical measurement; Axial measurement machines; Pneumatic comparators; Computer vision measurement systems; Micro- and Nano-Measurement methods; Analysis of measured data; Hardware and software requirements; Applications; Recent topics.

**References:**


- *L. Cocco (ed.), Modern Metrology Concerns, InTech, 2012.*
- *N.V. Raghavendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford University Press, 2013.*
- *Kevin Harding (ed.), Handbook of Optical Dimensional Metrology, LLCCRC, Taylor & Francis Group, 2013.*
- *T. Yoshizawa (ed.), Handbook of Optical Metrology: Principles and Applications, 2nd Edition, LLCCRC, Taylor & Francis Group, 2015.*
- *R.S. Sirohi, Introduction to Optical Metrology, Taylor & Francis Group, LLC, 2016.*

- *G.T. Smith, Machine Tool Metrology: An Industrial Handbook, Springer International Publishing Switzerland, 2016.*
- *X.J. Jiang and P.J. Scott, Advanced Metrology: Freeform Surfaces, Academic Press, Elsevier Inc., 2020.*

| **Course title** | **Engineering Statistics** | | | | **Course Code** | PDE571 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Data organization; Measures of location; Measures of dispersion; Measures of shape; Probability theory; Random variables and probability distributions; Mathematical expectation for random variables; Theoretical probability distributions; Sampling and sampling distributions; Estimation; Test of hypothesis; Analysis of variance; Nonparametric statistical methods; Regression analysis; Models verification; Order statistics and probability plots; Common statistical tests in engineering; Statistical power analysis; Reliability analysis; Introduction to Markov chains and stochastic processes; Simulation of simple stochastic processes; Essential statistical and simulation software; Engineering and industrial applications.

**References:**

- *D.C. Montgomery et al., Engineering Statistics, 5th Edition, John Wiley & Sons, Inc., 2011.*
- *D.C. Montgomery and G.C. Runger, Applied Statistics and Probability for Engineers, 7th Edition, John Wiley & Sons, Inc., 2018.*
- *A. Metcalfe et al., Statistics in Engineering with Examples in MATLAB® and R, 2nd Edition, Taylor & Francis Group, LLC, 2019.*
- *A.M. Haghighi and I. Wickramasinghe, Probability, Statistics, and Stochastic Processes for Engineers and Scientists, Taylor & Francis Group, LLC, 2021.*

| **Course title** | **Quality Engineering** | | | | **Course Code** | PDE572 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Quality definitions; An overview of statistical and management methods of quality; **Process Schema:** Data, Information, Knowledge. Fundamental statistics for quality control; Techniques of quality inspection; Defect analysis of products and processes; Product fault tree analysis; Pareto analysis; Ishikawa analysis; Failure mode and effect analysis; Quality models; Control charts; Application of control charts in reliability monitoring; Acceptance sampling; Process capability analysis; Tolerances; Quality measures; Reliability analysis; Quality costs; Design for robust quality; Multivariate statistical process control; Nonparametric statistical process control; Implementation of statistical process control; Essential software; Applications; Recent topics.

**References:**

- *D.C. Montgomery, Introduction to Statistical Quality Control, 7th Edition, John Wiley & Sons, Inc., 2013.*
- *A. Mitra, Fundamentals of Quality Control and Improvement, 4th Edition, John Wiley & Sons, Inc., 2016.*
- *K.S. Krishnamoorthi et al., A First Course in Quality Engineering: Integrating Statistical and Management Methods of Quality, 3rd Edition, Taylor & Francis Group, LLC, 2019.*

- *S. Anand and L. Priya, A Guide for Machine Vision in Quality Control, Taylor & Francis Group, LLC, 2020.*

| **Course title** | **Facility Management** | | | | **Course Code** | PDE581 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Facility management organization; Sustainable practices of facility management; Facility location; Facility design and planning; Workspace design; Material handling; Facility safety, risk management, and occupational health; Management of natural and occupational disasters; Value and life analysis; Facility development costing; Supportive services; Reliability and maintenance of facilities; Design of smart/intelligent constructions; Energy management and making use of renewable energy; Design of information and decision support systems for facility management; Essential software; Case studies; Recent topics.

**References:**

- *D.G. Cotts et al., The Facility Management Handbook, 3rd Edition, D.G. Cotts et al. Published by AMACOM, 2010.*
- *P. Barrett and E. Finch, Facilities Management: The Dynamics of Excellence, 3rd Edition, John Wiley & Sons, Ltd., 2014.*
- *K.O. Roper and R.P. Payant, The Facility Management Handbook, 4th Edition, K.O. Roper and R.P. Payant. Published by AMACOM, 2014.*
- *B. Atkin and A. Brooks, Total Facility Management, 4th Edition, John Wiley & Sons, Ltd., 2015.*
- *D. Lowry, The Complete Guide to Facility Management, Lowry Digital, LLC, 2017.*

| **Course title** | **Operations Management** | | | | **Course Code** | PDE582 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Summary for operations research and statistical techniques; Time series forecasting; Aggregate planning and master scheduling; Operations and capacity planning; Requirements planning; Inventory management; Logistics and supply chains; Operations scheduling and machine loading; Layout design and site selection; Principles of ergonomics; Work design; Product and process design; Project management; Manufacturing systems and their development; Application of best practices in manufacturing; Reliability and maintenance models for equipment, machines, and buildings; Information and decision support systems; Statistical quality control; Value engineering and performance measurement; Essential software; Applications; Recent topics.

**References:**

- *L.J. Krajewski et al., Operations Management: Processes and Supply Chains, 7th Edition, Pearson Education, Inc., 2016.*
- *J. Heizer et al., Principles of Operations Management: Sustainability and Supply Chain Managemen, Pearson Education Ltd., 2017.*
- *F.R. Jacobs and R.B. Chase, Operations and Supply Chain Management, 15th Edition, McGraw-Hill Education, 2018.*
- *W.J. Stevenson, Operations Management, 13th Edition, McGraw-Hill Education, 2018.*

- *N. Slack and A. Brandon-Jones, Operations and Process Management: Principles and Practice for Strategic Impact, 5th Edition, Pearson Education Limited, 2018.*

| Course title | Product Design | | | | Course Code | PDE583 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; An overview of engineering design; Geometric design; Integrated product manufacturing systems; Total product design; Kansei engineering; Quality tools for product design; Design for 'X'; Axiomatic design; Modular design; TRIZ method for product manufacturing; Assembly design; Information and decision support systems for product manufacturing; Product lifecycle management; (Standard for exchange of product model) STEP-based manufacturing; Product design for lean Six Sigma; Statistical techniques for product design; Taguchi method for product design; Product measurements; Product costing; Reverse engineering; Essential software; Engineering applications; Recent topics.

**References**:

- *K. Yang and B.S. El-Haik, Design for Six Sigma: A Roadmap for Product Development, McGraw-Hill Companies, Inc., 2009.*
- *G. Boothroyd et al., Product Design for Manufacture and Assembly, 3rd Edition, Taylor and Francis Group, LLC, 2011.*
- *G.A. Britton and S. Torvinen, Design Synthesis: Integrated Product and Manufacturing System Design, Taylor & Francis Group, LLC, 2014.*
- *W.D. Seider et al., Product and Process Design Principles: Synthesis, Analysis, and Evaluation, 4th Edition, John Wiley & Sons, Inc., 2017.*
- *A. Jamnia, Introduction to Product Design and Development for Engineers, Taylor & Francis Group, LLC, 2018.*
- *L.J. Gullo and J. Dixon (eds.), Design for Safety, John Wiley & Sons Ltd., 2018.*
- *F. Tosi, Design for Ergonomics, Springer Nature Switzerland AG, 2020.*
- *A. Jamnia and K. Atua, Executing Design for Reliability within the Product Life Cycle, Taylor & Francis Group, LLC, 2020.*

| Course title | Work Study | | | | Course Code | PDE584 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 1 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Techniques of collecting work data; Work database design; Statistical basics; Human factor effects on work; Working conditions, environment, and safety; Measurement and improvement of productivity; **Design and Analysis of Work Methods:** Process and Motion. Workplace design; **Design and Analysis of Work Time:** Direct time and Indirect time. Operator's performance measurement; Learning curves; Wage plans; Job design; Information systems and intelligent systems for work study; Essential software; Implementation of work study; Case studies; Recent topics.

**References**:

- *S. Konz and S. Johnson, Work Design: Occupational Ergonomics, 7th Edition, Taylor & Francis, 2008.*
- *M.M. Soares and F. Rebelo (eds.), Ergonomics in Design: Methods & Techniques, Taylor & Francis Group, LLC, 2017.*

- *A.B. Badiru and S.C. Bommer, Work Design: A Systematic Approach, Taylor & Francis Group, LLC, 2017.*
- *R.S. Bridger, Introduction to Human Factors and Ergonomics, 4th Edition, Taylor & Francis Group, LLC, 2018.*
- *F. Tosi, Design for Ergonomics, Springer Nature Switzerland AG, 2020.*

## Level (600)

| Course title | Elasticity and Plasticity | | | | Course Code | PDE611 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Foundations of elasticity and plasticity; Theory of elasticity and plasticity; Thermo elasticity and plasticity; Anisotropic elasticity and plasticity; Large-deformation elasticity and plasticity; Dynamic elasticity and plasticity; Hyperelasticity; Functions, models, and experiments of elasticity and plasticity; Nonlinear problems; Multidimensional problems; Modeling and solution methods in elasticity and plasticity; Numerical methods for elasticity and plasticity analysis; Essential software; Engineering applications; Recent topics.

**References:**

- *A. Bertram, Elasticity and Plasticity of Large Deformations: An Introduction, 3rd, Edition, Springer-Verlag Berlin Heidelberg, 2012.*
- *A. Bertram and R. Glüge, Solid Mechanics Theory, Modeling, and Problems, Springer International Publishing Switzerland, 2015.*
- *J.W. Rudnicki, Fundamentals of Continuum Mechanics, John Wiley & Sons, Ltd., 2015.*
- *M. Kassir, Applied Elasticity and Plasticity, Taylor & Francis Group, LLC, 2018.*
- *A. Shabana, Computational continuum mechanics, 3rd Edition, John Wiley & Sons Ltd., 2018.*
- *Z.R. Wang et al., Engineering Plasticity: Theory and Applications in Metal Forming, Higher Education Press, 2018.*
- *H. Wang and Q.-H. Qin, Methods of Fundamental Solutions in Solid Mechanics, Higher Education Press. Published by Elsevier Inc., 2019.*
- *M.H. Sadd, Elasticity: Theory, Applications, and Numerics, 4th Edition, Elsevier Inc., 2021.*

| Course title | Mechanics of Materials | | | | Course Code | PDE612 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Stress and strain; Mechanical properties of materials; Axial load; Torsion; Bending; Transverse shear; Combined loadings and stresses; Stress transformation; Strain transformation; Deflection; Buckling; Energy methods for stress-strain problem solving; Systems of testing and measurements in mechanics of materials; Analysis of internal forces and moments of structures; Fatigue failure mode and effect analysis; Corrosion and materials mechanics; Role of materials’ mechanics in mechanical design; Micromechanics of materials; Fracture mechanics; Numerical methods and simulation of materials mechanics; Essential software; Applications on machinery and structures; Recent topics.

**References:**

- *R.C. Hibbeler, Mechanics of Materials, 10th Edition in SI Units, R.C. Hibbeler. Published by Pearson Education, Inc., 2018.*
- *B.J. Goodno and J.M. Gere, Mechanics of Materials, 9th Edition, Cengage Learning, 2018.*
- *F.P. Beer et al., Mechanics of Materials, 8th Edition, McGraw-Hill Education, 2020.*
- *A. Bedford and K.M. Liechti, 2nd Edition, Mechanics of Materials, Springer Nature Switzerland AG, 2020.*

| **Course title** | **Fundamentals of Fracture Mechanics** | | | | **Course Code** | PDE613 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; An overview of fracture theory and fracture mechanisms; Crack growth rate under static and dynamic loads; Elastic stress field in cracked components; Linear analysis for elastic stress in two-dimensional cracks; Elastic fracture factors; Elastic-plastic stress field in cracked bodies; Energy flow in elastic fractures; Crack growth based on energy equilibrium; Critical stress intensity factor fracture criterion; J-Integral and crack opening displacement fracture criteria; Mixed-mode crack growth; Fatigue crack propagation; Environmentally assisted cracking; Fracture micromechanics; Fracture testing; Failure analysis; Fracture prognosis and diagnosis; Fracture of joints and structures; Design for fracture; Computational fracture mechanics; Essential software; Applications; Recent topics.

**References:**

- *T.L. Anderson, Fracture Mechanics: Fundamentals and Applications, 4th Edition, Taylor & Francis Group, LLC, 2017.*
- *A. Saxena, Advanced Fracture Mechanics and Structural Integrity, Taylor & Francis Group, LLC, 2019.*
- *E.E. Gdoutos, Fracture Mechanics: An Introduction, 3rd Edition, Springer Nature Switzerland AG, 2020.*

| **Course title** | **Optimum Design** | | | | **Course Code** | PDE614 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Optimization processes; Optimum design concepts; Unconstrained/Constrained optimum design problems; **Optimization Methods:** Exact methods, Heuristics, and Metaheuristics. **Modeling for Optimum Design:** Optimization models, Optimization model construction, and Optimization model boundedness. Interior and boundary optima; Parametric and discrete optima; Multi-objective/Multivariable optimum design problems; Approximation methods; Transformation methods; Numerical methods for optimum design; Interactive design optimization; Essential software; Applications; Recent topics.

**References:**

- *J.S. Arora, Introduction to Optimum Design, 4th Edition, Elsevier Inc., 2017.*
- *R. Sioshansi and A.J. Conejo, Optimization in Engineering: Models and Algorithms, Springer International Publishing AG, 2017.*
- *R.R. Rhinehart, Engineering Optimization Applications, Methods, and Analysis, R.R. Rhinehart, 2018.*

- *A.D. Belegundu and T.R. Chandrupatla, Optimization Concepts and Applications in Engineering, A.D. Belegundu and T.R. Chandrupatla. Published by Cambridge University Press, 2019.*
- *S.S. Rao, Engineering Optimization: Theory and Practice, 5th Edition, John Wiley & Sons, Inc., 2020.*

| **Course title** | **Machine Tools (1)** | | | | **Course Code** | PDE615 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Machining processes; Forming processes; Cutting machines; Forming machines; Hybrid machine tools; Elements of machine tools; Drives and mechanisms of machine tools; Machine tool mechanics; Machine tool design; Tool engineering; Material handling in machine tool systems; Management of machine tool systems; Health and safety aspects; Essential software; Applications; Case studies; Recent topics.

**References:**

- *Y. Ito, Modular Design for Machine Tools, McGraw-Hill Companies, Inc., 2008.*
- *P.H. Joshi, Machine Tools Handbook: Design and Operation, Tata McGraw-Hill Publishing Company Ltd., 2007.*
- *D. Zhang, Parallel Robotic Machine Tools, Springer Science + Business Media, LLC, 2010.*
- *S.F. Krar et al., Technology of Machine Tools, 7th Edition, McGraw-Hill Companies, Inc., 2011.*
- *N.K. Mehta, Machine Tool Design and Numerical Control, 3rd Edition, Tata McGraw Hill Education Private Ltd., 2012.*
- *J.P. Davim (ed.), Machining and Machine Tools: Research and Development, The editor and contributors, Published by Woodhead Publishing Ltd., 2013.*
- *K. Evans, Programming of CNC Machines, 4th Edition, Industrial Press, Inc., 2016.*
- *S.Y. Liang and A.J. Shih, Analysis of Machining and Machine Tools, Springer, 2016.*

| **Course title** | **Machine Tools (2)** | | | | **Course Code** | PDE616 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Development of machine tools and their components; Machine tool processes and operations; Concepts of structural components in machine tools; Control of machine tool processes; Robotized machine tools; Measurement of machine tools' performance and precision; High performance machine tools; Parallel kinematics for machine tools; Machine tools for micro- and nano-machining; Modular design for machine tools; Essential software; Applications; Case studies; Recent topics.

**References:**

- *Y. Ito, Modular Design for Machine Tools, McGraw-Hill Companies, Inc., 2008.*
- *P.H. Joshi, Machine Tools Handbook: Design and Operation, Tata McGraw-Hill Publishing Company Ltd., 2007.*
- *D. Zhang, Parallel Robotic Machine Tools, Springer Science + Business Media, LLC, 2010.*
- *S.F. Krar et al., Technology of Machine Tools, 7th Edition, McGraw-Hill Companies, Inc., 2011.*
- *N.K. Mehta, Machine Tool Design and Numerical Control, 3rd Edition, Tata McGraw Hill Education Private Ltd., 2012.*

- *J.P. Davim (ed.), Machining and Machine Tools: Research and Development, The editor and contributors, Published by Woodhead Publishing Ltd., 2013.*
- *K. Evans, Programming of CNC Machines, 4th Edition, Industrial Press, Inc., 2016.*
- *S.Y. Liang and A.J. Shih, Analysis of Machining and Machine Tools, Springer, 2016.*


| **Course title** | **Cutting Tools Engineering** | | | | **Course Code** | PDE617 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Fundamentals of cutting; Cutting dynamics; Cutting processes; **Evolution of Cutting Technology:** Processes, Tools, and Tool materials. **Cutting Tools:** Mechanical, Nonmechanical, and Hybrid. Cutting tools manufacturing; Cutting tools materials; Ceramics cutting tools; Joining of cutting inserts; Chip-breaking technology; Threading, cam cutting, and gear cutting technologies; Modular tooling; Tool and cutting process management; Cutting tribology; Tool life analysis; Treatment and protection of cutting tools; Machinability and surface integrity; Tool design for machining and tribology; Economics of cutting tools; Industrial cases for cutting tools selection; Simulation of cutting processes; Essential software; Recent topics.

**References:**


- *M.C. Shaw, Metal Cutting Principles, 2nd Edition, Oxford University Press, Inc., 2005.*
- *G.T. Smith, Cutting Tool Technology: Industrial Handbook, Springer-Verlag London Ltd., 2008.*
- *T. Atkins, The Science and Engineering of Cutting: The Mechanics and Processes of Separating, Scratching and Puncturing Biomaterials, Metals and Non-metals, Elsevier Ltd., 2009.*
- *M.J. Jackson, Micromachining with Nanostructured Cutting Tools, The Author, 2013.*
- *S.Y. Liang and A.J. Shih, Analysis of Machining and Machine Tools, Springer, 2016.*
- *D.A. Stephenson and J.S. Agapiou, Metal Cutting Theory and Practice, 3rd Edition, Taylor & Francis Group, LLC, 2016.*
- *S.P. Radzevich, Gear Cutting Tools: Science and Engineering, 2nd Edition, Taylor & Francis Group, LLC, 2017.*


| **Course title** | **Manufacturing Tools Engineering** | | | | **Course Code** | PDE618 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Structure of machine tools; **Jigs and Fixtures**—Types of jigs and fixtures; Jigs and fixtures for machining processes; Fixtures for forming processes; Hydraulic and automatic jigs and fixtures; Modular jigs and fixtures; Fixation and clamping methods; Foolproofing methods; Design of locators, bushes, clamps, indexing devices, and frames. **Press Tools**—Types of press tools; Design of frames and slides, dies, progressive dies, and compound dies; Hydraulic and automatic presses. **Cutting Tools**—Types of cutting tools; Geometry of cutting tools; Design of cutting tools, inserts, tool holders, and chip controllers; Tool wear, life, and failure. **Inspection Systems**—Gauges (standard, special, and receiver); Markers; Part fixtures; In-process and off-process automatic inspection systems. **Introduction to Forming Tools**; Tool materials; Tolerances on tools; Manufacturing of tools; Tool design for SMED; Tools selection; Tool design with TRIZ method; Knowledge-bases and design documentations of tools; Economics of tooling in manufacturing; Applications; Recent developments in tools and tool design.

**References:**

- *M.C. Shaw, Metal Cutting Principles, 2nd Edition, Oxford University Press, Inc., 2005.*
- *T. Atkins, The Science and Engineering of Cutting: The Mechanics and Processes of Separating, Scratching and Puncturing Biomaterials, Metals and Non-metals, Elsevier Ltd., 2009.*
- *P.H. Joshi, Jigs and Fixtures, 3rd Edition, Tata McGraw Hill Education Private Ltd., 2010.*
- *J.G. Nee (ed.), Fundamentals of Tool Design, 6th Edition, Society of Manufacturing Engineers, 2010.*
- *M.J. Jackson, Micromachining with Nanostructured Cutting Tools, The Author, 2013.*
- *V. Boljanovic, Sheet Metal Forming Processes and Die Design, 2nd Edition, Industrial Press Inc., 2014.*
- *K. Venkataraman, Design of Jigs, Fixtures and Press Tools, The Author. Published by John Wiley & Sons Ltd., 2015.*
- *N.K. Mehta, Metal Cutting and Design of Cutting Tools, Jigs & Fixtures, McGraw Hill Education (India) Private Ltd., 2015.*
- *S.P. Radzevich, Gear Cutting Tools: Science and Engineering, 2nd Edition, Taylor & Francis Group, LLC, 2017.*
- *S. Kainth, Die Design for Extrusion of Plastic Tubes and Pipes: A Practical Guide, Carl Hanser Verlag, Munich, 2018.*

<table>
<tr><th>Course title</th><th colspan="4">Fundamentals of Tribology</th><th>Course Code</th><th>PDE621</th></tr>
<tr><th rowspan="2">Teaching hours</th><th colspan="2">Lectures</th><th>Tutorial</th><th>Practical</th><th rowspan="2">Credit hours</th><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><th rowspan="2">Course grades</th><th>Oral</th><th>Practical</th><th>S. work</th><th>Final Exam</th><th rowspan="2">Total grades</th><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction; Lubricants; **Lubrication:** Hydrodynamic, Hydrostatic, Elastohydrodynamic, Boundary, Extreme pressure, and Solid. Computational hydrodynamics; Surface treatments for friction reduction; Fundamentals of contact and friction between solids; **Wear:** Abrasive, Erosive, Adhesive, Corrosive, and Fatigue. Wear mechanisms; Wear of non-metallic materials; Tribodesign; Tribological failure analysis; Biotribology; Nanotribology; Design of machine tool lubrication systems; Applications; Recent topics.

**References:**

- *I. Hutchings and P. Shipway, Tribology: Friction and Wear of Engineering Materials, 2nd Edition, Ian Hutchings and Philip Shipway. Published by Elsevier Ltd., 2017.*
- *M.M. Khonsari and E.R. Booser, Applied Tribology: Bearing Design and Lubrication, 3rd Edition, John Wiley & Sons Ltd., 2017.*
- *E. Omrani et al., Tribology and Applications of Self-Lubricating Materials, Taylor & Francis Group, LLC, 2018.*
- *K.C. Ludema and O.O. Ajayi, Friction, Wear, Lubrication: A Textbook in Tribology, 2nd Edition, Taylor & Francis Group, LLC, 2019.*

<table>
<tr><th>Course title</th><th colspan="4">Fault Analysis and Control</th><th>Course Code</th><th>PDE622</th></tr>
<tr><th rowspan="2">Teaching hours</th><th colspan="2">Lectures</th><th>Tutorial</th><th>Practical</th><th rowspan="2">Credit hours</th><td rowspan="2">3</td></tr>
<tr><td colspan="2">1</td><td>2</td><td>3</td></tr>
<tr><th rowspan="2">Course grades</th><th>Oral</th><th>Practical</th><th>S. work</th><th>Final Exam</th><th rowspan="2">Total grades</th><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; Essential dynamics and reliability methods for fault modeling and analysis; Faults of mechanical systems; Systems and techniques of maintenance; Systems for fault detection, diagnosis, and prognosis; Fault diagnosis of dynamic and nonlinear systems; Fault-Tolerant (linear/nonlinear) control systems; Fault estimation of stochastic systems; Fault diagnosis using Bayesian networks; Robust fault estimation; Fault isolation; Sensors and sensing strategies; Signal processing; Using database management systems in fault analysis; Intelligent Interfaces; Fault diagnosis and prognosis performance metrics; System logistics for performing maintenance operations; Essential hardware and software; Applications to machine tools, robotic, and autonomous systems; Recent topics.

**References:**


- *G. Vachtsevanos et al., Intelligent Fault Diagnosis and Prognosis for Engineering Systems, John Wiley & Sons, Inc., 2006.*
- *J. Yan, Machinery Prognostics and Prognosis Oriented Maintenance Management, John Wiley & Sons Singapore Pte. Ltd., 2015.*
- *A.W. Lees, Vibration Problems in Machines: Diagnosis and Resolution, Taylor & Francis Group, LLC, 2016.*
- *R. Gonzalez et al., Process Control System Fault Diagnosis: A Bayesian Approach, John Wiley & Sons, Ltd., 2016.*
- *Y. Lei, Intelligent Fault Diagnosis and Remaining Useful Life Prediction of Rotating Machinery, Xi'an Jiaotong University Press Co. Published by Elsevier Inc., 2017.*
- *H. Benaroya et al., Mechanical Vibration: Analysis, Uncertainties, and Control, 4th Edition, Taylor & Francis Group, LLC, 2017.*
- *M. Mansouri et al., Data-Driven and Model-Based Methods for Fault Detection and Diagnosis, Elsevier Inc. 2020.*


| **Course title** | **Tribology of Metal Cutting** | | | | **Course Code** | PDE623 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; An overview of science and engineering of cutting; Metal cutting systems; Metal cutting tools; Energy partition in the cutting system; Tribology of tool-chip and tool-workpiece interfaces; Cutting tool wear; Chip problems; **Cutting Fluids:** Types, Selection, Economics, Health aspects, and Evolution. Reliability analysis of cutting tools and cutting processes; Design of experiments for metal cutting tests; Improvement of tribological conditions for cutting processes; Essential software; Applications; Recent topics.

**References:**


- *V.P. Astakhov, Tribology of Metal Cutting, Elsevier Ltd., 2006.*
- *J.P. Davim (ed.), Tribology in Manufacturing Technology, Springer-Verlag Berlin Heidelberg, 2012.*
- *D.A. Stephenson and J.S. Agapiou, Metal Cutting Theory and Practice, 3rd Edition, Taylor & Francis Group, LLC, 2016.*
- *J.P. Byers, Metalworking Fluids: Manufacturing Engineering and Materials Processing, 3rd Edition, Taylor & Francis Group, LLC 2018.*


| **Course title** | **Analysis and Control of Mechanical Vibration** | | | | **Course Code** | PDE624 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; **Basics:** Concept of vibration; Types of vibration; Types of system models; Mathematics, statistics, and dynamics for vibration; ISO 8727 Standards. **Vibration Analysis**—Single degree of freedom vibration (damped, undamped, general loading); Variational principles and analytical dynamics of vibration; Multi degree of freedom vibration; Continuous models for vibration; Random vibration; Nonlinear vibration; Shock and transient vibration; Mechanical systems stability; Operators, responses, and models for vibration of mechanical systems. **Vibration Control**—At source vibration control; Passive vibration control (isolation, damping, and suppression)-*linear and nonlinear theory of vibration*; Active vibration control (suppression)-*Pontryagin principle and Krein moments method*; Statistical theory of vibration control; Active vibration control and stability of flexible systems; Viscoelastic damping of vibration; Vibration monitoring and measurement; Instruments for vibration monitoring, measurement, and control. Numerical methods and simulation; Essential hardware and software; Applications; Recent topics.

**References:**


- *A.W. Lees, Vibration Problems in Machines: Diagnosis and Resolution, Taylor & Francis Group, LLC, 2016.*
- *D.J. Inman, Vibration with Control, 2nd Edition, JohnWiley & Sons, Ltd., 2nd Edition, 2017.*
- *H. Benaroya et al., Mechanical Vibration: Analysis, Uncertainties, and Control, 4th Edition, Taylor & Francis Group, LLC, 2017.*
- *J. Jia and J.K. Paik (eds.), Engineering Dynamics and Vibrations: Recent Developments, Taylor & Francis Group, LLC, 2019.*


| **Course title** | **Manufacturing Automation** | | | | **Course Code** | PDE631 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Evolution of manufacturing systems; Mechanics of cutting and forming processes; Structural dynamics of machines; Machine tool vibration; Technology of manufacturing automation and robotics; Design and analysis of numerical control systems; Sensor-assisted machines; Robotic fixation, assembly, and material handling; Costing and management of automated manufacturing systems; Design and safety of workplace; Essential software; Case studies; Recent topics.

**References:**


- *Y. Altintas, Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design, 2nd Edition, Y. Altintas. Published by Cambridge University Press, 2012.*
- *M.P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, 4th Edition, Pearson Higher Education, Inc., 2015.*
- *M. Wilson, Implementation of Robot Systems: An Introduction to Robotics, Automation, and Successful Systems Integration in Manufacturing, Elsevier Inc., 2015.*
- *D. Zhang and B. Wei (eds.), Mechatronics and Robotics Engineering for Advanced and Intelligent Manufacturing, Springer International Publishing Switzerland, 2017.*
- *K.L.S. Sharma, Overview of Industrial Process Automation, 2nd Edition, Elsevier Inc., 2017.*
- *A.K. Gupta et al., Industrial Automation and Robotics, Mercury Learning and Information LLC, 2017.*
- *K. Wang et al. (eds.), Advanced Manufacturing and Automation VII, Springer Nature Singapore Pte Ltd., 2018.*
- *S. Manesis and G. Nikolakopoulos, Introduction to Industrial Automation, Taylor & Francis Group, LLC, 2018.*

<table>
<tr><td>Course title</td><td colspan="4">Virtual Manufacturing</td><td>Course Code</td><td>PDE632</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">1</td><td>2</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; Manufacturing processes and systems; Virtual reality, real virtuality, and augmented reality; **Augmented Reality—Manufacturing:** Systems, Supportive systems, Automation, and Control. Material handling systems; Embedded systems; **Mechatronics-Based Systems—**Virtual reality design. Virtual manufacturing systems; Virtual prototyping; Virtual enterprise; Essential software; Applications; Recent topics.

**References:**

- *W.A. Khan et al., Virtual Manufacturing, Springer-Verlag London Ltd., 2011.*
- *P.O. Kanife, Computer Aided Virtual Manufacturing Using Creo Parametric: Easy to Learn Step by Step Guide, Springer International Publishing Switzerland, 2016.*

<table>
<tr><td>Course title</td><td colspan="4">Fundamentals of Robotics</td><td>Course Code</td><td>PDE633</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>-</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; Robot components; Automation and robots; Types and applications of robots; Motion of rigid bodies; Mechanical systems of robots; Mechanics, modeling, and analysis of robots and their components; Electromechanical systems of robots; Control and programming systems of robots; Design of robotic systems and components; Information systems of robots; Visual sensory systems of robots; Visual perception system of robots; Robotic grasping and fixturing; Decision making systems of robots; Basic robotic prototypes; Autonomous robots; Biomimetic robots; Using the robotics in material handling systems; Using the robotics in manufacturing systems; Essential hardware and software; Applications; Recent topics.

**References:**

- *M. Wilson, Implementation of Robot Systems: An Introduction to Robotics, Automation, and Successful Systems Integration in Manufacturing, Elsevier Inc., 2015.*
- *D. Zhang and B. Wei (eds.), Mechatronics and Robotics Engineering for Advanced and Intelligent Manufacturing, Springer International Publishing Switzerland, 2017.*
- *B. Arnaldi et al. (eds.), Virtual Reality and Augmented Reality: Myths and Realities, ISTE Ltd., 2018.*

<table>
<tr><td>Course title</td><td colspan="4">Fundamentals of Mechatronics</td><td>Course Code</td><td>PDE634</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>-</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; Electromechanical systems; Modeling electromechanical systems; Modeling and simulation for Microelectromechanical systems (MEMS); Mechatronic design methodology; **Mechatronic System Components:** mechanical, electrical, and electronic. Interfaces, instrumentations, and control systems; Logic gates; Sequential control; Fundamentals of synchronizing and frequency; Timers and counters;

Operating amplifiers and control devices; Sensors; Actuators; Power semi-conductors; Networks and communication in mechatronic systems; Mechatronic control of manufacturing electromechanical systems; Implementation of mechatronic systems; Essential hardware and software; Design optimality of mechatronic systems; Recent topics.

**References:**


- *M. Jouaneh, Fundamentals of Mechatronics, Cengage Learning, 2013.*
- *W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 6th Edition, Pearson Education Limited, 2015.*
- *S. Cetinkunt, Mechatronics with Experiments, 2nd Edition, John Wiley & Sons Ltd., 2015.*
- *K. Reif (ed.), Automotive Mechatronics: Automotive Networking, Driving Stability Systems, Electronics, Springer Fachmedien Wiesbaden, 2015.*
- *C.W. de Silva et al. (eds.), Mechatronics: Fundamentals and Applications, Taylor & Francis Group, LLC, 2016.*
- *D. Zhang and B. Wei (eds.), Mechatronics and Robotics Engineering for Advanced and Intelligent Manufacturing, Springer International Publishing Switzerland, 2017.*
- *S.E. Lyshevski, Mechatronics and Control of Electromechanical Systems, Taylor & Francis Group, LLC, 2017.*
- *P. Kaltjob, Mechatronic Systems and Process Automation: Model-Driven Approach and Practical Design Guidelines, P. Kaltjob. Published by Taylor & Francis Group, CRC Press, 2018.*
- *D.G. Alciatore, Introduction to Mechatronics and Measurement Systems, 5th Edition, McGraw-Hill Education, 2019.*


| **Course title** | **Micro- and Nano-Electromechanical Systems** | | | | **Course Code** | PDE635 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Smart/Intelligent systems; **Micro- and Nano-Technologies:** Theory, Products, Applications, Processes, Systems. Micro- and Nano-Manufacturing; Materials for fabricating MEMS and NEMS; Manufacturing of MEMS and NEMS; Devices, synthesis, and structures of MEMS and NEMS; Scaling for MEMS and NEMS; Design tools of MEMS and NEMS; Control of MEMS and NEMS; Kinematics and modeling of MEMS and NEMS; MEMS and NEMS simulation; Computer aided design and modeling of MEMS and NEMS; Tribology for MEMS and NEMS; Packaging, assembly, and protection of MEMS and NEMS; Reliability of MEMS and NEMS; Engineering applications for MEMS and NEMS design; Essential hardware and software; Recent topics.

**References:**


- *S.E. Lyshevski, Nano- and Micro-Electromechanical Systems: Fundamentals of Nano- and Microengineering, 2nd Edition, Taylor & Francis Group, LLC, 2005.*
- *S.E. Lyshevski, Electromechanical systems and devices, Taylor & Francis Group, LLC, 208.*
- *C. Liu, Foundations of MEMS, 2nd Edition, Pearson Education, Inc., 2012.*
- *R. Lawes, MEMS Cost Analysis: From Laboratory to Industry, Taylor & Francis Group, LLC, 2013.*
- *F.G. Moritz, Electromechanical Motion Systems: Design and Simulation, John Wiley & Sons, Ltd., 2014.*
- *L. Castañer, Understanding MEMS: Principles and Applications, 2016 John Wiley & Sons Ltd., 2016.*
- *S.E. Lyshevski, Mechatronics and Control of Electromechanical Systems, Taylor & Francis Group, LLC, 2017.*
- *A. Jamnia, Design of Electromechanical Products: A Systems Approach, Taylor & Francis Group, LLC, 2017.*

- *R. Crowder, Electric Drives and Electromechanical Systems: Applications and Control, 2nd Edition, Elsevier Ltd., 2020.*

| **Course title** | **Digital and Statistical Signal Processing** | | | | **Course Code** | PDE636 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**
Introduction; Essential mathematics and statistics; Signal processing models; **Digital Signal Processing—** Discrete-time signals and systems, *z*-Transform, Structures of discrete-time Systems, Frequency domain analysis, Design and implementation of digital filters, Introduction to Kernel methods. **Statistical Signal Processing—**Statistical models, Parametric estimation, Linear estimation, Signal detection, Bayesian methods, Optimal and adaptive filtering, Spectral analysis, Array processing. Numerical analysis and simulation; Essential software and hardware; Applications; Recent topics.

**References:**
- *P.J. Schreier and L.L. Scharf, Statistical Signal Processing of Complex-Valued Data: The Theory of Improper and Noncircular Signals, Cambridge University Press, 2010.*
- *D. Kundu and S. Nandi, Statistical Signal Processing: Frequency Estimation, The Authors. Published by Springer New Delhi, 2012.*
- *G. Ruiz and J.A. Michell (eds.), Design and Architectures for Digital Signal Processing, InTech, 2013.*
- *S.M. Kay, Fundamentals of Statistical Signal Processing, Volume III: Practical Algorithm Development, Pearson Education, Inc., 2013.*
- *R. Chellappa and S. Theodoridis (eds.), Array and Statistical Signal Processing, Academic Press Library in Signal Processing, Elsevier Ltd., 2014.*
- *R. Woods et al., FPGA-Based Implementation of Signal Processing Systems, 2nd Edition, John Wiley & Sons, Ltd., 2017.*
- *W.E. Alexander and C.M. Williams, Digital Signal Processing: Principles, Algorithms and System Design, Academic Press, 2017 Elsevier Inc., 2017.*
- *J.L. Rojo-Álvarez et al., Digital Signal Processing with Kernel Methods, John Wiley & Sons Ltd., 2018.*
- *J. Benesty et al., Fundamentals of Signal Enhancement and Array Signal Processing, John Wiley & Sons Singapore Pte. Ltd., 2018.*
- *A. Veloni et al., Digital and Statistical Signal Processing, Taylor & Francis Group, LLC, 2019.*
- *L. Tan and J. Jiang, Digital Signal Processing: Fundamentals and Applications, 3rd Edition, Academic Press, Elsevier Inc., 2019.*
- *S.I. Abood, Digital Signal Processing: A Primer with MATLAB®, Taylor & Francis Group, LLC, 2020.*

| **Course title** | **Machine Learning Engineering** | | | | **Course Code** | PDE637 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**
Introduction; **Essentials for Machine Learning:** Mathematics and statistics, Decision support systems, Intelligent systems, Built learning machines. Data acquisition and processing; Planning for machine learning; **LEARNING STRATEGIES—Supervised Learning:** Classification, Regression analysis, Learner evaluation, Bias-Variance tradeoff in classification and regression; **Unsupervised Learning:** Clustering, Dimensionality reduction; Semi-Supervised Learning. **Deep Learning**; **Learning Techniques:** Ensemble learning, Reinforcement learning (reward-based algorithms), Active learning, Cross-validation

learning, Machine teaching, Automated machine learning. Optimization in machine learning; Linear and nonlinear machine learning; Feature engineering and selection; Feature learning; Essential software; Engineering applications; Recent topics.

**References:**


- *G. Hulten, Building Intelligent Systems: A Guide to Machine Learning Engineering, G. Hulten. Published by Apress, 2018.*
- *P. Larrañaga et al., Industrial Applications of Machine Learning, Taylor & Francis Group, LLC, 2019.*
- *J. Watt et al., Machine Learning Refined: Foundations, Algorithms, and Applications, Cambridge University Press, 2020.*
- *A. Subasi, Practical Machine Learning for Data Analysis Using Python, Academic Press, Elsevier Inc., 2020.*
- *A.F. Vermeulen, Industrial Machine Learning: Using Artificial Intelligence as a Transformational Disruptor, A.F. Vermeulen. Published by Apress, 2020.*
- *A.C. Faul, A Concise Introduction to Machine Learning, Taylor & Francis Group, LLC, 2020.*
- *B. Shi and S.S. Iyengar, Mathematical Theories of Machine Learning: Theory and Applications, Springer Nature Switzerland AG, 2020.*


| **Course title** | **Fundamentals of Fuzzy Control** | | | | **Course Code** | PDE638 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; An overview of intelligent control; Data acquisition, and knowledge formulation and processing, in intelligent control; **Foundations of Fuzzy Logic:** Fuzzy numbers, Fuzzy sets, Fuzzy logic operations, Fuzzy relations and graphs, Fuzzy inference and compositional rules, Membership function, Fuzzification and Defuzzification. Modeling of fuzzy systems; Design and implementation of fuzzy control systems; Fuzzy knowledge-based control; Adaptive fuzzy control; Non-linear fuzzy control; Stability of fuzzy control systems; Decision support fuzzy control; Existing fuzzy control system models; Essential software; Applications in industrial control; Recent topics.

**References:**


- *F. Matía et al. (eds.), Fuzzy Modeling and Control: Theory and Applications, Atlantis Press and the authors, 2014.*
- *D.S. Hooda And V. Raich, Fuzzy Logic Models and Fuzzy Control: An Introduction, Alpha Science International Ltd., 2017.*
- *W. Yu and R. Jafari, Modeling and Control of Uncertain Nonlinear Systems with Fuzzy Equations and Z-Number, The Institute of Electrical and Electronics Engineers, Inc., JohnWiley & Sons, Inc., 2019.*
- *S. Dong et al., Control and Filtering of Fuzzy Systems with Switched Parameters, Springer Nature Switzerland AG, 2020.*

| Course title | Finite Element Method | | | | Course Code | PDE639 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 1 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**
Introduction; Techniques of finite element methods; Types of finite elements; Modeling in finite element method; Finite element and corresponding functions; Representations for finite element method; Single and multidimensional finite element analysis; Nonlinear finite element method; Stochastic finite element method; Essential software; Applications to materials and manufacturing; Applications to biomedical engineering; Other applications; Recent topics.

**References:**

- *Farzad Ebrahimi (ed.), Finite Element Analysis: New Trends and Developments, 2nd Edition, ExLi4EvA, 2016.*
- *S.A. Ragab and H.E. Fayed, Introduction to Finite Element Analysis for Engineers, Taylor & Francis Group, LLC, 2018.*
- *V. Papadopoulos and D.G. Giovanis, Stochastic Finite Element Methods: An Introduction, Springer International Publishing AG, 2018.*
- *M. Moatamedi and H. Khawaja, Finite Element Analysis, Taylor & Francis Group, LLC, 2018.*
- *B. Zhu, The Finite Element Method: Fundamentals and Applications in Civil, Hydraulic, Mechanical and Aeronautical Engineering, Tsinghua University Press, John Wiley & Sons Singapore Pte. Ltd., 2018.*
- *I. Koutromanos et al., Fundamentals of Finite Element Analysis: Linear Finite Element Analysis, John Wiley & Sons Ltd., 2018.*
- *Z. Yang, Material Modeling in Finite Element Analysis, Taylor & Francis Group, LLC, 2020.*
- *T. Rabczuk et al., Extended Finite Element and Meshfree Methods, Academic Press, Elsevier Inc., 2020.*


| Course title | Engineering Materials (1) | | | | Course Code | PDE641 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 1 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**
Introduction; **Fundamentals:** Structures, Properties, Classification, Applications, and Economics. Evolution of engineering materials; Fabrication, forming, and joining of materials; Alloys; Phase diagrams; Mechanics and mechanisms of materials; Kinetics of engineering materials; Strength of materials; Failure, deformation, and fracture analysis of material systems; Diffusion; Oxidation and corrosion; Friction, abrasion, and wear; Engineering materials selection; Design with materials; Essential software; Applications; Recent topics.

**References:**

- *R.C. Hibbeler, Mechanics of Materials, 10th Edition in SI Units, R.C. Hibbeler. Published by Pearson Education, Inc., 2018.*
- *F. Cardarelli, Materials Handbook: A Concise Desktop Reference, 3rd Edition, Springer International Publishing AG, part of Springer Nature, 2018.*
- *H. Warlimont and W. Martienssen (eds.), Springer Handbook of Materials Data, 2nd Edition, Springer Nature Switzerland AG, 2018.*

- *D.R.H. Jones and M.F. Ashby, Engineering Materials 1: An Introduction to Properties, Applications and Design 5th, D.R.H. Jones and M.F. Ashby. Published by Elsevier Ltd., 2019.*
- *W.F. Smith, Foundations of Materials Science and Engineering, 6th Edition, McGraw-Hill Education, 2019*.

| **Course title** | **Engineering Materials (2)** | | | | **Course Code** | PDE642 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Metals; High performance alloys; Polymers; Ceramics; Composite materials; Nanomaterials; Metal-Polymer Nanocomposites; Piezoelectric materials; Smart/Intelligent materials; Glass; Wood; Design based on engineering materials; Protection of engineering materials; Reliability analysis of materials design; Essential software; Applications; Recent topics.

**References:**

- *M.F. Ashby and D.R.H. Jones, Engineering Materials 2: An Introduction to Microstructures and Processing, 4th Edition, M.F. Ashby and D.R.H. Jones. Published by Elsevier Ltd., 2013.*
- *F. Cardarelli, Materials Handbook: A Concise Desktop Reference, 3rd Edition, Springer International Publishing AG, part of Springer Nature, 2018.*
- *H. Warlimont and W. Martienssen (eds.), Springer Handbook of Materials Data, 2nd Edition, Springer Nature Switzerland AG, 2018.*
- *K. Kumar et al. (eds.), Micro and Nano Machining of Engineering Materials: Recent Developments, Springer Nature Switzerland AG, 2019.*
- *W.F. Smith, Foundations of materials science and engineering, 6th Edition, McGraw-Hill Education, 2019.*
- *M. Ashby et al., Materials: Engineering, Science, Processing and Design, 4th Edition, Butterworth-Heinemann, Elsevier Ltd., 2019.*

| **Course title** | **Composite Materials** | | | | **Course Code** | PDE643 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; **Composites Structure:** Matrices and Fillers. Classification of composites; Intelligent composites; Properties of composites; Degradation of composites; Design and analysis of composites; Composites fabrication processes and technology; Reinforcement materials; Joining, repair, and assembly of composites; Machining and cutting of composites; Nanocomposites; Sustainability and reliability of products and applications of composites; Applications of intelligent composites in biomedical engineering; Recycling of composites; Essential software; Recent topics.

**References**:

- *L.A. Carlsson et al., Experimental Characterization of Advanced Composite Materials, 4th Edition, Taylor & Francis Group, LLC, 2014.*
- *K.K. Chawla, Composite Materials: Science and Engineering, 4th Edition, Springer Nature Switzerland AG, 2019.*
- *T.W. Clyne and D. Hull, An Introduction to Composite Materials, 3rd Edition, T.W. Clyne and D. Hull. Published by Cambridge University Press, 2019.*

- *A.V. Vakhrushev and A. K. Haghi (eds.), Composite Materials Engineering: Modeling and Technology, Apple Academic Press, Inc., 2020.*
- *O.V. Mukbaniani et al. (eds.), Composite Materials for Industry, Electronics, and the Environment: Research and Applications, Apple Academic Press, Inc., 2020.*


| **Course title** | **Fundamentals of Polymer Science** | | | | **Course Code** | PDE644 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; **Basics:** Polymers classification (based on polymeric structure, polymerization techniques, and intermolecular forces), Nature and molecular structure of polymers, Properties of Polymers. **Polymeric Processes**—Polymerization (step-growth, chain-growth, solution, suspension, emulsion); Photopolymerization; Polymerization reaction engineering; Copolymerization and compositing; Modification of polymers; Polymer characterization; Polymer degradation and stability; Polymer processing and rheology; Reinforcement, protection, and coloring of polymers. **Special Polymers**—Functional polymers; Nanopolymers; Biopolymers, natural polymers and fibers; Smart polymers; Medical and biomedical polymers; Self-healing polymers. **Complementary Polymer Science**—Measurements and testing in polymers; kinetics and statistics of polymerization; Nano- and Micro- Mechanics of polymers; Thermodynamics of polymer mixtures; Hazards of polymers; Modeling and simulation of polymerization reaction engineering. Essential software; Applications; Recent topics.

**References:**


- *M. Akay, Introduction to Polymer Science and Technology, Mustafa Akay & Ventus Publishing ApS, 2012.*
- *A.M. Kochnev et al. (eds.), Compositional Analysis of Polymers: An Engineering Approach, Apple Academic Press, Inc., CRC Press, Taylor & Francis Group, 2016.*
- *A. Srinivasan and S. Bandyopadhyay (eds.), Advances in Polymer Materials and Technology, Taylor & Francis Group, LLC, 2017.*
- *S. Fakirov, Fundamentals of Polymer Science for Engineers, Wiley-VCH Verlag GmbH & Co. KGaA, 2017.*
- *U.W. Gedde and M.S. Hedenqvist, Fundamental Polymer Science, 2nd Edition, Springer Nature Switzerland AG, 2019.*
- *R. Narain (ed.), Polymer Science and Nanotechnology: Fundamentals and Applications, Elsevier Inc., 2020.*
- *S. Thomas and A. Surendran (eds.), Self-Healing Polymers-Based Systems, Elsevier Inc., 2020.*


| **Course title** | **Special Applications of Polymers** | | | | **Course Code** | PDE645 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Types and properties of polymers; **Application Fields**—Additive manufacturing; Vibration damping; Light-emitting devices, displays, and sensing devices; Electrics, electric energy, and electronics; Robotics and mechatronics; Optoelectronics; Gas and vapor separation membranes; Water purification; Space and aerospace; Lean construction; Implants; Tissue engineering; Nanotheranostics; Gene therapy; Agrifood. Case studies; Recent topics.

**References:**

- *M.M. Pradas, M.J. Vicent (eds.), Polymers in Regenerative Medicine: Biomedical Applications from Nano- to Macro-Structures, John Wiley & Sons, Inc., 2015.*
- *Ololade Olatunji (ed.), Natural Polymers: Industry Techniques and Applications, Springer International Publishing Switzerland, 2016.*
- *G. Perale and J. Hilborn (eds.), Bioresorbable Polymers for Biomedical Applications: From Fundamentals to Translational Medicine, Woodhead Publishing, Elsevier Ltd., 2017.*
- *T.G. Volova et al., Natural-Based Polymers for Biomedical Applications, Apple Academic Press, Inc., 2017.*
- *B. Liu (ed.), Conjugated Polymers for Biological and Biomedical Applications, Wiley-VCH Verlag GmbH & Co. KGaA, 2018.*
- *T.J. Gutiérrez (ed.), Polymers for Agri-Food Applications, Springer Nature Switzerland AG, 2019.*
- *M. Rosa Aguilar and J.S. Román (eds.), Smart Polymers and their Applications, 2nd Edition, Woodhead Publishing, Elsevier Ltd., 2019.*
- *B.C. Chakraborty and D. Ratna, Polymers for Vibration Damping Applications, Elsevier Inc., 2020.*
- *S. Thomas and A. Surendran (eds.), Self-Healing Polymers-Based Systems, Elsevier Inc., 2020.*
- *D.M. Devine (ed.), Polymer-Based Additive Manufacturing: Biomedical Applications, Springer Nature Switzerland AG, 2019.*

<table>
<tr><td>Course title</td><td colspan="4">Materials Selection for Manufacturing</td><td>Course Code</td><td>PDE646</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction; **Fundamentals**—Performance of engineering materials (corrosion, mechanical wear, degradation, radiation, and failure); Principles and criteria of engineering materials selection. Relationships between product design, engineering materials, and manufacturing processes; **Supportive Systems**—Materials design documentations; Information systems for materials; Decision support and intelligent systems. **Materials Selection Process**—Materials selection for engineering design; Materials selection for fatigue; Materials selection for manufacturing processes; Materials selection for composites; Fluids selection for machine tools; Materials selection for medical and biomedical purposes; Rules of materials treatment and protection selection; Materials substitution. Environmental, health, and safety considerations in materials selection; Lifecycle assessment of materials; Lifecycle cost assessment of materials; Essential software; Applications; Recent topics.

**References:**

- *M. Ashby and K. Johnson, Materials and Design: The Art and Science of Material Selection in Product Design, 2nd Edition, M. Ashby and K. Johnson, Butterworth-Heinemann. Published by Elsevier Ltd., 2010.*
- *M.F. Farag, Materials and Process Selection for Engineering Design, 3rd Edition, Taylor & Francis Group, LLC, 2014.*
- *M.F. Ashby, Materials Selection in Mechanical Design, 5th Edition, M.F. Ashby. Butterworth-Heinemann. Published by Elsevier Ltd., 2016.*
- *A. Jahan et al., Multi-Criteria Decision Analysis for Supporting the Selection of Engineering Materials in Product Design, 2nd Edition, Butterworth-Heinemann, Elsevier Ltd., 2016.*
- *T. Vert, Refractory Material Selection for Steelmaking, The American Ceramic Society and John Wiley & Sons, Inc., 2016.*
- *A. Öchsner and H. Altenbach (eds.), Properties and Characterization of Modern Materials, Springer Science + Business Media Singapore, 2017.*

- *J. Antonio et al., Structural Materials: Properties and Selection, Springer Nature Switzerland AG, 2019.*
- *M.A. White, Physical Properties of Materials, 3rd Edition, Taylor & Francis Group, LLC, 2019.*


| Course title | Composites Manufacturing | | | | Course Code | PDE651 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Engineering materials; Composite materials; Fabrication and conversion of composites; Product and process development for composites; Design for manufacturing of composites; Testing and selection of composites; Fabrication technologies of composites and their material systems; Process modeling for composites manufacturing; Planning of composites manufacturing; Joining and assembly of composites; Machining and cutting of composites; Composites forming; Machines, tools, and equipment in the industry of composites and their products; Cost accounting for composites manufacturing; Recycling of composites products; Protection of composites; Sustainability and reliability of composites; Simulation of composites; Essential software; Applications; Recent topics.

**References**:


- *A.B. Strong, Fundamentals of Composites Manufacturing: Materials, Methods, and Applications, 2nd Editions, Society of Manufacturing Engineers, 2008.*
- *P. Boisse, Advances in Composites Manufacturing and Process Design, Elsevier Ltd., 2015.*
- *M.K. Buragohain, Composite Structures: Design, Mechanics, Analysis, Manufacturing, and Testing, Taylor & Francis Group, LLC, 2017.*
- *K.K. Kar (ed.), Composite Materials Processing, Applications, Characterizations, Springer-Verlag Berlin Heidelberg, 2017.*
- *E.J. Barbero, Introduction to Composite Materials Design, 3rd Edition, Taylor & Francis Group, LLC, 2018.*
- *K.K. Chawla, Composite Materials: Science and Engineering, 4th Edition, Springer Nature Switzerland AG, 2019.*
- *T.W. Clyne and D. Hull, An Introduction to Composite Materials, 3rd Edition, T.W. Clyne and D. Hull. Published by Cambridge University Press, 2019.*
- *O.V. Mukbaniani et al. (eds.), Composite Materials for Industry, Electronics, and the Environment: Research and Applications, Apple Academic Press, Inc., 2020.*
- *A.V. Vakhrushev and A. K. Haghi (eds.), Composite Materials Engineering: Modeling and Technology, Apple Academic Press, Inc., 2020.*


| Course title | Sheet Metal Forming | | | | Course Code | PDE652 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 1 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Mechanics of sheet metal forming; Evolution of sheet metal forming technology; Sheet metal forming processes; Modeling and optimization of sheet metal forming processes; Sheet layout design; Design of sheet metal forming processes; Sheet metal laser forming; Forming dies, equipment, and machines; Materials of forming dies and equipment; Maintenance of forming systems; Failure analysis of products and processes; Health and safety considerations; Applications; Simulation of sheet metal forming processes; Essential software; Recent topics.

**References:**


- *D. Banabic, Sheet Metal Forming Processes: Constitutive Modelling and Numerical Simulation, Springer-Verlag Berlin Heidelberg, 2010.*
- *T. Altan and A.E. Tekkaya (eds.), Sheet Metal Forming: Fundamentals, ASM International, 2012.*
- *T. Altan and A.E. Tekkaya (eds.), Sheet Metal Forming: Processes and Applications, ASM International, 2012.*
- *V. Boljanovic, Sheet Metal Forming Processes and Die Design, 2nd Edition, Industrial Press Inc., 2014.*
- *D. Banabic (ed.), Multiscale Modelling in Sheet Metal Forming, Springer International Publishing Switzerland, 2016.*
- *P. Groche et al. (eds.), Manufacturing Integrated Design: Sheet Metal Product and Process Innovation, Springer International Publishing AG, 2017.*
- *G.M. Kakandikar and V.M. Nandedkar, Sheet Metal Forming Optimization: Bioinspired Approaches, Taylor & Francis Group, LLC, 2018.*
- *X.M. Lai et al., Sheet Metal Meso- and Microforming and their Industrial Applications, Taylor & Francis Group, LLC, 2019.*


| Course title | Mechanics of Sheet Metal Forming | | | | Course Code | PDE653 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 1 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Sheet metal deformation processes; Deformation of sheet metals in plane stress; Simplified stamping analysis; Load instability and tearing during sheet metal forming; Bending of sheet metals during forming processing; Stretching and simplified analysis of circular shells; Cylindrical deep drawing; Combined bending and tension of sheet metals; Mechanics of Hydroforming; Computational methods and software; Applications; Recent topics.

**References:**


- *S.C. Tang and J. Pan, Mechanics Modeling of Sheet Metal Forming, 2007 SAE International, 2007.*
- *V. Boljanovic, Sheet Metal Forming Processes and Die Design, 2nd Edition, Industrial Press Inc., 2014.*
- *D. Banabic (ed.), Multiscale Modelling in Sheet Metal Forming, Springer International Publishing Switzerland, 2016.*
- *Z.R. Wang et al., Engineering Plasticity: Theory and Applications in Metal Forming, Higher Education Press, 2018.*


| Course title | Die Design for Sheet Metal Forming | | | | Course Code | PDE654 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 1 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Metal sheet forming processes and their design; Fundamentals and developments of dies; Metal sheet forming machinery; Construction and assembly of metal sheet forming systems; Theory of sheet metal behavior and die-workpiece tribology; Design of dies and their auxiliary components; Die design for maintenance, and process quality and automation; Tribo-design of dies for reliability; Materials, surface finish, and costing of dies; Simulation for die design; Essential software; Applications; Recent topics.

**References:**


- *I. Suchy, Handbook of Die Design, 2nd Edition, I. Suchy. Published by McGraw-Hill, 2006.*
- *V. Boljanovic and J.R. Paquin, Die Design Fundamentals, 3rd Edition, Industrial Press Inc., 2006.*
- *J.G. Nee (ed.), Fundamentals of Tool Design, 6th Edition, Society of Manufacturing Engineers, 2010.*
- *V. Boljanovic, Sheet Metal Forming Processes and Die Design, 2nd Edition, Industrial Press Inc., 2014.*


| Course title | Manufacturing Engineering | | | | Course Code | PDE655 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Manufacturing processes; Evolution of manufacturing technology, systems, and paradigms; Best practices in manufacturing; Engineering design; Product design and rapid prototyping; Engineering materials; Manufacturing of engineering materials; Work holding, assembly, and material handling; Manufacturing automation and control; Manufacturing supportive systems; Manufacturing processes quality; Measurement techniques in manufacturing; Maintenance of manufacturing facilities; Micro- and Nano-Manufacturing technologies; Essential software; Applications; Case studies for manufacturing systems design; Recent topics.

**References:**


- *M.P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 5th Edition, John Wiley & Sons, Inc., 2013.*
- *P.D. Rufe (ed.), Fundamentals of Manufacturing, 3rd Edition, Society of Manufacturing Engineers, 2013.*
- *J.P. Davim (ed.), Modern Manufacturing Engineering, Springer International Publishing, 2015.*
- *A.Y.C. Nee (ed.), Handbook of Manufacturing Engineering and Technology, Springer-Verlag London, 2015.*
- *A. Posteucă, Manufacturing Cost Policy Deployment (MCPD) Transformation: Uncovering Hidden Reserves of Profitability, Taylor & Francis Group, LLC, 2018.*
- *M. Ram and J.P. Davim (eds.), Advanced Applications in Manufacturing Engineering, Elsevier Ltd., 2019.*
- *K. Kumar et al., Materials and Manufacturing Processes, Springer Nature Switzerland AG, 2019.*
- *Y. Bar-Cohen (ed.), Advances in Manufacturing and Processing of Materials and Structures, Taylor & Francis Group, LLC, 2019.*
- *A.B. Badiru et al., Manufacturing and Enterprise: An Integrated Systems Approach, Taylor & Francis Group, LLC, 2019.*
- *K. Gupta and M.K. Gupta (eds.), Optimization of Manufacturing Processes, Springer Nature Switzerland AG, 2020.*
- *H. Youssef and H. El-Hofy, Non-Traditional and Advanced Machining Technologies, 2nd Edition, Taylor & Francis Group, LLC, 2021.*

| Course title | Metal Cutting | | | | Course Code | PDE656 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 1 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Evolution of metal cutting technology; Metal cutting processes; Forces and stresses in metal cutting processes; Heat transfer in metal cutting processes; Cutting tool materials; Tool wear; Machinability; Coolants, lubricants, and other field media; High speed machining; Modeling of metal cutting processes; Simulation of metal cutting processes; Essential software; Management of metal cutting systems. Applications; Recent topics.

**References:**


- *E.M. Trent and P.K. Wright, Metal Cutting, 4th Edition, Butterworth–Heinemann, A Member of Reed Elsevier Group, 2000.*
- *M.C. Shaw, Metal Cutting Principles, 2nd Edition, Oxford University Press, Inc., 2005.*
- *T. Atkins, The Science and Engineering of Cutting: The Mechanics and Processes of Separating, Scratching and Puncturing Biomaterials, Metals and Non-metals, Elsevier Ltd., 2009.*
- *M.J. Jackson, Micromachining with Nanostructured Cutting Tools, The Author, 2013.*
- *D.A. Stephenson and J.S. Agapiou, Metal Cutting Theory and Practice, 3rd Edition, Taylor & Francis Group, LLC, 2016.*


| Course title | Plastics Engineering | | | | Course Code | PDE657 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; **Fundamentals**—Polymers and polymerization process; Engineering plastics; Common plastic products; Converting processes of plastics; Properties of plastics; Additives, colorants, and fillers for plastics; Evolution of plastics. **Plastics Processing**—Processing stages (heating, forming, and cooling); Molding, Extrusion, and Thermoforming; Calendering, Spinning of fibers, Electrospinning of nanofibers, and Casting; Reinforcement; Finishing, Fixation, and Assembly; Treatment, Protection, and Decoration; Tooling; Additive manufacturing for plastics. **Mechanics of Plastics and Plastics Processing**; **Analysis of Polymer Melt Flow**; **Manufacturing of Plastics Processing Machinery**; **Plastics Industrial Systems Management**—Plastics product design; Plastic products testing; Quality engineering of plastic products and machinery; Plastics sustainability and reliability; Recycling and disposal of waste plastics; Life cycle assessment of plastics. Essential software; Engineering applications; Recent topics.

**References:**


- *D.O. Kazmer, Plastics Manufacturing Systems Engineering, Carl Hanser Verlag, Munich, 2009.*
- *C.F. Jasso-Gastinel and J.M. Kenny (eds.), Modification of Polymer Properties, Elsevier Inc., 2017.*
- *S. Kainth, Die Design for Extrusion of Plastic Tubes and Pipes: A Practical Guide, Carl Hanser Verlag, Munich, 2018.*
- *M. Chanda, Plastics Technology Handbook, 5th Edition, Taylor & Francis Group, LLC, 2018.*
- *J.K. Fink, Reactive Polymers: Fundamentals and Applications—A Concise Guide to Industrial Polymers, 3rd Edition, Elsevier Inc., 2018*
- *A. Frick et al., Practical Testing and Evaluation of Plastics, 2019 Wiley-VCH Verlag GmbH & Co. KGaA, 2019.*

- *R.J. Crawford and P.J. Martin, Plastics Engineering, 4th Edition, Butterworth-Heinemann, Elsevier Ltd., 2020.*
- *V.K. Stokes, Introduction to Plastics Engineering, John Wiley & Sons Ltd., 2020.*


| **Course title** | **Metal Welding** | | | | **Course Code** | PDE658 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Evolution of metal welding technology; Gases and materials used for welding; **Welding Processes:** Fusion welding, Pressure welding, Hybrid welding, and Other welding processes. Setting of welding variables; Types and design of welding joints; Mechanics of welding processes; Thermal and metallurgical analysis of welding processes; Modeling of welding processes; Welding machines; Welding automation and robotics; Welding inspection and testing; Planning, monitoring, and control of welding processes; Health and safety in welding workplaces; Welding process selection; Life cycle assessment for welding processes; Essential software; Applications; Recent topics.

**References:**


- *E.R. Bohnart, Welding: Principles and Practices, 5th Edition, McGraw-Hill Education, 2018.*
- *V.A. Karkhin, Thermal Processes in Welding, Springer Nature Singapore Pte Ltd., 2019.*
- *J.J. Vora and V.J. Badheka (eds.), Advances in Welding Technologies for Process Development, Taylor & Francis Group, LLC, 2019.*
- *Ramesh Singh, Applied Welding Engineering: Processes, Codes, and Standards, 3rd Edition, Butterworth-Heinemann, Elsevier Inc., 2020.*


| **Course title** | **Die Casting Engineering** | | | | **Course Code** | PDE659 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Evolution of die casting technology; Materials, design, and setup of dies; Die casting machines; Thermal process and casting metallurgy; Concepts of cavity fill; Lubrication in die casting; Metal feed and handling systems; Die casting of nonmetallic materials; Microinjection and micro die design; Process control and value stream for die casting; Design for manufacturability of dies and castings; Safety and maintenance of die casting systems; Measurements and quality characteristics of dies and castings; Numerical methods and simulation; Essential software; Applications; Recent topics.

**References:**


- *B. Andresen, Die Casting Engineering: A Hydraulic, Thermal, and Mechanical Process, Marcel Dekker, 2005.*
- *M.E. Glicksman, Principles of Solidification: An Introduction to Modern Casting and Crystal Growth Concepts, Springer Science + Business Media, LLC, 2011.*
- *D. M. Stefanescu, Science and Engineering of Casting Solidification, 3rd Edition, Springer International Publishing Switzerland, 2015.*
- *J. Campbell, Complete Casting Handbook: Metal Casting Processes, Metallurgy, Techniques and Design, 2nd Edition, John Campbell. Published by Elsevier Ltd., 2015.*
- *J.A.P.-S. Elorz et al., Solidification and Solid-State Transformations of Metals and Alloys, Elsevier Inc., 2017.*

- *Z. Lipnicki, Dynamics of Liquid Solidification: Thermal Resistance of Contact Layer, Springer International Publishing AG, 2017.*
- *D.G. Eskin and J. Mi (eds.), Solidification Processing of Metallic Alloys under External Fields, Springer Nature Switzerland AG, 2018.*

| Course title | Optical Metrology | | | | Course Code | PDE661 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Light sources, lenses, prisms, and mirrors; Optoelectronic sensors; Optical devices and optomechanical elements; Optic principles and techniques for metrology; Measurement of displacement, straightness, and alignment; Measurement of surface roughness and flatness; Surface profilometry and three-dimensional shape measurement; Fringe analysis and photogrammetry; On-machine measurements; Essential hardware and software; Applications; Recent topics.

**References:**

- *W. Osten and N. Reingand (eds.), Optical Imaging and Metrology: Advanced Technologies, 2012 Wiley-VCH Verlag & Co. KGaA, 2012.*
- *K. Harding (ed.), Handbook of Optical Dimensional Metrology, Taylor & Francis Group, LLC, 2013.*
- *R.S. Sirohi, Introduction to Optical Metrology, Taylor & Francis Group, LLC, 2016.*
- *T. Yoshizawa (ed.), Handbook of Optical Metrology: Principles and Applications, 2nd Edition, Taylor & Francis Group, LLC, 2015.*
- *R.A. Chipman et al., Polarized Light and Optical Systems, Taylor & Francis Group, LLC, 2019.*

| Course title | Quality of Measurements | | | | Course Code | PDE662 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Fundamentals of metrology; Measurement systems and methods; Calibration systems and methods; International system of units; Modeling of measurements; **Quality Assurance of Measuring—** ISO 5725 and other standards; Measuring errors and their estimation; Setup of measuring systems; Traceability, verification, and calibration of measuring systems; Nanoscale calibration; Monitoring of measuring systems and processes. Essential statistical and quality methods; Evaluation of measured data; **Uncertainty of Measuring—**Sources of uncertainty; Uncertainty propagation; Uncertainty calculation; Reliability, capability, and stability of measuring systems, Uncertainty in calibration of measuring systems; Monte Carlo modeling of uncertainty. Essential statistical, quality, and simulation software; Applications; Recent topic.

**References:**

- *A.E. Fridman, The Quality of Measurements: A Metrological Reference, Springer Science + Business Media, LLC, 2012.*
- *S.V. Gupta, Measurement Uncertainties: Physical Parameters and Calibration of Instruments, Springer-Verlag Berlin Heidelberg, 2012.*
- *R. Willink, Measurement uncertainty and probability, R. Willink. Published by Cambridge University Press, 2013.*

- *J.A. Sładek, Coordinate Metrology: Accuracy of Systems and Measurements, Springer-Verlag Berlin Heidelberg, 2016.*

| Course title | Operations Research | | | | Course Code | PDE671 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Mathematical and statistical techniques of operations research; Linear programming; Network models; Integer programming; Goal programming; Nonlinear programming; Dynamic programming; Stochastic programming; Multi-objective programming; Branch & Bound technique; Project networks; Decision theory; Markov chains; Queueing theory; Inventory theory; Forecasting; Simulation; Reliability; Using heuristics and metaheuristics in operations research; Popular problems in operations research; Essential software; Engineering and industrial applications.

**References:**

- *P. Mariappan, Operations Research: An Introduction, Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2013.*
- *F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 10the Edition, McGraw-Hill Education, 2015.*
- *H.A. Taha, Operations Research: An Introduction, 10th Edition, Pearson Education Ltd., 2017.*
- *M.W. Carter et al., Operations Research: A Practical Approach, 2nd Edition, Taylor & Francis Group, LLC, 2019.*

| Course title | Decision Support Frameworks | | | | Course Code | PDE672 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Essential statistics and operations research; Theory of multiple criteria decision-making; Uncertainty in decision-making; Group decision-making; Construction of databases and knowledge-bases; **DECISION SYSTEMS—(1) Full Aggregation Approach:** AHP, ANP, MAUT, MACBETH; **(2) Outranking Approach:** PROMETHEE, ELECTRE; **(3) Reference-Level Approach:** TOPSIS, VIKOR, DEA. **REINFORCEMENT TECHNIQUES—(1) Fuzzy Techniques:** Fuzzy measure, Fuzzy integral, Hierarchical fuzzy integral, Fuzzy credibility constrained programming (FCCP); **(2) p-Robust Technique**; **(3) Process Information Maps (PRIMAs)**; **(4) Structural Model Techniques:** Interpretive Structural Modeling (ISM), DEMATEL, Fuzzy cognition maps (FCM). **Intelligent Systems**; **Integrated Systems**; Construction of decision support frameworks; Essential software; Applications to manufacturing process selection, tool selection, and material selection; Other applications; Recent topics.

**References:**

- *P.M. Pardalos and D.W. Hearn (eds.), Handbook of Multicriteria Optimization, Springer-Verlag Berlin Heidelberg, 2010.*
- *W. Pedrycz et al., Fuzzy Multicriteria Decision-Making: Models, Methods and Applications, John Wiley & Sons, Ltd., 2011.*
- *A. Ishizaka, Multi-Criteria Decision Analysis: Methods and Software, John Wiley & Sons, Ltd., 2013.*
- *J. Papathanasiou et al. (eds.), Real-World Decision Support Systems: Case Studies, Springer International Publishing Switzerland, 2016.*

- *P. Ekel et al., Multicriteria Decision-Making under Conditions of Uncertainty: A Fuzzy Set Perspective, John Wiley & Sons, Inc., 2020.*
- *R. Sharda et al., Analytics, Data Science, & Artificial Intelligence: Systems for Decision Support, 11th Edition, Pearson Education, Inc., 2020.*


| **Course title** | **Fundamentals of Monte Carlo Methods** | | | | **Course Code** | PDE673 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; **Basics:** Probability distributions, Markov chains, Stochastic systems. Uniform random number generation; Quasi-random number generation; Random variable generation; Random process generation; Markov chain Monte Carlo; Discrete event simulation; Statistical analysis of simulation data; Variance reduction techniques; Rare-event simulation; Estimation of derivatives; Randomized optimization; Statistical cross-entropy method; Particle methods; Inverse Monte Carlo; Essential software; Engineering applications; Recent topics.

**References:**


- *B.K. Choi and D. Kang, Modeling and Simulation of Discrete-Event Systems, John Wiley & Sons, Inc., 2013.*
- *G. Leobacher and F. Pillichshammer, Introduction to Quasi-Monte Carlo Integration and Applications, Birkhäuser, Springer International Publishing Switzerland, 2014.*
- *F.J. Mitchell (ed.), Monte Carlo Simulation: Methods, Assessment and Applications, Nova Science Publishers, Inc., 2017.*
- *R.Y. Rubinstein and D.P. Kroese, Simulation and the Monte Carlo Method, 3rd Edition, John Wiley & Sons, Inc., 2017.*
- *D.-G. Chen and J.D. Chen (eds.), Monte-Carlo Simulation-Based Statistical Modeling, Springer Nature Singapore Pte Ltd., 2017.*
- *A. Barbu and S.-C. Zhu, Monte Carlo Methods, Springer Nature Singapore Pte Ltd., 2020.*


| **Course title** | **Reliability Engineering** | | | | **Course Code** | PDE674 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 3 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Essential statistics for reliability; Reliability sampling; Qualitative and quantitative methods for failure analysis; Common mode and common cause failures, and multiple mode failure; Failure data collection and failure rate modeling; Stress-strength analysis; **Systems Classification:** Based on repair type, Connection of components, and State multiplicity. **Systems Reliability:** ‘Series, Parallel, *K-out-of-n*, Combined, Networked, Voting, Standby, Hybrid, Multistate. Models of reliability estimation; Stochastic aging; Life testing; Assessment of availability, maintainability, and risk; Reliability simulation models; Control charts for reliability; Design for reliability; Essential software; Engineering and industrial applications; Recent topics.

**References:**


- *K.S. Trivedi and A. Bobbio, Reliability and Availability Engineering: Modeling, Analysis, and Applications, Cambridge University Press, 2017.*

- *M. Ram (ed.), Modeling and Simulation Based Analysis in Reliability Engineering, Taylor & Francis Group, LLC, 2019.*
- *I. Vonta and M. Ram (eds.), Reliability Engineering: Theory and Applications, Taylor & Francis Group, LLC, 2019.*
- *M. Ram and J.P. Davim (eds.), Advances in System Reliability Engineering, Elsevier Inc., 2019.*
- *M. Ram (ed.), Reliability Engineering: Methods and Applications, Taylor & Francis Group, LLC, 2020.*
- *A. Blokus, Multistate System Reliability with Dependencies, Academic Press, Elsevier Ltd., 2020.*
- *Lirong Cui et al. (eds.), Stochastic Models in Reliability Engineering, Taylor & Francis Group, LLC, 2021.*


| **Course title** | **Design of Experiments** | | | | **Course Code** | PDE675 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; **Statistical Basics:** Basic statistical tests, Analysis of variance, and Analysis of covariance. **Fundamentals:** Measurements, Quality characteristics, Randomization, Replication, and Blocking. **Interactions in Processes**; **Phases of Experimental Design:** Planning phase, Design phase, Conducting phase, and Analyzing phase. Analytical tools for experimental design; Screening designs; Completely randomized designs; **Block Designs:** Randomized block design, Incomplete block designs, Latin's square designs, Graeco-Latin's square designs, and Youden's square designs. Full factorial designs; Fractional factorial designs; Nested designs; Robust designs; Split-unit designs; Split-lot designs; Response surface designs; Repeated measures designs; Multiple responses; Essential software; Engineering and Industrial applications; Recent topics.

**References:**


- *M.I. Rodrigues and A.F. Iemma, Experimental Design and Process Optimization, Taylor & Francis Group, LLC, 2015.*
- *T.B. Barker and A. Milivojevich, Quality by Experimental Design, 4th Edition, Taylor & Francis Group, LLC, 2016.*
- *D.C. Montgomery, Design and Analysis of Experiments, 9th Edition, John Wiley & Sons, Inc., 2017.*
- *A. Dean et al, Design and Analysis of Experiments, 2nd Edition, Springer International Publishing AG, 2017.*
- *K.G. Russell, Design of Experiments for Generalized Linear Models, Taylor & Francis Group, LLC, 2019.*


| **Course title** | **Total Quality Management** | | | | **Course Code** | PDE676 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Quality definitions; Quality measures; Philosophy of total quality management; **Structure of Total Quality Management—Basic Concepts:** Customer focus (external and internal), Process focus (continuous improvement), Business process control, 'Upstream' preventive decisions, Ongoing preventive decisions, and Leadership and teamwork; **Basic Elements:** Communicating mission, Aims, and Objectives, Collecting external experience, Measuring internal performance, Analyzing value, Benchmarking, Formulating potential improvement opportunities, Implementing changes, Steering and coordinating total quality program; **Basic Stages:** Statement and announcement of intents, Awareness, Diagnosis, Initial strategy, Management consensus, Launch. Approaches (Gurus), processes, tools, and techniques of total quality management; Quality management systems; Economics of quality; Information and decision support systems for total quality management; Essential software; Applications; Industrial cases; Upgrading to Six Sigma methodology; Recent topics.

**References**:


- *J.J. Dahlgaard et al., Fundamentals of Total Quality Management: Process Analysis and Improvement, Taylor & Francis, 2007.*
- *D.L. Goetsch and S.B. Davis, Quality Management for Organizational Excellence: Introduction to Total Quality, 7th Edition, Pearson Education, Inc., 2013.*
- *J.S. Oakland, Total Quality Management and Operational Excellence: Text with Cases, 4th Edition, J.S. Oakland. Published by Routledge, Taylor & Francis Group, 2014.*
- *E.C. Jones, Quality Management for Organizations Using Lean Six Sigma Techniques, Taylor & Francis Group, LLC, 2014.*
- *P.M. Charantimath, Total Quality Management, 3rd Edition, Pearson India Education Services Pvt. Ltd., 2017.*
- *J. Antony et al., Lean Six Sigma for Small and Medium Sized Enterprises: A Practical Guide, Taylor & Francis Group, LLC, 2016.*
- *T.T. Allen, Introduction to Engineering Statistics and Lean Six Sigma: Statistical Quality Control and Design of Experiments and Systems, 3rd Edition, Springer-Verlag London Ltd., Springer Nature, 2019.*
- *R. Jugulum, Robust Quality: Powerful Integration of Data Science and Process Engineering, Taylor & Francis Group, LLC, 2019.*


| Course title | Lean Six Sigma Methodology | | | | Course Code | PDE677 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 2 |
| | 1 | 2 | | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Statistical quality control and other Six Sigma statistics; Total quality framework and basic lean toolset; **Phases of Lean Six Sigma:** Define phase, Measure phase, Analyze phase, Improve phase, and Control phase. Configuration management of lean Six Sigma projects; Implementation frameworks for lean Six Sigma; Lessons learned; Essential software; Applications; Recent topics.

**References**:


- *E.A. Cudney and S.L. Furterer (eds.), Design for Six Sigma in Product and Service Development: Applications and Case Studies, Taylor & Francis Group, LLC, 2012.*
- *E.C. Jones, Quality Management for Organizations Using Lean Six Sigma Techniques, Taylor & Francis Group, LLC, 2014.*
- *E.G. Tetteh and B.M. Uzochukwu (eds.), Lean Six Sigma Approaches in Manufacturing, Services, and Production, IGI Global, 2015.*
- *M.J. Franchetti, Lean Six Sigma for Engineers and Managers: With Applied Case Studies, Taylor & Francis Group, LLC, 2015.*
- *W. Zhan and X. Ding, Lean Six Sigma and Statistical Tools for Engineers and Engineering Managers, Momentum Press, LLC, 2016.*
- *T.V. Stern, Leaner Six Sigma: Making Lean Six Sigma Easier and Adaptable to Current Workplaces, T.V. Stern. Published by Routledge/Productivity Press, Taylor & Francis Group, 2019.*

<table>
<tr><td>Course title</td><td colspan="4">Work Design</td><td>Course Code</td><td>PDE681</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Lectures</td><td>Tutorial</td><td colspan="2">Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>2</td><td>2</td><td colspan="2">-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction; Work measurement statistics; An overview of product design; Basics of ergonomics, occupational health, and safety; Law, ethics, and standards of work; Plant layout and workplace design; **Work Methods Design:** Process design and Motion design. **Work Measurement:** Work time measurement (direct and indirect), Work quality measurement, and Wage payment plans. Value stream mapping; Work design and implementation for Six Sigma; Job design; Evolution in work design technology; Information, decision support, and intelligent systems for work design and control; Using TRIZ method for work design; Axiomatic design for work; Essential software; Applications; Recent topics.

**References:**


- *S. Konz and S. Johnson, Work Design: Occupational Ergonomics, 7th Edition, Taylor & Francis, 2008.*
- *M.M. Soares and F. Rebelo (eds.), Ergonomics in Design: Methods & Techniques, Taylor & Francis Group, LLC, 2017.*
- *A.B. Badiru and S.C. Bommer, Work Design: A Systematic Approach, Taylor & Francis Group, LLC, 2017.*
- *R.S. Bridger, Introduction to Human Factors and Ergonomics, 4th Edition, Taylor & Francis Group, LLC, 2018.*
- *F. Tosi, Design for Ergonomics, Springer Nature Switzerland AG, 2020.*
- *K. Yang and B.S. El-Haik, Design for Six Sigma: A Roadmap for Product Development, McGraw-Hill Companies, Inc., 2009.*
- *W.D. Seider et al., Product and Process Design Principles: Synthesis, Analysis, and Evaluation, 4th Edition, John Wiley & Sons, Inc., 2017.*
- *A. Jamnia, Introduction to Product Design and Development for Engineers, Taylor & Francis Group, LLC, 2018.*


<table>
<tr><td>Course title</td><td colspan="4">Logistics and Supply Chain Management</td><td>Course Code</td><td>PDE682</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Lectures</td><td>Tutorial</td><td colspan="2">Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">2</td></tr>
<tr><td>1</td><td>2</td><td colspan="2">-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction; Strategic planning for logistics and supply chain; Logistics and customer value; Measuring logistics costs and performance; Strategic lead-time management; Inventory systems and outsourcing; Global enterprise supply chain; Synergistic supply chain; Modeling of logistics and supply chain; Supply chain risk management; Essential software; Applications; Case studies; Recent topics.

**References:**


- S. *Chopra and P. Meindl, Supply Chain Management: Strategy, Planning, and Operation, 6th Edition, Pearson Education, Inc., 2016*
- *M. Christopher, Logistics and Supply Chain Management, 5th Edition, M. Christopher. Published by Pearson Education Ltd., 2016.*
- *P.R. Murphy, Jr. and A.M. Knemeyer, Contemporary Logistics, 12th Edition, Pearson Education Limited, 2018.*
- *H. Zijm et al. (eds.), Operations, Logistics and Supply Chain Management, Springer International Publishing AG, 2019.*

- *M. Nakano, Supply Chain Management: Strategy and Organization, Springer Nature Singapore Pte Ltd., 2020.*
- *A.M. Pagano and M. Liotine, Technology in Supply Chain Management and Logistics: Current Practice and Future Applications, Elsevier Inc., 2020.*

| **Course title** | **Design of Material Handling Systems** | | | | **Course Code** | PDE683 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 1 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Principles of material handling; Unit load concept and classification of material handling systems; Industrial vehicles/trucks; Conveyors; Hoisting systems; Bulk handling systems; Shipping systems; Handling automation and robotic handling; Auxiliary equipment; Organization, maintenance, and safety; Essential software; Applications; Case studies; Recent topics.

**References:**

- *D. Schütz and F.M. Wahl (Eds.), Robotic Systems for Handling and Assembly, Springer-Verlag Berlin Heidelberg, 2010.*
- *M.P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, 4th Edition, Pearson Higher Education, Inc., 2015.*
- *M. Wilson, Implementation of Robot Systems: An Introduction to Robotics, Automation, and Successful Systems Integration in Manufacturing, Elsevier Inc., 2015.*
- *M.P. Stephens and F.E. Meyers, Manufacturing Facilities Design and Material Handling, 5th Edition, M.P. Stephens, 2013.*

| **Course title** | **Design of Manufacturing Processes** | | | | **Course Code** | PDE684 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; An overview for manufacturing processes; **Product Design:** Product planning, Part planning, and Assembly planning. **Manufacturing System Design:** Manufacturing stages, System layout, and Manufacturing paradigm. Work design; **Schema Design:** Data, Information, and Knowledge. Process planning, scheduling, and control; Integrated process planning and scheduling systems; Manufacturing resource capability analysis; Setup planning; Tolerance design; Manufacturing processes selection; Selection of machines, tools, equipment, and other requirements; **People Factors:** Perspectives, Power, and Values. Implementation of excellent manufacturing practices; Manufacturing process design for lean Six Sigma; Axiomatic design of manufacturing processes; Economics of manufacturing processes; Modeling and optimization of manufacturing processes; Coordinated knowledge-based systems for manufacturing planning and control; Essential software; Applications; Case studies; Recent topics.

**References**:

- *S. Grewal, Manufacturing Process Design and Costing: An Integrated Approach, Springer-Verlag London Ltd., 2011.*
- *M.P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 5th Edition, John Wiley & Sons, Inc., 2013.*
- *M.P. Stephens and F.E. Meyers, Manufacturing Facilities Design and Material Handling, 5th Edition, M.P. Stephens, 2013.*
- *D.M. Anderson, Design for Manufacturability: How To Use Concurrent Engineering to Rapidly Develop Low-Cost, High-Quality Products for Lean Production, D.M. Anderson. Published by CRC, Taylor & Francis Group, 2014.*

- *M.P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, 4th Edition, Pearson Higher Education, Inc., 2015.*
- *K. Kumar and J.P. Davim (eds.), Modern Manufacturing Processes, Woodhead Publishing, Elsevier Ltd., 2020.*

| **Course title** | **Fundamentals of Biomaterials** | | | | **Course Code** | PDE691 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Classification of biomaterials based on their types, structures, and applications; Evolution of biomaterials and their applications; Metallic biomaterials; Ceramics biomaterials; Polymeric biomaterials; Composite biomaterials; Biodegradable hydrogels; Biodegradable polymeric biomaterials; Biologic biomaterials; Smart functional biomaterials; Biomimetic materials; Micro- and Nano-Technology in biomaterials; Biomaterials for artificial organs; Biomaterials for tissue and cell engineering; Micro- and Nano-Bioengineering of tissues and cells; Biomaterials selection; Essential software; Recent topics.

**References:**

- *M.C. Tanzi et al., Foundations of Biomaterials Engineering, Academic Press, 2019 Elsevier Ltd., 2019.*
- *R.K. Tekade (ed.), Biomaterials and Bionanotechnology, Academic Press, Elsevier Inc., 2019.*
- *Y. Dahman, Biomaterials Science and Technology: Fundamentals and Developments, Taylor & Francis Group, LLC, 2019.*
- *W.R. Wagner et al. (eds.), Biomaterials Science: An Introduction to Materials in Medicine, 4th Edition, Academic Press, Elsevier Ltd., 2020.*
- *M. Mozafari (ed.), Handbook of Biomaterials Biocompatibility, Woodhead Publishing, Elsevier Ltd., 2020.*

| **Course title** | **Biomedical Engineering (1)** | | | | **Course Code** | PDE692 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; An overview of biotechnology; Fundamentals of biomedical engineering; Summary of biomaterials; Biofluids; Biomechanics; **Biomedical Manufacturing—**Medical instruments, Devices, and Systems; Artificial tissues, Organs, and Systems; Implants; Fixtures, plates, supports, and similar accessories. Clinical engineering and management; **Biomedical engineering Processes:** Imaging, Signal analysis, Implantation, Fixation, and Joining. Failures and failure analysis of biomedical supports and compensation systems and their components in vitro and in vivo; Optimum design of artificial organs; Ethical, legal, and societal aspects; Essential software; Industrial applications; Recent topics.

**References:**

- *M. Kutz (ed.), Biomedical Engineering and Design Handbook—Volume 1: Fundamentals, 2nd Edition, The McGraw-Hill Companies, Inc., 2009.*
- *M.C. Tanzi et al., Foundations of Biomaterials Engineering, Academic Press, 2019 Elsevier Ltd., 2019.*
- *Y. Dahman, Biomaterials Science and Technology: Fundamentals and Developments, Taylor & Francis Group, LLC, 2019.*

- *V. Grumezescu and A. M. Grumezescu (eds.), Materials for Biomedical Engineering: Inorganic Micro- and Nanostructures, Elsevier Inc., 2019.*
- *Sundararajan V. Madihally, Principles of Biomedical Engineering, 2nd Edition, Artech House, 2020.*

<table>
<tr><td>Course title</td><td colspan="4">Biomedical Engineering (2)</td><td>Course Code</td><td>PDE693</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction; Physiologic systems; Transplantation processes engineering; Tissue and cell engineering; Biocompatibility analysis for biomaterials; Bioprocess design; Automatic control of bioprocesses; Autonomous bioprocesses; Medical and biomimetic robotics; Biomedical measurements and biometrics; Biotribology; Nanobiomaterials; Nanobioengineering; Therapeutic materials engineering; Nuclear medicine engineering; Computational and simulation methods in bioengineering; Essential software; Industrial applications; Standards and regulations of biomedical engineering; Recent topics.

**References:**

- *Y. Dahman, Biomaterials Science and Technology: Fundamentals and Developments, Taylor & Francis Group, LLC, 2019.*
- *R.K. Tekade (ed.), Biomaterials and Bionanotechnology, Academic Press, Elsevier Inc., 2019.*
- *M.C. Tanzi et al., Foundations of Biomaterials Engineering, Academic Press, 2019 Elsevier Ltd., 2019.*
- *R.H.W. Lam and W. Chen, Biomedical Devices: Materials, Design, and Manufacturing, Springer Nature Switzerland AG, 2019.*
- *Sundararajan V. Madihally, Principles of Biomedical Engineering, 2nd Edition, Artech House, 2020.*
- *Z. Yang, Multiphysics Modeling with Application to Biomedical Engineering, Taylor & Francis Group, LLC, 2021.*

<table>
<tr><td>Course title</td><td colspan="4">Occupational Safety and Health</td><td>Course Code</td><td>PDE694</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction; Hazardous materials and processes; Analysis of hazards and risks; Safety and health foundations; **Safety and Health Management Systems:** Policy, Organizing, Planning, Measuring, Audit and review. **Hazards and Risks Control:** Materials, Processes, Workplace, Transport, Work equipment, Electrical, Fire, Chemical and biological, Musculoskeletal effort, Physical, Psychological. **Safety Systems:** Technological evolution, Maintenance, Intelligent systems and the role of mechatronics and robotics, Performance quality of safety systems. Design of safety equipment and systems; Job safety analysis; Human factors, Design of work units for safety; Ergonomic monitoring and control of work units; Change management for safety and health; Construction, environmental, and international aspects of safety and health; Lean safety systems; Lifecycle analysis of safety systems; Legal aspects and OSHA standards; Safety and health programs; Essential software; Applications; In-Situ cases; Recent topics.

**References:**

- *C.D. Reese, Occupational Health and Safety Management: A Practical Approach, 3rd Edition, Taylor & Francis Group, 2016.*
- *C.D. Reese, Occupational Safety and Health: Fundamental Principles and Philosophies, Taylor & Francis Group, LLC, 2017.*

- *S.Z. Mansdorf (ed.), Handbook of Occupational Safety and Health, 3rd Edition, John Wiley & Sons, Inc., 2019.*
- *T.P. Fuller (ed.), Global Occupational Safety and Health Management Handbook, Taylor & Francis Group, LLC, 2019.*


## Level (700)

| Course title | Machinery Design for Fatigue | | | | Course Code | PDE711 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Fundamentals of solid mechanics; **Design for Loading:** Static loading and cyclic loading. Fatigue failure theory and cycle counting methods; Fatigue faults of machinery and their elements; **Fatigue Analysis:** Stress and Strain methods for fatigue. Fatigue crack propagation; Fatigue impacts and surface integrity; Stochastic behavior of materials under fatigue; Fatigue modeling; Fatigue shock models of machinery; Systems for fatigue testing, diagnosis, and analysis; Fatigue accelerated life testing; Fatigue lifecycle improvement; Computational design for fatigue; Simulation of materials under fatigue; Essential software; Applications; Case studies; Recent topics.

**References:**


- *Y.-L. Lee et al., Metal Fatigue Analysis Handbook: Practical Problem-Solving Techniques for Computer-Aided Engineering, Butterworth-Heinemann, Elsevier Inc., 2012.*
- *C.F. Zorowski, Design for Mechanical Fatigue: Predicting Mechanical Failure under Variable Repetitive Cyclic Loading, CreateSpace Publishing, 2016.*


| Course title | Corrosion Engineering | | | | Course Code | PDE721 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Occurrence, nature, and mechanisms of corrosion; Engineering materials and corrosion forms based on mechanism and media; Electrochemistry, thermodynamic, and kinetics of corrosion; High temperature corrosion; Corrosion of machinery and large structures; Corrosion control; consequences of corrosion; Eelectrochemical, spectroscopic, and other methods and systems of corrosion inspection; Corrosion inspection of infrastructures; Corrosion measurements; Scientific and industrial methods of corrosion rate analysis; Statistical and quality methods for corrosion analysis; Design for corrosion; Essential software; Applications; Case studies; Recent topics.

**References:**


- *B.N. Popov, Corrosion Engineering: Principles and Solved Problems, Elsevier B.V., 2015.*
- *Luciano Lazzari, Engineering Tools for Corrosion: Design and Diagnosis, European Federation of Corrosion. Published by Elsevier Ltd., 2017.*
- *P. Pedeferri, Corrosion Science and Engineering, L. Lazzari and M.Pia Pedeferri (eds.) in Cooperation with others, Springer Nature Switzerland AG, 2018.*
- *C.A.C. Sequeira, High Temperature Corrosion: Fundamentals and Engineering, John Wiley & Sons, 2019.*

| Course title | Condition-Based Monitoring of Machinery | | | | Course Code | PDE722 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Faults of machinery; Machinery vibration and noise; Friction-Vibration interaction problems in machinery; Vibration and noise in friction systems; Rotor dynamics; Digital signal processing; Instrumentation of condition-based monitoring; Vibration monitoring and control; Noise monitoring and control; Thermography; Wear debris analysis; Other condition-based monitoring methods; Condition-based monitoring of machine tools; Shock models of machinery; Basics of maintenance engineering, and engineering failure analyses; Essential software; Applications; Case studies; Recent topics.

**References:**


- *T. Marwala, Condition Monitoring Using Computational Intelligence Methods: Applications in Mechanical and Electrical Systems, Springer-Verlag London Ltd., 2012*
- *R. Isermann, Fault-Diagnosis Applications—Model-Based Condition Monitoring: Actuators, Drives, Machinery, Plants, Sensors, and Fault-tolerant Systems, Springer-Verlag Berlin Heidelberg, 2011.*
- *A.R. Mohanty, Machinery Condition Monitoring: Principles and Practices, Taylor & Francis Group, LLC, 2015.*
- *R. Gonzalez et al., Process Control System Fault Diagnosis: A Bayesian Approach, John Wiley & Sons, Ltd., 2016.*
- *J. Yan, Machinery Prognostics and Prognosis Oriented Maintenance Management, John Wiley & Sons Singapore Pte. Ltd., 2015.*
- *A.W. Lees, Vibration Problems in Machines: Diagnosis and Resolution, Taylor & Francis Group, LLC, 2016.*
- *Y. Lei, Intelligent Fault Diagnosis and Remaining Useful Life Prediction of Rotating Machinery, Xi'an Jiaotong University Press Co. Published by Elsevier Inc., 2017.*
- *H. Benaroya et al., Mechanical Vibration: Analysis, Uncertainties, and Control, 4th Edition, Taylor & Francis Group, LLC, 2017.*
- *H. Ahmed and A.K. Nandi, Condition Monitoring with Vibration Signals: Compressive Sampling and Learning Algorithms for Rotating Machines, John Wiley & Sons Ltd., 2020.*
- *J. Carlos et al., Mechanical Vibrations and Condition Monitoring, Elsevier Inc., 2020.*


| Course title | Hydraulic Systems Engineering | | | | Course Code | PDE723 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; An overview of fluid mechanics; Hydraulic power advantages and limitations; Applications of hydraulic systems; Hydraulic manufacturing machinery; Components of hydraulic systems; Types and configurations of hydraulic systems; Types and functions of hydraulic system components; Hydraulic transmission systems; **Modeling of Hydraulic Components and Systems:** Steady state modeling and Dynamic modeling. Manufacturing of hydraulic components and systems; Hydraulic control systems; Fault diagnosis, shock models, reliability, and maintenance of hydraulic systems; Safety considerations in design and use of hydraulic facilities; Lifecycle assessment of hydraulic systems; Computational methods for hydraulic design; Essential software; Applications; Case studies; Recent topics.

**References:**


- *M.G. Rabie, Fluid Power Engineering, The McGraw-Hill Companies, Inc., 2009.*

- *J. Watton, Fundamentals of Fluid Power Control, J. Watton. Published by Cambridge University Press, 2009*
- *K. Subramanya, Hydraulic Machines, Tata McGraw Hill Education Private Ltd., 2013.*
- *A. Esposito, Fluid Power with Applications, 7th Edition, Pearson Education Ltd., 2014.*
- *P. Chapple, Principles of Hydraulic Systems Design, 2nd Edition, Momentum Press, LLC, 2015.*
- *Qin Zhang, Basics of Hydraulic Systems, 2nd Edition, 2018 by Taylor & Francis Group, LLC, 2018.*
- *N.D. Manring and R.C. Fales, Hydraulic Control Systems, 2nd Edition, John Wiley & Sons, Inc., 2020.*

| **Course title** | **Vibration of Continuous Systems** | | | | **Course Code** | PDE724 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 1 | | 2 | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; An overview of 'vibration of discrete systems'; Concept of total system energy; **Derivation of Equations:** Equilibrium approach, Variational approach, Integral equation approach. **Solution Procedure:** Eigenvalue and modal analysis approach, Integral transform methods. Transverse vibration; Longitudinal vibration; Torsional vibration; Vibration of circular and curved bodies; Vibration of membranes; Vibration of shells; Vibration of composite structures; Vibration monitoring, measurement, and control of continuous systems; Analysis of vibration energy harvesting systems; Approximate analytical methods; Numerical methods and simulation; Essential software; Applications; Case studies; Recent topics.

**References:**

- *S.S. Rao, Vibration of Continuous Systems, 2nd Edition, John Wiley & Sons, Inc., 2019.*
- *A. Shabana, Vibration of Discrete and Continuous Systems, 3rd Edition, Springer Nature Switzerland AG, 2019.*

| **Course title** | **Random Vibration of Mechanical Systems** | | | | **Course Code** | PDE725 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; **FUNDAMENTALS**—An overview of deterministic vibration; Essential mathematics, statistics, and dynamics; **Random Processes:** Statistical properties, Time domain, Frequency domain. **RANDOM VIBRATION**—Sources of random vibration; Random vibration of 'single degree of freedom' linear systems; Random vibration of 'multi degree of freedom' linear systems; Random vibration of nonlinear systems; Statistical methods for linearization and non-linearization; Methods of stochastic averaging; Characteristics of system responses to random vibration; Inverse problems; Random vibration and failures of mechanical systems; Random vibration control. Numerical methods and simulation; Essential software; Applications; Recent topics.

**References:**

- *C.W.S. To, Nonlinear Random Vibration: Analytical Techniques and Applications, 2nd Edition, Taylor & Francis Group, LLC, 2012.*
- *Z. Liang and G.C. Lee, Random Vibration: Mechanical, Structural, and Earthquake Engineering Applications, Taylor & Francis Group, LLC, 2015.*

<table>
<tr><td>Course title</td><td colspan="4">Engineering Noise Control</td><td>Course Code</td><td>PDE726</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">1</td><td>2</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; **Fundamentals:** Basics of acoustics; Essential mathematics and statistics for noise modeling and control; Random processes; Essential dynamics; ISO and ANSI/ASA Standards for noise. Noise-Vibration interaction; Human hearing and noise criteria; Instruments and methods for noise measurement, analysis, and control; Sound sources and sound power; Sound propagation; Sound in enclosed spaces; Partitions, enclosures and barriers; Muffling devices; Sound power and sound pressure level estimation procedures; Frequency analysis; Numerical methods and simulation; Essential hardware and software; Applications; Recent topics.

**References:**


- *D.A. Bies and C.H. Hansen, Engineering Noise Control: Theory and practice, 4th Edition, D.A. Bies and C.H. Hansen. Published by Spon Press, Taylor & Francis Group, 2009.*
- *Gerhard Müller and Michael Möser (eds.), Handbook of Engineering Acoustics, Springer-Verlag Berlin Heidelberg, 2013.*
- *D.A. Bies et al., Engineering Noise Control, 5th Edition, Taylor & Francis Group, LLC, 2018.*
- *R.N. Miles, Physical Approach to Engineering Acoustics, Springer Nature Switzerland AG, 2020.*


<table>
<tr><td>Course title</td><td colspan="4">Additive Manufacturing</td><td>Course Code</td><td>PDE731</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">1</td><td>2</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; Principles and evolution of additive manufacturing technology; Powder Metallurgy; Materials for additive manufacturing; Categories of additive manufacturing; Systems of additive manufacturing; Additive manufacturing process chain; Photopolymerization processes; Powder bed fusion processes; Extrusion-based systems; Printing processes; Sheet lamination processes; Direct write technology; Design for additive manufacturing; Process selection; Essential software; Applications; Case studies; Recent topics.

**References:**


- *R. Singh and J.P. Davim (eds.), Additive Manufacturing: Applications and Innovations, Taylor & Francis Group, LLC, 2019.*
- *B. AlMangour (ed.), Additive Manufacturing of Emerging Materials, Springer International Publishing AG, part of Springer Nature 2019.*
- *L.J. Kumar et al. (eds.), 3D Printing and Additive Manufacturing Technologies, Springer Nature Singapore Pte Ltd., 2019.*
- *D.M. Dietrich et al., Additive Manufacturing Change Management: Best Practices, Taylor & Francis Group, LLC, 2019.*
- *J. Pelleg, Additive and Traditionally Manufactured Components: A Comparative Analysis of Mechanical Properties, Elsevier Inc., 2020.*

| Course title | Intelligent Energy Field Manufacturing | | | | Course Code | PDE732 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Technology Innovations in manufacturing processes; Evolution of engineering and technology of intelligent energy field manufacturing; **Intelligent Energy Fields in Machining Processes:** Waterjets, Laser, Electrical and electrochemical processes, Micro electrical discharge, Ultrasonic waves. Energy field interactions in manufacturing using hybrid laser/non-laser systems; Energy field methods and electromagnetic sheet metal forming; Electrically assisted manufacturing; Laser-assisted manufacturing; Essential software; Applications; Case studies; Recent topics.

**References:**


- *W. Zhang (ed.), Intelligent Energy Field Manufacturing: Interdisciplinary Process Innovations, Taylor and Francis Group, LLC, 2011.*
- *M. Brandt (ed.), Laser Additive Manufacturing: Materials, Design, Technologies, and Applications, Woodhead Publishing, Elsevier Ltd., 2017.*
- *L. Bian et al. (eds.), Laser-Based Additive Manufacturing of Metal Parts: Modeling, Optimization, and Control of Mechanical Properties, Taylor & Francis Group, LLC, 2018.*
- *K. Kumar et al., Advanced Machining and Manufacturing Processes, Springer International Publishing AG, Springer Nature, 2018.*
- *Jagadish and K. Gupta, Abrasive Water Jet Machining of Engineering Materials, The Authors, under Exclusive License to Springer Nature Switzerland AG, 2020.*


| Course title | Analysis and Control of Robotic Systems | | | | Course Code | PDE733 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; Fundamentals of robotic systems; Kinematic configurations of robots; Kinematics and dynamics of robots; Newton–Euler formulations; Dynamic and force analysis; Differential motions and velocities; Trajectory planning and motion control systems; **Robotic Manipulators:** Kinematic and dynamic models, Coordination of arm, Visual servoing, Imitation learning, Visual perception, Grasping, Kinematic and dynamic control using single network adaptive critic, Kinematic analysis of parallel manipulators using screw theory. Control of mobile and flying robots; Formation and control of multi-robot systems; Joints control; Multivariable, force, and computed torque control; Implementation of robot control; Essential software; Applications; Case studies from automated manufacturing; Recent topics.

**References:**


- *D. Zhang and B. Wei (eds.), Adaptive Control for Robotic Manipulators, Taylor & Francis Group, LLC, 2017.*
- *S. Liu and G. Chen, Dynamics and Control of Robotic Manipulators with Contact and Friction, John Wiley & Sons Ltd., 2019.*
- *A.J. Kurdila and P. Ben-Tzvi, Dynamics and Control of Robotic Systems, John Wiley & Sons Ltd., 2020.*
- *A.T. Azar (ed.), Control Systems Design of Bio-Robotics and Bio-Mechatronics with Advanced Applications, Elsevier Inc., 2020.*
- *S.B. Niku, Introduction to Robotics: Analysis, Control, Applications, 3rd Edition, John Wiley & Sons Ltd., 2020.*

- *L. Behera et al., Intelligent Control of Robotic Systems, Taylor & Francis Group, LLC, 2020*.


| Course title | Digital Signal Processing | | | | Course Code | PDE734 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | 25 | 25 | 50 | | |

**Contents**

Introduction; **FOUNDATIONS—Signals:** Discrete-time and continuous-time signals, Analog, digital and mixed signals, Deterministic and random signals, Periodic and non-periodic signals, Power and energy signals, Properties of signals. An overview of *digital signal processing* (DSP) algorithms; Convolutions; Difference equations; z-transforms; Fourier transforms. **ANALYSIS OF DSP SYSTEMS—DSP Systems:** Discrete-time systems, Continuous-time systems, Linear time-invariant causal systems (discrete-time LTI; continuous-time LTI); **Analysis:** Basics of frequency analysis for DSP, z-transform of DSP systems, Fourier transform of DSP systems, Digital signals generation, sampling and detection, Filtering, Adaptive filtering, Adaptive disturbance elimination. **Design and Implementation of Digital Filters:** Finite impulse response (FIR) filters, Infinite impulse response (IIR) filters, Filters connection (cascade/parallel). **Design and Implementation of Data Converters**; Multirate signal processing; Random signal processing; Audio signal processing; **Real-Time DSP**; Complications in digital representations; Accuracy and precision analyses of DSP; Essential software and hardware; Applications; Recent topics.

**References:**


- *G. Ruiz and J.A. Michell (eds.), Design and Architectures for Digital Signal Processing, InTech, 2013.*
- *R. Woods et al., FPGA-Based Implementation of Signal Processing Systems, 2nd Edition, John Wiley & Sons, Ltd., 2017.*
- *W.E. Alexander and C.M. Williams, Digital Signal Processing: Principles, Algorithms and System Design, Academic Press, 2017 Elsevier Inc., 2017.*
- *J.L. Rojo-Álvarez et al., Digital Signal Processing with Kernel Methods, John Wiley & Sons Ltd., 2018.*
- *J. Benesty et al., Fundamentals of Signal Enhancement and Array Signal Processing, John Wiley & Sons Singapore Pte. Ltd., 2018.*
- *L. Tan and J. Jiang, Digital Signal Processing: Fundamentals and Applications, 3rd Edition, Academic Press, Elsevier Inc., 2019.*
- *S.I. Abood, Digital Signal Processing: A Primer with MATLAB®, Taylor & Francis Group, LLC, 2020.*


| Course title | Mechanics of Composite Materials | | | | Course Code | PDE741 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 1 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grades | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Fundamentals of composite design and solid mechanics; Lamina stress-strain relationships; Effective moduli of continuous fiber-reinforced lamina; Strength of continuous fiber-reinforced lamina; Analysis of lamina hygrothermal behavior; Analysis of discontinuously reinforced lamina; Analysis of laminates; Analysis of viscoelastic and dynamic behavior; Fracture analysis; Mechanical testing of composites and their constituents; Life ‘estimation & improvement’ of composites; Systems of testing and measurements in mechanics of composite materials; Computational methods; Essential software; Applications; Case studies; Recent topics.

**References:**
- *G.J. Dvorak, Micromechanics of Composite Materials, Springer Science + Business Media B.V., 2013.*
- *V.V. Vasiliev and E.V. Morozov, Advanced Mechanics of Composite Materials and Structures, 4th Edition, Elsevier Ltd., 2018.*
- *P.P. Camanho and S.R. Hallett (eds.), Numerical Modelling of Failure in Advanced Composite Materials, Woodhead Publishing, Elsevier Ltd., 2015.*
- *L.A. Carlsson et al., Experimental Characterization of Advanced Composite Materials, 4th Edition, Taylor & Francis Group, LLC, 2014.*
- *A.V. Vakhrushev and A. K. Haghi (eds.), Composite Materials Engineering: Modeling and Technology, Apple Academic Press, Inc., 2020.*

| **Course title** | **Modeling and Analysis of Materials** | | | | **Course Code** | PDE742 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grades** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction; Essentials of mathematics, statistics, continuum mechanics, and thermodynamics; An overview of materials design; Structures of materials; Random phenomena of materials' 'properties and structures'; Systems of materials' measurements; Quantum mechanics of materials; Molecular mechanics of materials; Atomistic models of materials and continuum concepts; Materials modeling using density functional theory; **Multiscale Methods—**Multilattice crystals and atomistic relations; **Atomistic-Continuum Coupling:** Static methods, Finite 'temperature and dynamics' methods. Materials modeling using finite element method; **Special Topics—**Multi-time-scale and multi-length-scale simulations, Multiscale simulations of plastic deformation and fracture, Multiscale simulations in biomaterial systems. Essential software; Applications; Recent topics.

**References:**
- *J.W. Rudnicki, Fundamentals of Continuum Mechanics, John Wiley & Sons, Ltd., 2015.*
- *S. Schmauder and I. Schäfer (eds.), Multiscale Materials Modeling: Approaches to Full Multiscaling, Walter de Gruyter GmbH, 2016.*
- *P.A. Muñoz-Rojas (ed.), Computational Modeling, Optimization and Manufacturing Simulation of Advanced Engineering Materials, Springer International Publishing Switzerland, 2016.*
- *A. Tiwari et al., Advanced Engineering Materials and Modeling, Scrivener Publishing LLC., John Wiley & Sons, Inc., 2016.*
- *A. Öchsner and H. Altenbach (eds.), Properties and Characterization of Modern Materials, Springer Science + Business Media Singapore, 2017.*
- *R.C. Hibbeler, Mechanics of Materials, 10th Edition in SI Units, R.C. Hibbeler. Published by Pearson Education, Inc., 2018.*
- *A. Shabana, Computational continuum mechanics, 3rd Edition, John Wiley & Sons Ltd., 2018.*
- *A. Filimon (ed.), Smart Materials: Integrated Design, Engineering Approaches, and Potential Applications, Apple Academic Press, Inc., 2019.*
- *Z. Yang, Material Modeling in Finite Element Analysis, Taylor & Francis Group, LLC, 2020.*
- *W. Andreoni and S. Yip (eds.), Handbook of Materials Modeling—Applications: Current and Emerging Materials, 2nd Edition, Springer Nature Switzerland AG, 2020.*

<table>
<tr><td rowspan="2">Course title</td><td colspan="4" rowspan="2">High Integrity Die Casting</td><td rowspan="2">Course Code</td><td rowspan="2">PDE751</td></tr>
<tr></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">1</td><td>2</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grades</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>25</td><td>25</td><td>50</td></tr>
</table>

**Contents**

Introduction; Molten metal flow; Vacuum die casting; Squeeze casting; Semi-solid metalworking; Thermal balancing and powder die lubricant processes; High integrity die casting machines; Component integration using high integrity die casting processes; Quality and simulation analysis of high integrity die casting processes; Developments in high integrity die casting; Essential software; Applications; Case studies; Recent topics.

**References:**


- *E.J. Vinarcik, High Integrity Die Casting Processes, John Wiley & Sons, 2003.*
- *B. Andresen, Die Casting Engineering: A Hydraulic, Thermal, and Mechanical Process, Marcel Dekker, 2005.*
- *J. Campbell, Complete Casting Handbook: Metal Casting Processes, Metallurgy, Techniques and Design, 2nd Edition, John Campbell. Published by Elsevier Ltd., 2015.*
- *J.A.P.-S. Elorz et al., Solidification and Solid-State Transformations of Metals and Alloys, Elsevier Inc., 2017.*
- *Z. Lipnicki, Dynamics of Liquid Solidification: Thermal Resistance of Contact Layer, Springer International Publishing AG, 2017.*
- *D.G. Eskin and J. Mi (eds.), Solidification Processing of Metallic Alloys under External Fields, Springer Nature Switzerland AG, 2018.*

# Chapter Nine:

## Textile Engineering Department

## Diploma in Textile Engineering

## Majoring in Textile Engineering

### Program description

The overall aim of the program is to provide graduates with specialized knowledge in textile engineering to gain employment in textile industry.

### Competencies for the program graduate

In addition to generic competencies for the Engineering science Diploma, the graduate of Engineering science Diploma in Textile Engineering must be able to:

1- Identify the structures and properties of textile fibres, yarns and fabrics for applying appropriate textile processing techniques for the development of the end products.
2- Relate advanced technologies in textile processing to the development of textile materials, machineries, processes and end products.

## Diploma in Textile Engineering

## Majoring in Knitting and Ready-Made Garments Engineering

### Program description

The overall aim of the program is to provide graduates with specialized knowledge in textile engineering, mainly in knitting and ready-made garments sectors to gain employment in a textile related industry.

### Competencies for the program graduate

In addition to generic competencies for the Engineering science Diploma, the graduate of Engineering science Diploma in Knitting and Ready-Made Garments Engineering must be able to:

1- Apply knowledge of knitting and garment technology to identify manufacturing problems and develop solutions.
2- integrate knitting / garment technology and machinery to the manufacturing process of developed products.

## Diploma in Textile Engineering

## Majoring in Functional Textiles Engineering

### Program description

The overall aim of the program is to provide qualified graduates with specialized knowledge in textile engineering, mainly in functional textiles to gain employment in a textile related industry.

## Competencies for the program graduate

In addition to generic competencies for the Engineering science Diploma, the graduate of Engineering science Diploma in in Functional Textiles Engineering must be able to:

1- Apply the principles, methods, and technologies of textile processing to produce functional textiles.
2- Relate advanced technologies in functional textiles processing to the development of textile materials, machineries, processes and end products.

## Master of Textile Engineering Program

## Program description

The objective of the Master of Science in Textile Engineering is to develop the student's potential for research and the technical and analytical skills needed for the design of new products and processes.

## Competencies for the program graduate

In addition to generic competencies for the M.Sc. in engineering, the graduate of Master of Science in Textile Engineering must be able to:

1. To develop skills to identify and analyze the appropriate material and production route for a specific end product;
2. To develop expertise and skills to conduct quality evaluation of textile products.

## Doctor of Philosophy in Textile Engineering Program

## Program description

The objective of the Doctor of Philosophy of Textile Engineering program is to qualify textile engineers who combine theory, practice, scholarly research and application of knowledge in their chosen professions.

## Competencies for the program graduate

In addition to generic competencies for the Ph. D. program, the graduate of Engineering science Ph.D. in Textile Engineering must be able to:

1- To be effective researchers.
2- To be professionals in their chosen field.

## List of level (500) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| TXE511 | New Spinning Systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE512 | Spinning Mill Organization | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE513 | Spinning Technology of Man-made Fibres | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE514 | Design of Spinning Machines | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| TXE515 | Mechanics of plied yarns | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE516 | Sewing Threads | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE521 | Un-Traditional Weaving Systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE522 | Weaving Mill Organization | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE523 | Weaving Machine Design | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| TXE524 | Modeling of Woven Fabrics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| TXE531 | Mills Planning of Knitting & Ready-Made Garments | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE532 | Knitting and Garment Machines | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE533 | Modeling in Knitting | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| TXE534 | Quality Control of Knitting & Ready-Made Garment | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE535 | Construction of knitted fabrics and sewing stitches | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE536 | Knitted Fabric Finishing | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE541 | Polymer Chemistry | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE542 | High Performance Fibers | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE543 | Polymer Processing | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE544 | Composite Materials | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE545 | Surface Finishing and Coating | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| TXE546 | New Products Development and Design | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TXE547** | Nanotechnology and Textiles | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE548** | Functional Textiles | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE549** | Smart Textiles | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE551** | Finishing Technology | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE561** | Statistical quality control | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE562** | Economics of Textiles Process (1) | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |

## List of level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Lectures** | **Tutorial** | **Practical** | **Contact Hours** | | | | **Semester Work** | **Practical/ Oral Exam** | **Written Exam** | **Total** |
| **TXE611** | New spinning systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE621** | Advanced Weaving Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE622** | Carpets manufacturing technology | 2 | 2 | - | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE631** | Economics of Knitting and Ready-made Garment | 2 | 2 | - | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE651** | Finishing Technology | 2 | 2 | - | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE652** | Developments in textiles processing | 2 | 2 | - | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE653** | Modeling and simulation of textile | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE654** | Selected Topics | 2 | 2 | - | 4 | 3 | 10 | 3 | 50 | 0 | 50 | 100 |
| **TXE655** | Project * | 2 | 2 | - | 4 | 3 | 10 | 3 | 50 | 50 ** | 0 | 100 |
| **TXE661** | Advanced Applied Statistics | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE662** | Computer Application and Programming | 2 | | 2 | 4 | ٤ | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE663** | Quality management | 2 | 2 | - | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE664** | Economics of Textile Process (2) | 2 | 2 | - | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **TXE665** | Specification and Measures | 2 | 2 | - | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| * **Core Courses** | | | | | | | | | | | | |
| ** **Discussion** | | | | | | | | | | | | |

## List of level (700) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical Exam | Written Exam | Total |
| **TXE741** | Nanotechnology and Coating of Textiles | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE742** | Functional and High-Performance Textiles | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE743** | Advanced Composite Materials | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE751** | Analysis and design of yarn and fabric formation systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE752** | Textile Evaluation | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE753** | Advanced Mechanics of Production Processes and Structure of Fibre Assemblies | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE754** | Environmental Management in Textile & Allied Industries | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE755** | Energy conservation and efficiency for textile companies | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE756** | Management of Textile Production | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE761** | Development in Wet Processing and Colour & Design | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE762** | Electronics and Controls for Textile Industry | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **TXE763** | Costing, Project Formulation and Appraisal | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

## Summary of Courses Specification

### Level (500)

| Course title | New Spinning Systems | | | | Course Code | TXE511 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**:

Introduction, a summary of the conventional and new spinning process, the basic principle of yarn formation, tasks, raw material, speed relationship of the various spinning process. The recent development in ring spinning and rotor spinning. New spinning techniques. Electrostatic spinning. Air vortex spinning (AVS). Air jet spinning (MJS, MTS), Friction spinning (Dref, Barmage, Platt sacollonel), Self-twist spinning (ST, STT, ...). False twist process (Fasciated spinning, ...), Rotofil spinning system, wrap spinning "hollow spindle techniques" (lesson, parafil 1000, 2000), Siro spun spinning system, Compact spinning systems (Rieter, Suessen, Zinser, Toyoda), Adhesive process "Bobtex and Twistless", Magnetic spinning. Comparison of the new spinning process

**References:**


- *Advances in Filament Yarn Spinning of Textiles and Polymers, Editor: Dong Zhang,28th January 2014*
- *Advances in Yarn Spinning Technology, Editor: C A Lawrence,27th September 2010,*
- *Spinnovation, publ. by Sussen Germany, http://www.rieter .com*


| Course title | Spinning Mill Organization | | | | Course Code | TXE512 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Methods of costing and accounting for spinning mills - operating stages and cost centers in spinning mills, the estimated cost for expanding projects - balance - cash flow methods - economic equilibrium model for equipment and machinery, cost elements, theoretical analysis of the economics of optimal packaging for production - determining the cost of a kilogram of yarn, Assessment of exhausts in factories - the relationship between cost and moisture content in products. Costs and their applications in the spinning and weaving industry - cost classification - the cost of production processes

**References:**


- *Advances in Filament Yarn Spinning of Textiles and Polymers ,Editor: Dong Zhang ,28th January 2014*
- *How to Spin: From Choosing a Spinning Wheel to Making Yarn ,Beth Smith ,2016 ,Storey Publishing*


| Course title | Spinning Technology of Man-made Fibres | | | | Course Code | TXE513 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Spinning techniques of man-made fibres, regenerated fibres , synthetic fibres, , Bi-component and bi-constituent spinning of synthetic polymer fibres , Electros pinning, processing and characterization of polymer-based nano-composite fibers Significance of the manmade fiber sector. Fiber characteristicsand spinnability of manmade fibers. Fiber properties and end-uses. Relationship between fiber properties and yarn quality and yarn characteristics in Ring, Rotor, Friction, and Air-jet spinning systems, Role of fiber finish in processing. Blending and its objectives. Processing of man-made fibers on the cotton spinning system, difficulties facing processing of man-made fibers in spinning mills, and how to overcome.

**References:**

- *Advances in Filament Yarn Spinning of Textiles and Polymers, Editor: Dong Zhang ,28th January 2014*

| Course title | Design of Spinning Machines | | | | Course Code | TXE514 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Design of mechanisms of ginning machines, design of the modern opening beaters, design of conical drums indirect feeding machine, design of filters in opening and cleaning lines and places of collecting dust, design of flats in carding machine with high productivity, design of drafting devices (top and bottom rollers, loads and required energy), design of flyers, design of bobbin building in the roving machine, design of ring and traveler in ring spinning machine, design of drafting device and bobbin building device in ring spinning machine, design of spindles (structure, speed, lying, vibrations), the effect of design for the different parts.

**References:**

- *Automation in Textile Machinery: Instrumentation and Control System Design Principles,L. Ashok Kumar, M Senthil kumar ,43194 ,CRC Press, 2018*

| Course title | Mechanics of plied yarns | | | | Course Code | TXE515 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Introduction , twist equilibrium, twist liveliness, twist diagram of ring, rotor and air jet yarns, Yarn plying ( folding), fibre immigration, Classification of yarns according to structure, The objective of yarn plying, single/ ply yarn twist, Balanced twist, Folding twist for maximum strength of cotton yarns, Yarn folding routine, Yarn folding machinery for: "Two-fold yarns, Multi-fold yarns, Fancy yarns", Conventional ring folding, Fancy yarn folding, Two-stage yam folding (the Hamel system), Two-for-one yarn folding, Dual up/down folding, plied yarns properties, effect of operating variables and single yarn properties on properties of the plied yarns.

**References:**

- *Schwartz, P. (Ed.). (2019). Structure and mechanics of textile fibre assemblies. Woodhead publishing.*
- *Theory of Structure and Mechanics of Fibrous Assemblies, 04 Jun 2015, Publisher Woodhead Publishing India Pvt Ltd, New Delhi, India, ISBN10 8190800175.*

| Course title | Sewing Threads | | | | Course Code | TXE516 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Systems for identifying sewing threads. Classifying of sewing threads: Types (Spun, Core spun, and Continuous filament threads); Yarn count, Twist; Basis of thread construction; Material used; typical applications. Properties and standard quality of sewing threads: Yarn number, Strength & elongation, Twist balance, Diameter, Shrinkage and elasticity. Requirements of sewing threads: Sewability, Seam security, Colour hatchability, fibre properties used in sewing threads, sewing performance. Cotton sewing threads: "Soft, Mercerized and Glace finish". Production techniques: 1st stage: Filament and Cotton threads technique, doubling, twisting – singing, smoothing – 2nd stage: Draw setting, Cross winding, Finishing, Dyeing, Setting, Post treatment and Spooling.

**References:**

- *Sewing for Fashion Designers ,Annete Fischer ,2015 ,Laurence King Publishing*

| Course title | Un-Traditional Weaving Systems | | | Course Code | TXE521 |
|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | Credit hours | 3 |
| | 2 | 2 | 0 | | |

| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
|---|---|---|---|---|---|---|
| | 20 | 0 | 30 | 50 | | |

**Contents**

Automatic shuttles weaving machines – Types of untraditional looms – Methods of pile fabric productions – Methods of tapes production and lappet looms – the latest developments in narrow fabrics , different applications of braided and woven fabrics - Computer application in jacquard fabric structures – Principles and methods of digital jacquard textile design - Structural digital design of jacquard textiles - Methods of carpet production - Craft and related products; Axminster weaving; Wireloom weaving; Face-to-face weaving; Flat woven carpets; Production of needlefelts; Other methods of carpet manufacture;

**References:**

- *Recent Developments in Braiding and Narrow Weaving ,Yordan Kyosev ,2016 ,Springer International Publishing*
- *Handbook of Weaving, Sabit Adanur, CRC Press, Jul 17, 2019 - Technology & Engineering - 448 pages.*

| Course title | Weaving Mill Organization | | | Course Code | TXE522 |
|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | Credit hours | 3 |
| | 2 | 2 | 0 | | |

| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
|---|---|---|---|---|---|---|
| | 20 | 0 | 30 | 50 | | |

**Contents**

The objectives of production planning, production cycle, processing planning, the foundations of the modern weaving mills planning "factory site selection, identifying spaces, buildings, lighting, ventilation, distribution of machinery and equipment" - Requirements for production technology. Identifying the needs of machinery, equipment and specifications – Labor - Raw materials and auxiliary materials - The energy required for operation, lighting, refrigeration, and air conditioning –and steam generation - Estimating and calculating production costs, wages and labor load - Study losses in the stages of preparations, weaving and use of materials.

**References:**

- *Woven Fabric Structure Design and Product Planning, J. Hayavadana,42018, CRC Press, 2016*

<table>
<tr><td>Course title</td><td colspan="4">Weaving Machine Design</td><td>Course Code</td><td>TXE523</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Theory and design of picking mechanism – principles of weaving machine design – Mechanics of weaving main processes – Shafts design – Design of shedding mechanisms – Design of picking mechanisms – design of fabric take-up – design of winding mechanisms – design and control of tension regulating devices in winding process – theoretical analysis of picking mechanisms in weaving machines - break design on weaving machine – Design of gear boxes – Design of conveyor belts – Mechanics of take-up devices – Mechanics of selvedges and scissors.

**References:**


- *Handbook of Weaving, Sabit Adanur, CRC Press, Jul 17, 2019 - Technology & Engineering - 448 pages.*
- *Joseph E. Shigley, Charles R. Mischke and Thomas H. Brown Jr,.Standard Handbook of Machine Design, McGraw-Hill Education; 3rd edition, ISBN-10: 0071441646, 2004.*


<table>
<tr><td>Course title</td><td colspan="4">Modeling of Woven Fabrics</td><td>Course Code</td><td>TXE524</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Idealized plain square fabric - Average float and maximum set - Crimp interchange - Effect of average float within the fabric - Estimation of dimensional properties by image analysis, Basic relationship between geometrical parameters, Relation between weave composition and structural parameters, Jammed structures, Prediction of fabric properties, Fabric cover, Fabric specific volume, Maximum cover and its importance, Application of geometrical model, Computation of fabric parameters, Weavability limit, Relation between fabric parameters for circular cross-section for different weaves, Crimp in the fabric

**References:**


- *Simulation in textile technology: Theory and applications Edited by D. Veit A volume in Woodhead Publishing Series in Textiles, Book • 2012*
- *Modeling and predicting textile behavior Edited by X. Chen Woodhead Publishing 2010*
- *Modeling of Woven Fabrics Geometry and Properties, B. K. Behera, Jiri Militky, Rajesh Mishra and Dana Kremenakova, 2012, DOI: 10.5772/38723*


<table>
<tr><td>Course title</td><td colspan="4">Mills Planning of Knitting & Ready-Made Garments</td><td>Course Code</td><td>TXE531</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>20</td><td>0</td><td>30</td><td>50</td></tr>
</table>

**Contents**

Knitting

Construction frame of knitting mills – Production plan sectors in knitting and ready-made garment mills – Production plans of weft knitted fabrics (circular - flat) - Production plans of warp knitted fabrics. Ready-made garment. Construction frame of garments manufacture – Different sectors in ready-made garments according to model type – Planning and organization of production – Mills organization of clothes – Basics of managements – Labour – Specification & Measurements – Performance measurement – Reducing of derivations - Design department – Marketing – Financial aspects – Sailing and buying of stock – Planning and production – Applied study for knitting and apparel.

**References:**

- *R. Rathinamoorthy & R. Surjit "Apparel Machinery and Equipments", Woodhead Publishing, 2015.*
- *David J. Spencer, "Knitting Technology", PERGAMON Press, 2014.*

| Course title | Knitting and Garment Machines | | | | Course Code | TXE532 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Knitting Machines

Basic types of knitting machines such as flat, circular and warp knitting machines – Comparison between weft and warp knitting machines – Basic knitting elements in knitting machines – Mechanics of stitches formation – New developments in knitting machine elements.

Garment Machines

Types of spreads - spreading quality specification - spreading equipment and tools- spreading method analysis - cutting equipment and tool analysis - vertical reciprocity cutting machine - Rotary cutting machine - Band knife machine - Die cutters, cutting drills - Identification and classification of sewing machines - pressing and molding production analysis - packing and shipping equipment.

**References:**

- *R. Rathinamoorthy & R. Surjit, "Apparel Machinery and Equipments ", Woodhead Publishing, 2015.*
- *David J. Spencer, "Knitting Technology", PERGAMON Press, 2014.*

| Course title | Modeling in Knitting | | | | Course Code | TXE533 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Geometric characteristics of knitted fabrics (wales and courses density – loop length – weight of square meter – fabric thickness – knitted fabric spirality) - Various mathematical models of different knitting stitches - The vacuum geometry of knitted fabrics - A study of the balance of knitted fabrics – dimensional stability of knitted fabrics - Analysis of stresses on needles during lifting and lowering - Study of forces and interaction between threads and knitting machine parts – Knitting force measurements.

**References:**

- *David J. Spencer, "Knitting Technology", PERGAMON Press, 2014.*
- *S C Ray, "Fundamentals and Advances in Knitting Technology", Woodhead Publishing, 2012.*

| Course title | Quality Control of Knitting & Ready-Made Garment | | | | Course Code | TXE534 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Quality importance – The main element of quality programs – Guide index for quality management – Quality control of products and inspection systems of knitting and garments – Classification of knitted fabric defects (holes – needle line – barre and etc.) – Quality control in inspection stages – Quality control during production, processing and final inspection – Final statistical estimation – quality control during manufacturing – Choice of developments topics in knitting and ready-made garments quality – Image analysis of knitted and apparel defects – Online quality control systems.

**References:**

- *Stanley Bernard Brahams, "The Fundamentals of Quality Assurance in the Textile Industry", CRC Press, 2016.*

| Course title | Construction of knitted fabrics and sewing stitches | | | | Course Code | TXE535 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents:**

Basic structures of knitted fabrics (weft and warp knitted fabrics) - Advanced structures of knitted fabrics - The basic requirement for the production of: plating, terry, inlaid, fleecy, piques and color striping - loop formation cycles for each fabrics and structure - Construction analysis of different knitted fabrics (basic and advanced) - The basic requirement for machines to produce different stitches - Different stitches of sewing stitches (types - features - derivatives) - Construction analysis of sewing stitches.

**References:**

- *M.Parthiban, M.R.Srikrishnan, P.Kandhavadivu, "Sustainability in Fashion and Apparels", Woodhead Publishing, 2017.*
- *David J. Spencer, "Knitting Technology", PERGAMON Press, 2014.*

| Course title | Knitted Fabrics Finishing | | | | Course Code | TXE536 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents:**

Different methods of dyeing knitted fabrics – Different dyeing machines and affected of knitted fabric properties - Different stages and processes for finishing knitted fabrics - Methods of squeezing knitted fabrics – Different drying methods - Different fabric opening width (calendar and compactor) and thermal fixing methods and their effect on the properties of knitted fabrics produced - Processing of finishing for knitted fabrics produced with elastic threads (Lycra) – New finishing techniques for knitted fabrics.

**References:**

- *N. N. Mahapatra, "Textile Dyes", Woodhead Publishing, 2016.*
- *M. L. Gulrajani, "Advances in the Dyeing and Finishing of Technical Textiles", Woodhead Publishing, 2013.*

| Course title | Polymer Chemistry | | | | Course Code | TXE541 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents:**

Introduction and Basic Concepts Polymers in Solution, Polymer Analysis: Molar Mass Determination, Polymers in Solid State, Partially Crystalline Polymers, Amorphous Polymers, Glass transition and crystallinity, Polymers as Materials, Polymerization techniques and kinetics, Step-Growth Polymerization, Radical Polymerization, Ionic Polymerization, Coordination Polymerization, Ring-Opening Polymerization, Copolymerization, Important Polymers Produced by Chain-Growth Polymerization, Chemistry with Polymers, Industrially Relevant Polymerization Processes, The Basics of Plastics Processing, Elastomers, Functional Polymers, Liquid Crystalline Polymers, Polymers and the Environment, Current Trends in Polymer Science

**References:**
- *Paul C. Hiemenz and Timothy P. Lodge, Polymer Chemistry, Second Edition 2nd Edition, Publisher: CRC Press; 2 edition, ISBN-10: 1574447793, 2007*

| Course title | High Performance Fibers | | | | Course Code | TXE542 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Introduction, Spinning techniques: Fundamentals and developments, Carbon fibres , Physical properties , PAN-based carbon fibres , Carbon nanotubes . Glass for fibres , Fibre manufacture , Fibre finish , Glass fibre properties , Fibre assemblies, Composites , Design of fibre glass composites. Ceramic fibres , Silicon carbide-based fibres. Other non-oxide fibres , Alumina-based fibres , Other polycrystalline oxide fibres Single-crystal oxide fibre . Other fibres Fibre manufacture an properties : Aramid, graphite, Polyurethane elastomeric fibers. Metallic compound fibers, Bioresorbable fiber, Optical fiber : Introduction, end uses , manufacturing and properties.

**References:**
- *C. A. Lawrence High-performance textiles and their applications, Woodhead Publishing, ISBN 13: 978-1-84569-180-6, 2014*
- *J. W. S. Hearle, High-performance fibres, ISBN 13: 978-1-85573-539-2, 2001*
- *Functional textiles for improved performance, protection, and health Edited by N. Pan and G. Sun*

| Course title | Polymer Processing | | | | Course Code | TXE543 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Introduction, History, the Polymer Processing Practice, , the Structural Formulation of the Field Through Elementary Steps, and the Future Perspectives, The Balance Equations and Newtonian Fluid Dynamics, Polymer Rheology and Non-Newtonian Fluid Mechanics, The Handling and Transporting of Polymer Particulate Solids, Melting, Pressurization and Pumping, Mixing, Devolatilization, the Single Rotor Machines, Single Screw Melt Extrusion Process, Twin Screw and Twin Rotor Processing Equipment, the Reactive Polymer Processing and Compounding, Die Forming, Molding, Stretch Shaping, Calendering.

**References:**
- *Principles of Polymer Processing, 2nd Edition, Zehev Tadmor, Costas G. Gogos, ISBN: 978-0-470-35592-3 December 2013.*
- *Polymer Processing, Principles and Modelling, 2017, Jean-François Agassant, Pierre Avenas, ... Michel Vince, Carl Hanser Verlag, Munich 2017, https://doi.org/10.3139/9781569906064*

| Course title | Composite Materials | | | | Course Code | TXE544 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Introduction, the Anisotropic and isotropic material properties, the Elastic response of anisotropic materials, Unidirectional composite laminates subject to plane stress, Thermomechanical behavior of multiangle composite laminates, the Predicting failure of a multiangle composite laminate, Composite beams, the Application of Textile Composites, the Natural Fiber Properties, the Natural Fiber Reinforcement Design, the Textile Reinforcement Modification and Matrix Materialization, the Some Aspects of Textile Composite Design, the Natural Fiber Composites Manufacturing Techniques, the Agriculture Waste Composites, the Testing Methods for Composite Materials.

**References:**

- *Natural Fiber Textile Composite Engineering ,Magdi El Messiry ,42909 ,(June 23, 2017)*
- *Nanostructured Polymer Blends and Composites in Textiles ,Mihai Ciocoiu, Seghir Maamir ,42341 , December 3, 2015*

| Course title | Surface Finishing and Coating | | | | Course Code | TXE545 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Introduction to active coatings for smart textiles, Types of active coatings, Memory polymer coatings for smart textiles, Environmentally mild self-cleaning processes on textile surfaces under daylight irradiation: Critical issues, Smart durable and self-healing textile coatings, Smart breathable coatings for textiles, Conductive polymer coatings, Natural photonic materials for textile coatings, Smart coating processes and technologies, Coating processes and techniques for smart textiles, Microencapsulation technology for smart textile coatings, Plasma surface treatments for smart textiles, Nanotechnology-based coating techniques for smart textiles, Biomimetic nanocoatings for structural coloration of textiles, Functional modification of fiber surface via sol–gel technology

**References:**

- *Active Coatings for Smart Textiles ,Author: Jinlian Hu ,14th April 2016 ,*
- *Coating Substrates and Textiles, Andreas Giessmann, 2012, Springer-Verlag Berlin Heidelberg, 10.1007/978-3-642-29160-9*

| Course title | New Product Development and Design | | | | Course Code | TXE546 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 4 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

General Overview of Innovation and Textile Product Development, Innovation and New Product Development in Textiles, Practical Aspects of Innovation in the Textile Industry, Textile Product Development and Definition, New Product Development of Textiles, New Product Development in Knitted Textiles, Fabrics and New Product Development, New Product Development in Automotive Upholstery, Nanotechnology Innovation for Future Development in the Textile Industry, New Product Development in Interior Textiles, New Product Development for E-Textiles: Experiences from the Forefront of a New Industry, Customer Co-Creation: Moving Beyond Market Research to Reduce the Risk in New Product Development, The Development and Marketing of SilverClear®

**References:**

- *Edited by L. Horne, New product development in textiles: Innovation and production, Woodhead Publishing, ISBN 13: 978-1-84569-538-5, 2011.*
- *Modelling and predicting textile behaviour, Xiaogang Chen, Woodhead Publishing 2010,*
- *Update on Flame Retardant Textiles : State of the Art, Environmental Issues and Innovative Solutions ,Alongi, Jenny; Horrocks, A. Richard; Carosio, Federico; ,2014 ,iSmithers Rapra Publishing*

| Course title | Nanotechnology and Textiles | | | | Course Code | TXE547 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Nanofiber production: Electrospinning of nanofibers, Producing nanofibre structures by electrospinning for tissue engineering, Continuous yarns from electrospun nanofibers, Producing polyamide nanofibers by electrospinning, Controlling the morphologies of electrospun nanofibers. Carbon nanotubes and nanocomposites: Synthesis, characterisation and applications of carbon nanotubes: The case of aerospace engineering, Carbon nanotube and nanofibre reinforced polymer fibers, Structure and properties of carbon nanotube polymer nanofibers using melt spinning, Multifunctional polymer nanocomposites for industrial applications, Nanofilled polypropylene (PP) fibers. Improving polymer functionality: Nanostructuring polymers with cyclodextrins, Dyeable polypropylene (PP) via nanotechnology, Polypropylene (PP)/clay nanocomposites, Multi-wall carbon nanotube-nylon 6 nanocomposites from polymerisation.

**References:**

- *Q. Wei., Functional nanofibers and applications, Woodhead Publishing, ISBN 13: 978-0-85709-069-0. 19th August 2016*
- *Electrospun Nanofibers ,Editor: Mehdi Afshari ,20th September 2016 , Woodhead Publishing*
- *Nanomaterials in the Wet Processing of Textiles ,Shahid Ul-Islam, B. S. Butola ,2018 ,Wiley*

| Course title | Functional Textiles | | | | Course Code | TXE548 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Introduction, definition, and scope of functional textiles, Home textiles, Textile-reinforced composite materials, Waterproof breathable fabrics, Textiles in filtration, Geotextiles in civil engineering, Textiles for healthcare and medical applications, Technical textiles for ballistic protection, Technical textiles for knife and slash resistance, Technical fibres or heat and flame protection, Technical textiles for personal thermal protection, Technical textiles for survival, Technical textiles in transport (land, sea, and air), Energy harvesting and storage textiles, Rope, cord, twine, and webbing, Finishing of functional textile, Future of functional textiles.

**References:**

- *Handbook of Technical Textiles Volume-2 ,Editors: A. Richard Horrocks Subhash C. Anand ,1st February 2016 ,*
- *Handbook of technical textiles C. Anand, Woodhead Publishing, ISBN 13: 978-1-85573-385-5, 1st February 2016, 2nd edition.*

| Course title | Smart Textiles | | | | Course Code | TXE549 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Introduction, properties and materials used in smart textiles, Conductive fibers for electronic textiles: an overview, Types of conductive fiber, Applications of conductive fibers, Conductive polymer yarns for electronic textiles, Techniques for processing CPYs, Carbon nanotube yarns for electronic textiles, Design and manufacture of textile-based sensors, Integration of micro-electronics with yarns for smart textiles, Design, and manufacture of heated textiles, Joining technologies for electronic textiles, Photovoltaic energy harvesting for intelligent textiles, Piezoelectric energy harvesting from intelligent textiles, Electronic textiles for military personnel……etc.

**References:**

- *Smart Textiles for Designers: Inventing the Future of Fabrics ,Rebeccah Pailes-Friedman ,2016 ,Laurence King Publishing*
- *Electronic Textiles: Smart Fabrics and Wearable Technology, Editor: Tilak Dias ,22nd April 2015*

| Course title | Finishing Technology | | | | Course Code | TXE551 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Finishing principles of cellulosic fabrics, crease recovery, anti-soil, Antistatic, anti-bacterial, fire-proof, Heat setting, and optical bleach finishes, Recent Developments and Current Challenges in Textile Finishing, Recent Concepts of Antimicrobial Textile Finishes , Flame Retardant Textile Finishes, Striving for Self-Cleaning Textiles, Metallization of Polymers and Textiles, Wettability Characterization in Textiles – Use and Abuse of Measuring Procedures, Surface Functionalization of Synthetic Textiles by Atmospheric Pressure Plasma, UV-Based Photo-Chemical Surface Modification of Textile Fabrics, Innovative Functionalities of Textiles, Tunable Wettability of Textiles, 3D Textile Structures for Harvesting Water from Fog, Textile-Fixed Catalysts and their Use in Heterogeneous Catalysis,.

**References:**

- *Textile Finishing: Recent Developments and Future Trends, K. L. Mittal, Thomas Bahners,2017, John Wiley & Sons*
- *Principles of Textile Finishing, Author: Asim Kumar Roy Choudhury ,1st April 2017 , Woodhead Publishing*

| Course title | Statistical quality control | | | | Course Code | TXE561 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Basic principles of control systems in textile manufacturing, Testing and statistical quality control in textile manufacturing, Process control in fibre production and yarn manufacture, Process and quality control in cultivating natural textile fibres, Process control in the manufacturing of synthetic textile fibres, Process control in blowroom and carding operations, Process control in drawing, combing and speed frame operations, Process control in ring and rotor spinning, Maintenance of yarn spinning machines, Process control in fabric manufacture, coloration and finishing, Process control in knitting, weaving, nonwovens production, dyeing of textiles, Process control in printing of textiles finishing of textiles, apparel manufacturing,

**References:**

- *The Fundamentals of Quality Assurance in the Textile Industry, Stanley Bernard Brahams, Productivity Press; 1 edition (November 17, 2016)*
- *A. Majumdar, A, Das, R. Alagirusamy and V. K. Kothari, Process control in textile manufacturing Woodhead Publishing, ISBN: 978-0-85709-027-0, 2013*

| Course title | Economics of Textile Process (1) | | | | Course Code | TXE562 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Methods of costing and accounting for spinning mills - operating stages and cost centers in spinning mills, the estimated cost for expanding projects - balance - cash flow methods - economic equilibrium model for equipment and machinery, cost elements, theoretical analysis of the economics of optimal packaging for production - determining the cost of a kilogram of yarn, Assessment of exhausts in factories - the relationship between cost and moisture content in products. Costs and their applications in the spinning and weaving industry - cost classification - the cost of production processes and initial cost - standard costs.

**References:**


- *Engineering Economic Analysis 13th Edition, by Donald G. Newnan (Author), Ted G. Eschenbach (Author), Jerome P. Lavelle (Author), (January 20, 2017)*
- *Economic and Environmental Policy Issues in Indian Textile and Apparel Industries ,Badri Narayanan Gopalakrishnan ,2018 ,Springer International Publishing*


## Level (600)

| Course title | New Spinning Systems | | | | Course Code | TXE611 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Recent developments and automation in cotton spinning. Yarn classification. Basic concepts, mechanisms of yarn formation, yarn structure and properties. Feature of spinning systems: Ring spinning, Rotor spinning, Rotofil spinning systems, Adhesive method of spinning, Friction spinning, Wrap spinning, Twist spinning, Air jet spinning, Air vortex spinning, Magnetic spinning, a self-twist spinning, Siro spun spinning, Fancy yarn spinning techniques, Core spun and other composite yarn spinning systems, compact spinning systems and Solo spun spinning. Evaluation of new spinning methods, applications and marketing. Possibilities for development of automation. Quality criteria and their impact on production quality. Future expected innovations.

**References:**


- *B. Purushothama," Handbook of Cotton Spinning Industry", 2016.*


| Course title | Advanced Weaving Systems | | | | Course Code | TXE621 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

New developments in shuttles weaving machines – New developments in weft insertion systems - New developments in Dobby shedding mechanisms - New developments in jacquard systems – New generations of shedding systems New developments in beat up mechanisms - New developments in warp let off and fabric take up motions- Warp wise multi-phase weaving – Weft wise multi-phase weaving(circular weaving) - 3-D weaving (Solid three-dimensional woven textiles, Hollow three-dimensional woven textiles) – Power electronics in modern weaving machine – Technology of production compound fabrics.

**References:**


- *Prabir Kumar Banerjee ," Principles of Fabric Formation", CRC Press , 2015*
- *Xiaogang Chen," Advances in 3D Textiles ", Woodhead Publishing,, 2015*
- *Valeriy V. Choogin, Palitha Bandara and Elena V. Chepelyuk,, "Mechanisms of Flat Weaving Technology", Woodhead Publishing,, 2013.*


| Course title | Carpets Manufacturing Technology | | | | Course Code | TXE622 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

The role of textiles in floor coverings- Types of textiles used as floor coverings- methods of carpets constructions- carpet yarns engineering- carpet yarns testing and quality control - Carpet manufacturing machines (Face to face, Axminster, Wire Wilton, and Loop Pile weaving) - Advances in carpet weaving, Developments in wool carpet manufacture (technologies for wool carpet yarns ,manufacturing techniques for wool carpets) - Coatings, Raw Materials, and Their Processes, Reducing static electricity in carpets, Finishing of carpets for value addition.

**References:**


- *K. K. Goswami, "Advances in Carpet Manufacture", Woodhead Publishing (UK) , 2018*


| Course title | Economics of Knitting and Ready-made Garments | | | | Course Code | TXE631 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Cost of Products: Materials and components used in production and their prices. Labor cost (direct and indirect) in the stages of production. Production cost in the various operating stages (cutting - sewing - ironing - finishing - inspection - packing). Production planning in knitting mills on various machines (Determining the number of machines - Days of production and operation - the number of thread cones) - Fixed expenses (buildings and machines) - Variable expenses (Energy and Maintenance). Fabric consumption, patron relationship and efficiency, fabric widths, and defects. Case studies of knitting and ready-made garment mills

**References:**


- *John A. White, Kellie S. Grasman, Kenneth E. Case , "Fundamentals of Engineering Economic Analysis ", Wiley, 2020.*
- *Donald G. Newnan, Ted G. Eschenbach, Jerome P. Lavelle, " Engineering Economic Analysis ", Oxford University Press, 2017.*


| Course title | Finishing Technology | | | | Course Code | TXE651 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Finishing principles of cellulosic fabrics: Crease recovery(Reasons for crease formation, Prevention of shrinkage and crease, Resin finishing, Effects on fabric properties)- Anti-soil finishes(Factors affecting soli release, Detergency and soil release, Soil release finishes, Evaluation of soli release)- Antistatic finishes (Generation of static electricity, Control of static electricity , Chemistry of antistatic finishes , Performance evaluation ) - Fire-proof finishes (Flammability of textile fibers, Flame retardants, Mechanism of flame retardancy, FR finishing of cotton) - Anti-bacterial finishes - Heat setting finishes - optical bleach finishes.

**References:**
- *Asim Kumar Roy Choudhury, "Principles of Textile Finishing", Woodhead Publishing (UK,) 2017.*

| Course title | Developments in Textiles Processing | | | | Course Code | TXE652 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Laser applications in textiles processing laser technology applied to textiles processing: cutting, carving, incision, sewing, transmutation, modification, dye fixation, bleaching, anti-counterfeit. textile, cutting using laser, engraving the fabric, using laser in garment manufacturing, advantages of Using Laser in textile processing Textile processing using bio macromolecule, value-Added, finishing of textile by biomolecule, plasma applications: desizing , water repellent finishing on cotton, felting of wool, dyeing, , anti-bacterial fabrics by deposition of silver particles in the presence of plasma. UV applications in textiles processing

**References:**
- *S. Basak, T. Senthilkumar, G. Krishnaprasad, P. Jagajanantha, Sustainable Development in Textile Processing, chapter of " Nanotechnology in the Life Sciences," © Springer Nature Switzerland AG, 2020.*
- R. Shishoo , Plasma technologies *for* textiles. *Cambridge England. CRC Press. Boca Raton Boston New York Washington, DC. Woodhead publishing, 2019.*

| Course title | Modeling and Simulation of Textile | | | | Course Code | TXE653 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to modeling and simulation in textile technology, Neural networks and their application to textile technology, Evolutionary methods and their application to textile technology, Fuzzy logic and its application to textile technology , Computational fluid dynamics (CFD) and its application to textile technology , The finite element method (FEM) and its application to textile technology , Simulation of fibrous structures and yarns , Simulation of wound packages, woven, braided and knitted structures.

**References:**
- *Yordan Kyosev, "Topology-Based Modeling of Textile Structures and Their Joint Assemblies, Springer, 2018.*
- *D Veit, .Simulation in Textile Technology Theory and Applications., Woodhead Publishing (UK), 2012.*

| Course title | Selected Topics | | | | Course Code | TXE654 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The student will study advanced subjects not found in the diploma courses and reflect the recent developments in the field of diploma, after the approval of the Department Council.

**References:**
- *Depend on the selected topics*

<table>
<tr><td>Course title</td><td colspan="4">Project *</td><td>Course Code</td><td>TXE655</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50 Discussion</td><td>0</td><td>50</td><td>0</td></tr>
</table>

**Contents**

A special study on the technical, economic and administrative aspects related to the textile industry "Yarn - Weaving - Knitting - Ready-Made Garments - Finishing" by the researcher. A series of seminars will be held for members of the academic department and industry.

**References:**

- *Depend on the selected topics*

<table>
<tr><td>Course title</td><td colspan="4">Advanced Applied Statistics</td><td>Course Code</td><td>TXE661</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Correlation analysis, Coefficient of determination, Partial correlation analysis, Regression analysis, Linear regression with one and more variables. Multivariate analysis, Multiple correlation analysis, Multiple regression analysis, Polynomial models, Standard error estimation, Analysis of variance, One-way analysis of variance, Two-way analysis of variance, Principles of experimental design, Experimental design. Completely randomized designs. Blocking designs, Latin square designs, Factorial Designs & Analysis, Fractional factorial experiments, Use of replicates. Techniques of optimization, Response surface designs, Statistical Central composite and Box-Behnken designs.

**References:**

- *Ramalingam Shanmuga ,"Statistics for Scientists and Engineers",John Wiley & Sons, Incorporated, 2015.*
- *Statistics for Textile Engineers,vJ. R. Nagla, Woodhead Publishing ISBN: 9789380308265, 2014.*

<table>
<tr><td>Course title</td><td colspan="4">Computer Application and Programming</td><td>Course Code</td><td>TXE662</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">4</td></tr>
<tr><td colspan="2">2</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>20</td><td>30</td><td>50</td></tr>
</table>

**Contents**

Introduction to applications of computer-based technology in the textile field for ( textile materials, fabric structure analysis , fabric defect analysis , modelling and simulation of textiles , garments) - Use one of programming languages to solve some simple textile engineering problems - Applications of image processing and neural networks in the textile field - Use one of the available statistical software packages for data statistical analysis (descriptive statistics and plotting, variance analysis, correlation analysis, regression analysis) - Use programming to solve one complicated application as a project.

**References:**

- *J. Michael Fitzpatrick and Ákos Lédeczi, " Computer Programming with MATLAB", 1st Revised PDF Edition June 2015.*
- *Jinlian Hu , "Computer Technology for Textiles and Apparel", Woodhead Publishing (UK) ,14th July 2011*

| Course title | Quality Management | | | | Course Code | TXE663 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Introduction about what is quality management systems - Difference between Quality Control and Quality Assurance - History of quality standards - The concept of quality - Quality Management structures - Quality management systems - poor quality and defects- Deming-Chain - quality improvement and failure prevention - Normative QM Systems - 7 principles of quality management (Customer focus, Leadership, Engagement of people, Process approach Improvement, Evidence-based decision making, Relationship management) - Detailed requirements for management systems(Context of the organization, Leadership, Planning, Support, Operation, Performance evaluation, Improvement) - The importance of data protection.

**References:**

- *Vivek Nanda, Quality Management System Handbook for Product Development Companies, CRC press , 2005.*
- *Ray Tricker , Quality Management Systems: A Practical Guide to Standards Implementation. Taylor & Francis, 2020*

| Course title | Economics of Textile Process (2) | | | | Course Code | TXE664 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Economics of spinning process, machine efficiency, machine and operative loading layout of processing area. Nature of economic decision, capital cost and use of discounting methods for projects evaluation. Technical economic interactions in the choice of techniques and the design of machinery. Purpose of accounting relationship of financial and cost accounting. Trading, profit and loss accounts, balance sheet, liquid capital and overtrading, corporation tax. Cost concepts, inventory costing, cost control, cost accounting, marginal costing, budgetary control and standard costing. Costing profit and loss account, fund flow statement, ratio analysis, and concept of cost capital, payback period and techniques for calculations.

**References:**

- *John A. White, Kellie S. Grasman, Kenneth E. Case , "Fundamentals of Engineering Economic Analysis ", Wiley, 2020.*
- *Donald G. Newnan, Ted G. Eschenbach, Jerome P. Lavelle, " Engineering Economic Analysis ", Oxford University Press, 2017..*

| Course title | Specification and Measures | | | | Course Code | TXE665 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 20 | 0 | 30 | 50 | | |

**Contents**

Identification and measurement unification of textile products and raw materials, Definitions of specification- Specification limits- Advantages of putting specifications – Problems of specifications – Required specifications of fibers, yarns, woven and knitted fabrics(grey and finished) – Kinds of quality standards – Standards making organizations –Specification preparation and its approval – Specification elements – Stages of standard specification preparation – Specification aims – Sampling inspection by attribute and variables plans- Quality assurance system, International specifications "ASTMBST" ISO., Standard test methods - Applied studies in the field of production of fibers, yarns, and fabrics.

**References**:
- *Ray Tricker , Quality Management Systems: A Practical Guide to Standards Implementation. Taylor & Francis, 2020.*
- *Stanley Bernard Brahams, "The* Fundamentals *of* Quality Assurance *in the* Textile Industry*", Productivity Press, 2016.*
- *ASTM Volume 07.02* Textiles (II)*, November 2019* Textiles (II).

## Level (700)

| Course title | Nanotechnology and Coating of Textiles | | | | Course Code | TXE741 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Nanotechnology in Textiles

Electrospinning of nanofibers and the charge injection method, Producing nanofiber, structures by electrospinning for tissue engineering, continuous yarns from electro spun nanofibers, producing polyamide nanofibers by electrospinning, controlling the morphologies of electro spun Nanofibers, carbon nanotubes and nanocomposites, multifunctional polymer nanocomposites for industrial applications.

Coating of Textiles

An introduction to textile and polymer coating, coating methods, the effect of the coating process on the properties of textiles, the different types of fabrics coating and their uses.

**References**:
- *Jinlian Hu, "Active Coatings for Smart Textiles", Woodhead Publishing, 2016.*

| Course title | Functional and High-Performance Textiles | | | | Course Code | TXE742 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction, High performance fibres, Novel surface treatments for high performance textiles, Plasma technologies for textiles, Plasma treatments for high performance textiles, Laser technologies for textiles , Comparing plasma and laser treatments of textile surfaces . High performance textiles for protective clothing. Requirements for protective clothing, High performance textile fibres , Conventional and high performance fibre blends for protective clothing , Cut resistant and energy absorption materials Clothing for fire fighters , Chemical protective clothing (CPC) , Materials to improve thermo-physiological comfort of protective clothing. Waterproof breathable fabrics, Medical textile, Smart textiles, Sportswear, Introduction of Geo Textile.

**References:**
- *T. Hongu and G. O. Phillips, "New fi bers Second edition", Woodhead Publishing, 2019.*
- *J. W. S. Hearle , Third edition. D. J. Spencer, "High-performance fibres", Woodhead Publishing, 2016.*

| Course title | Advanced Composite Materials | | | | Course Code | TXE743 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction, Material properties. Elastic response of anisotropic, materials, Structural Materials, Composite Materials, Fibers for Advanced Composites, Matrix Materials, Processing. Fundamentals of

Mechanics of Solids : Stresses , Equilibrium Equations , Stress Transformation , Displacements and Strains , Transformation of Small Strains , Mechanics of a Unidirectional Ply, Fiber-Matrix Interaction , Theoretical and Actual Strength , Statistical Aspects of Fiber Strength , Stress Diffusion in Fibers Interacting Through the Matrix , Mechanical Properties of a Ply under Tension, Shear, and Compression in different directions . Woven Fabric composite materials.. Predicting failure of composite materials.

**References:**

- *Dipayan Das Behnam Pourdeyhimi, "Composite Nonwoven Materials", Woodhead Publishing,2014.*

| Course title | Analysis and design of yarn and fabric formation systems | | | | Course Code | TXE751 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Textile product design - Textile product design concepts: basic elements and tools - Textile product design analysis and modeling - Textile modeling techniques - Modeling of textile fibrous structures - Yarn Modeling - Modeling the structures and properties of woven fabrics - Modeling three-dimensional (3-D) woven fabric structures - Modeling of nonwoven materials - Modeling of knitted fabrics - Modeling woven fabric behavior during the making-up of garments – New topics in analysis and design of yarn, fabric formation systems.

**References:**

- *J. Hayavadana, "Woven Fabric Structure Design and Product Planning", Woodhead Publishing, 2015.*

| Course title | Textile Evaluation | | | | Course Code | TXE752 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

-Research Methodology and Educational Statistics

Educational Research. Research Problem. Methods of Educational Research. Developing a Research Proposal. Hypothesis. Sampling. Tools and Techniques of Data Collection.. Reliability and Validity of Test Scores

-Simulation of Textile Processes

Concept of simulation, mathematical simulation, empirical model building, fuzzy logic, Application of different simulation techniques on cotton mixing, fiber blending, carding process, drafting, yarn formation, package building, simulation of weaving and knitting process

-Quality Control

Scope for process control in spinning, Key variable for process control, Establishing norms and standards, A framework for good quality management; Total Quality Management and case studies in TQM.

**References:**

- *J. R. Nagla, "Statistics for Textile Engineers", Woodhead Publishing ISBN: 9789380308265, 2014.*
- *A. Majumdar, A, Das, R. Alagirusamy and V. K. Kothari, "Process control in textile manufacturing", Woodhead Publishing, ISBN: 978-0-85709-027-0, 2013.*

<table>
<tr><td>Course title</td><td colspan="4">Advanced Mechanics of Production Processes and Structure of Fibre Assemblies</td><td>Course Code</td><td>TXE753</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Lectures</td><td>Tutorial</td><td colspan="2">Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>2</td><td>2</td><td colspan="2">0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Stress/strain relations and analysis. Strain energy and failure theories. Axisymmetric problems. Stress concentration problems. Energy methods. Application of advanced technology to the design, development and analysis of high-performance industrial materials. Advanced manufacturing process of fabric formation; fabric structure, geometry and mechanical properties; recent advances in theoretical and experimental fabric formation systems. Design methods for textile reinforced materials, including micro and macro-mechanics, finite element analysis. Recent advances in modeling and analysis of mechanical behavior of flexible structures.

**References**:

- *Gajanan Bhat, "Structure and Properties of High-Performance Fibers", Woodhead Publishing, 2016.*
- *Dipayan Das, "Theory of Structure and Mechanics of Fibrous Assemblies", Woodhead Publishing ISBN: 978-81-908001-7-4, 2012.*

<table>
<tr><td>Course title</td><td colspan="4">Environmental Management in Textile & Allied Industries</td><td>Course Code</td><td>TXE754</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Lectures</td><td>Tutorial</td><td colspan="2">Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>2</td><td>2</td><td colspan="2">0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Importance of ecological balance and environmental protection. Definition of waste and pollutant. Pollutant Categories and types. Waste management approaches. Environmental impact along the textile chain from fibre production to disposal. Toxicity of intermediates, dyes and other auxiliaries etc. Pollution load from different wet processing operations. Technology and principles of effluent treatment. Advanced colour removal technologies, Recovery and reuse of water and chemicals. Air and noise pollution and its control. Eco friendly textile processing: waste minimization. Standardization and optimization, process modification. Safe & ecofriendly dyes and auxiliaries. Energy recovery and chemical modification of fibre waste.

**References:**

- *S Muthu, "Assessing the Environmental Impact of Textiles and the Clothing Supply Chain, 1st Edition", Woodhead Publishing, ISBN: 9781782421047, 2014*
- *K Slater, "Environmental impact of textiles", Woodhead Publishing, ISBN: 978-1-85573-541-5, 2003.*

<table>
<tr><td>Course title</td><td colspan="4">Energy conservation and efficiency for textile companies</td><td>Course Code</td><td>TXE755</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Lectures</td><td>Tutorial</td><td colspan="2">Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>2</td><td>2</td><td colspan="2">0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Energy management, Waste heat recovery. High efficiency lighting, Power factor improvement. Energy consumption for: operating machines and compressed air, air conditioning and lighting, illuminating the atmosphere, Energy Consumption and Conservation in the fibres manufacturing, Energy consumption in yarn manufacturing, General energy usage in ring spinning, Energy consumption for different type of yarns, Factors affecting energy costs in ring Spun Yarn Production, Calculation of power consumption of bare spindle. Energy distribution of power requirements during yarn winding in ring spinning. Minimizing energy consumption of yarn winding ring spinning. Effect of yarn hairiness on energy consumption in rotating a ring-spun yarn package.

**References:**
- *S. C. Bhatia, Sarvesh Devra, "Energy Conservation", WPI, 2016.*
- *LAP Lambert, "Energy Conservation in Textile industry Energy Conservation", Academic Publishing, ISBN: 978-3-8443-2825-,2011.*

| Course title | Management of Textile Production | | | | Course Code | TXE756 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Textile Industry: Structure, production and exports. Textile Policy. Sickness of Textile Industry- Analysis and options. Essentials of production management, production systems, classification. Material management. Production, planning and control. Machine balancing. Layout and material handling. Machine assignment and allocation of jobs. Maintenance management - Productivity and improvement techniques. Quality management: Introduction to TQM, concepts of value and quality assurance, total quality control, quality circles, ISO 9000. Marketing management - Enterprise resource planning: Role of information in managerial decision making, information needs for various levels of management, decision makers, management information system, resource monitoring and control. Case studies in textiles.

**References**:
- *R. Senthil Kumar, "Process Management in Spinning", CRC Publishing, 2014.*
- *Gordana Colovic, "Management of Technology Systems in Garment Industry", Woodhead Publishing ,ISBN: 978-93-803-0807-4, 2011.*

| Course title | Development in Wet Processing and Colour & Design | | | | Course Code | TXE761 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Development in Wet Processing

Water vapor transmission rate and water repelling, Testing methods - Principle & mechanism of flame retardency, Flame retardency of cotton, polyester and C/P blends, Antimicrobial finish. Finishing of woolen fabrics – Moth proofing, permanent set& testing. Finishing of Synthetic fibres – Heat setting, antistatic, soil resistance finishes.

Colour & Design

Light and colour phenomena, physical basis of colour, Colour vision and light theory of colours, Pigment theory of colours. Biren's triangle, Modification of colours, Colour contrast, colour harmony, Application of colours, Mixed colour effect, Composition of designs, Shade mode, Harmony of succession, Different stages of colouring of textile materials.

**References**:
- *J. N. Chakraborty, "Fundamentals and Practices in Colouration of Textiles 2nd Edition", Woodhead, Publishing ISBN: 9789380308463, 2014.*
- *M. Clark, " Handbook of textile and industrial dyeing, volume 1: principles, processes and types of dyes, , 2011.*

| Course title | Electronics and Controls for Textile Industry | | | | Course Code | TXE762 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Overview of electronics and controls in modern textiles equipment's and machines. Overview of basic analog electronics: Elements (R, L, C, V, I), circuit laws and theorems. Overview of basic digital electronics:

Gates and ICs. Sensors and transducers. Signal Conditioning. Control elements, systems and examples. Data acquisition, analysis, control and automation by microprocessors and micro controllers. Motor and power drives. Power control devices. Some applications of data acquisitions and control systems in textiles and case studies. Laboratory: Experiments on sensors and transducers. Basic analog circuits with diodes and transistors. Basic digital Gates. SCR and TRIAC control of motor speed.

**References:**


- *Xiaoming Tao, "Handbook of Smart Textiles", Springer-Verlag GmbH ISBN 978-981-4451-45-1-68-0, 2015.*
- *Jian Fang, et.al, "Applications of Electrospun Nanofibers for Electronic Devices", Springer Singapore Publishing, ISBN: 978-981-4451-68-0, 2015.*


| Course title | Costing, Project Formulation and Appraisal | | | | Course Code | TXE763 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Importance of cost / cost systems, cost control. Project cycle: stages of project cycle description, evaluation of preparation stages, documentation and supervision, various project functions and technical, economic and administrative aspects. Project formulation and evaluation: evaluation concept, methodology for evaluation, various aspects of the market, management, financial and economic technology. Assessment of the technology axis of spinning and weaving projects: technology selection and evaluation, operating constraints, technology suitability, factors affecting selection. Benefits of projects and environmental aspects of spinning and weaving factories: Energy / Steam / Fuel / .........- Qualitative evaluation of modern projects / machine and equipment balance.

**References:**


- *Project Management Institute, " A Guide to the Project Management Body of Knowledge (PMBOK(R) Guide-Sixth Edition ", Project Management Institute Publishing, 2019.*
- *Frank K. Reilly and Keith C. Brown, "Investment Analysis and Portfolio Management (with Thomson ONE - Business School Edition and Stock-Trak Coupon) 10th Edition", ISBN: 978-0538482387, 2012.*

# Chapter Ten:

## Structural Engineering Department

# Diploma in Structural Engineering Majoring in Structural Engineering

## Program description

The main objective of this diploma degree program is to provide postgraduate education of high quality and of higher level that the undergraduate degree, however, the program courses are cast in simpler form and contents than those of master and doctoral degrees. The program should enable the student to develop a more comprehensive understanding of structural engineering fundamental aspects. Thus, the student is expected to establish a solid foundation in structural engineering, which enables to play a more active role in both academia and practice.

## Competencies for the diploma graduate

In addition to the competencies for all diploma engineering program, the graduate of diploma in Structural Engineering must be able to:

1. Demonstrate a comprehensive knowledge and understanding of advanced topics in the field of structural engineering.
2. Demonstrate knowledge and understanding of the design concepts of structures for environmental conditions.
3. Demonstrate knowledge and understanding of key methods of computational mechanics and use of available software in structural analysis.
4. Demonstrate knowledge and understanding of key issues in practice such as quality control and project management.

# Master of Science in Structural Engineering

## Program description

The objective of the master's degree program in Structural Engineering is to provide research informed knowledge in a broad spectrum of advanced topics in the different disciplines of Structural Engineering. The selection of the topics should direct student to develop in depth understanding of one or two of the major disciplines of the filed. This knowledge should enable a student to establish better understanding of academic and practical aspects in the selected major. A student should also develop research skills in order to carry out independent research work in a selected topic.

## Competencies for the program graduate

In addition to general competencies for the MSc. engineering program the graduate of a Master of Science in Structural Engineering must be able to:

1. Demonstrate a comprehensive knowledge and understanding advanced topics in the field of one or two disciplines of structural engineering; e.g., computational mechanics, structural design, geotechnical engineering, material engineering and construction project management.
2. Develop in depth knowledge in the theoretical and practical aspects in the field of specialization.
3. Develop mathematical or experimental skills in the field of specialization.
4. Work with/or develop software in the area of study.
5. Carry out independent research in a selected topic in the field of specialization.

# Ph.D. Program in Structural Engineering

## Program description

The Ph. D. program in Structural Engineering is a research-oriented degree program. Its purpose is to advance the knowledge in the disciplines of Structural Engineering and to enable highly qualified students to undertake specialized advanced studies in one of the major disciplines. The program is designed to prepare student who inherit originality and creativity to conduct original research. The graduates of this program should be fit in teaching and/or research career in academic institutions, engineering firms and leading governmental facilities. The program is meant with issues connected with high tech and current state-of-the art technology in a selected discipline of structural engineering.

## Competencies for the program graduate

In addition to general competencies for the Ph. D. program the graduate of Ph. D. program in Structural Engineering must be able to:

1. Demonstrate a comprehensive knowledge and understanding of advanced topics in the field of structural engineering.
2. Demonstrate a strong technical knowledge in a selected field of Structural Engineering so that he can lead and direct engineering and scientific industry teams in his chosen field.
3. Demonstrate the ability to learn independently and generate new knowledge in his chosen field of Structural Engineering.
4. Reach the highest academic level and demonstrate the ability to generate new knowledge by completing creative novel work and reporting on this work in a dissertation.
5. Apply scientific principles in integrating knowledge learned in previous courses into a dissertation.

## List of level (500) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Exam Duration | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| STE511 | Advanced Structural Analysis | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE512 | Introduction to Finite Element Method | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE513 | Structural Analysis programs | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE514 | Introduction to Structural Dynamics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE521 | Bearing Walls Buildings | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE522 | Quality Control in Concrete Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE523 | Repair and Strengthening of Concrete Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE524 | Technology and Strength of Construction Materials | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE531 | Applied Soil Mechanics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE532 | Theoretical Soil Mechanics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE533 | Soil Properties and Testing | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE541 | Advanced Reinforced Concrete | 2 | 2 | 0 | 3 | 3 | 8 | 2 | 50 | 0 | 50 | 100 |
| STE542 | Precast Concrete | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE543 | Concrete Bridges | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE544 | Introduction to Design of Concrete Structures for Lateral loads | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE545 | Introduction to Design of Prestressed Concrete | 2 | 2 | 0 | 3 | 3 | 8 | 2 | 50 | 0 | 50 | 100 |
| STE551 | Composite Steel Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE552 | Advanced Design of Steel Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE553 | Steel Bridges | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE561 | Cost Estimating and Monitoring | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| STE562 | Construction Contracts and Laws | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE563 | Quality and Safety Management | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE564 | Construction of Temporary Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE565 | Construction Management | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE566 | Construction Methods and Technology | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE567 | Construction Projects Planning | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE571 | Graduate Diploma Project | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 100 | 0 | 0 | 100 |

## List of level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Exam Duration | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **STE611** | Structural Dynamics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE612** | Advanced Structural Analysis | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE613** | Technical Language and Communication Skills | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE614** | Finite Element Method | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE615** | Theory of Elasticity | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE616** | Structural Analysis of Bridges | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE617** | Theory of Elastic Stability | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE621** | Soil-Structure Interaction | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE622** | Plastic Analysis and Design of Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE623** | Theory of Plates and Shells | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE624** | Earthquake Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE625** | Analysis of Wind Loads | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE626** | Earthquake Resistant Design of Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE627** | Introduction to Analysis and Design of Tall Buildings | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE628** | Advanced Numerical Analysis | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE631** | Seismic Analysis of Liquid Tanks and Pipelines | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE632** | Design of Prestressed Concrete Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE633** | Soil Hydraulics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE634** | Design of Reinforced Concrete Shell Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE635** | Advanced Soil Mechanics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE636** | Advanced Topics in Technology and Strength of Materials | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE637** | Introduction to Design of Bridges | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE641** | Soil Dynamics | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| **STE642** | Engineering Geology and Rock Mechanics | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| **STE643** | Site Investigation and Field Testing | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| **STE644** | Advanced Design of Shallow Foundations | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STE645** | Deep Foundations | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| **STE651** | Special Types of Concrete | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE652** | Creep and Shrinkage in Concrete Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE653** | Advanced Project Management | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE645** | Planning and Control | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE655** | Value Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE656** | Infrastructure Projects Management | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE657** | Geotechnical Measurements and Monitoring | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| **STE661** | Off-shore Geotechnical Engineering | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| **STE662** | Problematic soil in Desert | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| **STE663** | Geo-Environmental Engineering | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| **STE664** | Selected Advanced Topics in Structural Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE665** | Design of Steel tanks and Silos | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE666** | Design of Steel Towers (Electricity or Guide and Communication Towers) | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE667** | Design of Special Concrete Structures (1) | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **STE671** | Research of Special Topic (Oral Exam) | 2 | 2 | 0 | 4 | 3 | 8 | 0 | 100 | 0 | 0 | 100 |

## List of level (700) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Exam Duration | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| STE711 | Advanced Research methods and Seminars | 2 | 1 | 0 | 2 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| STE712 | Advanced Topics in Finite Elements | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE713 | Theory of Plasticity | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE721 | Soil Dynamics and Foundations | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE722 | Theory of shell Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE723 | Decision Analysis in Construction | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE724 | Expert Systems in Structural Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE725 | Special Steel Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STE731 | Optimization and Decision Analysis | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE732 | Unsaturated Soil Mechanics | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| STE733 | Soil Modeling | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| STE741 | Design of Special Concrete Structures (2) | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE742 | Behavior of Reinforced Concrete Elements | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE743 | Behavior of Steel Elements and Frames | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE744 | Design of Concrete Tall Buildings | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE745 | Nonlinear Analysis of Reinforced Concrete | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE746 | Design of Concrete Bridges | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE751 | Random Waves and Vibrations | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE752 | Cables and Suspension Bridges | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE753 | Suspension Roofs | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE754 | Design of Steel Towers | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE755 | Control of Ground Water | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| STE756 | Risk Management | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE761 | Applications of Geosynthatics in Geotechnical Engineering | 2 | 1 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| STE762 | Selected Advanced Topics in Modern Construction Materials | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE763 | Technology of Construction Materials | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE764 | Artificial Intelligence in Construction | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE765 | Selected Advanced Topics in Structural Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE766 | Selected Advanced Topics in Geotechnical Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

# Summary of Courses Specification

## Level 500

<table>
<tr><td>Course Title</td><td colspan="4">Advanced Structural Analysis</td><td>Course Code</td><td>STE511</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Analysis of structures using matrices: stiffness method of beams, frames, plane and space trusses, and grids - an introduction to the plastic analysis of structures.

**References:**

- *Srinivas Chandrasekaran ,Advanced Structural Analysis with MATLAB,2018*
- *Igor A. Karnovsky, Olga Lebed ,Advanced Methods of Structural Analysis, 2010*

<table>
<tr><td>Course Title</td><td colspan="4">Introduction to Finite Element Method</td><td>Course Code</td><td>STE512</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Principles of the finite element method – Types of finite elements – Modelling of loads and structural properties – Calculation of stresses – Bar element - rectangular and triangular elements – Plate elements subjected to bending moments – Numerical integration – Integration in two dimensions and three dimensions – Computer applications.

**References:**

*An Introduction to Finite Element Method, JN Reddy - New York, 1993*

<table>
<tr><td>Course Title</td><td colspan="4">Structural Analysis Programs</td><td>Course Code</td><td>STE513</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Applications on using modern mathematical computer programs for the analysis of practical structural problems - Applications on using modern computer programs in the structural analysis of practical structural problems. Examples of these programs are ETABS, Save, Sap.

**References:**

- *SAP2000 Integrated Software for Structural Analysis and Design, Computers and Structures Inc., Berkeley, California, 1979*
- *Srinivas Chandrasekaran, Advanced Structural Analysis with MATLAB,2018*
- *Introduction to finite and spectral element methods using MATLAB, C Pozrikidis – 2005*

| **Course Title** | **Introduction to Structural Dynamics** | | | | **Course Code** | STE514 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Equations of motion and dynamic stability of structures - Response of single degree of freedom structures to dynamic excitation loads: free vibration and periodic and pulsed loads with infinitesimal effecting times - Damping - Generalized systems of single degree of freedom – Newmark method for solving the equations of motion - Response of multi degree of freedom systems- Free vibration and natural mode shapes and vibrations under the influence of forces and damping systems - Introduction to analysis using the natural mode shapes and introduction to random vibrations.

**References:**


- *D. Roy and G. V. Rao, Elements of Structural Dynamics. Chichester, UK: John Wiley& Sons, Ltd, 2012.*
- *M. Paz and W. Leigh, Structural Dynamics. Boston, MA: Springer US, 2004*


| **Course Title** | **Bearing Walls Buildings** | | | | **Course Code** | STE521 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Unites of bearing wall buildings – Types of mortar – Tests for building units, mortar and part of walls – Types of walls - Mechanical behavior of walls – Stresses and strains – Connections between walls and the roof slabs – Repair and strengthening.

**References:**


*A.W. Hendry, B. P. Sinha and S.R. Davies, Design of Masonry Structures, Third edition, 2017*


| **Course Title** | **Quality Control in Concrete Structures** | | | **Course Code** | STE522 |
|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | 2 | - | | |
| **Course grades** | **Practical/Oral** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | 50 | 50 | | |

**Contents**

Quality definition - Program and plan of quality control – Interior and exterior quality control – Role of quality during the age of the project – Stages of quality control - Quality control for concrete materials – Tests of concrete during construction – Non-destructive tests of concrete – Load test for elements in the concrete structures.

**References:**


- *Day, K.W. (1998a) HPC in Australia and SE Asia, Structural Engineers World Congress, San Francisco, July.*
- *Day, K.W. 2008. Optimised concrete quality control. Holland: FIB Conference.*

| Course Title | Repair and Strengthening of Concrete Structures | | | Course Code | STE523 |
|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | Credit hours | 3 |
| | 2 | 2 | - | | |
| Course grades | Practical/Oral | S. work | Final Exam | Total grads | 100 |
| | - | 50 | 50 | | |

**Contents**

Causes of structure defects – Methods of avoiding cracking of concrete – Methods of evaluating of structural defects – Materials used for repair and protection of concrete structures – Methods of repair and strengthening of different structural elements – Protection of concrete structures – Case studies.

**References:**


- *Poonam I. Modi and Chirag N. Patel, "Repair and Rehabilitation of Concrete Structures", PHL Learning, Delhi 2016.*
- *Anibal Costa, Antonio Arede and Humberto Varum, "Strengthening and Retrofitting of Existing Structures, Springer Nature, 2018.*


| Course Title | Technology and Strength of Construction Materials | | | Course Code | STE524 |
|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | Credit hours | 3 |
| | 2 | 2 | - | | |
| Course grades | Practical/Oral | S. work | Final Exam | Total grads | 100 |
| | - | 50 | 50 | | |

**Contents**

Construction materials – types - problems- evaluation- selection- composite construction materials- advanced technology for concrete- special types- durability- corrosion and protection of metals- cracks and joints- materials and methods of repair- technology adapted for alternatives low-cost building materials- methods for assessing resistance of concrete in existing structures- laboratory and field methods to set and confirm the quality of the concrete- the requirements of codes relating to quality assurance.

**References:**


- *American Society for Testing and Materials (1994) C123 – Standard Test Method for Lightweight Pieces in Aggregate. ASTM, West Conshohocken.*
- *British Standards Institution (2003) PD 6682 – Aggregates – Part 1: Aggregates for concrete – Guidance on the use of BS EN 12620. BSI, London.*


| Course Title | Applied Soil Mechanics | | | | Course Code | STE531 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Site investigation - Field tests - Type of foundation – Foundation failure – Basics of vibrations – Retaining structures – Sheet piles walls – Braced cut –Stability of slopes – Introduction of soil reinforcement – introduction of analysis and design for machine foundations.

**References:**


*Braja M. Das, Principles of Foundation Engineering, 2011*

| Course Title | Theoretical Soil Mechanics | | | | Course Code | STE532 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Clay mineralogy - Distribution of stresses in soil – Soil stabilization. Shear strength of soil– Lateral earth pressure – Bearing capacity of soil.

**References:**

*An introduction to geotechnical engineering. By: Robert D. Holtz and William D. Kovacs, 1981*

| Course Title | Soil Properties and Testing | | | | Course Code | STE533 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Soil classification - Soil compaction and California bearing ratio – Soil permeability. Soil stabilization – Swelling – Soil collapse – Unconfined compression test – Direct shear test – Triaxial test.

**References:**

*An introduction to geotechnical engineering. By: Robert D. Holtz and William D. Kovacs, 1981*

| Course title | Advanced Reinforced Concrete | | | | Course Code | STE541 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Ductility of reinforced concrete elements, plastic analysis of reinforced concrete beams and redistribution of moments, shear and torsion. Braced and unbraced slender columns- the effect of (load, displacement) - beam-columns joints, design of reinforced slabs (equivalent frame method, strip method to solve the irregular slabs) - the simulation of the concrete elements by small scale models.

**References:**

- *Park & Paulay, Reinforced Concrete structures, 1975.*
- *Wight & MacGregor, Reinforced Concrete Mechanics and Design, 6th Edition, 2012*

| Course title | Precast Concrete | | | | Course Code | STE542 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction- uses of precast concrete- advantages and disadvantages- the basis of the organization- specifications- manufacturing- transportation- installation- joints- tolerances- fillers for joints- details- constructions with large panels: walls- wind forces- the analysis of shear walls- multi-story framed structures- cladding with precast concrete- combined concrete slabs.

**References:**

- *Steinle, H. Bachmann and M. Tillmann, Precast Concrete Structures, second edition, May 2019*
- *PCI Design Handbook: Precast and Prestressed Concrete*

| Course title | Concrete Bridges | | | | Course Code | STE543 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction- specifications- classification- design loads - design considerations- the various methods of analysis - method of working stress - limit design- implementation of prestressing - types of bridges-T-shaped beams- hollow beams - balanced cantilevers - continuous beams- rigid frames - arches-prestressed concrete bridges - supports and joints- cable-stayed bridges.

**References:**

*P. Mandorf, Concrete Bridges, Taylor and Francis, 2006*

| Course title | Introduction to Design of Concrete Structures for Lateral loads | | | | Course Code | STE544 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Types of lateral loads- the basic concepts and philosophy of design- periodical analysis- seismic zones- estimating lateral loads on an analytical basis and based on different building codes- the design of structural elements to resist lateral loads- reinforced concrete frames and ductile shear walls- filled concrete frames- reinforcement detailing- topics associated with resistance to lateral loads.

**References:**

*T. Paulay and M.J. N. Priestly, Seismic Design of Reinforced Concrete and Masonry Building, 1992*

| Course title | Introduction to Design of Prestressed Concrete | | | | Course Code | STE545 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

General concepts and prestressing methods- prestressing losses: concrete elastic shortening- shrinkage, creep, relaxation of steel- connecting ends – friction- analysis and design of sections: stresses- cracking moment- ultimate moment – shear- bond- and bearing stresses- deflections - Applications.

**References:**

- *P. Collins Michael and D. Mitchel, Prestressed concrete structures, 2006*
- *H. Nilson, Prestressed Concrete Structures, New York,1978*

| Course Title | Composite Steel Structures | | | | Course Code | STE551 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Composite beams – Analysis using elastic stress – Analysis using the ultimate load – Design – Shear connectors – Composite continuous beams – Composite floors – Composite columns.

**References:**

- *Yam, Lloyd CP. Design of composite steel-concrete structures. No. Monograph. 1981.*
- *Uy, Brian, and M. A. Bradford. "Elastic local buckling of steel plates in composite steel-concrete members." Engineering Structures 18.3 (1996): 193-200.*

| Course Title | Advanced Design of Steel Structures | | | | Course Code | STE552 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Structural behavior of steel members - Axially loaded columns – Design of beams for bending - Torsion of beams- columns with beams- steel structures design codes- backgrounds- organization basis- allowable stresses design method- the Egyptian Code.

**References:**

- *Trahair, Nick, and Mark A. Bradford. Behaviour and Design of Steel Structures to AS4100: Australian. CRC Press, 2017.*
- *Trahair, Nicholas Snowden, et al. The behaviour and design of steel structures to EC3. CRC Press, 2007.*

| Course Title | Steel Bridges | | | | Course Code | STE553 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Structural Systems of Bridges- Loads- Floors- Structural Analysis of Bridges- Arches and Truss bridges- Box Girder bridges- Fatigue- Bases- Code Applications.

**References:**

- *Suresh, Subra. Fatigue of materials. Cambridge university press, 1998.*
- *Leonhardt, Fritz. Bridges. 1984.*

| Course Title | Construction Contracts and Laws | | | | Course Code | STE562 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Types construction contracts - relations of construction contracts and project delivery systems - basic principles of construction law - liability of contractors- tendering methods- contract documents - prequalification - insurance and bonds- rules and regulations affecting construction - modifications- claims- dispute resolution - labor law and legal form of construction companies.

**References:**

- *Murdoch, J. and Hughes, W. (2008). Construction Contracts: Law and Management. 4th Edition, Spon Press, London.*
- *Hinze, J. (2010). Construction Contracts, 3rd Edition, McGraw-Hill Science, USA.*

| Course Title | Cost Estimating and Monitoring | | | | Course Code | STE561 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Approximate and detailed methods of cost estimating- feasibility studies and budgeting- bid pricing; quantity surveying- estimating indirect costs- estimating markup- cost control- cost control using network methods- earned value concept- cost forecasting- cost control in different types of contracts.

**References:**

- *Kalin, M., Weygant, R.S., Rosen, H.J. and Regener, J.R. (2010). Construction Specifications Writing: Principles and Procedures. 6th Edition, Wiley, New York.*
- *Peurifoy, R.L. (2013). Estimating Construction Costs. 6th Edition, McGraw Hill, N.Y., USA.*

| Course Title | Quality and Safety Management | | | | Course Code | STE563 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Principles of quality control- Total Quality Management- quality assurance- customer satisfaction;-evaluation of bids to satisfy quality- project delivery methods- project control- principles of construction safety management- an exploration of occupational safety and health from a human behavior perspective- health policies and safety regulations- development of safety management systems.

**References:**

- *Thorpe, B. and Sumner, P. (2005). Quality Management in Construction. 3rd Edition, Gower Pub Co, UK.*
- *Hill, D.C. (2004). Construction Safety Management and Engineering. American Society of Safety Engineers, Des Plaines, Illinois.*

| Course Title | Construction of Temporary Structures | | | | Course Code | STE564 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Temporary facilities used in construction industry for different projects- design and construction of temporary structures -formworks- false works- scaffolding- temporary dams- case studies.

**References:**

- *Robert Beale, João André, Design Solutions and Innovations in Temporary Structures, 2017.*
- *Christopher Souder, Temporary Structure Design, 2014.*

| Course Title | Construction Management | | | | Course Code | STE565 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Construction industry and its nature- types of construction projects- project life cycle- organizational structures- cost estimating- budgeting- information management systems- project planning and scheduling- productivity- construction automation- resources management- risk management.

**References:**

- *McCaffer, R., Harris, F. and Edum-Fotwe, F. (2013). Modern Construction Management. 7th Edition Wiley-Blackwell Granada Publishing, Great Britain.*
- *Halpin, D.W. and Woodhead, R.W. (2011). Construction Management, 4th Edition Wiley and Sons, New York.*

| Course Title | Construction Methods and Technology | | | Course Code | STE566 |
|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | Credit hours | 3 |
| | 2 | 2 | - | | |
| Course grades | Practical/Oral | S. work | Final Exam | Total grads | 100 |
| | - | 50 | 50 | | |

**Contents**

Construction materials – resources – additives - construction methods- formworks - precast concrete - prestressed concrete - temporary steel structures - foundation technology and soil mechanics - deep excavation and tunneling - construction of roads and bridges - quality control.

**References:**

- *Chau, K.W. (1997) Monte Carlo simulation of construction costs using subjective data: response, short communication. Construction Management and Economics, 15(1), 109–115.*
- *Chandra, S, and Bjornstrom, J. (2002) "Influence of cement and superplasticizer type and dosage on the fluidity of cement mortars," Cement and Concrete Research, 32, 1613–1619.*

| Course Title | Construction Projects Planning | | | | Course Code | STE567 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Projects planning methodology- importance of planning and scheduling- scheduling techniques- networking methods- PERT- line of balance- schedule updating; schedule compression- time-cost trade-off- resources scheduling and leveling- using computers in projects planning and control.

**References:**

- *Fisk, E.R. and Reynolds, W.D. (2013). Construction Project Administration. 10th Edition, Prentice Hall.*
- *Pierce, D. (2013). Scheduling and Management for Construction, 4th Edition, RS Means, USA.*

| Course Title | Graduate Diploma Project | | | | Course Code | STE571 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 100 | 0 | | |

**Contents**

Study a problem or more related to any one of the following areas: reinforced concrete, steel structures, engineering and materials technology, management and construction engineering, geotechnical engineering. Each student individually or in groups has to study analytically and/or numerically and/or experimentally the project under the supervision of one or more members of the faculty staff, students have to prepare and submit periodic and final reports and preparing and presenting the final project.

## Level 600

| Course Title | Structural Dynamics | | | | Course Code | STE611 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Dynamic equations of motion- Single Degree of Freedom structures – Effect of damping – Dynamic loads- Numerical methods for solving the equations of motion – Dynamic response of multi degree of freedom systems - Analysis using the natural mode shapes - Time history analysis – Approximate analysis methods - Distributed mass - Random vibrations - Finite element method for dynamic analysis.

**References:**


- *D. Roy and G. V. Rao, Elements of Structural Dynamics. Chichester, UK: John Wiley& Sons, Ltd, 2012.*
- *M. Paz and W. Leigh, Structural Dynamics. Boston, MA: Springer US, 2004*


| Course Title | Advanced Structural Analysis | | | | Course Code | STE612 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction - Analysis of structures having curved elements and supported on elastic foundations – Analysis of thin elements –Nonlinear analysis – Stability analysis – Applications on plastic analysis of beams and frames – Stress-strain relationships in plane and space. Plate theory – Yield line method.

**References:**


- *Advanced probabilistic structural analysis method for implicit performance functions, T Wu, HR Millwater, TA Cruse - AIAA journal, 1990*
- *Advanced structural dynamics and active control of structures, W Gawronski – 2004*

<table>
<tr><td>Course Title</td><td colspan="3">Technical Language and Communication Skills</td><td>Course Code</td><td>STE613</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Practical/Oral</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Review of the English grammar – Elements of technical writing – Types of reports and required skills – Drafts – Repetitive reviews - Oral reports – writing of letters.

**References:**


- *Bandler, R., and J. Grinder. 2005. The Structure of Magic: A Book About Language and Therapy. Vol 1. New ed. Palo Alto, CA: Science and Behavior Books.*


<table>
<tr><td>Course Title</td><td colspan="4">Finite Element Method</td><td>Course Code</td><td>STE614</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction – Stiffness method – Main topics of elasticity theory – Principles of finite element method – Problems of plane stress and plane strain – Linear strain triangular element – Rectangular element – Different types of finite elements – Principle of minimum total energy – Bending in thin plates - Three dimensional elements – Using computers in finite element method.

**References:**


- *Finite element method, X Wang - Qing Hua University Publishing Company, Beijing, 2003*
- *An Introduction to Finite Element Method, RÁ Cabal – 2014*


<table>
<tr><td>Course title</td><td colspan="4">Theory of Elasticity</td><td>Course Code</td><td>STE615</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction to Cartesian tensors – Stress analysis – Strain analysis – Main relationships – Energy theories – Plane stress and strain - General applications - Tension, bending and torsion of beams - Retaining walls - Yield conditions – Nonlinear relationship between stress and strain.

**References:**


- *Kang Feng , Zhong-Ci Shi, Mathematical Theory of Elastic Structures, 1996.*

| Course Title | Structural Analysis of Bridges | | | | Course Code | STE616 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Loads on bridges – Distribution of loads for bridges – Finite element method for bridges – Effect of stiffness of bridge elements on the stresses – Analysis of columns and supports of bridges – Types of bridges – Linear and nonlinear analysis - Dynamic analysis of moving loads on bridges – Seismic effect on bridges – Supports – introduction for simple methods for seismic analysis of bridges.

**References:**

- *C C Fu, Shuqing Wang, Computational analysis and design of bridge structures, 2015.*
- *Ehab Ellobody, Finite Element Analysis and Design of Steel and Steel-Concrete Composite Bridges, 2014.*

| Course title | Theory of Elastic Stability | | | | Course Code | STE617 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 3 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Bending of structural elements subjected to axial and lateral loads – Buckling of members subjected to compression and frames in elastic and inelastic field – local buckling – Lateral buckling of beams – Basic of design – Effect of imperfection – Effect of end conditions.

**References:**

- *S. Timoshenko and J. Geer, Theory of Elastic stability, second edition, 1961*
- *E M Lui, W F Chen, Structural Stability Theory and implementation, Elsevier, 1987.*

| Course Title | Soil-Structure Interaction | | | | Course Code | STE621 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

The effect of interaction between soil and each of shallow and deep foundations – Lateral earth pressure on walls, sheet piles, silos and tunnels.

**References:**

- *Deep excavation: Theory and practice. By: Chang-Yu Ou*
- *Soil-Structure Interaction. By: A.S. Cakmak*

| Course title | Plastic Analysis and Design of Structures | | | | Course Code | STE622 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | | 50 | 50 | | |

**Contents**

Introduction – Plastic Analysis of different cross-sections – Methods of plastic analysis – Plastic design of continuous beams, frames and connections – Effect of axial loads – Yield line method for slab analysis.

**References:**

*M. Bill Wong, Plastic Analysis and Design of Steel Structures. 2009.*

| Course title | Theory of Plates and Shells | | | | Course Code | STE623 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | - | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Analysis of stresses in plates – Analysis of circular plates – Classic solutions for rectangular plates – Continuous plates – Buckling of plates – Analysis of folded plates – Membrane theory of shell structures. Analysis of plates and shells using numerical methods.

**References:**

*B. K. Chatterjee, Theory and Design of Concrete shells, 1988*

| Course title | Earthquake Engineering | | | | Course Code | STE624 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Specification of earthquakes – Measuring earthquakes – Sources of earthquakes and seismic maps – Seismic waves - Behavior of buildings under the effect of earthquakes – Dynamic loads due to earthquakes – Ductility requirements – Structural systems to resist earthquakes – Models for earthquakes – Equivalent static lateral force method – Response spectra analysis –Time history analysis - Ductility properties of shear wall buildings and moment resisting frame buildings – Applications.

**References:**

*T. Paulay and M.J. N. Priestly, Seismic Design of Reinforced Concrete and Masonry Building, 1992*

| Course Title | Analysis of Wind Forces | | | | Course Code | STE625 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Nature of wind – Statistical analysis of wind layers – Spectral air – Nonhomogeneous horizontal air - Dynamics of wind - wind shapes and velocities – Wind tunnel model – resisting of buildings to wind – Forces in wind direction and lateral direction – Effect of random wind on elastic structures – Time history analysis of different structures under the effect of wind.

**References:**


- *Advanced Structural Wind Engineering, Yukio Tamura • Ahsan Kareem, Springer Japan 2013*
- *Wind Effects on Structures an Introduction to Wind Engineering, E. Simiu and R. H. Scanlan, New York:Wiley, 1986.*


| Course title | Earthquake Resistant Design of Structures | | | | Course Code | STE626 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Nature of earthquakes, Behavior of structures under earthquake effect – response spectra – Design for earthquakes using equivalent lateral force method - seismic codes recommendations and requirements - Nonlinear behavior of structural elements due to earthquakes – Philosophy of earthquake resistant design - Ductility requirements - Methods of seismic design of reinforced concrete beams, columns and beam-column connections- Applications.

**References:**


*T. Paulay and M.J. N. Priestly, Seismic Design of Reinforced Concrete and Masonry Building, 1992*


| Course Title | Introduction to Analysis and Design of Tall Buildings | | | | Course Code | STE627 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

General considerations – Effect of wind – Design for earthquake – Systems for resisting lateral forces for steel, reinforced concrete and composite buildings - Systems for resisting vertical forces for steel, reinforced concrete and composite buildings – Applications.

**References:**


*Bungale S. Taranath, Tall Building Design, 2017.*

*Bungale S. Taranath, Structural Analysis and Design of Tall Buildings, 2012*

| Course Title | Advanced Numerical Analysis | | | | Course Code | STE628 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction – Programming – Solution of problems – Numerical analysis using computers – Error analysis – Methods of solution of symmetrical matrices – Finite difference method – Retz method – Introduction to finite element method.

**References:**

- *Numerical analysis using MATLAB and Excel,* Steven T. Karris , *2007*
- *Numerical Solution of Partial Differential Equations: Finite Difference Methods ,G. D. Smith, 1986*

| Course Title | Seismic Analysis of Liquid Tanks and Pipelines | | | | Course Code | STE631 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Liquids retaining structures- circular and rectangular tanks and elevated tanks and underground tanks-Pipe lines – Earthquake Loads - Design methods and analysis - Detailing – Related modern topics.

**References:**

- *Donald G Anderson, Seismic analysis and design of retaining walls, buried structures, slopes, and embankments, 2008.*
- *EN 1998-4: 2006 Eurocode 8: Design of structures for earthquake resistance - Part 4: Silos, tanks and pipelines, 2006.*

| Course title | Design of Prestressed Concrete Structures | | | | Course Code | STE632 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction - Prestressing methods - Analysis and design of different sections: for prestressed concrete - Composite sections - Analysis and design of continuous beams – Special structural members - Design of bridges using prestressed concrete - Special structures

**References:**

- *P. Collins Michael and D. Mitchel, Prestressed concrete structures, 2006*
- *H. Nilson, Prestressed Concrete Structures, New York,1978*

| Course Title | Soil Hydraulics | | | | Course Code | STE633 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Permeability – Environmental pressure – Surface tension – Confined flow – Unconfined flow - Seepage analysis – seepage from channels - Analysis of Seepage in three dimensions – Vertical drains – Soil Grouting – theory of wells.

**References:**
*Soil Mechanics in Engineering Practice. By: Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri, 1996*
*Martin Preene, Groundwater Lowering in Construction - A Practical Guide to Dewatering, Second Edition, 2013*

| Course title | Design of Reinforced Concrete Shell Structures | | | | Course Code | STE634 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**
Introduction – Membrane theory – Reinforced concrete shell structures – Design and analysis of cylindrical shells – Shells with double curvature – Detailing of shell structures – Applications – Modern topics.

**References:**
*B. K. Chatterjee, Theory and Design of Concrete shells, 1988*

| Course Title | Advanced Soil Mechanics | | | | Course Code | STE635 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | **50** | **50** | | |

**Contents**
Stress-Strain behavior – Stress path method – Theory of consolidation (One Dimension – radial – Three Dimension) - Maximum stress on soil – Yield surfaces – Critical state method - Theory of bearing capacity – Bearing capacity of deep foundation – Theory of lateral earth pressure – Analysis of slopes stability.

**References:**
*Andrew Schofield and Peter Wroth, Critical state soil mechanics. By: Andrew Schofield and Peter Wroth, 1968*

| Course Title | Advanced Topics in Technology and Strength of Materials | | | Course Code | STE636 |
|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | Credit hours | 3 |
| | 2 | 2 | - | | |
| Course grades | Practical/Oral | S. work | Final Exam | Total grads | 100 |
| | - | 50 | 50 | | |

**Contents**
The student will study the issue or advanced topics reflect recent developments in the field of technology and strength of materials.

**References:**
- *Jamal M. Khatib "Sustainability of Construction Materials", Woodhead Publishing Series, No 70, 2016.*
- *Nel De Belie, Marios Soutso, and Elke Gruyaert, "Properties of Fresh and Hardened Concrete Containing Supplementary Cementitious Materials", State of the Art Report of RILEM, Technical Committee 238-SCM 2018*

| Course title | Introduction to Design of Bridges | | | | Course Code | STE637 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Historical review – Economy of bridges - Structural materials for bridges - Structural systems for bridges – Design and analysis of bridge superstructure – Design of simple bridges – Types of bridge foundations.

**References:**

*P. Mandorf, Concrete Bridges, Taylor and Francis, 2006*

| Course Title | Soil Dynamics | | | | Course Code | STE641 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Fundamentals of vibrations – Soil dynamic properties – Soil liquefaction – Propagation of waves – Analysis of soil seismic response – Soil-structure dynamic interaction.

**References:**

*Braja M. Das, G.V. Ramana, Principles of Soil Dynamics, 2nd Edition, 2011.*

| Course Title | Engineering Geology and Rock Mechanics | | | | Course Code | STE642 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Physical and mechanical properties of rocks – Classification of rock mass – Laboratory and field tests of rock – Foundations rest on rocks – Rock's slope stability – Underground caves in rock.

**References:**

*John Jaeger, N. G. Cook, Robert Zimmerman, Fundamentals of Rock Mechanics, (4th Edition), 2007.*

| Course Title | Site Investigation and Field Testing | | | | Course Code | STE643 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Planning and design of site investigation – Excavation methods – Classification of soil and rock – Field testing (Cone – Delatometer – Vane…….) - Geophysical testing – Measuring and Monitoring.

**References:**

*Braja M. Das, Principles of Foundation Engineering, 2011*

| Course Title | Advanced Design of Shallow Foundations | | | | Course Code | STE644 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Design of raft – Foundation on reinforced soil – Design for foundation of machines – Vibration damping – Design for repeated loads – Applications.

**References:**

*Robert D. Holtz and William D. Kovacs, An introduction to geotechnical engineering, 1981*

| Course Title | Deep Foundations | | | | Course Code | STE645 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Classification and construction methods of piles – Analysis and design for Vertically loaded piles- Negative skin friction – Pile groups- Settlement of piles – Pile loading test (Type-Configuration-analysis) - piles under lateral and torsional loading- Design of caissons.

**References:**

*Lymon C. Reese, William M. Isenhower, Shin-Tower Wang, Analysis and Design of Shallow and Deep Foundations, 2005*

| Course title | Special Types of Concrete | | | | Course Code | STE651 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Normal concrete – Light-weight concrete – Polymer concrete – Fiber reinforced concrete – Nuclear power station concrete – High strength concrete – Self compacting concrete - Heated concrete – Architectural concrete - Shotcrete concrete – Another selected types of concrete.

**References:**

- *Rafat Siddique, "Self-Compacting Concrete, Materials, Properties, and Applications", Woodhead Publishing Series, 2020*
- *Mark Alexander, Arnon Bentur, and Sidney Mindess,"Durability of Concrete, Design and Construction", CRC Press 2017*

| Course title | Creep and Shrinkage in Concrete Structures | | | | Course Code | STE652 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Deformations of concrete – Concrete drying at different heat degrees and humidity – Measuring of creep and shrinkage practically and mathematically – Different methods for calculating and analysis of creep and shrinkage – Numerical analysis of creep in concrete structures.

**References:**

- *A Favre Ghali and M. Elbadry, "Concrete Structures: Stresses and Deformations, Analysis and Design for Sustainability", Taylor&Francis 2019*
- *Zdenek P. Bazant and Milan Jirasek, 2Creep and Hygrothermal Effects in Concrete Structures", Springer Sciences 2018*

| Course Title | Advanced Project Management | | | | Course Code | STE653 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Topics in construction management and engineering including: network methods - creating and monitoring a construction project schedule - resource allocation of single and multiple skills- non-deterministic scheduling techniques - dealing with project uncertainty - risk management - bid preparation and markup estimation - delay and claim analysis - project control - construction site planning, and computer applications in project management.

**References:**

*Ellis, R. and Fryer, B.G. (2004). The Practice of Construction Management. Blackwell Publishing.*
*PMI (2013). A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Edition, Project Management Institute.*

| Course Title | Planning and Control | | | | Course Code | STE654 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Basic and advanced principles of construction projects planning- project activities and sequencing- networking- linear projects and line of balance method- PERT- GERT- cost curve and cash flow analysis- project control- schedule updating- time-cost relationship- schedule compression- resources assignment and leveling- computer applications in construction project planning and control.

**References:**

- *Virendra Kumar Paul and Chaitali Basu, "A Handbook for Construction Project Planning and Scheduling", Copal Publishing Group, 2017*
- *Tom Stephenson, "Planning, Scheduling, and Controlling of Construction Projects", American Technical Publishers, 2018*

| Course Title | Value Engineering | | | | Course Code | STE655 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Principles of value engineering - Methods of applying value engineering - Value and performance evaluation of structures - Responsibility for value engineering studies - Methods of functional analysis - Matrix evaluation - Brainstorming- life-cycle cost analysis – Applications - Other topics in value engineering.

**References:**

*R.G.Chaudhari, "Techniques of Training In Value Engineering", Notion Press 2018*

*Herbert Robinson, "Design Economics for the Built Environment", Wiley Blackwell 2015*

| Course title | Infrastructure Projects Management | | | | Course Code | STE656 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Infrastructure projects - Building Information Modeling - Design, construction and maintenance - Framework for asset management - Condition assessment of infrastructure projects – sustainability - needs assessment - Life cycle cost - Economics of infrastructure projects - Deterioration modeling - Planning and management of maintenance works - Applying of optimization methods in maintenance.

**References:**

- *Dipti Ranjan Mohapatra, "Economic and Financial Analysis of Infrastructure Projects", Educreation Publishing 2017*
- *Lasse Gerrits and Stefan Verweij, "The Evaluation of Complex Infrastructure Projects", Edward Elgar Publishing 2018*

| Course Title | Geotechnical Measurements and Monitoring | | | | Course Code | STE657 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Objectives and types of monitoring - accuracy and sensitivity in geotechnical measurements - monitoring of ground water - monitoring of movement - monitoring of internal water pressure.

**References:**

*An introduction to geotechnical engineering. By: Robert D. Holtz and William D. Kovacs, 1981*

| Course Title | Off-shore Geotechnical Engineering | | | | Course Code | STE661 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Origin and classification of sedimentation soil - off-shore geotechnical testing - Foundations for mass and marine structures - Deep marine foundation- Back-filling in water.

**References:**

*E.T.R Dean, Offshore Geotechnical Engineering: Principles and Practice, 2010*

| Course Title | Problematic soil in Desert | | | | Course Code | STE662 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

properties of swelling soil - methods of sampling - Laboratory and field testing - Practical considerations - properties of collapsing soil - methods of sampling - Laboratory and field testing - Practical considerations.

**References:**

*Soil Mechanics in Engineering Practice. By: Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri, 1996*

| Course Title | Geo-Environmental Engineering | | | | Course Code | STE663 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Field classification for contaminant sites - contaminates transfer in soil (Modeling and hydrology) - Design of contaminant sites treatment - soil and contaminant properties - Methods of collecting rubbish.

**References:**

- *Soil Mechanics in Engineering Practice. By: Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri*
- *Foundation Analysis and Design. By: Bowels*

| Course Title | Selected Advanced Topics in Structural Engineering | | | | Course Code | STE664 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

The student will study the issue or advanced topics reflect recent developments in the field of structural engineering.

| Course Title | Design of Steel Tanks and Silos | | | | Course Code | STE665 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Steel Tanks (ground, elevated, circular, rectangular) - Static Analysis and Design- Dynamic Analysis and Equivalent Static Load - Steel Siloes- Effect of Solid Materials – Loads- Loading Systems- Shells.

**References:**


- *Virella, J. C., L. A. Godoy, and L. E. Suárez. "Dynamic buckling of anchored steel tanks subjected to horizontal earthquake excitation." Journal of Constructional Steel Research 62.6 (2006): 521-531.*
- *Flügge, Wilhelm. Stresses in shells. Springer Science & Business Media, 2013.*


| Course Title | Design of Steel Towers (Electricity or Guide and Communication Towers) | | | | Course Code | STE666 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Types of Towers- Design Loads of Towers - Design Requirements- Structural Analysis- Design of Elements and Connections- Foundations and Fixing of towers- Design Codes.

**References:**


- Knight, G. M. S., and A. R. Santhakumar. "Joint effects on behavior of transmission towers." *Journal of Structural Engineering* 119.3 (1993): 698-712.
- Tapia-Hernández, Edgar, Santiago Ibarra-González, and David De-León-Escobedo. "Collapse mechanisms of power towers under wind loading." *Structure and Infrastructure Engineering* 13.6 (2017): 766-782.


| Course title | Design of Special Concrete Structures (1) | | | | Course Code | STE667 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Methods of design of reinforced concrete – Static analysis – Dynamic analysis methods – Effect of wind and earthquakes - Modern design of reinforced concrete halls - applications - Space analysis of reinforced concrete structures - New topics in reinforced concrete.

**References:**


*T. Paulay and M. J. N. Priestly, Seismic Design of Reinforced Concrete and Masonry Buildings, 1992.*

<table>
<tr><td>Course Title</td><td colspan="4">Research of Special Topic (Oral Exam)</td><td>Course Code</td><td>STE671</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>100</td><td>0</td></tr>
<tr><td colspan="7"><u>Contents</u><br>An introduction to research techniques in construction management; problem definition-selecting appropriate research methodology- data collection and questionnaires- statistical analysis-mathematical modeling and automation- students should submit a research paper and presenting it considering the abovementioned techniques.</td></tr>
</table>

# Level 700

| Course title | Advanced Research Methods and Seminar | | | | Course Code | STE711 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Advanced methods in research techniques in construction management - Modeling - Design and development of structural systems - Verification methods - Implementation using computers - Students are asked to submit and present a research paper in one of the problems in the structural engineering domain.

**References:**


- *Tan, W. (2004). Practical Research Methods. Pearson Prentice Hall, New York.*
- *Cramer, D. (2003). Advanced Quantitative Data Analysis. Open University Press, McGraw-Hill Education.*


| Course Title | Advanced Topics in Finite Elements | | | | Course Code | STE712 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Modelling of structural elements (beams, curved beams and plates ) – General modeling of shell elements – Nonlinear analysis using finite elements - Limits of stresses and strains – Trusses and cables – Two-dimensional elements - Three-dimensional isoparametric elements – Behavior of elastic materials - Behavior of plastic materials – Solution of equilibrium equations in dynamic analysis – Direct integration method – Wilson-Theta method – Newmark method.

**References:**


*K. Bathe, Finite Element Procedures, Second Edi. 2014.*


| Course title | Theory of Plasticity | | | | Course Code | STE713 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction – Cartesian tensor Analysis - Three dimensional analysis of stresses – Theories of yield and failure - Three dimensional analysis of strains – Stress–strain relationships for elastic materials - Stress–strain relationships for fully plastic materials – Applications for concrete and steel – Limit Analysis of structures.

**References:**


*W. F. Chen and D. Han, Plasticity for structural engineers, 1988*

| Course Title | Soil Dynamics and Foundations | | | | Course Code | STE721 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Behavior of dynamically loaded soil- Dynamic properties of soil - Laboratory and field investigations for determining dynamic properties of soil - Dynamic behavior of soil for seismic movements - instability of soil due to earthquakes - Vibrations of foundation - Interaction between soil and structures and its effect on dynamic behavior of buildings.

**References:**

*Soil Mechanics in Engineering Practice. By: Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri, 1996*

| Course title | Theory of Shells | | | | Course Code | STE722 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction – Theory of shells for curved surfaces - Theory of shells for surfaces with double curvature – Analysis of cylindrical shells and parabolic shells – Strains, stresses and symmetrical loads – Bending theory for cylindrical shells - Applications.

**References:**

*B. K. Chatterjee, Theory and Design of Concrete shells, 1988*

| Course title | Decision Analysis in Construction | | | | Course Code | STE723 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Procedures for deciding under uncertainty - Analysis of problems using decision trees that including risk and time preferences - Determination of the economic value of perfect and imperfect information in one or several variables in a decision problem - Use of fuzzy logic in decision analysis.

**References:**

- *Amarjit Singh, " Quantitive Risk Management and Decision Making in Construction" American Society of Civil Engineering 2017*
- *Patricia Guarnieri, "Decision Models in Engineering and Management", Springer 2015*

| Course title | Expert Systems in Structural Engineering | | | | Course Code | STE724 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction to expert systems: definitions and historical and philosophical backgrounds - Components of the expert system: knowledgement base and induction engine - Main tasks: information acquisition and representation - Research methods: progressive, regressive and non-systematic sensory – Applications: reviewing current applications of expert systems in structural engineering - A practical exercise using ready-made programs - Introduction to Prolog language - Project: Preparing simple units for expert systems.

**References:**


- *Buchanan, B. and Shortliffe, E. (1984). Rule-Based Expert Systems, Addison-Wesley, Menlo Park, California.*
- *Dym, C. and Levitt, R. (1991). Knowledge-Based Systems in Engineering. McGraw-Hill, New York.*
- *Durkin, J. (1994) Expert systems Design and Development. 1st Edition Macmillan Coll Div.*


| **Course Title** | **Special Steel Structures** | | | | **Course Code** | STE725 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Space Structures – Suspension Systems – Structures with Steel Pipes – Prestressed Systems - Applications.

**References:**


- *Tomasz Michalowski and Marek Tomasz Piekarczyk, "Selected Issues of Special Steel Structures", Wydawnictwo PK 2019*
- *Srinivasan Chandrasekaran, "Advanced Steel Design of Structures", Taylor&Francis Group 2020*


| **Course title** | **Optimization and Decision Analysis** | | | | **Course Code** | STE731 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Static and dynamic models - Queuing theory - Monte Carlo simulation - Linear programming- The simplex method - Transportation and assignment problems - Evolutionary algorithms - Multi-objective optimization.

**References:**


- *Amarjit Singh, " Quantitive Risk Management and Decision Making in Construction" American Society of Civil Engineering 2017*
- *Patricia Guarnieri, "Decision Models in Engineering and Management", Springer 2015*


| **Course Title** | **Unsaturated Soil Mechanics** | | | | **Course Code** | STE732 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 |
| | 2 | | 1 | - | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Fundamentals of unsaturated soil - Unsaturated soil mechanics - Laboratory testing for unsaturated soil - Modeling of unsaturated soil.

**References:**


*Soil Mechanics in Engineering Practice. By: Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri, 1996*

| Course Title | Soil Modeling | | | | Course Code | STE733 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Linear and nonlinear elasticity - hypoelasticity - plasticity - hardening functions - yield surfaces - Critical state method- Applications of numerical solutions.

**References:**

*Soil Mechanics in Engineering Practice. By: Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri, 1996*

| Course title | Design of Special Concrete Structures (2) | | | | Course Code | STE741 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Methods of design - shell structures - applications - folded plates roofs - structures related to nuclear safety - structures with space frames - new topics in reinforced concrete.

**References:**

- *Feng Fu, "Design and Analysis of Tall and Complex Structures", Elsevier 2018*
- *Iskhakov and Y. Ribakov, "Design Principles and Analysis ofThin Concrete Shells, Domes and Folders", Taylor&Francis 2015*

| Course title | Behavior of Reinforced Concrete Elements | | | | Course Code | STE742 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Behavior and strength of reinforced concrete elements – Beams under bending, shear and torsion – short and slender columns under concentric and eccentric loads - deflection and cracking of concrete – Current codes provisions and their use.

**References:**

*Wight & MacGregor, Reinforced Concrete Mechanics and Design, 6th Edition, Prentice-Hall Int., USA, 2012*

| Course Title | Behavior of Steel Elements and Frames | | | | Course Code | STE743 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Behavior of open and closed thin walled sections under the effect of torsion- Numerical and Analytical methods for the analysis of the elements and frames with thin walls – Elastic and plastic behavior of steel elements – Plastic instability in plane and space – Design of columns under loads with double eccentricity – special problems for structural stability

**References:**

- *Qing Quan Liang, "Analysis and Design of Steel and Composite Structures" Taylor & Francis Comp. 2015*
- *Raffaele Landolfo, Federico Mazzolani, Dan Dubina, Luis Simoes da Silva and Mario D Aniello, "Design of Steel Structures for Buildings in Seimic Areas", Eurocode 8, Wiley 2017*

<table>
<tr><td>Course Title</td><td colspan="4">Design of Concrete Tall Buildings</td><td>Course Code</td><td>STE744</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction – Different loads affecting on tall buildings – Principles of earthquake resistant design - Structural systems for resisting loads in tall buildings - Methods of design of tall R/C buildings – Design of foundations for tall buildings – Advanced topics in design of tall buildings.

**References:**

- *Reinforced Concrete Design of Tall Buildings, Bungale S. Taranath , 2009.*
- *Tall Buildings: Structural Systems and Aerodynamic Form* , Mehmet Halis Günel, Hüseyin Emre Ilgin , *2014*

<table>
<tr><td>Course Title</td><td colspan="4">Nonlinear Analysis of reinforced Concrete</td><td>Course Code</td><td>STE745</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction – Plasticity in Reinforced Concrete – Main properties of concrete and steel – Failure in concrete – Different models for concrete behavior – Cracks in concrete – Models for cracks – Analytical application using finite element method – Models for bond – Deformations due to long term – Nonlinear behavior of structures. Advanced topics.

**References:**

- *Non-linear Finite Element Analysis of Solids and Structures, M. A. Crisfield, 1991.*
- *Nonlinear Finite Element Analysis of Composite and Reinforced Concrete Beams, Xiaoshan Lin, Yixia (Sarah) Zhang, Prabin Pathak, 2020.*

<table>
<tr><td>Course title</td><td colspan="4">Design of Concrete Bridges</td><td>Course Code</td><td>STE746</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction – Structural systems for concrete bridges – Principles of Analysis and Design – Design and analysis of bridge superstructure – Expansion joints – Protection of bridge surface and drainage systems – Design of special type bridges – Design and Analysis of bridge foundations.

**References:**

*P. Mandorf, Concrete Bridges, Taylor and Francis, 2006*

<table>
<tr><td>Course Title</td><td colspan="4">Random Waves and Vibrations</td><td>Course Code</td><td>STE751</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Principles of random vibrations – Free vibrations and forced vibrations – Stresses due to waves- Effect of wind on different types of surfaces - Surface Waves and body waves – Applications on Blast loads Special topics.

**References:**

- *Structural vibration: analysis and damping,* Beards, C. F. *1996*
- *Structural Dynamics and Vibration in Practice: An Engineering Handbook,* Douglas Thorby *, 2008*

<table>
<tr><td>Course Title</td><td colspan="4">Cables and Suspension Bridges</td><td>Course Code</td><td>STE752</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Types of Cables – Supporting of Cables – Types of Cable bridges – Types of bridge towers - Suspension Bridges – Loads and specification on bridges – Static analysis using the elastic method and the deflection theory - Dynamic analysis – Stability of bridges - Different methods of bridge construction.

**References:**

- *Sreenivas Alampalli and William J. Moreau, "Inspection, Evaluation and Maintenance of Suspension Bridges", Taylor & Francis 2016*
- *Alessio Pipinato, "Innovative Bridge Design Handbbok, Construction, Rehabilitation and Maintenance", Elsevier 2016*

<table>
<tr><td>Course Title</td><td colspan="4">Suspension Roofs</td><td>Course Code</td><td>STE753</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>-</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction - Types of Cables and cables roofs – Supporting of Cables – Types of roofs – Types of loads on roofs – Methods of Static and dynamic analysis – Advantages and disadvantages of cantilever systems.

**References:**

- *Numerical Analyses of Cable Roof Structures, Gunnar Tibert, 1999.*
- *Cable-Suspended Roofs, Second Edition, Prem Krishna, 2013.*

| Course Title | Design of Steel Towers | | | | Course Code | STE754 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Introduction – Structural analysis of braced towers – Safety conditions – Braced towers under the effect of loads – Stability of braced multi-levels towers – Types of loads on Towers – Dynamic analysis of braced towers – Advanced buckling of braced towers.

**References:**

- *Libin Wang and Farhad Dehghan, "Design of Steel Structures", Scitus Academics 2018*
- *Bungale S. Taranath, "Tall Building Design, Steel, Concrete and Composite Systems", Taylor & Francis 2017*

| Course Title | Control of Ground Water | | | | Course Code | STE755 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Methods of dewatering – Impermeables and natural obstacles – Impermeables by grouting - freezing - Electrical methods.

**References:**

- *Soil Mechanics in Engineering Practice. By: Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri*
- *Foundation Analysis and Design. By: Bowels*

| Course title | Risk Management | | | | Course Code | STE756 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Risks - Risk management in construction projects - Risk management cycle - Risk identification - Risk quantification: qualitative and quantitative assessment - Sensitivity analysis - Monte Carlo simulation; decision tree - Artificial intelligence techniques - Risk response: risk mitigation- risk sharing; risk avoidance.

**References:**

- *Howard Kunreuther, Robert J. Meyer, and Erwann O. Michel Kerjan, "The Future of Risk Management", University of Pennsyvania Press 2019*
- *Thomas Wolke, "Risk Management", Walter de Gruyter GmbH, Berlin 2017*

| Course Title | Applications of Geo-synthatics in Geotechnical Engineering | | | | Course Code | STE761 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 |
| | 2 | | 1 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Types of Geo-synthetics - Main uses of Geo-synthetics in Geotechnical Engineering - Design and applications of separation - design and applications of drainage - Design and applications of filter - Design and application of reinforcement- design and applications of liquid obstructing - testing methods and quality control.

**References:**

*Soil Mechanics in Engineering Practice. By: Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri*
*Foundation Analysis and Design. By: Bowels*

| Course title | Selected Advanced Topics in Modern Construction Materials | | | | Course Code | STE762 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

The student will study the issue or advanced topics reflect recent developments in the field of design of reinforced concrete structures.

**References:**

- *P. Purushothama Raj, "Building Construction Materials and Techniques", Pearson Education India 2017*
- *Jiri Brozovsky, "Modern and Renewable Materials in Civil Engineering", Trans Tech Publishing 2020*

| Course title | Technology of Construction Materials | | | | Course Code | STE763 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

Composite construction materials – Failure theories – Mechanics and technology of concrete – principles of mechanics of concrete fracture – Mechanics of green concrete – Creep and shrinkage – Resistance to fire – Methods of protecting and repair – Failure of buildings due to materials (types – causes) – case studies.

**References**

- *Rafat Siddique, "Self-Compacting Concrete, Materials, Properties, and Applications", Woodhead Publishing Series, 2020*
- *Mark Alexander, Arnon Bentur, and Sidney Mindess, "Durability of Concrete, Design and Construction", CRC Press 2017*

| Course title | Advanced Artificial Intelligence in Construction | | | | Course Code | STE764 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | | 50 | 50 | | |

**Contents**

Use and / or development of computer applications to advanced artificial intelligence techniques such as neural networks - A comparative analysis of cases - Algorithms / genetic programming - Preparing a final report and a computer program to use those techniques.

**References:**

- *Paul Marsden, "Digital Quality Mangement in Construction", Taylor & Francis 2019*
- *Geoff Hulten, "Building Intelligent Systems", Apress 2018*

| Course Title | Selected Advanced Topics in Structural Engineering | | | | Course Code | STE765 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

The student will study the issue or advanced topics reflect recent developments in the field of structural engineering.

**References:**

- *Wyatt Kelly, „Structual Engineering", Larsen and Keller Education 2019*
- *Brightwood Engineering Education, "Structural Engineering; Problems and Solutions", Professional Publications, 2018*

| Course Title | Selected Advanced Topics in Geotechnical Engineering | | | | Course Code | STE766 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | - | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | - | - | 50 | 50 | | |

**Contents**

The student will study the issue or advanced topics reflect recent developments in the field of geotechnical engineering.

# Chapter Eleven:

## Irrigation and Hydraulics Engineering Department

# Department of Irrigation and Hydraulics Engineering
# Graduate Studies (Diploma, M.Sc., and Ph.D.)

## Program Description:

The purpose of this chapter is to provide students with information about the available graduate studies in the department of Irrigation and Hydraulics Engineering (IRH) pursuing a graduate degree (Diploma, M.Sc., and Ph.D.) in one of the most important specialization in Civil Engineering. The offered programs provide engineers who have completed their Bachelors or Masters with high quality in-depth education, training and research needs in the fields of Irrigation and Hydraulics Engineering. The programs aim to generate high quality academic researchers and world class professionals who able to participate and lead the field of water engineering to develop the scientific research and serve the society, as well as to contribute in the realization of the Egyptian Sustainable Vision Strategy (SVS 2030), which of its goals are the integrated and sustainable development of Egyptian water resources

## Degree Awarded:

The students have opportunities to focus on any of following research graduate programs of our department in the pursuit of awarded one of the following degrees:

1. **Diploma of Engineering Sciences** in Irrigation and Hydraulics Engineering: Specialization Water Resources.
2. **Diploma of Engineering Sciences** in Irrigation and Hydraulics Engineering: Specialization Irrigation and Drainage Engineering.
3. **Diploma of Engineering Sciences** in Irrigation and Hydraulics Engineering: Specialization Coastal and Ports Engineering.
4. **Master of Engineering Sciences (M.Sc.)** in Irrigation and Hydraulics Engineering.
5. **Doctor of Philosophy (Ph.D.) in Engineering Sciences** in Irrigation and Hydraulics Engineering.

### Competencies for the Engineering science Diploma graduate

In addition to generic competencies for the Engineering science Diploma, the graduate of Engineering science Diploma in Irrigation and Hydraulics Engineering must be able to:

1. Acquire advanced and in-depth knowledge in Irrigation and Hydraulics Engineering in general and in the specific specialization of each Diploma in particular in order to extend their prior knowledge which was acquired during the bachelor's degree program.
2. Demonstrate the capabilities to further discover, develop and use the new knowledge and technologies related to irrigation and hydraulics engineering in practical applications and research projects in the specific specialization of each Diploma.
3. Analyze and evaluate problems of Irrigation and Hydraulics Engineering relevant to the specific specialization of each Diploma providing innovated solutions through the application of appropriate tools and techniques.

### Competencies for Master of Science in Irrigation and Hydraulics Engineering graduate

In addition to generic competencies for the M.Sc. in engineering, the graduate of Master of Science in Irrigation and Hydraulics Engineering must be able to:

1. Plan and perform research in Irrigation and Hydraulics Engineering professionally, ethically and responsibly.
2. Appraise available information and research evidence and apply it to problem-solving and different engineering & technology decision making scenarios for practical and scientific applications related to Irrigation and Hydraulics Engineering.

### Competencies for the Doctor of Philosophy (Ph.D.) in Engineering Sciences graduate

In addition to generic competencies for the Ph. D. program, the graduate of Engineering science Ph.D. in Doctor of Philosophy (Ph.D.) in Engineering Sciences in Irrigation and Hydraulics Engineering must be able to:

1. Use practical, scientific and personal skills to synthesize knowledge and contribute in original research that leading to novel and innovative ideas and broadening the frontier of knowledge in Irrigation and Hydraulics Engineering
2. Provide scientific and innovated advices to society in Irrigation and Hydraulics Engineering through conduct research independently and adhere to legal, ethical and professional.

## Course Coding System

The generating of unique code which identifies the course is strongly suggested because it aids in managing the program, generating reports and registering students. The used course coding system is followed section (7) in the Egyptian Reference Framework for Preparing Study Programs for the Graduate Studies in Faculties of Engineering (2020) as shown in following figure. Note that, the second digit in the coding indicates nature of the course discipline and its exact specialization as reflected in following table.

| Digit | Field |
|---|---|
| 1 | Advanced Common General Courses |
| 2 | Hydraulics and Water Structures |
| 3 | Hydrology and Water Resources |
| 4 | Irrigation and Drainage |
| 5 | Coastal and Ports Engineering |
| 6 | Water Power |
| 9 | Research Project and Advanced Topics |

## List of Level (500) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Final Exam Duration | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **IRH511** | Computer Applications in Hydraulic Engineering * | 2 | 0 | 3 | 5 | 3 | 8 | 3 | 50 | --- | 50 | 100 |
| **IRH512** | Operation Research Methods | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | ---- | 50 | 100 |
| **IRH521** | Advanced Hydraulics * | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 30 | 20 | 50 | 100 |
| **IRH522** | Advanced Design of Hydraulic Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH523** | Sediment Transport | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH531** | Advanced Hydrology | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH532** | Water Resources Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH541** | Modern Irrigation and Drainage Technologies | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | ---- | 50 | 100 |
| **IRH542** | Soil, Plant and Water Relation | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | ---- | 50 | 100 |
| **IRH543** | Land Reclamation | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | ---- | 50 | 100 |
| **IRH551** | Coastal Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH552** | Ports and Waterways | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |

(*) Note that the courses IRH511 "Computer Applications in Hydraulic Engineering" and IRH 521 "Advanced Hydraulics" are compulsory courses for all IRH graduate studies programs

## List of Level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Final Exam Duration | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **IRH611** | Numerical Modelling of Flow and Transport | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH612** | Environmental Impact Assessment (EIA) of Water Projects and Egyptian Law for the Environment | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | ---- | 50 | 100 |
| **IRH613** | GIS and Remote Sensing Applications for Water Resources Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **IRH621** | River Mechanics and Sediment Transports | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH622** | Pump Stations and Water Supply Works | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | ---- | 50 | 100 |
| **IRH623** | Dams Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH624** | Bridge Engineering | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | ---- | 50 | 100 |
| **IRH631** | Groundwater Hydrology | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | ---- | 50 | 100 |
| **IRH632** | Stochastic Methods in Hydrology | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | ---- | 50 | 100 |
| **IRH633** | Vadose Zone hydrology | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **IRH634** | Water Resources Development in River Basins | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | ---- | 50 | 100 |
| **IRH651** | Coastal Process and Sediment Transports | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH652** | Design of Marine Structures | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | ---- | 50 | 100 |
| **IRH653** | GIS and Remote Sensing Applications for Coastal Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| **IRH661** | Marine Renewable Energy | 2 | 2 | 0 | 4 | 3 | 7 | 3 | 50 | ---- | 50 | 100 |
| **IRH699** | Research Project * | 1 | 2 | 3 | 6 | 3 | 10 | 3 | 50 | ---- | 50 | 100 |

(*) Note that the course IRH699 “Research Project” is a compulsory course for all IRH graduate studies programs.

## List of Level (700) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Final Exam Duration | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **IRH711** | Probabilistic Design and Risk Analysis in Hydraulic Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH712** | Soil Dynamics and Foundations | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH721** | Estuaries hydraulics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH722** | Flood Control and Drainage Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH723** | Sustainable Urban Drainage Systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH724** | Water Hammer in Pipes and Protection Methods | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH731** | Water Resources Systems Planning and Management | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH732** | Hydrosystems Engineering Reliability and Risk Analysis | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH733** | Sustainable Water Resources Management | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH751** | Hydrodynamic Loads on Offshore Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH752** | Design of Offshore Floating Structures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH753** | Integrated and Sustainable Coastal Zone Management | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH754** | Marine Dock Design | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH755** | Port Planning and Infrastructure Design | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH791** | Advanced Topics in Hydraulic Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |
| **IRH792** | Research Related Course | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | ---- | 50 | 100 |

## Summary of Courses Specification

<table>
<tr><td>Course title</td><td colspan="4">Computer Applications in Hydraulic Engineering*</td><td>Course Code</td><td>IRH511</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>0</td><td>3</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>----</td><td>20</td><td>30</td><td>50</td></tr>
</table>

**Contents**

Introduction to computer programming language – Numerical modeling techniques - Computer modeling of surface and subsurface hydrology – Computer modeling of flood plain hydraulics – Computer modeling of water resources – Computer modeling in hydraulics, coastal engineering, port engineering. Computer modeling of hydraulic structures design- Morpho-dynamics - coastal process and/or sedimentation. Theoretical basis - application and design studies. Integrated student-developed original computer programs and commercially available software will be used to further students understanding usage and programming.

**References:**

- *Tutorial Manuals for available Hydraulics and Hydrology software, WSM, CMS, 2017.*
- *Haestad Methods Engineering Staff "Computer applications in hydraulic engineering: connecting theory to practice" The Bentley Institute Press, third edition 2016.*

(*) Note that the courses "IRH511" is a compulsory course for all IRH graduate studies programs

<table>
<tr><td>Course title</td><td colspan="4">Operation Research Methods</td><td>Course Code</td><td>IRH512</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>----</td><td>----</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Course Overview – Definitions - Linear Programming Duality in Linear Programming – Sensitivity analysis in Linear Programming - Graphical Method - Procedures for Solving LPP by Graphical Method - Linear Programming Applications - The Simplex Method - The Two-Phase Method - The Big - M Method - Transportations Method – Formulation and Initial Solution - Finding the Optimal Solution - Probabilistic Approach - Project Evaluation and Review Technique (PERT) - Project Crashing - Network Analysis – Shortest Route and Minimal Spanning Tree - Network Analysis – Maximal Flow - Case Study, Solving the Pipe Network Analysis Problem Using Optimization Techniques

**References:**

- *F.Hillier and J.Lieberman, "Introduction to Operation Research", McGraw Hill, latest edition.2018.*
- *Hamdy Taha, "Operations Research", Prentice Hall, latest edition, 2015.*

<table>
<tr><td>Course title</td><td colspan="4">Advanced Hydraulics*</td><td>Course Code</td><td>IRH521</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>----</td><td>20</td><td>30</td><td>50</td></tr>
</table>

**Contents**

Introduction to course syllabus and review of undergraduate hydraulics courses - Basic principles - Specific energy - momentum and energy principles - Uniform flow and gradually varied flow versus rapidly varied flow - Differential equations governing unsteady flow in open channels - Simple surface waves in subcritical and supercritical flows - Introduction of kinematic, diffusion, and dynamic wave methods - Simplified methods of flow routing.

**Laboratory experiments:** conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

**References:**

- *Terry W. Sturm," Open Channel Hydraulics ", McGraw-Hill Education, 2019 (ISBN 978-0071267939).*
- *Cengel, Y.A. and Cimbala, J.M., "Fluid Mechanics. Fundamental and Applications", McGraw-Hill, 2017.*
- *Houghtalen, R.J., Akan, A.O.H., & Hwang, N.H.C., "Fundamentals of Hydraulic Engineering Systems", Prentice Hall, 4th Edition, 2011.*

(*) Note that the courses "IRH521" is a compulsory course for all IRH graduate studies programs

<table>
<tr><td>Course title</td><td colspan="4">Advanced Design of Hydraulic Structures</td><td>Course Code</td><td>IRH522</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>----</td><td>----</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Design of a variety of hydraulic structures is explored to provide student with the advanced knowledge about their types, functions, importance, planning and design based on economic, environmental, ethical, political, societal, health and safety considerations. Analysis and design of hydraulics structures such as soil retaining structures, bridges, Water conveys structure (syphon aqueducts), measuring devices (weirs), rapidly varied flow structures (spillways), regulating structures (River Nile barrages), energy dissipation basins, etc. Analysis and design of channels including uniform flow (canals and drains) and gradually varied flow (flood routing) taking in consideration channel design problems (geometric considerations, scour, channel stabilization, sediment transport).

**References:**

- *Sheng-Hong Chen, "Hydraulic Structures", Springer-Verlag Berlin Heidelberg 2015*
- *Houghtalen, R.J., Akan, A.O.H., & Hwang, N.H.C., "Fundamentals of Hydraulic Engineering Systems", Prentice Hall, 4th Edition, 2016 Fourth edition.*
- *Egyptian Standard Codes of Practice and Guidelines, 2015.*

| Course title | Sediment Transport | | | | Course Code | IRH523 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction – Origin and Formation of Sediment and Its Properties - Properties of Water – Properties of Transport Material – Imitation of Particle Motion – Fall Velocity of Sediment Particles - Turbulence - Basic Conceptions of Sediment Movement - Flow Resistance in Alluvial Streams - Transport Mechanism, Bed forms, Alluvial Roughness – Bed Material Transport, Bed Load Bed Load Motion, Suspended Load Motion of Suspended Sediment, Total Load – Sediment Transport Capacity of the Flow - Influence of the Existence of Sediment on Flow Stable Channel – Morphological Computations – Local Scour – Measurement Techniques – Sediment Transport in Pipes.

References:


- *H.N.C. Breusers, "Sediment Transport I", International Course in Hydraulic Engineering, Delft Hydraulics. 2016.*
- *Ning Chien and Zhaohui Wan, "Mechanics of Sediment Transport", ASCE PressISBN (print): 978-0-7844-0400-3ISBN (PDF): 978-0-7844-7890-5, 2017.*


| Course title | Advanced Hydrology | | | | Course Code | IRH 531 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction: hydrologic cycle, atmospheric hydrology - thunderstorm cell model: IDF relationships, spatial averaging methods of rainfall, factors affecting evaporation, estimations & measurement of evaporation, energy balance estimation & measurement of evaporation, energy balance method, aerodynamic method and pans evaporation - subsurface water and surface water, unit hydrograph: definition and limitation of a UH, UH optimization using regression, matrix, and LP methods, synthetic unit hydrograph - S-curve - hydrologic statistics probability concepts, random variables, laws of probability, PDF and CDF, normal & binormal distributions - statistical parameters: expected value, variance, skewness and peakednese.

**References:**


- *Saeid Eslamian "Handbook of Engineering Hydrology Environmental Hydrology and Water Management", 2014 ·*
- *"HYDROLOGY AND WATER RESOURCES ENGINEERING, 2016*
- *K. Subramanya "Engineering Hydrology", Tata McGraw Hill Publishing Company, Delhi.*
- **https://nptel.ac.in/courses/105104029/2**

| Course title | Water Resources Engineering | | | | Course Code | IRH532 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction (The World's Fresh Water Resources) - Water Resources Sustainability (Challenges to Water Resources Sustainability, Surface Water System )– Water Budgets - Hydraulic Processes: Flow and Hydrostatic Forces - Principles of water resources engineering - the science of surface and ground water - irrigation engineering principles - Hydraulic Processes: Open-Channel Flow - Hydraulic Processes: Groundwater Flow - Hydrologic Processes - Surface Runoff - Reservoir and Stream Flow Routing - hydraulic structures for flow diversion and storage - Hydraulic Processes: Pressurized Pipe Flow - Probability, Risk, and Uncertainty Analysis for Hydrologic and Hydraulic Design - hydropower engineering.

**References:**

- *Larry W. Mays," Water Resources Engineering", 2011, John Wily & Sons, First edition.*
- https://nptel.ac.in/courses/105105110/

| Course title | Modern Irrigation and Drainage Technologies | | | | Course Code | IRH541 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to water resources - Accurate estimation of crop coefficients relating to the types of crops and area - Irrigation by flooding and by strips - Furrow irrigation - Sprinkler irrigation - Drip irrigation - Improving performance of surface irrigation systems - Subsurface irrigation - Irrigation with magnetically treated water - Salinity Hazards - Surface drainage - Subsurface drainage – Bio-drainage - Modern irrigation systems operation and maintenance - Comparison of different irrigation systems - Recommendation on operating and maintaining sprinkler Irrigation systems - Recommendation on operating and maintaining drip Irrigation systems - Water savings due to switching to more efficient systems - Determining irrigation time - Determining sprinkler irrigation time - Determining drip irrigation time.

**References:**

- *Waller, P., and Muluneh, Y., Irrigation and drainage engineering, ed Cham: Springer International Publishing, 2016.*
- *Omran, E.S.E., Negm, A.M. (eds.) Technological and Modern Irrigation Environment in Egypt: Best Management Practices & Evaluation, Springer, 2020.*
- https://www.researchgate.net/publication/318394690_Modern_Irrigation_Systems_Operation_and_Maintenance

| Course title | Soil, Plant and Water Relation | | | | Course Code | IRH542 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction and definition of units - Water properties - Soil properties (physical properties, Mineral soil, organic soil), (Porosity – Compaction – Salinity – and sodicity) – categories of salt affected soils - Soil structure- Soil-water characteristics curve and relationship - Static water in soil - Moving water in saturated soil - Field capacity, wilting point, available water, and the non-limiting water range – water intake – Soil water Content – Surging – Soil cracking Tension-meters – Infiltration – Evapotranspiration - Sap flow - Solar radiation, black bodies, and energy balance.

**References:**

- *Kirkham, M. B. Principles of Soil and Plant Water Relations (Second Edition), M. B. Kirkham, Ed., ed Boston: Academic Press, 2014.*
- https://digitalcommons.usu.edu/govdocs/516

| Course title | Land Reclamation | | | | Course Code | IRH543 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Course overview – Definitions – Terminology - Soil and ecosystem – types of soil – soil characteristics - Soil erosion - Reducing soil erosion - Methods to increase fertility and productivity of soils - Characteristics of Arid and Desert Ecosystems - Management of Water Resources - Amendment of Saline and Alkaline Soils - Wind Erosion and Regeneration of Vegetation Cover in Arid and Semi-arid Areas - The Potential of Desert Areas - Management of groundwater in reclamation sites – Re-vegetation techniques - Erratum to: Reclamation of Arid Lands - Reclamation equipment.

**References:**

- *Jafari, M., Tavili, A., Panahi, F., Zandi Esfahan, E., and Ghorbani, M., Reclamation of Arid Lands, ed Cham: Springer International Publishing, 2018.*

| Course title | Coastal Engineering | | | | Course Code | IRH551 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

The coastal environment - Understanding coastal system behavior - Wave theory - Small-amplitude wave theory - Wave transformation and attenuation processes - Finite amplitude waves - Wave forces - Surf zone processes - Design wave specification - Short-term wave statistics - Directional wave spectra - Wave energy spectra, the JONSWAP spectrum - Swell waves - Prediction of deep-water waves - Prediction of near shore waves - The TMA spectrum - Numerical transformation of deep-water wave spectra - Long-term wave climate changes - Coastal water level variations - Astronomical tide generation - Tide data - Harmonic analysis - Numerical prediction of tides - Theory of long-period waves - Tidal flow modelling - Storm surge – Tsunamis - Long-term water level changes.

**References:**
- *US Army Corps of Engineers*, "Coastal Engineering Manual", *EM1110-2-1100, 2008*
- *J. William Kamphuis, "Advanced Series on Ocean Engineering: Volume 48 - Introduction to Coastal Engineering and Management" 3rd Edition, World scientific, hardcover ISBN hardcover:978-981-120-799-0, eBook ISBN:978-981-120-898-0, 2020*

| **Course title** | **Ports and Waterways** | | | | **Course Code** | IRH552 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents:**
An introduction to ports and waterways, history, types and functions, port authority and organization, integral planning, safety, sustainability; Preplanning stage and studies, environmental studies, economic and finance, vessel study, site surveying, geotechnical investigation, etc; Planning stage, function of the port, develop alternatives related to selected strategy, objectives and environmental impact assessment, economical evaluation, optimize and select of alternative, General layout and master plan, Flexible planning, Berthing area and water front length, terminal areas, turning basin, navigation channels, breakwater, land use area planning.

**References:**
- *Han Ligteringen, "Ports and Terminals", Delft Academic Press, 2nd edition, 2017*
- *J. William Kamphuis, "Advanced Series on Ocean Engineering: Volume 48 - Introduction to Coastal Engineering and Management" 3rd Edition, World scientific, hardcover ISBN hardcover:978-981-120-799-0, eBook ISBN:978-981-120-898-0, 2020*

| **Course title** | **Numerical Modelling of Flow and Transport** | | | | **Course Code** | IRH611 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**
Introduction for mathematical problems - simulation of various physical processes involved in rivers, estuaries, channels, lakes, seas, etc. - introduction to numerical methods and techniques for solving ordinary and partial differential equations - numerical methods for initial value problems - solution of first order ordinary differential equation: time integration, convergence, consistency and stability - solution system of first order differential equations - numerical methods for boundary value problems - partial differential equations - diffusion equation - finite difference method - finite element method - finite volume method - two-step and implicit schemes - convection equation - space discretization and time integration - convection diffusion equation .

**References:**
- *Joel H. Ferziger, Milovan Perić, Robert L. Street, "Computational Methods for Fluid Dynamics", DOI: 10.1007/978-3-319-99693-6, ISBN: 978-3-319-99691-2, 2020*
- *M. Zijlema, " Computational modelling of flow and transport", Delft University of Technology, Item number (Artikelnummer 06917300083), 2015.*
- *Ziya Uddin, "Computational Fluid Dynamics", LAP Lambert Academic Publishing, 2012*

| **Course title** | **Environmental Impact Assessment (EIA) of Water Projects and Egyptian Law for the Environment** | | | | **Course Code** | IRH612 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Theory and practice of environmental impact assessment (EIA) - Introduction of environmental impact assessment - Environment and Background - Sustainable development - History of Environmental Impact Assessment - Definition of Environmental Impact Assessment - Benefits and Directive of Environmental Impact Assessment - The Environmental Impact Assessment Process - Types of Assessments - Environmental Impact Statement - Basic Steps in the Process - Alternative - Screening - Scoping - Impact analysis - Mitigation - Follow up - Public involvement - Impact prediction methodologies and mitigation measures – Air, Surface and ground water – Egyptian Law for the Environment (Law 4/1994 for the Protection of the Environment Amended by Law 9/2009) - Case study (EIA study for a water related structure)

**References:**


- *Mareddy, Anji Reddy, Anil Shah, and Naresh Davergave. Environmental impact assessment: theory and practice. Butterworth-Heinemann, 2017.*
- *Eccleston, Charles H. Environmental impact assessment: A guide to best professional practices. Crc Press, 2011.*


| **Course title** | **GIS and Remote Sensing Applications for Water Resources Engineering** | | | | **Course Code** | IRH613 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | ---- | 40 | 50 | | |

**Contents**

Introductory for Geographical Information System (GIS) and Remote Sensing techniques relevant for analysis of Water Resources - Basics and geospatial analysis in GIS - An introduction to the graph theory - Data models and data structure - Watershed delineation in GIS - Mapping of surface water systems such as reservoirs, canal systems, River and watershed networks - Introduction to remote sensing techniques - Overview satellite principles and measurements - Image pre-processing, Data and corrections - Digital image processing, thermal and microwave remote sensing, Case studies.

**References:**


- *Elbeih, Salwa Farouk, Negm, Abdelazim M., Kostianoy, Andrey, "Environmental Remote Sensing in Egypt", Springer International Publishing, ISBN: 978-3-030-39592-6, 2020*
- *Skidmore, Andrew, "Environmental modelling with GIS and remote sensing", CRC Press, 2017.*
- *A. Cazenave, N. Champollion, J. Benveniste, J. Chen, "Remote Sensing and Water Resources", Springer International Publishing, ISBN: 978-3-319-81288-5, 2016.*
- *van Dijk, A., Bos, Marinus G., "GIS and Remote Sensing Techniques in Land- and Water-management", Springer Netherlands, ISBN: 978-94-010-6492-7, 2001*

| Course title | River Mechanics and Sediment Transports | | | | Course Code | IRH621 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction – Definitions – Terminology - Review on basic concepts of sediment transport properties along the rivers - Open channel flow and hydraulics of sediment transport - Bed regime – governing equations of sediment transport – Bed load – suspended load – wash load – total load - Erosion and sedimentation problems along the river sections - River mechanics and morphology - Mathematical modeling of river hydraulics - Sediment transport and river channel changes – River meandering and scour - Design and environmental problems in Rivers - Erosion control and river training – river bed degradation .

**References:**


- *Armanini, Aronne, "Principles of River Hydraulics", eBook ISBN: 978-3-319-68101-6, Springer International Publishing, 2018*
- *H. J. de Vriend, H. Havinga, B.C. van Prooijen, P.J. Visser and Z.B. Wang, "River Engineering" Delft University of Technology, 2011*


| Course title | Pump Stations and Water Supply Works | | | | Course Code | IRH622 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction to Water Transport and Distribution - Main objectives and components of WTD systems - Water demand categories, patterns, calculation and forecasting - Steady-state hydraulics of pressurized flows, single pipe calculation, branched and looped networks, pressure driven demand - Hydraulics of storage and pumps - Hydraulic design: choice of supply scheme, network layouts, design of pumping stations, power requirements and energy consumption - Engineering design: choice of pipe materials, valves and other equipment - Network construction: pipe laying, testing and disinfection - Operation & maintenance, regular & irregular supply, network cleaning and rehabilitation.

**References:**


- *Trifunovic, Nemanja." Introduction to urban water distribution", Unesco-IHE lecture note series. CRC Press, 2016.*


| Course title | Dams Engineering | | | | Course Code | IRH623 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ----- | 50 | 50 | | |

**Contents**

Introduction to Dams Engineering - Hydrologic and Environmental Aspects of Reservoir Planning and Design - Classification and Selection of the Dam Types Based on the Geologic studies and Geomorphologic Criteria – Types of dams according its function - Essential Design Elements for Embankment Dams - Concrete Dams: Classification of Concrete Dams - Preliminary Design of

Gravity Dams - Preliminary Design of Arch Dams - Dam Safety – classification of forces on gravity dams – stability analysis of dams – Modes of dam failure.

**References:**

- *Hager W. H., Schleiss A. J., Boes r. M., Pfister M. "Hydraulic Engineering of Dams", CRC Press, ISBN-13: 978-0415621533, 2020.*
- *Houghtalen, R.J., Akan, A.O.H., and Hwang, N.H.C., "Fundamentals of Hydraulic Engineering Systems ", 4th Edition, 2011, Prentice Hall*

| Course title | Bridge Engineering | | | | Course Code | IRH624 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction to bridge Engineering - History of bridges and sustainable development - Components and classifications of bridges - General considerations, standards specifications and guidelines for hydraulic structural design of highways and River bridges - Background investigations, Site visit, data collections, - Hydrology and hydraulic analysis: the collection of flood discharges, flow patterns, levels and velocities - Area of bridge waterway , Scour assessment and scour protection measures - Structural analysis and design process: loads on bridges, slab bridges and culverts, Girder and T beam bridges, Basics of selection and forces for bridge bearings, Substructures design, foundations, - Available software for hydraulic and structural design will be employed.

**References:**

- *L.W. Zevenbergen, L.A. Arneson, J.H. Hunt, A.C. Miller, "Hydraulic Design of Safe Bridges" Hydraulic Design Series No. 7, Publication No. FHWA-HIF-12-018, 2015*
- *"Hydraulic Design of Highway Culverts", Third Edition, Hydraulic Design Series No. 5, FHWA Publication Number: HIF-12-026, 2014*
- *Vazirani, Chandola, "Handbook for Civil Engineering", Khanna Publishers, ISBN 9788174092274, 2013*

| Course title | Groundwater Hydrology | | | | Course Code | IRH631 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Background – hydrologic cycle- water budgets – Darcy's law and hydraulic potential – the steady state groundwater flow equation – streamlines and flow nets – regional flow and geologic controls on flow – transient flow – aquifer storage and compressibility – unconfined flow – groundwater interaction with streams and lakes – numerical methods – flow in fractured rock – well hydraulics: Thiem and Theis equations – pump tests and slug tests – contaminant transport: advection and dispersion, sorption and diffusive mass transfer – couples flow and transport with density driven flow, freshwater/saltwater interaction.

**References:**

- *Todd and Mays, (2015), "Groundwater hydrology", Wiley India Edition, Third edition.*
- *Charles F. Fitts,n (2013), "Groundwater science", Elsevier, Second edition.*
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-72-groundwater-hydrology-fall-2005/index.htm

| Course title | Stochastic Methods of Hydrology | | | | Course Code | IRH632 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction: bivariate distribution, independence - functions of random variables, moments of distributions - commonly used probability distributions: normal distribution, continues distribution - data generation: parameter estimation, covariance and correlation, data generation - time series analysis: frequency domain analysis, ARIMA model, case studies - Markov chains - frequency analysis: probability plotting, goodness of fitness, IDF relationships - multivariate model: multiple linear regression, principle component analysis, regression on principle component, multivariate stochastic model - data consistency checks – applications.

**References:**


- *Bras R.L. &Rodriguez-Iturbe, (2011), "Random Functions and Hydrology", Dover Publications, New York, USA.*
- *Clarke, R.T., (2014), "Statistical models in Hydrology", John Weily, chinchester.*
- https://nptel.ac.in/courses/105108079/4


| Course title | Vadose Zone hydrology | | | | Course Code | IRH633 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | 10 | 40 | 50 | | |

**Contents**

Introduction to physical and transport properties of soils near ground surface - quantifying hydrological processes and investigating land atmosphere interactions - properties of soils and porous media - soil water content - soil water retention, capillarity, and soil water characteristic curve (SWC) - saturated and unsaturated flow through soil (Darcy's Equation + Richard's Equation) - radiation and energy balance, and land-atmosphere interactions using remote sensing - solute transport in soils (solute transport mechanisms in porous media, breakthrough curves, convection-dispersion equation)

**Laboratory experiments**: using the constant head method to measure the saturated hydraulic conductivity.

**References:**


- *Schultz, G.A., Engman, E.T. (eds) Remote Sensing in Hydrology and Water Management. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-59583-7_1, 2012.*
- *Srivastava, P. K., Petropoulos, G. P., and Kerr, Y. H., Eds., Satellite Soil Moisture Retrieval, ed: Elsevier, 2016.*


| Course title | Water Resources Development in River Basins | | | | Course Code | IRH634 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction to the concepts and approaches for sustainable river basin development - Hydrology and hydraulics, agricultural water management - Environmental impact assessment, and basin development and management plans - Data collection, monitoring, analysis, and field techniques for water and sediment sampling - Deterministic and probabilistic design for river structures, and flood frequency analysis - Using remote sensing for river basin development and obtaining freely available remote sensing data. - Developing models to provide river basin development decisions.

**References:**


- *United Nations. Department of Economic Social Affairs, Integrated River Basin Development: Report of a Panel of Experts: UN, 1970.*
- *Melesse, A. M., Abtew, W. and Setegn, S. G., Eds., Nile River Basin: Ecohydrological Challenges, Climate Change and Hydropolitics, Springer International Publishing, 2014.*
- *Pereira-Cardenal, S. J., Riegels, N. D., Berry, P. A. M., Smith, R. G., Yakovlev, A., Siegfried, T. U., et al., Real-time remote sensing driven river basin modeling using radar altimetry, Hydrol. Earth Syst. Sci., vol. 15, pp. 241-254, 2011.*


| Course title | Coastal Process and Sediment Transport | | | | Course Code | IRH**651** |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Characteristics of coastal sediments - Sediment transport - Modes of transport - Description of the threshold of movement – Bed forms - Estimation of bed shear stress - The entrainment function (Shields parameter) – Bed load transport equations - A general description of the mechanics of suspended sediment transport - Suspended sediment concentration under currents - Suspended sediment concentration under waves and waves with currents - Total load transport formulae - Cross-shore transport on beaches - Longshore transport ('littoral drift') - Concluding notes on sediment transport - Coastal morphology: analysis, modelling and prediction - Beach profiles - Beach plan shape - Nearshore morphology - Long-term prediction.

**References:**


- *Sarhan Th.E.," Port Engineering", 2017, ISBN 978-997-6988-66-5,*
- "Coastal Engineering Manual" Volume , USA , 2008.
- Hu Huang, "Dynamics of Surface Waves in Coastal Waters, Wave-Current-Bottom Interaction", Springer, 2009, ISBN 978-7-04-025061-9.


| Course title | Design of Marine Structures | | | | Course Code | IRH652 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction to history, types, functions of marine structures - Planning and design principles - Marine Composite Materials and Structure - Wind and Wave loads - Design theories - Shipping structures - Rubble mound breakwater (general aspects, layout, cross section geometry, construction and maintenance) - Vertical and composite structures - Rock protection to marine structures - Shoreline protection and beach control structures such as groyne, revetment, detached breakwaters, etc.

**References:**


- *Yong Bai and Wei-Liang Jin, "Marine Structural Design", Butterworth-Heinemann, ISBN: 978-0-08-099997-5, 2015.*
- *Han Ligteringen, "Ports and Terminals", Delft Academic Press, 2nd edition, 2017*

| **Course title** | **GIS and Remote Sensing Applications for Coastal Engineering** | | | | **Course Code** | IRH653 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | **Tutorial** | | **Practical** | **Credit hours** | 3 |
| | 2 | 2 | | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | 10 | 40 | 50 | | |

**Contents**

Course overview – Definitions – Terminology - Introduction to Remote Sensing Data and Corrections - Satellite Image Corrections - Digital Image Processing-I - Digital Image Processing-II - Thermal and Microwave - Imaging Spectroscopy-I - Imaging Spectroscopy-II & GIS-I - GIS-II and Application - Geospatial Analysis - Planning, Implementation, and Management of GIS - Modern Trends of GIS – Applications in the field of shoreline evaluations and monitoring of shoreline for successive periods - Case Study: Monitoring the Coastal Environment Using Remote Sensing and GIS Techniques

**References:**

- *Skidmore, Andrew, ed." Environmental modelling with GIS and remote sensing", CRC Press, 2017.*

| **Course title** | **Marine Renewable Energy Resources** | | | | **Course Code** | IRH661 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | **Tutorial** | | **Practical** | **Credit hours** | 3 |
| | 2 | 2 | | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Course overview – Definitions - Review of hydrodynamic theories - Renewable Energy (Onshore wind - Hydro energy - Solar energy - Geothermal – Bioenergy) - Marine Renewable Energy ( Offshore wind - Marine biomass (micro- and macro-algae)) - Renewable Ocean Energy (Wave - Tide (current and range) - Ocean current - Osmotic gradient - Thermal gradient) - Tidal energy - Offshore wind - Wave energy - Other forms of ocean energy - In Situ and remote methods for resource characterization - Ocean modeling for resource characterization – Optimization - Other aspects of ocean renewable energy - Application of a marine Energy project worldwide

**References:**

- *Neill, Simon P., and M. Reza Hashemi. Fundamentals of ocean renewable energy: generating electricity from the sea. Academic Press, 2018.*
- *Marine Energy (World Energy Resources 2016),* https://www.researchgate.net/publication/309012890_Marine_Energy_World_Energy_Resources_2016

| **Course title** | **Research Project*** | | | | **Course Code** | IRH699 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | **Tutorial** | | **Practical** | **Credit hours** | 3 |
| | 1 | 2 | | 3 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

A supervised research project supported and complemented by supervisory discussions with the academic advisor. That substantive research project will help student to understand and apply research principles and research practices. Student will identify his own research topic in the broad area of water resources, coastal or irrigation engineering, and thereafter frame appropriate research questions and hypotheses or propositions, select research methodology, conduct necessary detailed research, analyze and discuss the results and finally write an academic research report.

**References:**

- *Prior arrangement with the academic supervisor.*

(*) Note that the courses "IRH699" is a compulsory course for all IRH graduate studies programs

| **Course title** | **Probabilistic Design and Risk Analysis in Hydraulic Engineering** | | | | **Course Code** | IRH711 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents:**

Introductory to fundamental principles of probability – theory and basic concepts for systems and risk analysis – risk evaluation – application of probabilities and statistics in water resources engineering: probability calculus, risk analysis and risk evaluation – reliability analysis of systems: calculation basics, levels and methods, uncertainties of engineering designs and decisions, advanced topics and applications in risk-based engineering design for the field of hydraulic engineering – identifying and modeling problems – nondeterministic problems in engineering – understanding many recently issued engineering codes.

**References:**

- *S.N. Jonkman, R.D.J.M. Steenbergen, O.Morales-Nápoles, A.C.W.M. Vrouwenvelder & J.K. Vrijling, "Probabilistic Design: Risk and Reliability Analysis in Civil Engineering", Delft University of Technology, 2015*

| **Course title** | **Soil Dynamics and Foundations** | | | | **Course Code** | IRH**712** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic definitions – Soil behaviour – Types of loads, static and dynamic loads – Types of dynamic forces -seismic forces – wave forces – current forces – operation forces – degree of freedom - energy absorption - stiffness - dynamic motion equation - vibration devoid of absorption energy and vibration by absorption method - motion under the influence of forces and free dynamic motion - Soil dynamics and foundation modeling in offshore and earthquake engineering. The spectrum of topics include, soil behavior, soil dynamics, earthquake site response analysis, soil liquefactions, the modeling and assessment of shallow and deep foundations. Theory and practical applications, and approaches with engineering applications, Anchor piles, suction piles, pile torsion modeling, soil ageing effects and scour estimation.

**References:**

- *Jia, Junbo, "Soil Dynamics and Foundation Modeling", Springer, 2018.*
- *Linag, R. Y., Jiangu Qian, P.E. and Junliang Tao, "Advances in Soil Dynamics and Foundation Engineering", ISBN (print): 9780784413425, ASCE Library, 2014*
- *Srinivasan Chandrasekaran, " Dynamic Analysis and Design of Offshore Structures", Springer (India) Pvt. Ltd., 2015.*
-

| **Course title** | **Estuaries Hydraulics** | | | | **Course Code** | IRH721 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Course over view – Definitions – Terminology - General Description of Estuarine Behaviour- Transport of Solids - Hydrodynamics of Estuaries (waves, Currents, Tides, wave currents interaction), Equation of Motion, Equation Averaged Over The Depth of The Liquid, Equation Averaged Over A Cross Section – Mixing Processes, General Transport Equations, Diffusion Coefficients, Variability of Diffusion/ Dispersion Parameters, Estimation of Diffusion/Dispersion Values – Sediment Movement – The Study of Tidal Systems, Field Measurements, Mathematical Tidal Models – Water Quality Models – Hydraulic Models – Control of Estuaries.

**References:**


- *Jos´e F. Rodr´ıguez and Alice Howe,” Estuarine WetlandEcohydraulics and MigratoryShorebird Habitat Restoration,” 2013 John Wiley & Sons, Ltd. Published 2013 by John Wiley & Sons, Ltd*


| **Course title** | **Flood Control and Drainage Engineering** | | | | **Course Code** | **IRH722** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Flood problems - Rainfall analysis - Watershed hydrology, Estimation of flood, Flood routing through reservoirs and channels - Design of spillways - Flood mitigation through planning of reservoir capacities and operation of reservoirs - Flood mitigation through river protection and improvement works - Flood forecasting - Warning and flood fighting - Economics of flood control projects - Design of surface drainage system - Design of subsurface drainage system - Water-logging and salinity - Application of remote sensing technology for flood control - Flood plain delineation and flood hazard assessment - Flood damage management.

**References:**


- *Şen, Zekâi. "Flood modeling, prediction and mitigation." Springer Inter. Publishing, 2018.*
- *Guo, James CY. "Urban flood mitigation and stormwater management." New York: CRC Press, 2017.*
- *Ghosh, Some Nath. "Flood control and drainage engineering." 4th Edition, The Netherlands: CRC Press/Balkema, 2014.*


| **Course title** | **Sustainable Urban Drainage Systems** | | | | **Course Code** | **IRH723** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents:**

General Introduction to sustainable urban drainage system “**SUDS**” , design and planning of SUDS – urban drainage and environmental technologies for a sustainable development around the world – challenges in Egypt cities posed by urbanization, demography and climate change towards sustainable planning and resilience cities – Urban sewer systems (design criteria, construction, operation and maintenance) – Required hydrological processes studies related to urban Storm water and the impacts of urbanization on hydrological processes and the generation of urban runoff- Wet weather flow characteristics - Dry weather flow characteristics- Data collection and processing for urban drainage management- Design principles of SUDS - Analyze quantity and quality characteristics of Storm water and wastewater originating from urban environments- planning and design of drainage and sewerage system.

**References:**

- *Guo, James CY. "Urban flood mitigation and stormwater management." New York: CRC Press, 2017.*
- *Ghosh, Some Nath. "Flood control and drainage engineering." 4th Edition, The Netherlands: CRC Press/Balkema, 2014.*

| **Course title** | **Water Hammer in Pipes and Protection methods** | | | | **Course Code** | **IRH724** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents:**

Course Overview, Definitions, Flow in pipes characteristics, Unstable flow in pipes and its types, governing equations for unstable flow with flexible and viscous pipes, simplified gyovsky equation, introduction to the different numerical methods used to study unstable flow- Numerical approach - characteristics method - waves method - cavitation phenomenon - protection methods - pressure relief from hydraulic hammer – available professional soft-wares -computer applications – case study. Water hammer protection methods for commercial use in daily life.

**References:**

- *Fox, J. A., "Hydraulic Analysis of Unsteady Flow in Pipe Networks", Springer Link, https://doi.org/10.1007/978-1-349-02790-3*
- *Wuyi Wan ,ID and Boran Zhang ,"Investigation of Water Hammer Protection in Water Supply Pipeline Systems Using an Intelligent Self-Controlled Surge Tank", Energies 2018, 11, 1450; doi:10.3390/en11061450*

| **Course title** | **Water Resources Systems Planning and Management** | | | | **Course Code** | **IRH731** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents:**

Introduction - concepts of systems and systems analysis - optimization with methods using calculus - linear programming - dynamic programming – simulation - combination of simulation and optimization - multi-objective planning - reservoir sizing & operation, simulation and optimization of hydropower systems - introduction to stochastic optimization - review of probability theory - chance constrained linear programming - reliability programming - stochastic dynamic programming - steady state and real-time reservoir operating policies - case studies - recent modeling tools: ANN, Fuzzy inference systems, Genetic algorithms.

**References:**

- *"A Handbook for Integrated water Resources Management in Basins", 2010*

- *Melesse, A. M., Abtew, W. and Setegn, S. G., Eds., Nile River Basin: Ecohydrological Challenges, Climate Change and Hydropolitics, Springer International Publishing, 2014.*
- *Bhave, P. R., (2011)," Water Resources Systems", Narosa Publishing House, New Delhi.*

| **Course title** | **Hydro-systems Engineering Reliability and Risk Analysis** | | | | **Course Code** | IRH732 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Course overview – Introduction – Definitions – Terminology - Reliability in hydro-system engineering - fundamentals of probability and statistics for reliability analysis - hydrological frequency analysis - reliability analysis considering load resistance interference - time to failure analysis - Monte Carlo simulation ( CDF Inverse Method – Acceptance Rejection Method – Variable Transformation Method) – Reliability of Systems – General view of system reliability computation - integration of reliability in optimal hydro-system design. Optimal Risk-based design of Hydro-system infrastructures – Optimization of Hydro-system by chance constrained methods.

**References:**

- *Yeou-Koung Tung, Ben-Chie Yen, and Charles S. Melching, (2016), "Hydro-systems Engineering Reliability Assessment and Risk Analysis", McGraw-Hill.*

| **Course title** | **Sustainable Water Resources Management** | | | | **Course Code** | IRH733 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Introduction to the concepts and approaches for sustainable river basin development - hydrology and hydraulics, agricultural water management - environmental impact assessment, basin development and management plans - data collection, monitoring, analysis, field techniques for water and sediment sampling - deterministic and probabilistic design for river structures, flood frequency analysis - remote sensing for river basin development and obtaining freely available remote sensing data - models used to provide river basin development decisions.

**References:**

- *"A Handbook for Integrated water Resources Management in Basins", 2010*
- *Melesse, A. M., Abtew, W. and Setegn, S. G., Eds., Nile River Basin: Ecohydrological Challenges, Climate Change and Hydropolitics, Springer International Publishing, 2014.*

| **Course title** | **Hydrodynamic Loads on Offshore Structures** | | | | **Course Code** | IRH751 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Offshore structures – Environmental forces- Wind Force - Wave Forces -Wave Theories - Current Forces- Earthquake Loads Ice and Snow Loads - Marine Growth – Mass – Damping - Dead Load - Live Load - Impact Load - General Design Requirements - Steel Structures

- Allowable Stress Method - Limit State Method - Fabrication and Installation Loads - Lifting Force - Load-Out Force - Transportation Forces - Launching and Upending Force - Accidental Load - Introduction to Structural Dynamics - Fundamentals of Structural Hydrodynamics - Equation of Motion - Simple Harmonic Motion Method (SHM Method). - Newton's Law - Energy Method - Rayleigh's Method - D'Alembert's Principle.

**References:**

- *Srinivasan Chandrasekaran,"Dynamic Analysis and Design of Offshore Structures", Springer, Ocean and Oceanography, Vol.5, USA, 2015, ISBN 978-81-322-2267-7.*

<table>
<tr><td>Course title</td><td colspan="4">Design of Offshore Floating Structures</td><td>Course Code</td><td>IRH752</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction to offshore structures analysis and design, methods of analysis and criteria in design such as wave loads and motion in waves, floating dynamic stability, structural strength and fatigue, Safety assessment and design aids & codes, design parameters and elements of offshore structures, design of offshore structures such as: mooring lines and flexible risers - semi-submersibles and immersed structures, spar platforms, floating jack-up structures and elements such as reinforced (hull) plating and mooring turntables, etc.

**References:**

- *Subrata K. Chakrabarti, "Dynamics of Floating Offshore Structures (Advanced Series on Ocean Engineering)", World Scientific Pub Co Inc, ISBN-13: 978-9814280563, 2020*
- *J. Romanoff, Guedes Soares, "Structural design of a floating foundation for offshore wind turbines in red sea", Taylor & Francis Group, DOI: 10.1201/b15120-78, 2013*
- *US Army Corps of Engineers, "Coastal Engineering Manual", EM1110-2-1100, ٢٠٠8*

<table>
<tr><td>Course title</td><td colspan="4">Integrated and Sustainable Coastal Zone Management</td><td>Course Code</td><td>IRH753</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Coastal zone and coastal beach definition and classification - Coastal dynamics - Coastal hazards - Climate change; mitigation and adaptation strategies - DPSIR model - Integrated Coastal Zone Management, principles, contents and mechanisms - Principles of IWRM; water management in coastal area - MAR techniques - Regional databases and Knowledge framework for coastal risks management - European approach; UNEP/MAP; ICZM protocol, EU recommendations - Coastal risks management - Integrated approach and best practices in littoral management and protection; Solutions and best practices

**References:**

- *Skidmore, Andrew, ed, "Environmental modelling with GIS and remote sensing", CRC Press, 2017.*

| **Course title** | Marine Dock Design | | | | **Course Code** | IRH**754** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction - Design Standards for Quay Walls - Factors Affecting The Selection of Structural Systems for Quay Walls - Forces Affecting The Design of Quay Walls - Structural Systems for Quay Walls – Gravity Type (Concrete Blocks – Caissons – Cantilever and Counterfort Concrete Walls) – Wall Systems ( Cantilever Sheet Piles – Anchor Sheet Piles – Cellular Cofferdam Straight Web Sheet Piles – Diaphragm Concrete Walls) – Deep Foundations (Reinforced Concrete Slab Supported on Piles – Mooring Dolphins) – Composite Systems - Numerical Models Used in The Design and Study of balance Quay Walls and Jetties – Applications

**References:**

- *Sarhan Th.E.," Port Engineering", 2017, ISBN 978-997-6988-66-5,*
- *Recommendations of the Committee for Waterfront Structures, EAU 2004 8$^{th}$ Edition (ISBN 3-433-01790-5)*
- *JOHN W. GAYTHWAITE, P.E, "Design of Marine Facilities for The Berthing, Mooring, and Repair of Vessels", VAN NOSTRAND REINHOLD, 2016*

| **Course title** | **Port Planning and Infrastructure Design** | | | | **Course Code** | IRH755 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Maritime Transport - Various Types of Merchant Ships; Commodities and Types of Vessels - Port Master Planning - Port Functions and Organization, Port Planning Methodology, Planning Process - Design of Wet Areas - Ship Manoeuvring and Hydrodynamic Behaviour, Approach Channels, Manoeuvring Areas within The Port, Port Basins and Berth Areas - Design of Terminals - Terminal Services, Terminal Components, Types of Terminals, Terminal Capacity, Terminal Dimensions - Introduction to Queuing Theory as A tool on Port Planning - Design and Construction of Berthing Structures (bulk cargo terminals…etc) - Typical Lay-out and Components of Berthing Structures - Design Criteria - Structural Considerations –

**References:**

- *Sarhan Th.E.,"Port Engineering", 2017, ISBN 978-997-6988-66-5,*
- *Recommendations of the Committee for Waterfront Structures EAU 2004 8$^{th}$ Edition (ISBN 3-433-01790-5), last edition, 2016.*
- *Technical Standards and Commentaries for Port and Harbour Facilities In JAPAN, The Overseas Coastal Area Development Institute of JAPAN, 2002.*

| **Course title** | **Advanced Topics in Hydraulic Engineering** | | | | **Course Code** | IRH791 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Advanced topics will be selected and covered in the broad field of irrigation and hydraulics, water resources, and coastal engineering with emphasis on providing students the knowledge of analyze and design of recent applications and developments in the specialty.

**References:**

- Prior arrangement with an instructor at the beginning of the semester

| **Course title** | **Research Related Course** | | | | **Course Code** | IRH792 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 3 |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | ---- | ---- | 50 | 50 | | |

**Contents**

Topics that serves the student’s research based on discussion and agreement with the academic supervisor.

**References:**

- Prior arrangement with an instructor at the beginning of the semester

# Chapter Twelve:

## Public Works Engineering Department

## Diploma in Public Works Engineering specialized in Surveying Engineering

**Program description**

The main objective of this program is to gain Surveying Engineering diploma students' sufficient knowledge, skills, and width of view to achieve the demands of the job market and the national development objectives.

**Competencies for the program graduate**

In addition to general competencies for the diploma in engineering the graduate of public works engineering specialized in surveying engineering must be able to:

1. Have well skills and knowledge in the Surveying Engineering discipline for research and development.
2. Gain entrepreneurial skills in students to ensure competitiveness.
3. Have better understanding of the technical foundation of Surveying Engineering to facilitate self-learning, particularly of experiential knowledge, and professional development.

## Diploma in Public Works Engineering specialized in Sanitary and Environmental Engineering

**Program description**

The main objective of the Diploma of Sanitary and Environmental Engineering is to prepare a distinguished engineer and researcher in the field of sanitary and Environmental engineering, able to compete in the local and regional labor market.

**Competencies for the program graduate**

In addition to general competencies for the diploma in engineering the graduate of public works engineering specialized in sanitary and Environmental engineering must be able to:

1. Employ practical thinking with commitment to economic, innovative, and optimum use of resources in the field of sanitary and environmental engineering.
2. Understand the technical vocational foundation of sanitary engineering to facilitate self-learning, particularly of experiential knowledge, and professional development.
3. Apply optimal design for sanitary and environmental engineering projects such as water supply networks, sewage networks, water, and wastewater treatment plants.
4. Identify, formulate, and solve complex engineering problems in the field of sanitary and environmental engineering by applying engineering fundamentals, basic science, and mathematics.

## Diploma in Public Works Engineering specialized in Highway and Airport Engineering

### Program description

The main objective of this program is to provide Highway and Airport Engineering Diploma students' sufficient knowledge, and skills to attain the demands of the job market and the national development objectives.

### Competencies for the program graduate

In addition to general competencies for the diploma in engineering the graduate of public works engineering specialized in highway and airport engineering must be able to:

1. Apply specialized knowledge of the highway and airport engineering concepts he gained in the professional practice
2. Identify and solve engineering problems in Highway and Airport Engineering discipline.
3. Master the professional skills and use of appropriate technological means to serve the highway and airport engineering professional practice.

## Diploma in Public Works Engineering specialized in Transportation Engineering

### Program description

The main objective of this program is to provide Transportation Engineering Diploma students' sufficient knowledge, and skills to attain the demands of the job market and the national development objectives.

### Competencies for the program graduate

In addition to general competencies for the diploma in engineering the graduate of public works engineering specialized in transportation engineering must be able to:

1. Apply specialized knowledge of the transport planning, traffic, and railway engineering in the professional practice
2. Identify and suggest solutions for transportation engineering problems.
3. Master the professional skills and use the suitable and new technologies in the professional practice for transportation planning, traffic, and railway engineering.

## Master of Science in Public Works Engineering

### Program description

The main objective of the Master of Science program in Public Works engineering is to provide students with research informed knowledge in a broad spectrum, and skills to fulfill the demands of the job market and the national development objectives.

**Competencies for the program graduate**

In addition to general competencies for the Master of Science engineering program the graduate of the MSc public works engineering must be able to:

1. Master the basics and methodologies of scientific research and use different tools in the fields of Surveying Engineering, Sanitary Engineering, Transportation Planning and Traffic Engineering, Railways, and Highway and Airport Engineering.
2. Apply and utilize the analytical methods theories in the Public Works Engineering disciplines.
3. Integrate the specialized knowledge with related knowledge and apply it in the professional practice.
4. Display awareness of the ongoing problems and modern visions in the fields of Surveying Engineering, Sanitary Engineering, Transportation Planning and Traffic Engineering, Railways, and Highway and Airport Engineering.

## Ph.D. in Public Works Engineering

**Program description**

The main objective of the PhD program in Public Works engineering is to prepare PhD students for undertaking advanced study and original research for a research or teaching career in industry, research institutions, universities, and government.

**Competencies for the program graduate**

In addition to general competencies for the PhD program the graduate of PhD in public works engineering must be able to:

1. Demonstrate competency and mastery of basics, methods, and tools of scientific research in the fields of Surveying Engineering, Sanitary Engineering, Transportation Planning and Traffic Engineering, Railways, and Highway and Airport Engineering.
2. Apply and utilize scientific knowledge to continuously update in the field of Surveying Engineering, Sanitary Engineering, Transportation Planning and Traffic Engineering, Railways, and Highway and Airport Engineering.
3. Demonstrate in depth awareness of the ongoing problems and the modern theories in Public Works Engineering disciplines.
4. Identify and create solutions for the professional Problems in Public Works Engineering disciplines.
5. Acquire in depth understanding of common areas of professional skills in the fields of Surveying Engineering, Sanitary Engineering, Transportation Planning and Traffic Engineering, Railways, and Highway and Airport Engineering.

## List of level (500) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **PWE521** | Geodesy | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE522** | Satellite geodesy | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE523** | Photogrammetry (2) | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE524** | Remote sensing applications | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE525** | Map projection | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE526** | Precise surveying works (2) | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE527** | Design and application of GIS | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE528** | Marine surveying | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE529** | Research Project | 1 | 4 | 0 | 5 | 3 | 10 | - | 70 | 30 * | - | 100 |
| **PWE531** | Wastewater treatment systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE532** | Sewer networks | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE533** | Water distribution networks | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE534** | Water Treatment Systems | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE535** | Environmental Sciences | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE536** | Environmental Management and Legislation | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE537** | Sanitary chemistry | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE538** | Environmental pollution control | 2 | 2 | 0 | 4 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **PWE539** | Research project | 1 | 4 | 0 | 5 | 3 | 10 | - | 70 | 30 * | - | 100 |
| **PWE541** | Soil Mechanics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE542** | Pavement Materials | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE543** | Highway Geometric Design | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE544** | Highway Structural Design | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE545** | Bituminous Materials and Mixtures | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE546** | Highway and Airport Construction Equipment and Technology | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE547** | Airport Planning and Design | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE548** | Pavement Evaluation and Maintenance | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE549** | Research Project | 1 | 4 | 0 | 5 | 3 | 10 | - | 70 | 30 * | - | 100 |
| **PWE551** | Traffic Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE552** | Traffic Impact Studies | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PWE553** | Urban Transportation Planning | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE554** | Transportation Economics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE556** | Geometric Planning of Railways | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE557** | Principles of Railway Operation | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE 558** | Turnouts and Signals | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE 559** | Terminals and Yards | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE 561** | Track Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE562** | Highway-Rail Grade Crossing Safety | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE563** | Research Project | 1 | 4 | 0 | 5 | 3 | 10 | - | 70 | 30 * | - | 100 |

* **Discussion**

## List of level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **PWE621** | Geometric geodesy | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE622** | Physical geodesy | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE623** | Hydrographic surveying | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE624** | GNSS Theory and Applications | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE625** | Remote Sensing | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE626** | Observation Adjustment in Geomatics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE627** | Advanced Photogrammetric and Ranging Techniques | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE628** | Theory and Applications of Terrestrial Laser Scanner | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE629** | Geomatics Programming | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE631** | Advanced sanitary engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE632** | Treatment of industrial wastewater | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE633** | Sludge treatment | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE634** | Solid waste engineering management | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE635** | Anaerobic Treatment of Wastewater | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE636** | Selected Topics in Sanitary Engineering | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE641** | Advanced Soil Mechanics | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| **PWE642** | Advanced Pavement Material | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Characterization | | | | | | | | | | | |
| **PWE643** | Flexible Pavement Design and Analysis | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE644** | Rigid Pavement Design and Analysis | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE645** | Infrastructure Engineering and Management | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE646** | Pavement Maintenance and Rehabilitation | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE647** | Pavement Structural Design for Airports | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE648** | Selected Topics in Highway and Airport Engineering | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE651** | Urban Transportation Planning Models - Principles and Applications | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE652** | Advances in Public Transportation Planning, Operations & Control | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE653** | Fundamentals of Traffic Flow Theory | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE654** | Modeling Transportation and Spatial Economics | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE655** | Computer Applications in Transportation Engineering | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE656** | GIS for Transportation Engineering | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE657** | Track Capacity | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE658** | Modern Turnouts Technology | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE659** | Advanced Technology of Railway Signals | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE661** | Modern Methods of Railway Station Planning | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE662** | Railway Freight Transport Systems | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE663** | Research seminar | **1** | **4** | **0** | **5** | **3** | **10** | **-** | **70** | **30 *** | **-** | **100** |

* **Discussion**

## List of level (700) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| **PWE721** | Numerical Analysis in Geomatics | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE722** | Advanced Global Geophysics and Geodynamics | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE723** | Atmospheric Effects on Satellite Navigation Systems | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PWE724** | Advanced Topics in Photogrammetry | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE725** | Advanced Physical Geodesy | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE726** | Advanced Geospatial Information Systems | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE727** | Geodetic Astronomy | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE731** | Re-use of Wastewater | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE732** | Water Quality Modeling | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE733** | Advanced wastewater treatment | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE734** | Water Microbiology | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE735** | Disinfection processes | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE736** | Selected Advanced topics in sanitary engineering | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE741** | Applied Statistics in Highway Engineering | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE742** | Advanced Geometric Design | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE743** | Micromechanics of Asphalt Concrete Materials | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE744** | Systems Design of Pavements | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE745** | Advanced Pavement Design and Analysis | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE746** | Energy Harvesting in Pavements | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE747** | Expansive Soils Fundamentals | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE748** | Advanced Topics in Highway and Airport Engineering | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE751** | Traffic Safety Analysis | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE752** | Traffic Operations and Management | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE753** | Urban Transport Systems | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE754** | Travel Demand Analysis | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE755** | Traffic Flow Theories and Engineering | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE756** | Intelligent Transportation Systems | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE757** | Special Topics in Transportation Engineering | **2** | **2** | **0** | **4** | **3** | **8** | **3** | **50** | **0** | **50** | **100** |
| **PWE758** | Research seminar | **1** | **4** | **0** | **5** | **3** | **10** | **-** | **70** | **30 *** | **-** | **100** |

* **Discussion**

# Summary of Courses Specification

## Level (500)

| Course title | Geodesy | | | | Course Code | PWE521 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Position Theory – Geodetic parameters – Molodensky equation and method of solving – Least squares adjustment – Helmert technique – Kernel equation – Geoid undulation – gravity – solving by integration – Fourier technique for rapid transformation – Geoid determination – Gravity modeling and prediction – current research activities- Time and Frequency Metrology of Relativistic Geodesy- Measuring the Gravitational Field in General Relativity- Equations and the Gravitational Compass - Relativistic Clock Gradiometry- General Relativistic Gravity Gradiometry- Gauss as Scientific Mediator Between Mathematics and Geodesy - Operator Methodologies of Resolution and Regularization- Geodetic Observables in Multiscale Framework.

**References:**

- ***Pützfeld, Dirk, Lämmerzahl, Claus, " Relativistic Geodesy : foundations and applications "***, SPRINGER,***2019.***
- ***Willi Freeden, M. Zuhair Nashed, " Handbook of Mathematical Geodesy: Functional Analytic and Potential Theoretic Methods "***, Birkhäuser, ***2018.***

| Course title | Satellite geodesy | | | | Course Code | PWE522 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Review for navigation systems and positioning from the space (the concept and General Description) - properties and readings of receivers and antenna – models for point positioning from static and kinematic observations - real-time navigation – data processing – data integration methods - terrestrial, marine and aerial applications – case studies- Least-Squares Adjustments- Recursive Least Squares - GNSS Receiver Antennas- Satellite signals- Satellite orbits- Satellite signals- Observable - Satellite Signal Tracking and Data Demodulation - Interference Multipath and Scintillation - Performance of StandAlone GPS- Integration of GPS with Other Sensors and Network Assistance

**References:**

- ***Leick, Alfred; Rapoport, Lev; Tatarnikov, Dmitry, " GPS Satellite Surveying "***, Wiley ***,2015.***
- ***Dr. Bernhard Hofmann-Wellenhof, Dr. Herbert Lichtenegger, Dr. Elmar Wasle (auth.), " GNSS — Global Navigation Satellite Systems: GPS, GLONASS, Galileo, and more "***, Springer-Verlag Wien, ***2008.***

| Course title | Photogrammetry (2) | | | | Course Code | PWE523 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Types of camera in photogrammetry, camera application methods, ground coordinates from aerial photographs, mapping from photogrammetry, terrestrial photogrammetry, digital photogrammetry, software programming for photo analysis, satellite photographs, photogrammetric project planning- Integration of geoinformation technologies - Imaging sensors- Photogrammetry Evolution of photogrammetry- Principles of analytical and digital photogrammetry- Digital photogrammetric operations- Color Restoration of Aerial Photographs- High-Quality Seamless Panoramic Images- Assessment of Stereoscopic Precision- Photogrammetry for Archaeological- Underwater Photogrammetry- Film to Digital Photogrammetric Cameras- Photogrammetry for disasters prevention- Change detection and deformation analysis

**References:**


- ***Konecny, Gottfried, " Geoinformation: Remote Sensing, Photogrammetry and Geographic Information Systems ",*** CRC Press,***2014.***
- ***D. da Silva, " Special Applications of Photogrammetry ",*** Intech, ***2012.***


| Course title | Remote sensing applications | | | | Course Code | PWE524 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Using of optical methods, infrared, Microwaves – Physical principles – Imaging systems – Radiometric corrections – Calibration and adjustment methods –Atmospheric effects – classification of land surface – accuracy of remote sensing operation - Integrity of spatial information reference-Opportunities by the Copernicus Program - Automatic Change Detection from High-Resolution Satellite Imagery- Passive remote sensing methods—Lidar- Airborne electromagnetics-SfM photogrammetry-Orbital Sensors- The Linear Spectral Mixture Model- Fraction Images-spectral mixture- spectral bands -radiant flux-Digital number-Radiometry- MODIS - hyperspectral analysis of rocky surfaces- implementation of hyperspectral remote sensing data

**References:**


- ***Diofantos G. Hadjimitsis, Kyriacos Themistocleous, Branka Cuca, Athos Agapiou, Vasiliki Lysandrou, Rosa Lasaponara, Nicola Masini, Gunter Schreier, " Remote Sensing for Archaeology and Cultural Landscapes: Best Practices and Perspectives Across Europe and the Middle East*** Springer " International Publishing,***2020.***
- ***Paolo Tarolli, Simon M. Mudd, "Remote Sensing of Geomorphology: Volume 23", Elsevier, 2019***

| Course title | Map projection | | | | Course Code | PWE525 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Types of projections – Conic projection- Cylindrical projection – Mercator projection – Orthographic projection – planar projection – Pseudo cylindrical projection - Lambert azimuthal equal-area projection – Coordinates system in Egypt – Maps- Cartograms as Map Projections- The Wright Approach- Scale, Globe Maps and Flat Maps- Distortions- Cylindrical Projections- Direction and Distance on Map Projections- Flat World Maps- Classes of Projections for World Maps - Aspects of Projections- Meridians and Parallels- Time Zones and Meridians- Non-symmetrically Interrupted Arrangements- Missing and False Frames- Hemispheres

**References:**

- ***Miljenko Lapaine, E. Lynn Usery (eds.), " Choosing a Map Projection ",*** Springer International Publishing,***2017.***
- ***Mark Monmonier, " Rhumb Lines and Map Wars: A Social History of the Mercator Projection ",*** University Of Chicago Press, ***2004.***

| Course title | Precise surveying works (2) | | | | Course Code | PWE526 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Precise leveling and its application in civil engineering, digital precise level, application of total station in engineering project, methods of structural health mentoring, setting out techniques, terrestrial laser scanner, global position system (GPS), types of receivers, measurements accuracy of GPS- Satellite Signals in GPS- GPS Control Segment- DIFFERENTIAL GPS AND SBAS (SATELLITE-BASED AUGMENTATION SYSTEMS)- Differential GPS(DGPS) Basedon Signal Travel Time Delay Measurement- Different Correction Services- GNSS APPLICATIONS- Location-Based Services (LBS)- UAV PHOTOGRAMMETRY- Flight Plan Design

**References:**

- ***Leonid Nadolinets, Eugene Levin, Daulet Akhmedov, " Surveying instruments and technology ",*** CRC Press, Taylor & Francis Group ***,2017.***
- ***Merrin, Jack, " Introduction to error analysis : the science of measurements, uncertainties, and data analysis ", CreateSpace Independent Publishing Platform, 2017.***

| Course title | Design and application of GIS | | | | Course Code | PWE527 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Concepts and applications of GIS – database modeling – design of databases relations – advanced topics for databases – organize databases – data dictionaries – GIS Programming and software – design and implementation of the system- Point Pattern Analysis Kernel Density Estimation- Locational Outliers- Spatial Autocorrelation- Cluster and Outlier Analysis- Optimized Hot Spot Analysis- Spatial Econometrics- Regression and Geographically Weighted- Designing an Enterprise GIS- Enterprise Architecture- System Visualization-Meta Data – Data Standard Collecting Field Data with GIS and GPS Technologies .- Mapping and Analyzing Geology Data with GIS

**References:**


- *Armin kargol, " Spatial Analysis Methods and Practice: Describe – Explore – Explain through GIS ", Cambridge University Press ,2020.*
- *John Woodard, " Enterprise GIS: Concepts and Applications ", CRC Press, 2020.*


| Course title | Marine surveying | | | | Course Code | PWE528 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grad | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Determination of marine positions –radio navigation systems from the ground and satellites (GPS) – Accuracy of observations – observations methods by Ultrasonic – Echo acoustic radiation – sonar –laser from the air – Electromagnetic methods and adjustment - Portable barometer- hydro-pneumatic Baroscope - Barometrical instrument - Boiling water apparatus – Micrometer- LAND SURVEYING - Description of plans- Base lines - fixed objects - boundaries- Deep Sea Navigation Techniques- The Atlas Hydrosweep and Parasound Systems- Recording Multichannel Wide-Angle Seismic Data on the Seabed.

**References:**


- *Harry Phelps, "Practical Marine Surveying", Wentworth Press ,2015*


| Course title | Research Project | | | | Course Code | PWE529 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 4 | 0 | | |
| Course grades | Discussion | Practical | S. work | Final Exam | Total grads | 100 |
| | 30 | - | 70 | - | | |

**Contents**

A research proposal/review/project related to survey engineering.

| Course title | Wastewater treatment systems | | | | Course Code | PWE531 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Impact of regulations on wastewater engineering, wastewater characteristics, importance of improved wastewater characterization, wastewater constituents, waste water sources, flow discharge of wastewater, the quality requirements of treated effluent, wastewater treatment techniques. Preliminary and primary treatment,(equalization, screen, grinding, grit removal, primary sedimentation, flotation), secondary treatment including mass-transfer fundamentals of biological treatment, aeration systems, chemical treatment,(chemical precipitation, chemical oxidation, chemical neutralization), sludge quantities and methods of its treatment, removal of phosphorus and nitrogen (chemical precipitation of phosphorus and nitrogen).

**References:**

- *Schaider, L. A., Rodgers, K. M., & Rudel, R. A. (2017). Review of organic wastewater compound concentrations and removal in onsite wastewater treatment systems. Environmental science & technology, 51(13), 7304-7317.*

| Course title | Sewer networks | | | | Course Code | PWE532 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The characteristics and of wastewater, design flow rates calculation, wastewater collection systems, sewer pipes and manholes types, pipes materials, lift stations and pumps used in wastewater discharge, dry wet pump stations, wet pump stations, design of sewer networks and rising mains, identify the soft wares used in the design of sewer systems, operation, maintenance and design of wastewater networks, desirable operation conditions, wastewater system elements, Maintenance and repair, Prevention and safety, Principal operations, Public relations and management, types of valves on force mains, pipe materials of force mains.

**References:**

- *Leitão, J. P., Carbajal, J. P., Rieckermann, J., Simões, N. E., Marques, A. S., & de Sousa, L. M. (2018). Identifying the best locations to install flow control devices in sewer networks to enable in-sewer storage. Journal of Hydrology, 556, 371-383.*

| Course title | Water distribution networks | | | | Course Code | PWE533 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Characteristics of drinking water and design flow rates calculation, design criteria for water networks, network planning, identify the purpose and capacity of elevated tanks, hydraulic design of water networks, network fittings and fire hydrants, Air valves, wash valves, pressure relief valve, flow control valves, operation, maintenance and design of water services, desirable operation conditions, Water distribution system elements, Water delivery and monitoring, Maintenance and repair, Prevention and safety, Principal operations, Public relations and management, software programs for the hydraulic design of water supply networks, transmission lines design.

**References:**

- *Giustolisi, O., Ridolfi, L., & Simone, A. (2019). Tailoring centrality metrics for water distribution networks. Water Resources Research, 55(3), 2348-2369.*
- *Sinagra, M., Sammartano, V., Morreale, G., & Tucciarelli, T. (2017). A new device for pressure control and energy recovery in water distribution networks. Water, 9(5), 309.*

| Course title | Water Treatment Systems | | | | Course Code | PWE534 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Drinking water sources: groundwater, surface water, rainwater, Characteristics of surface water and underground water, calculation of design flow rates required, drinking water quality requirements and standards. Collection works (types of intakes, factors affecting choice the type and location of intake, design of different types of intakes), drinking water purification units (mechanisms and design) include coagulation, flocculation, sedimentation, filtration and disinfection. Design of water treatment units and identify residuals treatment methods, treatment and disposal of drinking water treatment sludge.

**References:**

- *Bhojwani, S., Topolski, K., Mukherjee, R., Sengupta, D., & El-Halwagi, M. M. (2019). Technology review and data analysis for cost assessment of water treatment systems. Science of the Total Environment, 651, 2749-2761.*
- *Pooi, C. K., & Ng, H. Y. (2018). Review of low-cost point-of-use water treatment systems for developing communities. Npj Clean Water, 1(1), 1-8.*

| Course title | Environmental Sciences | | | | Course Code | PWE535 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to environmental engineering, environmental science concepts, environmental systems, Ecosystem Structure, environmental risk assessment, water resources planning, development, and management. Water sources conservation. The role of environmental considerations and interrelation between land and water, ways to avoid negative impacts on the environment. Projects effect on the environment and social responses, legal aspects, self-purification of water streams, wastewater reclamation and reuse. (Urban reuse, Agricultural reuse, Environmental reuse, Industrial reuse, Planned potable reuse, Indirect potable reuse, Direct potable reuse, Reuse in space).

**References:**

- *Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. Environmental Development, 17, 48-56.*

| Course title | Environmental Management and Legislation | | | | Course Code | PWE536 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | Practical | | Credit hours | 3 |
| | 2 | 2 | 0 | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Definition of environmental management, environmental management systems: quality management of water, air, soil, solid and waste, rationale for environmental legislation and regulations, Environmental Protection Policy (Environmental policy integration, Environmental policy studies), Environment Protection Policies of Air quality, water quality, waste and noise, the environmental legislation in Egypt: law 48/82 for the protection of water bodies, law 93 to protect networks and sewage plants, law

4/94 for environmental protection, Policy and Regulations for seawater desalination. Environmental impact of hazardous and toxic material and wastes.

**References:**

- *Krishna, I. M., & Manickam, V. (2017). Environmental management: science and engineering for industry. Butterworth-Heinemann.*

| Course title | Sanitary chemistry | | | | Course Code | PWE537 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic concepts in environmental chemistry, water sources, water pollution, contamination type, sampling and analytical procedures, sampling; methods of sample analysis; units of measurement for physical and chemical parameters; useful chemical relationship, physical characteristics of water (solids, particle size distribution, turbidity, color, absorption transmittance, temperature, conductivity, density, specific gravity and specific weight) and chemical inorganic characteristics of water (pH, chlorides, alkalinity, nitrogen, phosphorus, sulfur, odor), chemical organic characteristics (BOD, COD, TOC, oil and grease), biological characteristics.

**References:**

- *Wacławek, S., Lutze, H. V., Grübel, K., Padil, V. V., Černík, M., & Dionysiou, D. D. (2017). Chemistry of persulfates in water and wastewater treatment: a review. Chemical Engineering Journal, 330, 44-62.*

| Course title | Environmental pollution control | | | | Course Code | PWE538 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Definition of environmental engineering, environmental systems. Water: the sources and types of water pollution and its treatment and control. Air: physical and chemical basics, criteria of air pollution and their impact, fixed and mobile sources of contaminants and methods of its control. Solid waste: definition, sources and environmental hazards and methods of processing and control. Noise: sources and environmental impact, criteria and methods of control, pesticides: types and their environmental impact and environmental alternative methods.

**References:**

- *Khalaf, M. N. (2016). Green polymers and environmental pollution control. CRC Press.*

| Course title | Research Project | | | | Course Code | PWE539 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 4 | 0 | | |
| Course grades | Discussion | Practical | S. work | Final Exam | Total grads | 100 |
| | 30 | - | 70 | - | | |

**Contents**

A research proposal/review/project related to sanitary engineering.

| Course title | Soil Mechanics | | | | Course Code | PWE541 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Soil formation, structure, and description – soil classification systems and test procedures – basic, physical, and engineering soil properties for road and airport construction – soil permeability and seepage (concepts and testing) – density-moisture relationship – soil and earthworks compaction – soil effective stress and pore water pressure – contact pressure and stress distribution – soil compressibility and consolidation (concepts and testing) – soil shear strength (failure criterion and test procedures) – lateral earth pressure– soil stabilization and reinforcement – stability of slopes and embankments – site investigation.

**References:**


- McCarthy, D. F. (2014) Essentials of soil mechanics and foundations: basic geotechnics. 7th edition, Pearson.


| Course title | Pavement Materials | | | | Course Code | PWE542 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction – pavement materials types – Relationship between pavement material type and stress distribution and cost– mechanical and resilient behaviour of pavement materials– subgrade material characterization and testing procedure – unbound base/subbase material characterization and testing procedure – bound/modified materials characterization and testing procedure – asphalt sources and refining – asphalt physical, mechanical, and rheological properties – asphalt grades – asphalt-cement modification – types of asphalt mixtures – properties of asphalt mixtures – volumetric analysis of asphalt mixture – design of asphalt mixtures and testing procedures – design of concrete mixtures.

**References**:


- Huang, S. and Benedetto, H. (2015) Advances in Asphalt Materials Road and Pavement Construction. Woodhead Publishing, Elsevier.
- Egyptian code for urban and rural roads (2008) Part 4, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.


| Course title | Highway Geometric Design | | | | Course Code | PWE543 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction – Basics of highway geometric design - cross section elements – sight distance concept – stopping sight distance – passing sight distance – design of horizontal alignment – sight distance on horizontal curves – extra widening for horizontal curves – vertical alignment concept – design of road profile – vertical curve fundamentals – design of vertical curves – intersections – elements of intersection and conflict points – interchanges – sight triangle on intersections and design cases – design controls for intersections – curb turning radius design – auxiliary lanes – channelization – delineation with pavement marking – computer applications in geometric design.

**References:**

- American Association of State Highway and Transportation Officials (AASHTO) (2018) A Policy on Geometric Design of Highways and Streets. 7th ed. AASHTO, Washington, D.C.
- Egyptian code for urban and rural roads (2008) Part 3, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.

| Course title | Highway Structural Design | | | | Course Code | PWE544 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction – Pavement types – basics of pavement structural design – strength of subgrade materials – strength of unbound base and subbase materials – stiffness of asphalt concrete materials – traffic data for pavement design input – traffic load limits – equivalent traffic loads – pavement design methods - pavement materials evaluation and testing – stress strain analysis for flexible pavement – stress strain analysis rigid pavement – multilayer linear elastic solutions – multilayer nonlinear elastic solutions – viscoelastic solutions – 1993 AASHTO design method for flexible and rigid pavements.

**References:**

- Das, A. (2014) Analysis of Pavement Structures. CRC Press.
- Egyptian code for urban and rural roads (2008) Part 6, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.

| Course title | Bituminous Materials and Mixtures | | | | Course Code | PWE545 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction. Asphalt mixtures types (i.e., Marshall, and SUPERPAVE) and methods of design. Fundamental properties of aggregates used in asphalt mixtures. Fundamental properties of asphalt binders. SUPERPAVE laboratory testing procedure for asphalt binders, aggregates, and asphalt mixtures. Selection of a design aggregate structure. Selection of aggregates and the Design of asphalt binder content. Design, analysis, and interpretation of collected testing data. Evaluation of moisture sensitivity in accordance with the AASHTO T283. Performance evaluation testing of asphalt mixture.

**References**:

- Huang, S. and Benedetto, H. (2015) Advances in Asphalt Materials Road and Pavement Construction. Woodhead Publishing, Elsevier.
- Mallick, R. B._ El-Korchi, T. (2013) Pavement Engineering - Principles and Practice, 2nd Edition, Taylor & Francis.

| Course title | Highway and Airport Construction Equipment and Technology | | | | Course Code | PWE546 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction – Equipment types – characteristics – performance - productivity –excavation equipment for embankments, subgrades, subbase and base layers – compactors and types – compactor weight, speed, orientation, temperature, and passing rate – equipment of soil transportation – finisher – spray seal equipment – hot-mix asphalt mixtures plants and types – milling machine for the reclamation of pavement – plants of modified asphalt – equipment of pavement marking – principles of equipment economics– equipment of pavement maintenance for the construction of asphalt surface and its effect on performance – equipment of paving concrete.

**References:**

- Gransberg, D. D., and Rueda, J. A. (2020) Construction Equipment Management for Engineers, Estimators, and Owners, 2nd Edition, CRC press.
- Egyptian code for urban and rural roads (2008) Part 8, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.

| Course title | Airport Planning and Design | | | | Course Code | PWE547 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to airport planning – aviation organizations – Fundamental concepts for planning airports and design– airport site selection – airport master plan – airport project plan – airport layout – aircrafts types and characteristics – landing gear configuration – airport classifications – coding of airports according to ICAO – runway configurations – runway orientation (wind rose) – basic runway length – corrections for runway length – runway and taxiway marking and lighting – exit taxiway geometry – imaginary surfaces – cross-section of runway and taxiway – sight distance – vertical alignment – horizontal alignment – navigation systems.

**References:**

- Antonin Kazda, and Robert E. Caves (2015) Airport Design and Operation. 3rd edition, Emerald Group Publishing Limited.

| Course title | Pavement Evaluation and Maintenance | | | | Course Code | PWE548 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to roadway maintenance and management – Asphalt and concrete mixtures – Concept of performance-age survival curve – Data systems to support maintenance – Maintenance of road surface, shoulder, drainage, and roadside – pavement distresses – Types of maintenance and rehabilitation – Types of pavement evaluation and surveys – quality control – Tests procedures for structural capacity evaluation – Factors affecting pavement performance – Procedures for functional and ride quality evaluation – Repairs techniques for flexible and rigid pavements – special asphalt concrete mixtures and additives - overlay design.

**References**:
- Mallick, R. B._ El-Korchi, T. (2018) Pavement Engineering - Principles and Practice, 3rd Edition, Taylor & Francis.
- Egyptian code for urban and rural roads (2008) Part 10, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.

| Course title | Research Project | | | | Course Code | PWE549 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 4 | 0 | | |
| Course grades | Discussion | Practical | S. work | Final Exam | Total grads | 100 |
| | 30 | - | 70 | - | | |

**Contents**

A research proposal/review/project related to highway and airport engineering.

| Course title | Traffic Engineering | | | | Course Code | PWE551 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction: What is Traffic Engineering? Traffic Problems, Characteristics of Driver, Pedestrian, Vehicle, and Road, Traffic Flow Characteristics: Traffic Flow Elements, Volume, Speed, Travel Time and Delay Studies, Capacity and Level of Service, Weaving at Intersections, Freeways, and Expressways:

Traffic Control Devices: Definition, Types and Purposes of Devices, Installation Requirements, Uniformity of The Devices, Intersection Control: Conflict Points at Intersections, Types of Intersection Control, Traffic Signals: Warrant for Use of Traffic Signals, Phasing, Vehicular and Pedestrian Safety Requirements, Saturation Flow, Cycle Time Calculation, Green Allocation, Parking: Types of Parking Facilities, Parking Characteristics, Parking Surveys, Design Principles of Parking Spaces.

**References:**
- *Roess, R. P., E. S. Prassas, and W. R. McShane. **Traffic Engineering, Fourth Edition**. International Edition, Pearson (2011)*
- *Transportation Research Board (TRB) (2016-10-24). "Highway Capacity Manual, Sixth Edition: A Guide for Multimodal Mobility Analysis"*

| Course title | Traffic Impact Studies | | | | Course Code | PWE552 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The focus of this course is on the Determination of The Affected Area Around The new Activity / Activities, the Traffic Data Collection for The Adjacent Transportation Network, the Assessment of The Current Situation, the Determination of The Trip Generation, Trip Distribution, Modal Split, and Trip Assignment for The new Activity / Activities, the Assessment of The Future Situation that would result from the new Activity / Activities, and Proposals for Solving The Traffic Problems Resulted From The new Activity / Activities.

**References:**

- *Dey, Soumya Sekhar, and Jon D. Fricker. "Manual of Traffic Impact Studies, 3 Volumes: Volume 1-Final Report, Guidelines for Traffic Analysis of Developments Along State Highways." (1992).*
- *Florida Department of Transportation. Transportation Site Impact Handbook, (2019). Available online:* https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/systems/programs/sm/pdfs/2019-site-impact-handbook.pdf


| Course title | Urban Transportation Planning | | | | Course Code | PWE553 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The focus of this course includes the study of the Transportation Planning Stages, the four-step model, the data collection procedures for Urban Studies, the Analysis and the Collaboration of Data, the Study Sectors and the Zoning System, the Trip Generation and Distribution, Mode Choice, in addition to different statistical analysis procedures for the different transportation planning steps, and finally studying the Road Network Planning and Evaluation, and the effect of the Public Transport on the Road Network.


**References:**

- Ortuzar, J.D. and L.G. Willumsen. **Modelling Transport,** Third Edition, Jon Wiley&Sons, Inc. (2011)
- Papacostas, C.S. and Prevedouros, P.D. **Transportation Engineering and Planning**. Third Edition, Pearson Canada, Toronto, 2000.


| Course title | Transportation Economics | | | | Course Code | PWE554 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The focus of this course includes the study of the Annual Cost Formulas, the Motor Vehicles Operation Cost and the Economic Analysis, the Economic Theory and the Behavior of Large Transportation Systems, Urban and Intercity Passengers and Freight, the Estimation and the Application of Production Costs, Demand Functions, the Evaluation of Governmental Transportation Policies, in addition to the Economic Regulations, Infrastructure Investments, the Pricing and Financing Costs, and finally the Benefit Analysis Impact Upon Economic Efficiency.


**References:**

- Beckmann, Martin J., Charles B. McGuire, and Christopher B. Winsten. "Studies in the Economics of Transportation." (1956).
- Small K.A., Verhoef E.T. The Economics of Urban Transportation (2007).
- Prassas, Elena S., and Roger P. Roess. *Engineering economics and finance for transportation infrastructure*. Springer, (2013).

| Course title | Geometric Planning of Railways | | | | Course Code | PWE556 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this introduction course, students will learn the basics of geometrical design of railways, the track geometry for a railway line, the design speeds, the requirements for increasing the speed along a railway line, setting lines for high speed, the horizontal and vertical alignment design, Superelevation of the railway tracks, the Smooth and appropriate motion, the centrifugal acceleration and the permissible limits, the Transition curves and their equivalents, and finally studying the transition reverse curves.

**References:**

السكك الحديدية: الجزء الأول والثاني د. محمد عبد الرحمن الهوارى وآخرين – كلية الهندسة-جامعة القاهرة (١٩٧١)
هندسة السكك الحديدية: الجزء الأول. د. حسن محمد حميدة، محمود توفيق سالم ، منشأة المعارف بالإسكندرية (١٩٨٤)
American Railway Engineering Association. *Manual for railway engineering*. American Railway Engineering Association, (2017).

| Course title | Principles of Railway Operation | | | | Course Code | PWE557 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The objective of this course is that students shall be able to understand key principles of railway operations and important interrelationships and dependencies to be able to move railway vehicles efficiently and safely, Dynamic of movement, traction and power, Gradient and determination of ruling grade, Impact of speeds on the power of the locomotive, set up of movement tables, calculation the time of braking, calculation the size of the train fleet, Volume of employees, maintenance of mobile units, Movement securing on highway-rail grade crossing.

**References:**

- *John Glover, Principles of Railway Operation, Ian Allan Publishing; 1st Edition (January 1, 2013)*
- *Nigel G Harris, Hans Haugland, Nils Olsson and Mads Veiseth, An introduction to railway operations planning, A & N Harris, 2016.*

| Course title | Turnouts and Signals | | | | Course Code | PWE558 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The focus of this course includes studying of the General forms of the turnouts, Switches, Diamond crossing, Slips, Turnouts stresses, Rail gauge in turnouts, in addition to the Intersections, the Turnouts and their types, the Turnouts maintenance, the Signs purposes and types, the general principles for signs position, rail lines in the mechanical operating system, Automatic control in the trains movements, Railway telecommunication systems and wireless, The efficiency of the rail lines and its relation with signs organization.

**References:**
- *Pachl, J.: Railway Signalling Principles. Braunschweig, 2020*
- *Wang, Ping. Design of high-speed railway turnouts: theory and applications. Academic Press, 2015.*

| Course title | Terminals and Yards | | | | Course Code | PWE559 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students learn details of the design, operations planning, management and optimization of the terminal facilities required for the railway network to function as an efficient freight transportation system. This course shall cover the different types of stations and their engineering characteristics, namely: the different types of passenger terminals, the cargo terminals, the Joint terminals for passengers and cargo, the container terminals, in addition, the locomotives backyard, efficiency and management of movements in stations.

**References:**
- *John Albert Droege, Freight Terminals and Trains: Including a Revision of Yards and Terminals, Franklin Classics, 2018*
- *American Railway Engineering Association. Manual for railway engineering. American Railway Engineering Association, (2017).*

| Course title | Track Engineering | | | | Course Code | PWE561 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the details of rails stresses and railway track cross-section design, Sleeper stresses and fastening methods, Ballast thickness, and calculation of the stresses on the track subgrade, Calculation of the Rail Bending Stress at the Base of the Rail, Allowable rail bending stress at the rail base, Calculation of the Rail Bending Stress at the Lower Edge of the Rail, Calculation of the Vertical Deflection of the Rail, Allowable vertical deflection, Longitudinal Temperature Stresses Induced in the Rail, different calculation methods for calculating the longitudinal stresses and finally the maintenance and renovations of tracks.

**References:**
- *Coenraad Esveld ,Modern Railway Track: Digital Edition, MRT-Productions; 4th Edition (April 26, 2015)*
- *American - Railway Engineering Association. Manual for railway engineering. American Railway Engineering Association, (2017).*

| Course title | Highway-Rail Grade Crossing Safety | | | | Course Code | PWE562 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the details of the highway-railroad grade crossings (level crossings) safety. The focus of this course includes studying of traffic warning and traffic control devices, Active

Grade Crossings (bells, flashing lights, and gates), in addition to passive warning devices such as crossbucks, yield or stop signs and pavement markings. , geometric design and grade separations, grade crossing surfaces, train detection and warning systems, traffic signals, operation control, warnings and highway signals, quiet zones,

**References:**

- *Ogden, Brent D., and Chelsey Cooper. Highway-Rail Crossing Handbook, 3rd edition. FHWA-SA-18-040/FRA-RRS-18-001. United States. Federal Highway Administration, 2019.*

| **Course title** | **Research Project** | | | | **Course Code** | **PWE563** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | **3** |
| | **1** | | **4** | **0** | | |
| **Course grades** | **Discussion** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | **30** | **-** | **70** | **-** | | |

**Contents**

Research project or literature review in Transportation engineering.

# Summary of Courses Specification Level (600)

| Course title | Geometric geodesy | | | | Course Code | PWE621 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Fundamental concepts, definitions and basic aims of geodesy. Branches of Geodesy- Geoid – terrain – ellipsoid Representation of the Earth's surface: physical and mathematical figures of the Earth, geodetic reference systems, frames and co-ordinates, reference ellipsoids and geodetic datums, maps. Basic types of geodetic reference systems, computational procedures, co-ordinate transformation methods. Geodetic coordinates, transformation parameters and direct and inverse problem. Elements of map projections, examples and applications. UTM projection, ETM projection, MTM projection. Map projection formulas.

**References:**


- *Willi Freeden, M. Zuhair Nashed, " Handbook of Mathematical Geodesy: Functional Analytic and Potential Theoretic Methods ",* Birkhäuser*, 2018.*
- *Anderson, M.J., and E.M. Mikhail, Surveying: Theory and Practice. McGraw Hill, (5th Edition), 2017.*


| Course title | Physical geodesy | | | | Course Code | PWE622 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to geodesy, its principles, tasks and applications. Geoid – terrain – ellipsoid. The gravity field and the geoid in science and engineering. Gravity anomaly and boundary value problems, the normal field and gravimetric measurements. Normal gravity field, Remove restore technique. distributing potential. Gravity reductions in geoid determinations, isostasy. Geoid determination, Stokes's formula, plumb line deflections. combination methods, least-squares collocation. Vertical positioning and height datums and systems. orthometric and normal corrections. Laplace equation in polar coordinates and Cartesian coordinates.

. **References**:


- ***Soňa Molčíková, Viera Hurčíková, and Peter Blišt'an, "Advances and Trends in Geodesy, Cartography and Geoinformatics", 2020.***
- ***Willi Freeden, M. Zuhair Nashed, " Handbook of Mathematical Geodesy: Functional Analytic and Potential Theoretic Methods ", Birkhäuser, 2018.***


| Course title | Hydrographic surveying | | | | Course Code | PWE623 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Objectives and basic principles of hydrographic surveying. Tides water levels and reference surfaces. Underwater acoustics including velocity and system parameters. Sonar and echosounder systems.

Acoustic positioning concepts. Depth determination and sounding: Single & multi-beams and Sea water properties & Tide Gauge. Sea bed exploration. The Vertical positioning and datums. Types of surveys and specifications. Global navigation satellite systems, GNSS error sources and biases, Application of hydrographic surveying. Locating horizontal control and Locating vertical control. Positioning accuracy.

**References:**

- *Leick, Alfred; Rapoport, Lev; Tatarnikov, Dmitry, " GPS Satellite Surveying "*, Wiley *,2015.*

| Course title | GNSS Theory and Applications | | | | Course Code | PWE624 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Overview of space positioning and navigation systems; concepts and general description. Global Navigation Satellite System signal description. GNSS error sources and biases; atmospheric delays. Dilution of Precision. Observation equations and Mathematical models for static point and relative positioning. Kinematic single point and differential post mission and real time positioning, Precise Point Positing, navigation and location. Augmentation methods, VRS and Permanent GNSS networks. Land, marine, airborne applications .GNSS applications. Total electron content. GNSS radio occultation. Processing data.

**References:**

- *Leick, Alfred; Rapoport, Lev; Tatarnikov, Dmitry, " GPS Satellite Surveying "*, Wiley *,2015.*
- *Rustam B. Rustamov and A.M. Hashimov, "Multifunctional Operation and Application of GPS",2018.*

| Course title | Remote Sensing | | | | Course Code | PWE625 |
|---|---|---|---|---|---|---|
| Credit hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | 100 | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic concepts: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Response and Spectral Signature, Spectral, Spatial, Temporal and Radiometric resolutions. Remote sensing satellites and sensors. A survey of modern quantitative remote sensing using optical, infrared and microwave radiation. Across-track Scanners, Along-track Scanners. Geometries; radiometric corrections, including calibration and atmospheric correction; geometric corrections, including registration and land cover classification algorithms, including accuracy assessment and geospatial data integration. Principles of digital image Processing. Thermal remote sensing. Lidar Principles.

**References**:

- ***Paolo Tarolli, Simon M. Mudd, "Remote Sensing of Geomorphology: Volume 23", Elsevier, 2019***
- ***Constantin Andronache,"Remote Sensing of Clouds and Precipitation, Springer", 2018.***

<table>
<tr><td rowspan="2">Course title</td><td colspan="4" rowspan="2">Observation Adjustment in Geomatics</td><td>Course Code</td><td>PWE626</td></tr>
<tr></tr>
<tr><td rowspan="2">Credit hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>100</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Surveying measurements and errors. Mistakes , systematic errors. Random errors. Sources of errors. Standard error and weights. Propagation of errors in surveying observations. Variance covariance matrix. Dealing with linear surveying models. Dealing with non-linear surveying models. Linearization of distance and angle equations. The least-squares method. Least squares adjustment-parametric technique. Least-squares adjustment-conditional technique. Least-squares adjustment -combined technique. adjustment of level nets. adjustment of horizontal surveys. Adjustment of GPS networks. Determination of error ellipse, blunders detection. Precession analysis.

**References:**


- ***Anderson, M.J., and E.M. Mikhail, Surveying: Theory and Practice. McGraw Hill, (5th Edition), 2017***
- ***Merrin, Jack, " Introduction to error analysis : the science of measurements, uncertainties, and data analysis ", CreateSpace Independent Publishing Platform, 2017.***


<table>
<tr><td>Course title</td><td colspan="4">Advanced Photogrammetric and Ranging Techniques</td><td>Course Code</td><td>PWE627</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Photogrammetric Principles, Photogrammetric Triangulation, Space intersection, Space resection. Principles of active imaging systems, principles of laser scanning, mathematics of LiDAR mapping, LiDAR data acquisition, information extraction from LiDAR data and error analysis. the basic principles of calibrating, georeferencing, and processing of lidar data. LiDAR and photogrammetric data integration, DTM and DEM creation from LiDAR. Basic principles of RADAR. Topographic Mapping with Lidar. Quantitative and qualitative methods used in industry standards for quality assurance and accuracy assessment of lidar-derived data products.

**References:**


- ***Pinliang Dong and Qi Chen, "LiDAR Remote Sensing and Applications ", 2018***
- ***William Emery and Adriano Camps, "Introduction to Satellite Remote Sensing", 2017***


<table>
<tr><td>Course title</td><td colspan="4">Theory and Applications of Terrestrial Laser Scanner</td><td>Course Code</td><td>PWE628</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Basics and concepts of 3D Terrestrial Laser Scanner, measurement principle, Triangulation based measurement, Time-based measurement. different laser scanning systems, Calibration and resolutions. Application of Terrestrial Laser Scanner in Bridge Inspection, archaeology, architectural and mining. Applications of terrestrial laser scanning for tunnels. Accuracy, resolution and point density. Registration of point cloud. Indirect Registration, Geo-Referencing. Direct Registration & Geo-Referencing. General aspect of Registration and Geo-Referencing. Point Cloud representations, Data improvement, Direct 2D modelling from point clouds.

**References**:

- ***Pinliang Dong and Qi Chen, "LiDAR Remote Sensing and Applications ", 2018***

| Course title | Geomatics Programming | | | | Course Code | PWE629 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to programming language. Basic programming concepts like variables, conditionals (if statements), loops, and functions. Data types, data Structures, objects and inheritance. Basic Input and Output. Algorithm design, and program structure. Use of procedures, loops, and arrays. Debugging and verification of programs. Introduction to Functions, File Handling: Reading and Writing the Data to File. File Input and Outpu. Programming for Geomatics Engineering applications. Visualization and data representation. Build applications to automate survey data processing and graphical software packages.

**References:**

- ***Bjarne Stroustrup (2015): The C# Programming Language, 4th edition.***

| Course title | Advanced sanitary engineering | | | | Course Code | PWE631 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction in advanced sanitary engineering. Characteristics of different water sources. Definition of water hardness, types of water hardness and removal of water hardness. Different methods of Iron and manganese removal from water. Ion exchange (definition, mechanism, methods and materials). Different methods of desalination, chemical treatment methods. Adsorption (adsorbent, adsorbate, mechanism and types of adsorption process). Reverse osmosis (RO) (definition, contaminants will RO remove from water, methods and materials used). Other technologies for advanced water treatment.

**References:**

- *Wilderer, P. A., Grambow, M., Brenner, A., & Bauer, W. P. (2016). Sanitary Engineering: Central or Decentral Solutions? In Global Stability through Decentralization? (pp. 139-164). Springer, Cham.*
- *Hansima, M. A. C. K., Makehelwala, M., Jinadasa, K. B. S. N., Wei, Y., Nanayakkara, K. G. N., Herath, A. C., & Weerasooriya, R. (2020). Fouling of Ion Exchange Membranes used in the Electrodialysis Reversal Advanced Water Treatment: A Review. Chemosphere, 127951.*

| Course title | Treatment of industrial wastewater | | | | Course Code | PWE632 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction- Water Usage in Industry. Characteristics of industrial wastewater. Strategy for industrial wastewater management. Separation Processes and Conventional Methods of Wastewater Treatment. Industrial Wastewater Treatment Process Engineering. Physical processes: screening, flash and the slow mixing filters, filtration, gaseous transfer including ventilation and scavenging, adsorption, membrane separation technology. Chemical treatment processes: coagulation, chemical precipitation, ion exchange. Anaerobic treatment methods. Advanced Oxidation Technologies for industrial Wastewater Treatment. Simulation, Control, and Optimization of Water Systems in Industrial Plant.

**References:**


- *Edwards, J. D. (2019). Industrial Wastewater Treatment. CRC press.*
- *Popat, A., Nidheesh, P. V., Singh, T. A., & Kumar, M. S. (2019). Mixed industrial wastewater treatment by combined electrochemical advanced oxidation and biological processes. Chemosphere, 237, 124419.*


| Course title | Sludge treatment | | | | Course Code | PWE633 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction, solids and bio-solids sources, solids and bio-solids characteristics, estimating the quantities of solids, main contaminants in sludge, sludge and scum pumping, Design of collection and transition works of sludge, sludge treatment processes; Preliminary Operations (grinding, degritting, blending, and storage), sludge thickening, sludge stabilization, sludge conditioning, sludge disinfection, sludge dewatering, sludge drying, sludge composting, Thermal Reduction, and Ultimate Disposal of sludge (disposal at landfills sites, accumulation at the plant via stockpiling or lagoons and beneficial uses).

**References:**


- *Zhang, Q., Hu, J., Lee, D. J., Chang, Y., & Lee, Y. J. (2017). Sludge treatment: Current research trends. Bioresource technology, 243, 1159-1172.*


| Course title | Solid waste engineering management | | | | Course Code | PWE634 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction, Sources, Types, and Composition of Municipal Solid Waste (MSW), Physical, Chemical, and Biological Properties of MSW. The negative effects of solid waste on the environment and public health. Storage, Collection, and Transfer: Solid Waste Generation and Collection Rate, Waste Handling and Separation, Storage, and Processing at the Source, Collection of Solid Waste. Recovery, Treatment Technologies; Material Separation and Processing Technologies, Thermal Conversion Technologies, Biological and Chemical Conversion Technologies. Hazardous Waste Management, final disposal methods.

**References:**


- *Joshi, R., & Ahmed, S. (2016). Status and challenges of municipal solid waste management in India: A review. Cogent Environmental Science, 2(1), 1139434.*

| Course title | Anaerobic Treatment of Wastewater | | | | Course Code | PWE635 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction on anaerobic treatment. Applicability of anaerobic system. Advantages and disadvantages of anaerobic process. Principals of Anaerobic Digestion. General design consideration for anaerobic treatment processes (Wastewater characteristics, flow and loading variation, organic concentrations and temperature, wastewater alkalinity, nutrients, inorganic and organic toxic compounds, solids retention time, expected methane gas production and treatment efficiency needed). Different types of anaerobic suspended growth treatment processes. Different types of anaerobic sludge blanket processes. Attached growth anaerobic processes. Other anaerobic treatment processes.

**References:**

- *Akshaya, V. K., Prangya, R. R., Puspendu, B., & Rajesh, D. R. (2016). Anaerobic Treatment of Wastewater. In Green Technologies for Sustainable Water Management (pp. 297-336).*

| Course title | Selected topics in sanitary engineering | | | | Course Code | PWE636 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Research topics related to any relevant field in sanitary engineering.

**References:**

- *Bomsta, T. (2017). Sanitary Engineering. Pleiades: Literature in Context, 37(1), 47-48.*

| Course title | Advanced Soil Mechanics | | | | Course Code | PWE641 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic concepts of soil mechanics – Soil shear strength – drained and undrained static triaxial testing – Repeated load triaxial testing for measuring resilient modulus in accordance with the AASHTO T307 – permeability and seepage – soil settlement and applications– design of retaining structures and reinforcement of soils - unsaturated soil mechanics theories – Types of suction – Matric suction and its influence on soil strength – Methods of measurement of suction in the laboratory – Shrinkage and wetting impact on expansive soils – Modern techniques used for soil stabilization.

**References:**

- *McCarthy, D. F. (2014) Essentials of soil mechanics and foundations: basic geotechnics. 7th edition, Pearson.*
- *Smith, I. (2014) Smith's Elements of Soil Mechanics, 9th Edition. Wiley.*

| Course title | Advanced Pavement Material Characterization | | | | Course Code | PWE642 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction. Dynamic modulus and asphalt mixture performance tester (AMPT). Linear viscoelastic behavior of asphalt mixtures. Permanent deformation characterization using simple performance tests for rutting. Flow number and repeated creep and recovery tests for viscoplastic behavior characterization. Creep compliance and tensile strength of hot mix asphalt. Fatigue of asphalt mixtures, endurance limit, polymer modification in asphalt mixtures, and crack healing. Thermal cracking performance modeling using a fracture energy approach. Innovations in hot mix asphalt performance testing.

**References**:


- Mallick, R. B._ El-Korchi, T. (2013) Pavement Engineering - Principles and Practice, 2nd Edition, Taylor & Francis.
- Huang, S. and Benedetto, H. (2015) Advances in Asphalt Materials Road and Pavement Construction. Woodhead Publishing, Elsevier.


| Course title | Flexible Pavement Design and Analysis | | | | Course Code | PWE643 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to flexible pavement design and analysis. Flexible pavement design process and design factors. Stress-Strain analysis for flexible pavement. Analysis of traffic loads. Unbound Material characterization. Fundamental properties of aggregates and asphalt binder. Material considerations in design (Properties, Environmental Effects, and Evaluation). Factors affecting design, serviceability concept and failure criteria for flexible pavements. Asphalt Institute thickness design method for full depth, conventional and stabilized pavements. AASHTO 1993 design method for structural design of flexible pavements.

**References:**


- Das, A. (2014) Analysis of Pavement Structures. CRC Press.
- Srinivasa Kumar (2013) Pavement design. Orient Blackswan Private Limited - New Delhi
- Egyptian code for urban and rural roads (2008) Part 6, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.


| Course title | Rigid Pavement Design and Analysis | | | | Course Code | PWE644 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to rigid pavement design and analysis. General design consideration for rigid pavements (traffic volume and loads, subgrade, climate, design life, reliability, other factors). Concrete pavement type selection and design features. Subgrade characterization for rigid pavement design. Drainage considerations. Unbound subbase/base selection and design. Concrete slab thickness design. Methods for rigid pavement design and analysis. Types of joints and design. Shoulder considerations. Construction activities. Special design considerations for reinforced concrete rigid pavements and prestressed rigid pavements.

**References:**

- Delatte, N. J. (2014) Concrete Pavement Design, Construction, and Performance. Second Edition, CRC Press.
- Egyptian code for urban and rural roads (2008) Part 6, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.

| Course title | Infrastructure Engineering and Management | | | | Course Code | PWE645 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic concepts. Infrastructure systems. Infrastructure management framework and levels. Infrastructure management data. Infrastructure condition inspection and assessment. Random sampling for infrastructure condition inspection. Maintenance level of service (LOS). Pavement deterioration mechanisms and distress types. Development and application of pavement condition index (PCI). Types of performance models and its influence on decision making. Common maintenance and rehabilitation treatments for pavement. Life cycle cost analysis for evaluating alternative maintenance and rehabilitation strategies. Probabilistic life cycle cost analysis of maintenance and rehabilitation strategies.

**References**:

- Haas R., Hudson W. R., Falls L. C. (2015) Pavement Asset Management. Wiley-Scrivener.

| Course title | Pavement Maintenance and Rehabilitation | | | | Course Code | PWE646 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to pavement maintenance and rehabilitation. Types of pavements. Data inventory for pavement maintenance. Pavement distresses and causes. Pavement evaluation as part of an overall pavement management process. Pavement evaluation using pavement condition survey. Structural evaluation by non-destructive pavement testing. Types of maintenance and rehabilitation techniques. Common surface treatments. Overlay Design. Modern techniques for repairing, rehabilitation, and reconstruction of roads such as full-depth reclamation, cold in-place recycling, and micro surfacing. Modern equipment for pavement maintenance.

**References:**

- Haas R., Hudson W. R., Falls L. C. (2015) Pavement Asset Management. Wiley-Scrivener.
- AASHTO (2007) Maintenance Manual for Roadways and Bridges. AASHTO, Washington, D.C.
- Egyptian code for urban and rural roads (2008) Part 10, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.

<table>
<tr><td>Course title</td><td colspan="4">Pavement Structural Design for Airports</td><td>Course Code</td><td>PWE647</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Fundamental concepts for pavement structural design of airports – aircraft characteristics and configuration related to pavement structure design – soil investigation and evaluation – pavement construction materials – effect of frost on soil strength – design of flexible pavements using FAA methods (equivalent aircraft method and cumulative damage failure method) – other flexible pavement design methods such as CBR method and layered elastic design – design of rigid pavements using Westergaard's analysis and finite element theory – joints and joint spacing – pavement construction and maintenance.

**References:**


- Federal Aviation Administration (FAA) (2012) Airport Design, Advisory Circular AC 150/5300-13, Change 14, Washington, D.C.
- Antonin Kazda, and Robert E. Caves (2015) Airport Design and Operation. 3rd edition, Emerald Group Publishing Limited.


<table>
<tr><td>Course title</td><td colspan="4">Selected Topics in Highway and Airport Engineering</td><td>Course Code</td><td>PWE648</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Selected contemporary topics in highway and airport engineering.

**References**:


- Mallick, R. B._ El-Korchi, T. (2018) Pavement Engineering - Principles and Practice, 2nd Edition, Taylor & Francis.
- Egyptian code for urban and rural roads (2008) Parts 1-10, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.


<table>
<tr><td>Course title</td><td colspan="4">Urban Transportation Planning Models - Principles and Applications</td><td>Course Code</td><td>PWE651</td></tr>
<tr><td rowspan="2">Teaching hours</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Urban transportation planning models. Land use transportation interaction, trip production and attraction, trip distribution, mode choice, tree building and capacitated and un-capacitated route assignment, aggregate and disaggregate model analysis.

**References:**


- Ortuzar, J.D. and L.G. Willumsen. **Modelling Transport,** Third Edition, Jon Wiley&Sons, Inc. (2011)
- Papacostas, C.S. and Prevedouros, P.D. **Transportation Engineering and Planning**. Third Edition, Pearson Canada, Toronto, 2000.

| Course title | Advances in Public Transportation Planning, Operations & Control | | | | Course Code | PWE652 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The focus of this course is on the use of quantitative techniques to analyze and solve problems arising in the planning, design, operation and management of urban public transportation systems. Topics include an introduction to public transportation modes, transit performance analysis, fleet sizing and route design; control of transit operations, and paratransit planning, scheduling and dispatching. The course also covers various transit modelling issues arising in the Advanced Public Transportation Systems that aim at maximizing transit system efficiency and reliability using emerging technologies such as global positioning systems (GPS), electronic fare payment, and automatic passenger counters and pre-trip/en-route passenger information systems.

**References:**

- Meyer, Michael D. **Transportation planning handbook**. Wiley (2016)
- Ceder, Avishai. ***Public Transit Planning and Operation: Theory, Modeling and Practice***. Burlington, MA: Elsevier, 2007
- Vuchic, Vukan R. **Urban transit systems and technology**. John Wiley & Sons, 2007.
- Vuchic, Vukan. ***Urban Transit: Operations, Planning and Economics***. New York, NY: Wiley, 2005
- **Transit Capacity and Quality of Service Manual**, 3rd Edition, Transportation Research Board, 2013.

| Course title | Fundamentals of Traffic Flow Theory | | | | Course Code | PWE653 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 3 |
| | 2 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the fundamentals of traffic flow theory. The focus of this course includes the examination of the formulation, the derivation, and the application of theories associated with traffic flow on interrupted and uninterrupted road networks. The topics of this course include traffic stream characteristics, human factors, car following models, safety, energy and emissions, and traffic flows at signalized and unsignalized intersections. Theoretical models will be tested using field data and simulation.

**References:**

- May, Adolf. *Traffic flow fundamentals*. 1990.
- Gartner, Nathan H., Carrol Jl Messer, and Ajay Rathi. "Traffic flow theory-A state-of-the-art report: revised monograph on traffic flow theory." (2002). Available online: https://rosap.ntl.bts.gov/view/dot/35775/dot_35775_DS1.pdf

| Course title | Modeling Transportation and Spatial Economics | | | | Course Code | PWE654 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the fundamentals of modelling transport and spatial economics. This course focuses on modeling the Spatial Economic and Transportation Interaction (SETI) process for the purposes of freight flow forecasting, the land use transportation interaction modeling, and the economic impact analysis of transportation infrastructure. The topics in the course include the specification, estimation, validation, calibration, and the application of econometric input-output models, the spatial computable general equilibrium models, and agent-based models of transportation and land use.

**References:**

- Fujita, Masahisa, Paul R. Krugman, and Anthony Venables. *The spatial economy: Cities, regions, and international trade*. MIT press, 1999.
- Mills, Edwin, Edwin S. Cheshire, Jacques François Thisse, Gilles Duranton, and William C. Strange. *Handbook of regional and: Urban economics*. Vol. 2. Elsevier, 1986.
- **Lin , Jingyi. Spatial analysis and modeling of urban transportation networks. Royal Institute of Technology Stockholm, Sweden, 2017. Available online: https://www.diva-portal.org/smash/get/diva2:1159523/FULLTEXT01.pdf-**
- Ortúzar J.d.D. and Willumsen L.G. Modelling Transport. Fourth Edition, John Wiley & Sons Ltd, Chichester, UK.(2011)

| Course title | Computer Applications in Transportation Engineering | | | | Course Code | PWE655 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

This course focuses on the fundamentals behind some of the most popular computer software packages used in the planning, design, operations, and management of transportation systems, such as PTV Vissim and PTV Visum, Trafficware Synchro, SUMO, etc. This course topics include signal optimization and evaluation at various levels of spatiotemporal scales, forecasting of traffic flows and passenger volumes for both long-term and short-term planning, simulation of traffic and transit systems, design and evaluation of Intelligent Transportation Systems.

**References:**

- Barcelo J. Fundamentals of Traffic Simulation. Simulation 2010;145:399–430. https://doi.org/10.1007/978-1-4419-6142-6.
- PTV “Planung Transport Verkehr A G.” VISSIM 5.40 user manual. Karlsruhe, Germany: 2012.
- Trafficware, L. L. C. "Synchro Studio 9-Synchro plus SimTraffic and 3D Viewer." (2017).

| Course title | GIS for Transportation Engineering | | | | Course Code | PWE656 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the fundamentals of the GIS applications for different transportation engineering. The focus of this course includes an overview of basic concepts, methods and techniques of geospatial information systems (GIS). The application and related technologies of GIS for the planning, design, operations, and maintenance of transportation engineering systems. In addition to GIS project design. Finally, the course shall provide students with hands-on experience with GIS software and transportation engineering examples / case studies.

**References:**

- *Thill, Jean-Claude, ed. Geographic information systems in transportation research. New York: Pergamon, 2000.*
- *Rodrigue, Jean-Paul. The geography of transport systems. Taylor & Francis, 2016.*
- *Miller, H.J. and S.L. Shaw. Geographic Information Systems for Transportation: Principles and Applications. New York: Oxford University Press (2001).*

| Course title | Track Capacity | | | | Course Code | PWE657 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the fundamentals of railway track capacity, specifically defining, measuring, analyzing, improving and controlling track capacity utilization. An overview of the concept of capacity and the railway capacity challenge is explained. The past approaches to defining and analyzing the concept of railway capacity are covered. Existing methods for estimating capacity utilization shall be studied in four categories: analytical methods, parametric models, optimization and simulation. Various factors affecting capacity utilization. Scheduling and timetable, Network analysis. Line and network simulation. Computer applications.

**References:**

- *Ceder, Avishai. Public Transit Planning and Operation: Theory, Modeling and Practice. Burlington, MA: Elsevier, 2007*
- *Vuchic, Vukan R. Urban transit systems and technology. John Wiley & Sons, 2007.*
- *Vuchic, Vukan. Urban Transit: Operations, Planning and Economics. New York, NY: Wiley, 2005*
- *Transit Capacity and Quality of Service Manual, 3rd Edition, Transportation Research Board, 2013.*

| Course title | Modern Turnouts Technology | | | | Course Code | PWE658 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the fundamentals of railway turnouts Development, the Different types of turnouts, Methods and Modern Apparatus to Ensure Safety Operating of Both Switches and Turnouts, Level Crossing of Railway Track and Roads Specifications and Design, Movable Railway Bridge: Operating and Maintenance. The High Speed Turnout Geometry, the High Speed Turnout Technology, the Switching Technology for High Speed, In addition to the Key Factors for a Successful High Speed Turnout Technology.

**References:**


- *Ping Wang, Design of High-Speed Railway Turnouts: Theory and Applications, 1st edition, Academic Press, 2015*
- *American Railway Engineering Association. Manual for railway engineering. American Railway Engineering Association, (2017).*


| Course title | Advanced Technology of Railway Signals | | | | Course Code | PWE659 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the fundamentals of advanced technology of railway signals. The course contents includes: different Block signaling systems, the Automatic and Light Signals Development Study for Both Urban (Underground Metro) Or Rural Trains, the Train Driver Cabin Signals, the Centralized Traffic Control (C.T.C) and the Automatic Train Control (A.T.C) Study, Remote Sensing System for Train Operating, Line, Car, Station Capacity Improvements By Using Developed Signal System, in addition to the Satellite Technology for Advanced Railway Signaling.

**References :**


- *Pachl, J.: Railway Signalling Principles. Braunschweig, 2020*
- *Ali G. Hessami (Editor), Modern Railway Engineering, 2018 (https://www.intechopen.com/books/modern-railway-engineering)*


| Course title | Modern Methods of Railway Station Planning | | | | Course Code | PWE661 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the fundamentals of railway station planning methods. This includes: the Architectural, Aesthetic, Operational Requirements for Station Design, Railway Station Layout and Elements, Space, Light and Ventilation, Circulation and Linkages, The Station as a Landmark, The Station as an urban renewal catalyst Freight Station and Cranes Types, Locomotive, Stabling and Marshalling Yards Atomization, How to Improve Urban (Underground Metro) and Rural Station Capacity, in addition to the design of terminal railway stations.

**References:**


- *Edwards, Brian. The modern station: new approaches to railway architecture. Taylor & Francis, 2013.*
- *Richards, Jeffrey, and John M. MacKenzie. The Railway Station: a social history. Oxford: Oxford University Press, 1986.*
- *Bruinsma, Frank, Eric Pels, Hugo Priemus, Piet Rietveld, and B. Van Wee. "Railway development." Impact on urban dynamics (2008).*
- *Bertolini, Luca, and Tejo Spit. Cities on rails: The redevelopment of railway stations and their surroundings. Routledge, 2005.*

| **Course title** | **Railway Freight Transport Systems** | | | | **Course Code** | **PWE662** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | **3** |
| | **2** | | **2** | **0** | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | **0** | **0** | **50** | **50** | | |

**Contents**

In this course, students shall learn the fundamentals of the rail freight transport which is the use of railroads and trains to transport cargo as opposed to human passengers. The course contents includes: the Freight Transport Systems Role, the Transport Chain, the logistics chain, the Freight Trains Types, Freight Transports Planning, Problems, Marshalling Yards Container Transports, Station and Handle Systems. Handle Types and Tools, Store Methods, Freight Transport Methods, Intelligent Systems in the Railway Freight Management.

**References :**

*- Vasco Reis, and Rosário Macário, Intermodal Freight Transportation, Elsevier, 2019, https://doi.org/10.1016/C2017-0-01106-0*

*- Ralf Elbert, Christian Friedrich, Manfred Boltze, Hans-Christian Pfohl (Editors), Urban Freight Transportation Systems, Elsevier, 2019, https://doi.org/10.1016/C2018-0-01271-2*

| **Course title** | **Research Seminar** | | | | **Course Code** | **PWE663** |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | **3** |
| | **1** | | **4** | **0** | | |
| **Course grades** | **Discussion** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | **30** | **-** | **70** | **-** | | |

**Contents**

A research topic/review/project related to any relevant field in public works engineering

# Summary of Courses Specification Level (700)

| Course title | Numerical Analysis in Geomatics | | | | Course Code | PWE721 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Interpolation, Interpolation techniques, 2D and 3D transformation, Purposes and necessity of transformation, Introduction to spherical trigonometry, Solving direct problem and inverse problem, Matrix algebra, Solution of Linear equations Interpolation, Interpolation techniques, 2D and 3D transformation, Purposes and necessity of transformation, Introduction to spherical trigonometry, Solving direct problem and inverse problem, Matrix algebra, Solution of Linear equations and matrix inversion, Numerical differentiation and numerical integration. Linearization, Taylor series, Regression analysis, Statistical concepts and Statistical tests. matrix inversion, Numerical differentiation and numerical integration. Linearization, Taylor series, Regression analysis, Statistical concepts and Statistical tests.

**References:**

- ***Merrin, Jack, " Introduction to error analysis : the science of measurements, uncertainties, and data analysis ", CreateSpace Independent Publishing Platform, 2017.***

| Course title | Advanced Global Geophysics and Geodynamics | | | | Course Code | PWE722 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to geophysics. Basic principles in studying the physical properties of earth materials and the dynamic processes of the earth. Elasticity, figure of the Earth, Earth structure and seismology, gravity and its temporal variations, Magnetism, isostasy, tides, Earth rotation and orientation, time, plate flexure, glacial rebound, continental drift, geodetic observation methods for geodynamics. Introduction to geodynamics and plate tectonics. Types of plate boundaries, triple junctions, Euler poles, plate tectonics on a sphere. Plate Tectonics & Mantle Geodynamics.

**References**:

- ***Karl Seibert ,"Advanced and Applied Geophysics ", 2015.***
- ***Khan, Amir,*** *Deschamps* ***andFrédéric , "The Earth's Heterogeneous Mantle" A Geophysical, Geodynamical, and Geochemical Perspective, 2015***

| Course title | Atmospheric Effects on Satellite Navigation Systems | | | | Course Code | PWE723 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to GNSS. Theoretical and observed aspects of radio wave propagation in the ionosphere and troposphere, with an emphasis on L-band (GPS) signals. Fundamentals of absorption, attenuation, depolarization, and defraction will be covered, in addition to characteristics and physical properties of the propagation medium and atmospheric constituents. The impact of such effects, and methods of mitigation, will be interpreted with respect to satellite navigation applications. GNSS radio occultation principles and applications. GNSS Atmosphere Sounding. Atmospheric properties using GNSS signals.

**References:**


- Leick, Alfred; Rapoport, Lev; Tatarnikov, Dmitry, " GPS Satellite Surveying ", Wiley ,2015.
- Rustam B. Rustamov and A.M. Hashimov, "Multifunctional Operation and Application of GPS",2018.


| Course title | Advanced Topics in Photogrammetry | | | | Course Code | PWE724 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Quality Assurance (QA) and Quality Control (QC) of photogrammetric mapping: flight configuration, camera calibration, system calibration, precision, and accuracy; Modern digital imaging systems: frame cameras, multi-head frame cameras, and bush-broom scanners. Overview of aerial triangulation procedures. Mapping from space. Multi-sensor aerial triangulation (integrating aerial and satellite imagery with navigation data). Photogrammetric products (Digital Elevation Models, ortho-photos). The role of features in photogrammetric operations, utilizing road network captured by terrestrial navigation systems in various orientation procedures.

**References:**


- *Riccardo Salviniand Francesco Mancin, "Applications of Photogrammetry for Environmental Research",2020*
- *Elements of Photogrammetry with Application in GIS, by Paul R Wolf, Bon A DeWitt, and Benjamin EWilkinson, 4th ed, McGraw-Hill Education, 2015.*


| Course title | Advanced Physical Geodesy | | | | Course Code | PWE725 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to geoid determination , Gravitational law, Laplace's equation and boundary value problem. Gravity field, normal field and anomalous field of the earth. Global gravitational field and spherical harmonic expansions. Stokes' formula, Poisson's integral and Vening Meinesz formula. Trunction errors, combination of Stokes' formula with global gravitational models. Applications to gravity prediction, geoid determination, deflection estimation, satellite altimetry and airborne gravimetry and gradiometry. Methods of geoid/quasigeoid determination based on terrestrial data. Methods of geoid/quasigeoid determination based on satellite data.

**References**:


- *Soňa Molčíková, Viera Hurčíková, and Peter Blišt'an, "Advances and Trends in Geodesy, Cartography and Geoinformatics", 2020.*
- *Willi Freeden, M. Zuhair Nashed, " Handbook of Mathematical Geodesy: Functional Analytic and Potential Theoretic Methods ", Birkhäuser, 2018*

| Course title | Advanced Geospatial Information Systems | | | | Course Code | PWE726 |
|---|---|---|---|---|---|---|
| Credit hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | 100 | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

GIS tools for editing, geoprocessing and analysis. GIS tools for generalisation, overlay analysis and space-time cluster analysis. Introduction to Geospatial Information Systems and Geographic Information Science, Georelational vector data model, object-based vector data model, raster data model, map projections, geodetic datums, co-ordinate systems, georeferencing, database design and management, query language, geometric transformations, vector data analysis, raster data analysis, spatial interpolation, terrain modelling and analysis, triangulated irregular network data model, path and network analysis. Surface modeling, Spatial statistics, Data visualization.

**References:**

- ***Elements of Photogrammetry with Application in GIS, by Paul R Wolf, Bon A DeWitt, and Benjamin EWilkinson, 4th ed, McGraw-Hill Education, 2015.***
- ***Michael J. de Smith,Michael F. Goodchild,Paul A. Longley. Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools,2015.***

| Course title | Geodetic Astronomy | | | | Course Code | PWE727 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Astronomy - planets, stars, galaxies, and the universe - Universe starts - Celestial body movements, Naked Eye Astronomy and the Foundational Physics of Astronomy, Celestial coordinates system - solar and lunar eclipse - process and appearance of eclipses and the phases of the Moon;The shape of the planetary orbits and the relationship between their distance from the Sun and their orbital period; Calendars - Spherical triangle -Concept of time- Movement of the sun- Determination of Position.

**References:**

- *DK "The Astronomy Book: Big Ideas Simply Explained",2017*
- *Paul Murdin, "Discovering the Universe: The Story of Astronomy", 2015.*

| Course title | Re-use of Wastewater | | | | Course Code | PWE731 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Wastewater reclamation and reuse, the role of water recycling in the hydrologic cycle, wastewater reuse applications, public health and environmental issues in water reuse, introduction in risk assessment, water reclamation technologies, constituent removal technologies, process flow diagrams for water reclamation, treatment process combinations, storage of reclaimed water, industrial water reuse and use, ground water recharge with reclaimed water, evaluation of irrigation water quality, planned indirect and direct potable water reuse, reuse treated water for irrigation.

**References:**

- McKinney, Jerry L. (2020), "Wastewater re-use systems." U.S. Patent 10,697,155.

| Course title | Water Quality Modeling | | | | Course Code | PWE732 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Engineering and water quality, Reaction kinetics, first order reaction, second order reactions, Mass balance, steady state solution and response time, non-steady state solution and response time, Particular solutions, Feed forward systems of reactors, Feedback systems of reactors, BOD of water sample analysis, micro-organisms kinetics, BOD modeling, DO of water sample analysis, DO modeling, microbial growth kinetics, kinetics terminology, rate of biomass growth, bacterial growth and energetics, software used in water quality modeling.

**References:**

- *Loucks, D. P., & van Beek, E. (2017). Water quality modeling and prediction. In Water Resource Systems Planning and Management (pp. 417-467). Springer, Cham.*

| Course title | Advanced wastewater treatment | | | | Course Code | PWE733 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Need for advanced water treatment, technologies used for advanced treatment, classification of technologies, removal of organic and inorganic colloidal and suspended solids, removal of dissolved organic matter, removal of dissolved inorganic matter, removal of biological constituents, process selection, depth filtration, surface filtration, disc-filters, cloth- media disk filters, adsorption, activated carbon treatment, membrane filtration process, gas stripping, analysis of gas stripping, design of stripping towers, ion exchange, advanced oxidation processes, applications, operational problems, distillation, reclamation applications.

**References:**

-Sher, F., Hanif, K., Iqbal, S. Z., & Imran, M. (2020). Implications of advanced wastewater treatment: Electrocoagulation and electroflocculation of effluent discharged from a wastewater treatment plant. Journal of Water Process Engineering, 33, 101101.

-Mohamad, S., Fares, A., Judd, S., Bhosale, R., Kumar, A., Gosh, U., & Khreisheh, M. (2017, May). Advanced wastewater treatment using microalgae: effect of temperature on removal of nutrients and organic carbon. In IOP Conference Series: Earth and Environmental Science (Vol. 67, p. 012032). IOP Publishing.

| Course title | Water Microbiology | | | | Course Code | PWE734 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Components and structure of living cells, the classification and nomination of microorganisms (bacteria, Protozoa fungi, algae, , rotifers , viruses, worms), the breeding and growth of microorganisms in the water, methods to estimate the biological indicators in the water, tools and devices used in bacteriological water analyses, biological methods for identifying and measuring the concentration of microorganisms in the water, the biological characteristics of water, prepare reports and comment on them.

**References:**

Yates, M. V. (2016). Drinking Water Microbiology. Manual of Environmental Microbiology, 3-1.

| Course title | Disinfection processes | | | | Course Code | PWE735 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Regularity requirements for water disinfection, Disinfection theory, characteristics of an ideal disinfectant, disinfectant methods and means, mechanisms of disinfectants, factors influencing the action of disinfectants, Disinfection with chlorine, characteristics of chlorine compounds, modeling the chlorine disinfection process, formation and control of disinfection byproducts, environmental impacts of disinfection byproducts, Disinfection with chlorine dioxide, Dechlorination, design of chlorination and dechlorination facilities, dosage control, chlorination storage facilities, Disinfection with Ozone, Design of Chlorination, UV radiation Disinfection, comparison of alternatives.

**References:**

Gassie, L. W., & Englehardt, J. D. (2017). Advanced oxidation and disinfection processes for onsite net-zero greywater reuse: A review. Water research, 125, 384-399.

| Course title | Selected Advanced topics in sanitary engineering | | | | Course Code | PWE736 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Selected Advanced topics in sanitary engineering.

**References:**

Patwardhan, A. D. (2017). Industrial wastewater treatment. PHI Learning Pvt. Ltd.

| Course title | Applied Statistics in Highway Engineering | | | | Course Code | PWE741 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic concepts – Data analysis (numerical and graphical methods) – Introduction & Sampling Techniques - Basic probability concepts- modeling uncertainty – Random variables and Discrete Distributions and their properties – Markov chains – continuous probability distributions – Model estimation and testing – large-sample tests of hypothesis – small-sample tests of hypothesis – estimation and confidence intervals based on means and medians or Wilcoxon – design of experiments – Methods of regression (simple and multiple linear and nonlinear regression) and multivariate analysis- Simulation techniques for design – applications.

**References:**


- Witte R. S., and Witte J. S. (2017) Statistics. 11th ed., Wiley.


| Course title | Advanced Geometric Design | | | | Course Code | PWE742 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to geometric design of highways – Traffic signals, signs, and pavement marking – vehicle characteristics – highway capacity for multilane, two-lanes, freeways, and expressways. design of intersections and interchanges – design controls for intersections and design of turning radii – auxiliary lanes on ramps and loops – design of ramps and loops – pedestrians requirements – bicycles lanes and requirements – disabilities requirements in geometric design – parking studies – sidewalks – lighting – right of way – utility lines under pavements- design considering the environment.

**References**:


- American Association of State Highway and Transportation Officials (AASHTO) (2018) A Policy on Geometric Design of Highways and Streets. 7th ed. AASHTO, Washington, D.C.
- Egyptian code for urban and rural roads (2008) Part 3, 1st edition, Ministry of housing, Utilities and urban development, Housing and building national research centre, Egypt.


| Course title | Micromechanics of Asphalt Concrete Materials | | | | Course Code | PWE743 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to the micromechanics of asphalt concrete materials. Characterization and analysis of asphalt materials. Theory of composite materials. Anisotropic viscoelastic modeling for asphalt concrete in compression. Fracture of asphalt mixtures in compression. Permanent deformation of asphalt mixtures in compression. Damage modeling of cemented particulate materials. Top-down cracking performance model. Interparticle stresses and quasi-static contacts. Plasticity criteria in asphalt concrete. Mechanics of healing and surface energy. Measuring healing in asphalt mixtures. Tensile failure characterization in asphalt concrete.

**References:**


- Kim R. Y. (2014) Asphalt Pavements. Taylor & Francis.
- Huang, S. and Benedetto, H. (2015) Advances in Asphalt Materials Road and Pavement Construction. Woodhead Publishing, Elsevier.


| Course title | Systems Design of Pavements | | | | Course Code | PWE744 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Definitions and concept of systems design of pavements. Back calculation of pavement layer properties. Factors affect computation of the back-calculation modulus. Prediction of permanent deformation in flexible pavement materials. Factors affect the prediction of permanent deformation. Effects of multiple traffic loads on rutting. Fracture mechanics computation for asphalt mixtures. Micro-cracking and healing mechanism. Road roughness. Vehicle dynamics on compressible road surface. Vibrations of a mass with base excitation. Models for prediction of reflection cracking. The mechanism of pumping in rigid pavements.

**References:**


- Delatte, N. J. (2014) Concrete Pavement Design, Construction, and Performance. Second Edition, CRC Press.
- Mallick, R. B._ El-Korchi, T. (2018) Pavement Engineering - Principles and Practice, 2nd Edition, Taylor & Francis.


| Course title | Advanced Pavement Design and Analysis | | | | Course Code | PWE745 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to advanced pavement design and analysis. Types of advanced design methods for flexible and rigid pavements. Empirical and mechanistic-empirical pavement design procedures. Key performance indicators for pavements. Primary factors affecting pavement performance. Appropriate values for climatic, reliability, traffic volume and loads, soil properties, and material design inputs. Design of flexible and rigid pavements for roadways using common procedures and computational tools. Development and evaluation of alternative pavement designs for any given roadway project.

**References**:


- AASHTO (2008) Mechanistic–Empirical Pavement Design Guide. AASHTO, Washington, D.C.
- Das, A. (2014) Analysis of Pavement Structures. CRC Press.

| Course title | Energy Harvesting in Pavements | | | | Course Code | PWE746 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Definition and philosophy of energy harvesting in pavements. Multifunctional asphalt concrete pavement (Piezoelectricity, Thermoelectricity, other methods). Harvesting Heat Energy from flexible Pavements. Energy Harvesting via Pyroelectric Effect. Energy harvesting from flexible pavements using pyroelectric single crystal and nanocomposite based smart materials. Piezoelectric Energy Harvesting from Traffic Induced Deformation of flexible Pavements. Thermoelectric Energy Harvesting System across flexible Pavement Structure. Urban heat island (concept, causes, mitigation, materials, and relationship between asphalt thermal properties and urban heat island)

**References:**

- Pacheco-Torgal F., Amirkhanian S., Wang H., and Schlangen E. (2020) Eco-Efficient Pavement Construction Materials. Woodhead Publishing, Elsevier.

| Course title | Expansive Soils Fundamentals | | | | Course Code | PWE747 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic concepts of soil mechanics. Continuum theory of mixtures. Hydraulic conductivity. Stress states in unsaturated soils. Volume change in unsaturated soils. Capillary rise in soils. Capillary tension in dry soils. Soil suction concept and types. Measurement of soil suction. Factors affecting soil suction. Shrinkage and swelling of soil. Creep of unsaturated soils. Permanent deformation in unsaturated soils. Thermal properties of unsaturated soils. Moisture exchange at the soil surface. Diffusion of water in expansive soils.

**References:**

- McCarthy, D. F. (2014) Essentials of soil mechanics and foundations: basic geotechnics. 7th edition, Pearson.
- Smith, I. (2014) Smith's Elements of Soil Mechanics, 9th Edition. Wiley.

| Course title | Advanced Topics in Highway and Airport Engineering | | | | Course Code | PWE748 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Contemporary selected topics in highway and airport engineering.

**References**:

- Kim R. Y. (2014) Asphalt Pavements. Taylor & Francis.
- Mallick, R. B._ El-Korchi, T. (2018) Pavement Engineering - Principles and Practice, 2nd Edition, Taylor & Francis.
- Das, A. (2014) Analysis of Pavement Structures. CRC Press.

| Course title | Traffic Safety Analysis | | | | Course Code | PWE751 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

This course provides an understanding of the safety management process and the variety of tools used. Topics include: probability models of accident occurrence; estimation of safety in developing and evaluating countermeasures; methods for identifying hazardous elements; the safety of different road facilities: intersections, roadways, roadsides, railroad crossings and traffic control elements; the driver, the pedestrian and the bicycle safety; the applications of human factors principles; the safety audits; vehicle safety; biomechanics of injuries; multidisciplinary accident investigation.

**References:**

- Evans, Leonard. *Traffic safety*. 2004.
- Hauer, Ezra. *The art of regression modeling in road safety*. New York: Springer, 2015.
- Hauer, Ezra. Observational Before-After Studies in Road Safety: Estimating the Effect of Highway and Traffic Engineering Measures on Road Safety. Oxford, U.K.: Pergamon Press, Elsevier Science Ltd.; 1997.

| Course title | Traffic Operations and Management | | | | Course Code | PWE752 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The course introduces topics related to the management of congestion on urban road networks. These include: capacity analysis; deterministic and stochastic models of traffic behavior; the traffic assignment models; incident detection and management; ramp metering; signal timing for networks and arterials; Applications of Intelligent Transportation Systems (ITS); demand management. In addition, the course shall cover traffic flow principles, Highway capacity analysis, Traffic Operations and Management in the real world, Intersection control, Capacity analysis of urban streets, network optimization, simulation models, and Other aspects of traffic management and capacity analysis.

**References:**

**- Persaud, B. CV8401 TRAFFIC OPERATIONS & MANAGEMENT. Course notes,** Ryerson Multiprint 2020
- Canadian Capacity Guide for Signalized Intersections 2008
-Roess, R. P., E. S. Prassas, and W. R. McShane. **Traffic Engineering, Fourth Edition**. *International Edition, Pearson* (2011)
- *Transportation Research Board (TRB) (2016-10-24). "Highway Capacity Manual, Sixth Edition: A Guide for Multimodal Mobility Analysis*

| Course title | Urban Transport Systems | | | | Course Code | PWE753 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

This course deals with optimization and simulation methods to solve logistics problems faced by decision-makers for urban infrastructure, including public transport systems, last-mile freight operations, traffic dynamics, and emergency response. The course emphasizes on the methods that used to evaluate strategies in an urban setting complicated by dense populations, high uncertainty, and ubiquitous data. Applications include transit network design, facility location problems, congestion pricing, and humanitarian logistics. Basic knowledge of transportation engineering and optimization is expected.

**References:**

- Vuchic, Vukan R. *Urban transit systems and technology*. John Wiley & Sons, 2007.'
- Hensher, David Alan, and Kenneth John Button, eds. *Handbook of transport systems and traffic control*. Elsevier Science, 2001.
- Hutchinson, Bruce G. "Principles of urban transport systems planning." (1974).
- Yaghoubi, Hamid (Editor), Urban Transport Systems. (2017). Available online: https://www.intechopen.com/books/urban-transport-systems

| Course title | Travel Demand Analysis | | | | Course Code | PWE754 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Knowing the demand for transportation is a key input to any decision-making process related to investments in transportation and traffic facilities and services such as highways, subways, parking lots, bike-sharing system, etc. The travel demand analysis consists of developing behavioural models that can predict the individual mobility patterns in response to supply and demographic changes, level of service, and other external factors. This course will introduce data-driven as well as hypothesis-driven approaches that can mathematically model correlation, heterogeneity, dynamics, and latent behavior with respect to travel related choice making. Furthermore, the use of such models in simulation to forecast the travel demand will be demonstrated.

**References:**

- Ben-Akiva, Moshe E., Steven R. Lerman, and Steven R. Lerman. *Discrete choice analysis: theory and application to travel demand*. Vol. 9. MIT press, 1985.
- Domencich, Thomas A., and Daniel McFadden. *Urban travel demand-a behavioral analysis*. No. Monograph. 1975.
- Ortuzar, J.D. and L.G. Willumsen. **Modelling Transport,** Third Edition, Jon Wiley&Sons, Inc. (2011)

| Course title | Traffic Flow Theories and Engineering | | | | Course Code | PWE755 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

In this course, students shall learn the fundamentals of the traffic flow theories. The focus of this course include studying the Deterministic traffic Models, intersections and roadway capacities, Differential and Integral Equations, Shock Wave Theory, Traffic Flow Parameters Measurements, Stochastic Models, the Queuing Theory, the Vehicles and Pedestrian Delays, the Gap Acceptance Estimation method, Engineering Applications, Optimum Usage of Traffic Signals, Buses Unloading, Determination of Critical Zones, Cycle Time Calculation and Green Allocation, Actuated Traffic Signals Systems.

**References:**

- May, Adolf. *Traffic flow fundamentals*. 1990.
- Gartner, Nathan H., Carrol Jl Messer, and Ajay Rathi. "Traffic flow theory-A state-of-the-art report: revised monograph on traffic flow theory." (2002). Available online: https://rosap.ntl.bts.gov/view/dot/35775/dot_35775_DS1.pdf

| Course title | Intelligent Transportation Systems | | | | Course Code | PWE756 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The purpose of this course is to introduce students to the basic elements of intelligent transportation systems (ITS), focusing on technological, systems and institutional aspects. Topics include advanced traveler information systems; transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions, ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS and sustainable mobility, travel demand management, electronic toll collection, and ITS and road-pricing.

**References :**

- McQueen, Bob, and Judy McQueen. *Intelligent transportation systems architectures*. 1999.
- Chowdhury, Mashrur A., and Adel Wadid Sadek. *Fundamentals of intelligent transportation systems planning*. Artech House, 2003.

| Course title | Special Topics in Transportation Engineering | | | | Course Code | PWE757 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

This course discusses different advanced topics related to transportation engineering.

| Course title | Research Seminar | | | | Course Code | PWE758 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 |
| | 1 | | 4 | 0 | | |
| Course grades | Discussion | Practical | S. work | Final Exam | Total grads | 100 |
| | 30 | - | 70 | - | | |

**Contents**

A research project/literature review/Lab study related to any relevant field in public works engineering.

# Chapter Thirteen:

## Architectural Engineering Department

## Engineering Sciences Diploma Program in Architectural Engineering

**Program description:**

The aim of the Diploma in Architectural Engineering program is to increase scientific competition in the applied fields in the field of architecture through specialized studies and specialized scientific sources and participation in working groups to prepare applied projects.

## Master of Engineering Science Program in Architectural

**Program description:**

The aim of the Master's degree program in Architectural Engineering is to achieve development in the field of specialization chosen by the master's student from within the research plan of the scientific department by studying advanced scientific approaches and various scientific research approaches.

## Doctor of Philosophy Program in Engineering Sciences in Architectural Engineering

**Program description:**

The aim of the Doctor of Philosophy in Engineering Sciences in Architectural Engineering program is to develop independent scientific thinking by studying advanced scientific approaches in the field of specialization, which is chosen through the research plan of the scientific department

### Level (500)

| Course Code | Course Title | Teaching hours | | | | Credit hours | Student's Workload (SWL) | Final exam time | Grades Distribution | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Exercises | Practical | Contact hours | | | | Term Work | Practical / oral | Written exam | Total |
| ARE511 | Basics and ethics of Practicing the Profession | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| ARE512 | Practice (1) | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 40 | 10 | 50 | 100 |
| ARE513 | Practice (2) | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 40 | 10 | 50 | 100 |
| ARE514 | Computer and Architectural Visualization | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARE515 | Technical English language | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| ARE516 | Development of Existing Residential Areas | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| ARE517 | Technical Writing and Research Types | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| ARE518 | Architectural Applied Projects | 2 | 2 | 0 | 4 | 3 | 8 | -- | 70 | 30 * | -- | 100 |
| ARE521 | Alternative and Renewable Energy in Architecture | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| ARE522 | Studies of Environmental Design Concepts | 2 | 0 | 0 | 2 | 3 | 6 | 2 | 50 | 0 | 50 | 100 |
| ARE523 | Environmental Design and Programming Approaches | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ARE524 | Environmental Control Studies and Energy Efficiency strategies in buildings | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| ARE525 | Sustainability and Environmental impact Assessment of Projects | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| ARE526 | Environmental Materials and Technologies for Energy Efficiency in Buildings | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

* **Discussion**

## Level (600)

| Course Code | Course Title | Teaching hours | | | | Credit hours | (SWL) Student's Workload | Final exam time | Grades Distribution | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Exercises | Practical | Contact hours | | | | Term Work | Practical / oral | Written exam | Total |
| **ARE611** | **Basics of Writing Scientific Theses** | 2 | 2 | 0 | 4 | 3 | 8 | -- | 70 | 30 * | -- | 100 |
| **ARE612** | **Research Methods in Architecture and Urbanism** | 2 | 2 | 0 | 4 | 3 | 8 | -- | 70 | 30 * | -- | 100 |
| **ARE613** | **Architectural design and landscaping studio** | 2 | 2 | 0 | 4 | 3 | 8 | -- | 70 | 30 * | -- | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ARE614** | **Applied Project - Building Science and Technology** | 2 | 2 | 0 | 4 | 3 | 8 | -- | 70 | 30 * | -- | 100 |
| **ARE615** | **Laws, Codes and legislation for Energy Efficiency in Buildings** | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **ARE616** | **Housing, Development and Urban Planning** | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **ARE617** | **Visual Studies of the City** | 2 | 2 | 0 | 4 | 3 | 8 | - | 50 | 0 | 50 | 100 |
| **ARE618** | **Specialized Studies in Architecture** | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| *** Discussion** | | | | | | | | | | | | |

## Level (700)

| Course Code | Course Title | Teaching hours | | | | Credit hours | (SWL) Student's Workload | Final exam time | Grades Distribution | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Exercises | Practical | Contact hours | | | | Term Work | Practical / oral | Written exam | Total |
| **ARE711** | **Solar Studies in Architecture and Urbanism** | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **ARE712** | **Ecosystem integration Studies for Energy Efficiency in Buildings** | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **ARE713** | **Architectural Concepts in Contemporary Egyptian Reality** | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **ARE714** | **Studies of Recent and Future Architecture** | 2 | 0 | 0 | 2 | 3 | 6 | 3 | 50 | 0 | 50 | 100 |
| **ARE715** | **Individual Studies (A) - Building Science and Technology** | 2 | 2 | 0 | 4 | 3 | 8 | -- | 70 | 30 * | -- | 100 |
| **ARE716** | **Individual Studies (B) - Environmental and Energy Design** | 2 | 2 | 0 | 4 | 3 | 8 | -- | 70 | 30 * | -- | 100 |
| **ARE717** | **Individual Studies (C) - Research in Urban Studies** | 2 | 2 | 0 | 4 | 3 | 8 | -- | 70 | 30 * | -- | 100 |
| *** Discussion** | | | | | | | | | | | | |

# A brief description of the course contents

## Level 500

| ARE511 | Course Code | Basics and ethics of Practicing the Profession | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 0 | 0 | 50 | 50 | |

**Content:**

Introduction - the basic principles of ethics in the practice of the profession - the spatial relations that bind the person and the practice of the profession of architecture - the recognized models that govern the relationship between the architect and the client - the role of international and local organizations in developing and following up the organizational foundations - the responsibilities to control the relationship between the practicing architect and the client - the principles and foundations of practice in the industry Building and construction - Building laws and specifications in many regional and global countries - Egyptian building codes and codes and specifications - Structural safety and building safety - Application of case studies for many examples through exercises and paper work.

**References:**


- *Michael Davis. "Engineering Ethics", London, 15 May 2017.*


| ARE512 | Course code | Practice (1) | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Teaching Hours |
| | | 10 | 0 | 40 | 50 | |

**Content:**

Introduction - Analyzing the different stages of architectural design and the processes associated with each stage - The various entrances and mechanisms to control timelines - Design management in engineering offices - Applying these mechanisms through specific exercises and using specialized computer programs developed for use in architectural applications - Study and analysis of contemporary patterns for the practice of the profession In private architectural offices - the organizational and legal aspects - the nature and variation of services provided by architectural offices to clients - the effect of this difference on the management of architectural offices.

**References:**


- *Mark McAfee . "Principles and Practice of Engineering: Architectural Engineering Sample Questions and Solutions", 2nd Edition, January 2010.*

| ARE513 | Course Code | Practice (2) | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | | | 2 | |
| 100 | Total | Oral exam | Course grades | Term work | Written exam | Course Grades |
| | | 10 | 0 | 40 | 50 | |

**Content:**

Introduction - value engineering - applications of value engineering in the field of architecture in the architectural design stage - concepts and principles of value engineering - mechanisms of application in design and its relationship to design phases and schedules for developing architectural projects - local and international models - studying and analyzing the main fields and methods of practicing the profession - Identifying issues Contemporary professional practices - proposing business, concluding contracts and resolving disputes - functional and professional relations between the elements of the practice of the profession - issues of architectural practice locally and focusing on pressing local architectural issues such as issues: environment, technology, art and beauty - developing the student's critical and cognitive capabilities through critical handling of models from Architectural practice of issues of concern.

**References:**

- *American Society of Civil Engineers, Nicole Susan Jenkins, P.E. "Architectural Engineering P.E. Practice Exam and Solutions", September 2017.*

| ARE514 | Course code | Computer and Architectural Visualization | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 4 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 10 | 0 | 40 | 50 | |

**Content**

Introduction - Traditional architectural presentation and expression methods - Architectural perception by traditional means - Advantages and disadvantages of traditional architectural perception - Modern techniques used in architectural visualization - Advanced methods using computers - Concepts and principles of computer and virtual reality applications - Simulation programs and their role in the design process - Digital design - Using mathematical equations (logarithms) in architectural design - programming languages and how to use them in architectural design - how to formulate and present advanced information and data using the computer through new digital means of better control in the management and construction of projects and design with high efficiency and lower costs.

**References:**

- *Rivka Oxman , Robert Oxman. "Theories of the Digital in Architecture", 1st Edition, February 2014*

| ARE515 | Course code | Technical English language | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 4 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 10 | 0 | 40 | 50 | |

**Content**

Introduction - The use of English language techniques in sound technical writing in the field of engineering in general and architecture in particular - A comprehensive review of practical examples of the most important grammar and writing style - Effective sentence models in technical writing and their characteristics - Identifying some common errors and how to correct them by making a technical review - Analysis Excerpts from technical writing in the field of architecture - How to write technical reports - Elements of technical reports - Developing communication skills and writing scientific research in the field_of specialization - Knowing the foundations of scientific writing for scientific research and dissertations - Practical applications

**References:**


- *Elizabeth Tebeaux, Sam Dragga. "The Essentials of Technical Communication", December 2017.*
- *Daniel Riordan. "Technical Report Writing", January 2013.*


| ARE516 | Course code | Development of Existing Residential Areas | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 0 | 0 | 50 | 50 | |

**Content:**

Introduction - Residential development for existing areas (formal and informal housing) and areas of a special nature (desert, rural, remote, ... etc.) - Urban and non-urban aspects (political, social, economic, legislative, administrative, technical, etc.). The main theories of urban development and planning - fundamentals of the planning process - statistical means of factor analysis - variables affecting the urban planning process - planning rates and their change with time and place - the relationship and influence of the state's economic, political and social thought on urban planning processes..

**References:**


- *Mike E. Miles, Laurence M. Netherton, et al." Real Estate Development : Principles and Process", 5th Edition, June 2015.*
- *West Dunbartonshire Council. "Residential Development: Principles for Good Design", September 2013.*

| ARE517 | Course code | Technical Writing and Research Types | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 4 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 10 | 0 | 40 | 50 | |

**Content:**

Introduction - the different stereotypical forms of scientific research - methods of writing scientific research - the principles of using and writing scientific sources - the different methods of writing them and using programs to write them - types of scientific writings and their different levels - how to write literature for scientific research - elements of technical writing for scientific research - ethical considerations in technical writing for research Scientific - scientific misconduct: impersonation - forgery - writing in disguise - manipulation of figures and drawings - scientific consequences - legal aspects and respect for intellectual property - methods of writing specialized technical reports - practical models and applications.

**References:**


- *K. Hyland. "Teaching and researching writing". 3rd edition Routledge academic publisher, 2016.*


| ARE518 | Course code | Architectural Applied Projects | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 30 | 0 | 70 | -- | |

**Content:**

Introduction - Knowing the different methods of collecting information and sources and surrounding scientific approaches - different means of expression and demonstration through one of the architectural topics from the contemporary local reality - Quarterly environmental analysis of projects - How to study the site and benefit from it in architectural solutions and agree with it - Study the design determinants until reaching the alternatives Different design - methods of evaluating different alternatives - choosing the optimal alternative - and proposing design solutions that achieve environmental, cultural, visual and economic aspects - practical applications for local and international projects.

**References:**


- *Dominique Hes, Chrisna du Plessis." Designing for Hope: Pathways to Regenerative Sustainability", December 2014.*
- *Scott Boylston. "Designing Sustainable Packaging Paperback", Laurence King Publishing, April, 2009.*

| ARE521 | Course code | Alternative and Renewable Energy in Architecture | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 0 | 0 | 50 | 50 | |

**Content:**

Introduction - Basics of energy science in buildings - Basic concepts of alternative and renewable energy - Types of renewable energies - Methods of employing them in the various stages of the project - Alternative and renewable energy potentials in the various Egyptian regions - The impact of alternative and renewable energies on the architectural and urban formation - Philosophy and the impact of renewable energy on architectural trends Modern - Energy systems management in buildings - Identification of energy-saving solutions at the level of architectural design - Energy-saving environmental planning and levels - Energy-saving buildings and zero-energy buildings that produce them.

**References:**


- *John Randolph PhD and Gilbert M. Masters. "Energy for Sustainability, Second Edition: Foundations for Technology, Planning, and Policy", August 2018.*


| ARE522 | Course code | Studies of Environmental Design Concepts | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 0 | 0 | 50 | 50 | |

**Content**

Introduction - Environmental design concepts and its various levels - Improvement and development of environmental design at the level of buildings, neighborhood and city - Study of the impact of ecological factors (living nature) on sites and city design - Propose appropriate and compatible ideas and methods for solving environmental problems at the level of buildings and urban areas - Integrated environmental design to achieve control In the field of solar energy and other natural energies - controlling noise levels and thermal insulation for projects - studying selected models for global projects in general, and in developing countries in particular -Applications.

**References:**


- *John Glasson, Riki Therivel. "Introduction To Environmental Impact Assessment (Natural and Built Environment Series)", March 2019.*
- *Peter Wathern. "Environmental Impact Assessment: Theory and Practice", Routledge, Feb 2013.*

| ARE523 | Course code | Environmental Design and Programming Approaches | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 4 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Course Grades | Course Grades |
| | | 0 | 0 | 50 | 50 | |

**Content:**

Introduction - Different environmental design approaches - Environmental design concepts - Different computer programs that can be used in the different stages of projects that follow the foundations of environmental design - Identify human requirements and convert them into data that can be used in environmental design - Environmental design and programming - Different future horizons - the future of programming And simulation and its role in the various design stages - Building energy simulation models in architecture including computational models using environmental simulation programs - Analysis of local and international examples - Practical applications.

**References:**


- *Tetsuya Sakuma, Shinichi Sakamoto, et al. "Computational Simulation in Architectural and Environmental Acoustics: Methods and Applications of Wave-Based Computation", August 2014.*
- *Brian w. Edwards and Emanuele. "Green Buildings Pay", Routledge, USA and Canada, 2013.*


| ARE524 | Course code | Environmental Control Studies and Energy Efficiency strategies in buildings | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 0 | 0 | 50 | 50 | |

**Content:**

Introduction - Concepts and theories of environmental control and its relationship to humans and approaches to dealing with them - Thermal comfort and human physical needs - Basics of energy conservation - Energy efficiency strategies in buildings - Reciprocal relationships that link the architectural and urban environment with the natural and industrial environment - Control of noise level and thermal insulation - An applied perspective in the fields of Environmental sciences, people and materials - the relationship between the environment, architecture, urbanism, heritage and sustainable development - comparative studies between different aspects and their implications for the built environment, and their impact on global architectural trends - practical applications.

**References:**


- *Daniel M. Martinez , Ben W. Ebenhack, et al. "Energy Efficiency: Concepts and Calculations", May 2019.*
- *Jan L. M. Hensen & Roberto Lamberts. "Building Performance Simulation for Design and Operation", Routledge, February, 2011.*

<table>
<tr><td>ARE525</td><td>Course code</td><td colspan="4">Sustainability and Environmental impact Assessment of Projects</td><td>Course Title</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Credit Hours</td><td>Practical</td><td colspan="2">Teaching Hours</td><td>Lecture</td><td rowspan="2">Teaching Hours</td></tr>
<tr><td>0</td><td colspan="2">2</td><td>2</td></tr>
<tr><td rowspan="2">100</td><td rowspan="2">Total</td><td>Oral exam</td><td>Practical exam</td><td>Term work</td><td>Course Grades</td><td rowspan="2">Course Grades</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Content:**

Introduction - Concepts of sustainability and development in the framework of preserving the environment in its comprehensive sense - the environmental impact of engineering, economic and social projects - Basics of environmental impact assessment for projects - Basic entrances for preparing environmental impact studies for projects at the local and international levels - - Sustainability approaches and methods of adopting green buildings and their suitability for the state, technologically and environmentally And its impact on local and global contemporary architecture - Various global and regional environmental assessment systems - The Egyptian Green Pyramid system and environmental assessment of buildings and projects in Egypt - Practical applications.

**References:**


- *John Glasson and Riki Therivel. "Introduction To Environmental Impact Assessment (Natural and Built Environment Series)", March 2019.*


<table>
<tr><td>ARE526</td><td>Course code</td><td colspan="4">Environmental Materials and Technologies for Energy Efficiency in Buildings</td><td>Course Title</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Credit Hours</td><td>Practical</td><td colspan="2">Teaching Hours</td><td>Lecture</td><td rowspan="2">Teaching Hours</td></tr>
<tr><td>0</td><td colspan="2">2</td><td>2</td></tr>
<tr><td rowspan="2">100</td><td rowspan="2">Total</td><td>Oral exam</td><td>Practical exam</td><td>Term work</td><td>Written exam</td><td rowspan="2">Course Grades</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Content**

Introduction - Building a knowledge base in the field of materials and architectural construction and construction techniques - Physical and thermal properties of materials - Nanomaterials - Basic principles of environmental control and its reflection on architectural design - Designer's tasks and tools - Environmental control levels and fields - Self and objective control standards, methods and operational methods - Zero buildings Energy - Technologies used to achieve zero energy buildings - Computer programs used to calculate energy consumption - Simulations and simulation software used to improve energy consumption.

**References:**


- *Umberto Desideri, Francesco Asdrubali. "Handbook of Energy Efficiency in Buildings: A Life Cycle Approach", November 2018.*

## Level 600

| ARE611 | Course code | Basics of Writing Scientific Theses | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 4 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Course grades | Course Grades |
| | | 30 | 0 | 70 | -- | |

**Content**

Introduction - Scientific methods of writing scientific dissertations - Determining the research point and converting it into a research problem and formulating hypotheses - Determining the architectural or urban problem - The various methods of documenting and analyzing the problem - How to develop solutions to the research problem - Objectives of the main and sub-thesis - Organizational structure of scientific dissertations and expected scientific additions - Preparation For writing: writing and organizing content, writing sentences, methods of explaining paragraphs, methods of beginning - parts of writing: abstract, introduction, introduction, abstract - obstacles facing researchers - forms of writing: research presentations, articles, research projects, scientific theses - various topics: addressing Texts, writing titles, references, attachments, figures and tables - Method for presenting information and preparing and discussing research proposals.

**References:**


- *Claudia Kousoulas. "Writing for Planners: A Handbook for Students and Professionals in Writing, Editing, and Document Production", December 2019.*
- *John Giba. "Developing skills in scientific writing", October 2013.*


| ARE612 | Course code | Research Methods in Architecture and Urbanism | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 4 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course Grades |
| | | 30 | 0 | 70 | -- | |

**Content:**

Introduction - Methods and foundations of quantitative and qualitative scientific research in architectural studies - Various research methods and methods of application in this field - How to develop research structures and their components - developing hypotheses and formulating them - Methods of testing, measurement and questionnaire - Testing the reliability of hypotheses - Making applications and measurement - How to deal with areas of qualitative study For the formation, aesthetics and architectural design. Tools used to conduct experimental research in engineering sciences related to architecture - Methodologies and foundations of quantitative and qualitative scientific research in architectural studies - How to set up research structures and their components - How to deal with the qualitative fields of study of formation, aesthetics and architectural design

**References**:


- *ELLEN LUPTON, J. ABBOTT MILLER. "Design/Writing/Research: Writing on Graphic Design", 2014.*

| ARE613 | Course code | Architectural design and landscaping studio | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 4 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 30 | 0 | 70 | -- | |

**Content:**

Introduction - the integrated approach to the architectural design and site coordination processes - the foundations of site coordination - taking into account the design determinants of the surrounding environment, climatic conditions, site conditions, economic standards, architectural shaping determinants and other site coordination determinants - sustainable design of site coordination elements - the role of site coordination elements in improving the thermal efficiency of public sites - Growing roofs and their role in raising the thermal efficiency of the building - Cost and maintenance study - The role of site coordination elements in improving the functional and environmental conditions of buildings - Practical and practical projects.

**References:**

- *Philip Black, Taki Sonbli. "The Urban Design Process (Concise Guides to Planning)", January 2020.*

| ARE614 | Course code | المشروع التطبيقي- علوم وتكنولوجيا البناء | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 4 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 30 | 0 | 70 | 0 | |

**Content**

Introduction - the different concepts of dynamic systems and their application in architecture and urbanism - the methods of evaluation followed for the structure of systems and the extent of their overlap, as well as the constituent systems of the various systems intertwined in the overall system of the building or project - Building a knowledge base in the field of materials and building techniques - The basic principles of the built environment and its relationship to the choice of building materials in terms of Efficiency, selection method, and method of installation - dynamic systems and different equilibrium methods between different systems and the possibilities of controlling these systems and discussing them in seminars - applied and practical projects.

**References:**

- *Charles J. Kibert . "Sustainable Construction: Green Building Design and Delivery", May 2016.*

| ARE615 | Course code | Laws, Codes and legislation for Energy Efficiency in Buildings | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Course grades | Course grades |
| | | 0 | 0 | 50 | 50 | |

**Content:**

Introduction - Energy in buildings - Methods of saving energy in buildings - Negative systems that require energy saving in buildings - Basic laws for architecture, urbanism and the environment - The Egyptian Code for Energy Efficiency in Buildings - Implementing regulations and codes setting standards - Practices and specifications governing the quality of the architectural product - Environmental legislation including Introducing its basic concepts and methods of achieving its mandatory requirements - energy efficiency requirements in buildings and sustainable development - energy efficiency strategies in buildings - applied and practical projects.

**References:**

- *Egyptian Code to Improve Energy Efficiency in Buildings (Residential Buildings): code No.306/2005.*

| ARE616 | Course code | Housing, Development and Urban Planning | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 0 | 0 | 50 | 50 | |

**Content:**

Introduction - the concepts of comprehensive and urban development - housing as one of the most important pillars of development processes - the history of thought and theories of development - the most important trends in the field of housing and housing development - experiences of developing countries and their evaluation and market forces, supply and demand - housing policies and their impact on development processes - housing legislation and its role in the development of residential areas - The main theories of development and urban planning - fundamentals of the planning process - statistical means of factor analysis - variables affecting the urban planning process - planning rates and their change with time and place - the relationship and influence of the state's economic, political and social thought on urban planning processes.

**References:**

- *John M. Levy. "Contemporary Urban Planning", USA, September 2016.*

| ARE617 | Course code | Visual Studies of the City | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 4 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 10 | 0 | 50 | 50 | |

**Content**

Introduction - the basics and theories of urban design and its concepts - the different methodological frameworks for preparing visual studies of the city - the visual sequence of the city - the visual elements in the city - the study of the sky line and the land line and the relationship between them and the formation of the city - documentation studies, analysis and evaluation of the built environment - field monitoring and means of architectural demonstration and expression - The mental image of the city at the time of the day and night - the reciprocal relationship between the internal and external spaces and their impact on the visual image - The analysis of urban projects at the local, regional and global level - an applied and practical project.

**References:**


- *Rem Koolhaas, Harvard Graduate School of Design, et al. "Elements of Architecture" , October 2018.*
- *Taylor & Francis Ltd. "The Urban Design Reader 2nd New edition, Routledge", London, United Kingdom, 2012.*


| ARE618 | Course code | Specialized Studies in Architecture | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 0 | 0 | 50 | 50 | |

**Content**

Introduction - How to analyze and define problems - Specialized studies related to research fields in architecture and reflecting the research interests of students, examples of environmental, cultural and social problems of architectural problems existing in the Egyptian society - The course provides various fields for studying and developing the new topics presented and evaluating them through research and discussion seminars - Presentation And proposing solutions to the architectural problems existing in the Egyptian society.

**References:**


- *Kyriaki Tsoukala, Nikolaos-Ion Terzoglou and Charikleia Pantelidou "Intersections of Space and Ethos (Routledge Research in Architecture)", December 2014.*

## Level (700)

| ARE711 | Course code | Solar Studies in Architecture and Urbanism | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 0 | 0 | 50 | 50 | |

**Content**

Introduction - the different technologies that can be used to benefit from solar energy in architecture and urban planning - reviewing and analyzing global and local experiences to show how to benefit from it in Egypt. Light systems, sources and levels - the relationship between humans and the optical environment, natural and industrial lighting systems - concepts of optical design and architectural formation - available design tools and approaches from manual calculations - uses of computational models using computer, field measurements and lighting techniques.

**References:**


- *Daniel Yergin "The New Map: Energy, Climate, and the Clash of Nations", September 2020.*


| ARE712 | Course code | Ecosystem integration Studies for Energy Efficiency in Buildings | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 0 | 0 | 50 | 50 | |

**Content:**

Introduction - Environmental systems concepts and their dynamic nature - Building analysis methods into systems and components with a view to integrating their performance - Specific frameworks for architectural design processes - Integration of environmental systems for energy efficiency in buildings that affect the formulation of design process objectives, standards and evaluation of projects - Energy-saving and producing buildings - Analysis studies And evaluation of contemporary design projects and approaches - an applied and practical project.

**References:**


- *Jacob J. Dr Lamb, Bruno G. Professor Pollet. "Energy-Smart Buildings: Design, Construction and Monitoring of Buildings for Improved Energy Efficiency", July 2020.*

| ARE713 | Course code | Architectural Concepts in Contemporary Egyptian Reality | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 0 | 0 | 50 | 50 | |

**Content**

Introduction - Shedding light on a number of issues affecting contemporary Egyptian architecture, including: identity, slums and unplanned urban extensions in the Egyptian environment, technology and its impact on the Egyptian urban and architectural reality, environmental pollution, and preserving the urban and architectural heritage - Heritage preservation methods - discussion Environmental problems, urbanization and resources - political, economic and cultural transformations in Egyptian societies and their impact on contemporary Egyptian architecture - modern technologies and their impact on architectural and urban transformations in Egyptian reality - an applied and practical project.

**References:**


- *S. Cottrell. "Critical Thinking Skills", 3rd Edition, published by Macmillan Study Skills, 2017.*
- *Joseph Gwilt. "Elements of Architectural Criticism for the Use of Students", Amateurs, and Reviewers, 2010.*


| ARE714 | Course code | Studies of Recent and Future Architecture | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | | Lecture | Teaching Hours |
| | | 0 | 2 | | 2 | |
| 100 | Total | Oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 0 | 0 | 50 | 50 | |

**Content:**

Introduction - Specific frameworks for architectural design processes that affect the formulation of the objectives of design processes - Criteria for project evaluation - Models of cultural, social, political and economic problems in addition to environmental, urban and resource issues - Shedding light on a number of issues affecting contemporary architecture: identity, development, technology, environment Heritage - studying and analyzing models of cities that have been able to achieve sustainability - nanomaterials and their impact in the field of construction - facing architecture with future problems in the fields of energy and conservation and modern building materials - resilience in facing crises.

**References:**


- *J. Wiley & Sons. "Becoming an Architect, A Guide to Careers in Design 3rd Ed", 2014.*

| ARE715 | Course code | Individual Studies (A) - Building Science and Technology | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | Lecture | | Teaching Hours |
| | | 0 | 4 | 2 | | |
| 100 | Total | oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 30 | 0 | 70 | -- | |

**Content**

Introduction - Preparing students for specific research topics directed by the faculty member (s) for students enrolled in one of the selected subjects in the field of building science and technology.

**References:**

- *Madan L Mehta Ph.D., Walter Scarborough, et al. "Building Construction: Principles, Materials, and Systems (What's New in Trades & Technology)", January 2017.*

| ARE716 | Course code | Individual Studies (B) - Environmental and Energy Design | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | Lecture | | Teaching Hours |
| | | 0 | 4 | 2 | | |
| 100 | Total | oral exam | Practical exam | Term work | Written exam | Course grades |
| | | 30 | 0 | 70 | -- | |

**Content**

Introduction - Preparing students for specific research topics directed by faculty member (s) for students enrolled in one of the selected subjects in the field of design, environmental planning and energy

**References:**

- *Tom Daniels and Katherine Daniels. "Environmental Planning Handbook: For Sustainable Communities and Regions", 2017.*

| ARE717 | Course code | Individual Studies (C) - Research in Urban Studies | | | | Course Title |
|---|---|---|---|---|---|---|
| 3 | Credit Hours | Practical | Teaching Hours | Lecture | | Teaching Hours |
| | | 0 | | 2 | | |
| 100 | Total | oral exam | Course grades | Term work | Written exam | Course grades |
| | | 30 | 0 | 70 | -- | |

**Content**

Introduction – Encourage students for specific research topics directed by the faculty member (s) for students enrolled in one of the selected topics in the field of urban studies research.

**References:**

- *Roberta Steinbacher, Virginia Benson. "Introduction to Urban Studies", 4th Edition, 2014.*

# Chapter Fourteen:

## Interdisciplinary Postgraduate Programs

## 14.1 : Engineering Science Diploma in Biomedical Engineering

## 14.2 : Master of Science (M.Sc.) in Biomedical Engineering

## 14.3 : Engineering Science Ph.D. in Biomedical Engineering

## Engineering science Diploma in Biomedical Engineering

**Competencies for the diploma graduate**

In addition to generic competencies for the Engineering science Diploma, the graduate of Engineering science Diploma in Biomedical Engineering must be able to:

1. An ability to identify, formulate, and solve complex engineering problems by applying advanced principles of engineering, science and mathematics.
2. An ability to apply engineering design to produce advanced solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental and economic factors.
3. An ability to develop scientific methods to collect, analyze and interpret data.
4. An ability to use engineering judgment to draw conclusions.

## Master of Science (M.Sc.) in Biomedical Engineering

**Competencies for the program graduate**

In addition to generic competencies for the M.Sc. in engineering, the graduate of Master of Science in Biomedical Engineering must be able to:

1. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
2. An ability to apply quality assurance standards in all procedures related to biomedical engineering.
3. An ability to calibrate medical devices and diagnose faults in order to get accurate diagnosis.

## Engineering science Ph.D. in Biomedical Engineering

**Competencies for the program graduate**

In addition to generic competencies for the Ph. D. program, the graduate of Engineering science Ph.D. in Biomedical Engineering must be able to:

1. An ability to develop expertise and practical experience to lead research and development of biomedical engineering technology in academia, industry, and government.
2. An ability to use machine learning techniques to develop computer-aided diagnostic systems to help physicians in early diagnosis.

**Benchmark**

Bioengineering Department, University of Louisville, USA
https://engineering.louisville.edu/graduatedegrees/

**(Students with BSc in Engineering Fields other than Biomedical Engineering)**

## Preparatory Courses (16 hours - 2 semesters– 0 Credits)

| Course Code | Course Name | Pre-requisite | Credit Hours | Contact Hours | | SWL | Exam Duration | Class Work | Final Exam Grade |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Lec | Tut | | | | |
| BME 411 | Organic Chemistry | | 0 | 2 | 2 | 6 | 2 | 50 | 50 |
| BME 412 | Biochemistry | | 0 | 2 | 2 | 6 | 2 | 50 | 50 |
| BME 413 | Introduction to Anatomy | | 0 | 2 | 2 | 6 | 2 | 50 | 50 |
| ECE 414 | Digital Image Processing | | 0 | 2 | 2 | 6 | 2 | 50 | 50 |
| BME 415 | Introduction to Physiology | BME 413 | 0 | 2 | 2 | 6 | 2 | 50 | 50 |
| ECE 416 | Biomedical Instrumentation | | 0 | 2 | 2 | 6 | 2 | 50 | 50 |
| ECE 417 | Bioinformatics | | 0 | 2 | 2 | 6 | 2 | 50 | 50 |
| BME 418 | Microbiology | BME 412 | 0 | 2 | 2 | 6 | 2 | 50 | 50 |

## Level 500 Courses

| Course Code | Course Name | Credit Hours | Contact Hours | | SWL | Exam Duration | Class Work | Final Exam Grade |
|---|---|---|---|---|---|---|---|---|
| | | | Lec | Tut | | | | |
| BME 511 | Biomechanics* | 3 | 2 | 2 | 6 | 2 | 50 | 50 |
| BME512 | Biostatistics* | 2 | 2 | 0 | 5 | 2 | 50 | 50 |
| BME 513 | Clinical Engineering* | 3 | 2 | 2 | 6 | 2 | 50 | 50 |
| BME 514 | Research Ethics in Bioengineering* | 2 | 2 | 0 | 6 | 2 | 50 | 50 |
| PDE 515 | Advanced Biomaterials | 2 | 1 | 2 | 6 | 2 | 50 | 50 |
| BME 516 | Medical Devices* | 2 | 2 | 0 | 6 | 2 | 50 | 50 |

**(*) Mandatory Courses of Diploma of Basic Engineering in Biomedical Engineering**

## Level (600) Courses

| Course Code | Course Name | Credit Hours | Contact Hours | | SWL | Exam Duration | Class Work | Final Exam Grade |
|---|---|---|---|---|---|---|---|---|
| | | | Lec | Tut | | | | |
| BME 611 | Medical Image Computing | 2 | 1 | 2 | 6 | 2 | 50 | 50 |
| ECE 612 | Biomedical Signal Processing | 2 | 1 | 2 | 6 | 2 | 50 | 50 |
| BME 613 | Modeling of physiological Systems | 2 | 1 | 2 | 6 | 2 | 50 | 50 |
| ECE 614 | Machine Learning in Medicine | 2 | 1 | 2 | 6 | 2 | 50 | 50 |
| PDE 615 | Artificial Organs | 2 | 1 | 2 | 6 | 2 | 50 | 50 |
| BME 616 | Rehabilitation Engineering | 2 | 1 | 2 | 6 | 2 | 50 | 50 |
| BME 617 | Introduction to Tissue Engineering | 2 | 1 | 2 | 6 | 2 | 50 | 50 |
| BME 621 | Cardiovascular Dynamics | 3 | 2 | 2 | 7 | 2 | 50 | 50 |
| BME 622 | Injury Biomechanics | 3 | 2 | 2 | 7 | 2 | 50 | 50 |
| BME 623 | Bioengineering Research Design & Methods | 3 | 2 | 2 | 7 | 2 | 50 | 50 |
| BME 624 | Healthcare Information Systems (HCIS) | 3 | 2 | 2 | 7 | 2 | 50 | 50 |
| BME 625 | Industrial Pharmacy | 3 | 2 | 2 | 7 | 2 | 50 | 50 |

## Level (700) Courses

| Course Code | Course Name | Credit Hours | Contact Hours | | SWL | Exam Duration | Class Work | Final Exam Grade |
|---|---|---|---|---|---|---|---|---|
| | | | Lec | Tut | | | | |
| BME 721 | Clinical Pathology | 3 | 2 | 2 | 8 | 2 | 50 | 50 |
| CSE 722 | Medical Decision Support Systems (MDSS) | 3 | 2 | 2 | 8 | 2 | 50 | 50 |
| ECE 723 | Introduction to Deep Learning | 3 | 2 | 2 | 8 | 2 | 50 | 50 |
| ECE 724 | Internet of Medical Things (IoMT) | 3 | 2 | 2 | 8 | 2 | 50 | 50 |
| PDE 725 | Joint Replacement Technology | 3 | 2 | 2 | 8 | 2 | 50 | 50 |
| ECE 726 | Biomedical Photonics | 3 | 2 | 2 | 8 | 2 | 50 | 50 |

# Summary of Courses Specification

| Course title | Organic Chemistry | | | | Course Code | BME 411 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 0 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Structure and Bonding - Acids and Bases: Functional Groups - Structure and Stereochemistry of Alkanes - The Study of Chemical Reactions – Stereochemistry - Alkyl Halides - Nucleophilic Substitution - Structure and Synthesis of Alkenes; Elimination - Reactions of Alkenes – Alkynes – Alcohols –Spectrometry - Conjugated Systems, Orbital Symmetry, and Ultraviolet Spectroscopy - Nuclear Magnetic Resonance Spectroscopy – Condensations and Alpha Substitutions of Carbonyl Compounds - Ethers - Aromatic Compounds - Ketones and Aldehydes – Amines - Carboxylic Acids - Condensations and Alpha Substitutions of Carbonyl Compounds - Carbohydrates and Nucleic Acids

**References:**

- *L. Wade, " Organic Chemistry", Pearson; 9th edition, 2016*

| Course title | Biochemistry | | | | Course Code | BME 412 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 0 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The Foundations of Biochemistryonization of Water, Weak Acids, and Weak Bases - Buffering agains pH Changes in Biological System - Amino Acids, Peptides, and Proteins - The Three-Dimensional Structure of Proteins - Protein Function - An Introduction to Enzymes- Carbohydrates and Glycobiology - Nucleotides and Nucleic Acids - DNA-Based Information Technologies- Lipids- Structural Lipids in Membranes- Biological Membranes and Transport – Biosignaling- Bioenergetics and Biochemical Reaction Types- Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway - Principles of Metabolic Regulation

**References:**

- *D. Nelson , "Principles of Biochemistry", W. H. Freeman, 7th edition, 2017*

| Course title | Introduction to Anatomy | | | | Course Code | BME 413 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 0 Cr |
| | | | | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introducing the Human Body - Cells and Tissues - The Integumentary System - The Skeletal System - The Muscular System - The Central Nervous System - The Peripheral Nervous System - The Sense Organs - Endocrine Control - The Circulatory System: Blood - The Circulatory System: The Heart - The Circulation of Blood and Lymph - Internal Defense: Immune Responses - The Respiratory

System -The Digestive System - The Urinary System and Fluid Balance - Reproduction

**References:**

- *E. Solomon, "Introduction to Human Anatomy and Physiology", Saunders; 4th edition, 2015*

| Course title | Digital Image Processing | | | | Course Code | ECE 414 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 0 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to digital image processing - Image acquisition and sampling - types of digital images - point processing – histogram stretching – histogram equalization - neighborhood processing – convolution and filtering - frequency of an image - edge sharpening - 2D-Fourier transform – properties of Fourier transform - transform processing - image restoration in spatial and frequency domains - image segmentation - edge detection - Hough transform - morphological operations - processing of color images – image coding and compression.

**References:**

- *Rafael C. Gonzalez, "Digital Image Processing", Pearson; 4th edition, 2017.*

| Course title | Introduction to Physiology | | | | Course Code | BME 415 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 0 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Pre-requisites: BME 413**

**Contents**

Introduction to human physiology - Cell Transport - Excitable Membranes and Synapses - Smooth and Cardiac Muscle - Cardiac Electrophysiology and ECGs - Cardiac Mechanics and Systemic Circulation - Control of the Cardiovascular System - Repiratory Mechanics, Gas Transport, and Control of Breathing - Autonomic Nervous System - Brain and Spinal Cord - Somatic Nerves and Control of Movement - Auditory System - Visual System - Renal System - Endocrine System – The Immune System – The Digestive System

**References:**

- *S. Fox ," Human Physiology", McGraw-Hill Education; 15th edition, 2018*

| Course title | Biomedical Instrumentation | | | | Course Code | ECE 416 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 0 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to biomedical instrumentation - Biomedical instrumentation and devices- Sensors and transducers - Signal filtering and amplification - Data acquisition and signal processing – Electrocardiography – Electro-encephalo-grapy- Digital hearing aids- Mobile health, wearable health technology and wireless implanted devices - Safety of biomedical instruments and devices - Fluorescent microscopy, Florescence process, bioelectronics and biomechanical instruments - Applications of statistics, probabilities, signal analysis, noise suppression, and Fourier techniques in bioinstrumentation - biomedical embedded systems – A mini project in biomedical engineering.

**References:**


- *A. Webb, "Principles of Biomedical Instrumentation", Cambridge University Press; 1st edition, 2017*


| **Course title** | **Bioinformatics** | | | | **Course Code** | ECE 417 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 0 Cr |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Review of DNA replication, transcription, and translation, Genome organization - Review of molecular biology methods - DNA and protein databases, data storage, file formats, information retrieval - Database queries, sequence retrieval, Creation of restriction endonuclease maps - Dot plots, Sequence alignment, Local alignment, Global alignment, Multiple alignments - Alignment scores, Statistical significance of database searches - Genetic distances, Distance based phylogenies, Phylogenetic tree construction - Consensus sequences, Finding genes and open reading frames in DNA sequences - Microarray analysis and applications of microarrays - Introduction to proteomics

**References:**


- *J. Momand, "Concepts in Bioinformatics and Genomics" , Oxford University Press; 1st edition, 2016*


| **Course title** | **Microbiology** | | | | **Course Code** | BME 418 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 0 Cr |
| | 2 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | 0 | 0 | 50 | 50 | | |

**Pre-requisites: BME 412**

**Contents**

The Microbial World - Chemical Principles - Observing Microorganisms through a Microscope - Functional Anatomy of Prokaryotic and Eukaryotic Cells - Microbial Metabolism - Microbial Growth - Microbial Genetics - Biotechnology and DNA Technology - Classification of Microorganisms - The Prokaryotes: Domains Bacteria and Archaea - The Eukaryotes: Fungi, Algae, Protozoa, and Helminths - Viruses, Viroids, and Prions - Principles of Disease and Epidemiology - Microbial Mechanisms of Pathogenicity - Innate Immunity: Nonspecific Defenses of the Host - Adaptive Immunity - Applications of Immunology - Antimicrobial Drugs - Microorganisms and Human Disease - Environmental and Applied Microbiology

**References:**

- *G. Tortora, " Microbiology: An Introduction", Pearson; 13th edition, 2018*


| Course title | Biomechanics | | | | Course Code | BME 511 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

An Introduction To Biomechanics – Basic concepts of Mechano-biology - Hard Tissue Biomechanics - Biomechanics of Musculoskeletal Soft Tissues - Cardiovascular Solid Biomechanics - Fluid Biomechanics and Circulation - Fluid Biomechanics and Respiration - Modeling Flows in Collapsible Tubes - Growth and Remodeling - Cell Mechanics and Mechano-biology – Main applications of biomechanics and mechano-biology; Biomechanics: Applications in Orthopedics - Biomechanics: Applications in Rehabilitation - Human Locomotion Biomechanics – Multi-scale Modeling Of Human Pathophysiology - Case studies related to the course.

**References:**


- *Manuel Doblare, "Biomechanics", Eolss Publishers Co. Ltd., 2015*


| Course title | Biostatistics | | | | Course Code | BME 512 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 Cr |
| | 2 | | 0 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Descriptive Statistics –Arithmetic Mean- Measures of Spread -The Coefficient of Variation. Grouped Data. Graphic Methods– Probability - Some Useful Probabilistic Notation - The Addition Law of Probability - Conditional Probability- Bayes' Rule and Screening Tests - Discrete Probability Distributions. - The Binomial Distribution - The Poisson Distribution. - Continuous Probability Distributions - The Normal Distribution- Estimation - Randomized Clinical Trials - Case Study - Hypothesis Testing - Test for the Mean of a Normal Distribution - The Relationship Between Hypothesis Testing and Confidence Intervals. The Paired t Test - Interval Estimation for the Comparison of Means from Two Paired Samples. Non-parametric tests – Analysis of time series- Biomedical applications on each subject.

**References:**


- *Bernard Rosner, "Fundamentals of Biostatistics", Cengage Learning Inc, 2015*


| Course title | Clinical Engineering | | | | Course Code | BME 513 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to clinical engineering - Product development – testing - usability Clinical trials and research - FDA definitions and approval process - Acute care، anesthesia، hemodialysis - Imaging، radiation therapy، lasers Cardiology، infusion and general medical، laboratory Tele-health، RTLS، special purpose systems - Healthcare facility design & special environments - Radiation safety، MRI safety - EMI/RFI، laser safety Laboratory، electrical، and construction safety، hazardous materials - Sanitation and infection prevention Disaster planning/emergency preparedness codes، standards، regulations، and accreditation

**References:**

- *A. Taktak, "Clinical Engineering", Elsevier Ltd., 2nd edition, 2020*

| Course title | Research Ethics in Bioengineering | | | | Course Code | BME 514 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 Cr |
| | 2 | | 0 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Ethics and Values in Medical Cases - Values in Health and Illness - Ethical Principles in Medical Ethics - Benefiting the Patient and Others - Justice: The Allocation of Health Resources - Autonomy - Veracity: Honesty with Patients - Fidelity: Promise-Keeping, Loyalty to Patients, and Impaired Professionals - Avoidance of Killing - Special Problem Areas - Abortion, Sterilization, and Contraception - Genetics, Birth, and the Biological Revolution - Mental Health and Behavior Control - Ethical Disclosure of Medical Information - Organ Transplants - Health Insurance - Experimentation on Human - Consent and the Right to Refuse Treatment – Death and dying.

**References:**

- *Robert M. Veatch, "Case Studies in Biomedical Ethics: Decision Making, Principles, and Cases", Oxford University Press, 2015.*

| Course title | Advanced Biomaterials | | | | Course Code | PDE 515 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 Cr |
| | | | | | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Polymers, Blends and Nano-composites for Implants, Scaffolds and Controlled Drug Release Applications - Polyelectrolyte Complexes (PECs) for Biomedical Applications - Plasma Surface Modification of Biomaterials for Biomedical Applications - Biomaterials for Induction and Treatment of Autoimmunity – Decellularized Tissue Engineering - Current Progress in Bio-printing - Controlled Gene Delivery Systems for Articular Cartilage Repair- Biomaterials Based Strategies for Engineering Tumor Microenvironment - Magnetic Nanoparticles: Functionalization and Manufacturing of Pluripotent Stem Cells - Fluorescent Gold Nano-clusters as a Powerful Tool for Sensing Applications in Cancer Management

**References:**

- *Anuj Tripathi, "Advances in Biomaterials for Biomedical Applications (Advanced Structured Materials)", springer, 2017*

| Course title | Medical Devices | | | | Course Code | BME 516 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 Cr |
| | 1 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Medical devices: definitions and types - General regulations of medical devices - Quality management systems for medical device manufacture - he process of gaining approval for new medical devices - Risk assessment management for a new medical device - Safety testing of a new medical device - Clinical testing of a new medical device - Product development overview - Electrocardiographs - EEG - EMG - Ventilators - Patient Monitor - Diathermy - Anesthesia - Medical Endoscopy

**References:**

- *Seeram Ramakrishna, " Medical Device: Regulations, Standards, and Practices", Elsevier, 2015*

| Course title | Medical Image Computing | | | | Course Code | BME 611 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 Cr |
| | 1 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Fundamentals of 2-D and 3-D image computing - application of image computing algorithms to medical images - enhancement and restoration of 2-D and 3-D medical data - fundamentals of machine vision and medical data visualization - Applications on image restoration - Image synthesis and super-resolution in medical imaging - Machine learning for image reconstruction - Text mining and deep learning for disease classification - Segmentation using adversarial image-to-image networks - Multimodal medical volumes translation and segmentation with generative adversarial network - - computer vision to medical data through examples and reading papers.

**References:**

- *S. Kevin Zhou, Daniel Ruecker, Gabor Fichtinger, " Handbook of Medical Image Computing and Computer Assisted Intervention", 1st Edition, Elsevier, 2019.*

| Course title | Biomedical Signal Processing | | | | Course Code | ECE 612 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 2 Cr |
| | 1 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to biomedical signals – classification of biomedical signals - processing of digital signals - artificial intelligence, characterization of biomedical signals: Feature engineering and extraction, supervised and unsupervised learning, machine learning in biomedical signal processing with ECG applications, deep EEG: deep learning in biomedical signal processing with EEG applications, fuzzy logic in medicine, neural network applications in medicine, analysis and management of sleep data, analysis of esophageal motility records, A mini project in biomedical engineering.

**References:**

- *Walid A. Zgallai, "Biomedical Signal Processing and Artificial Intelligence in Healthcare", Elsevier, 2020.*

| Course title | Modeling of Physiological Systems | | | | Course Code | BME 613 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 2 Cr |
| | 1 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Physiological complexity and the need for models: Introduction - Complexity - System dynamics - Control in physiological systems - models and the modeling process: Model formulation - Model identification - Model validation - Model simulation - modeling the data, modeling the system, model identification, parametric modeling- the identifiability problem, parametric modeling - the estimation problem, nonparametric modeling- signal estimation, model validation, linear regression – non-linear regression - case studies.

**References:**

- *Claudio Cobelli, Ewart Carson, "Introduction to Modeling in Physiology and Medicine", Elsevier, 2019*

| Course title | Machine Learning in Medicine | | | | Course Code | ECE 614 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 2 Cr |
| | 1 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Fundamentals of medical data, application of machine learning models & algorithms to medicine, learning from data & classification of disorders, and overview of health data collection with sensors, body area networks, Hierarchical Clustering and K-Means Clustering to Identify Subgroups in Surveys, Density-Based Clustering to Identify Outlier Groups in Otherwise Homogeneous Data, Two Step Clustering to Identify Subgroups and Predict Subgroup Memberships in Individual Future Patients, Nearest Neighbors for Classifying New Medicines , Predicting High-Risk-Bin Memberships

**References:**

- *Ton J. Cleophas, Aeilko H. Zwinderman, "Machine Learning in Medicine - a Complete Overview", Springer, 2015*

| Course title | Artificial Organs | | | | Course Code | PDE 615 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | Tutorial | | Practical | Credit hours | 2 Cr |
| | 1 | 2 | | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction - Bioengineering design of artificial organ replacement systems and their clinical usage. Commercially available systems analyzed for mass transfer efficiency; biomechanics and relation to size and efficiency of the device - Biomaterials in Tissue Engineering - Harnessing the Potential of Stem Cells from Different Sources for Tissue Engineering - Induced Pluripotent Stem Cells in Scaffold-Based Tissue Engineering - Biosensors for Optimal Tissue Engineering: Recent Developments and Shaping the Future - Tissue-Engineered Human Skin Equivalents and Their Applications in Wound Healing.

**References:**

- *Joseph D. Bronzino, Donald R. Peterson, "Tissue Engineering and Artificial Organs", CRC Press, 2016.*

| **Course title** | **Rehabilitation Engineering** | | | | **Course Code** | BME 616 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 Cr |
| | 1 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to rehabilitation engineering and assistive technology. Medical aspects of disability, assistive technology applications and current rehabilitation research - Physiological basis of neuromotor recovery - An overall framework for neurorehabilitation robotics: Implications for recovery Biomechatronic design criteria of systems for robot-mediated rehabilitation therapy - Actuation for robot-aided rehabilitation: Design and control strategies -Assistive controllers and modalities for robot-aided neuro-rehabilitation - Exoskeletons for upper limb rehabilitation - Exoskeletons for lower-limb rehabilitation - Software platforms for integrating robots and virtual environments - Robot-assisted rehabilitation of hand function

**References:**

- *Roberto Colombo, Vittorio Sanguineti, " Rehabilitation Robotics", Elsevier, 2018*

| **Course title** | **Introduction to Tissue Engineering** | | | | **Course Code** | BME 617 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Lectures** | | **Tutorial** | **Practical** | **Credit hours** | 2 Cr |
| | 1 | | 2 | 0 | | |
| **Course grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | **100** |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction - From Mathematical Models to Clinical Reality - Stem Cells as Building Blocks - Moving into the Clinic - Tissue Engineering: Current Status and Future Perspectives - Molecular Biology of the Cell - Molecular Organization of Cells - The Dynamics of Cell-ECM Interactions, with Implications for Tissue Engineering - Matrix Molecules and Their Ligands - Morphogenesis and Tissue Engineering - Gene Expression, Cell Determination, differentiation, and Regeneration - Engineering Functional Tissues: In Vitro Culture Parameters - Principles of Bioreactor Design for Tissue Engineering

**References:**

- *Clemens van Blitterswijk, Jan De Boer, "Tissue Engineering", Elsevier, 2018.*

| Course title | Cardiovascular Dynamics | | | | Course Code | BME 621 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Review of basic cardiovascular physiology. Application of basic engineering principles, including electrical and mechanical analog models to describe cardiovascular function and data acquisition and analysis techniques to develop medical devices and instrumentation. A study case: the physiological changes and consequences that occur in humans during spaceflight. It specifically presents the adaptations of the cardiovascular and the respiratory system. Specific changes occurring after 10, 20 or more days in space are depicted.

**References:**

- *T. Kenner, "Cardiovascular System Dynamics: Models and Measurements", springer, 2013.*
- *Hanns-Chrestian Gunga, " Cardiovascular System, Red Blood Cells, and Oxygen Transport in Microgravity", Springer, 2016.*

| Course title | Injury Biomechanics | | | | Course Code | BME 622 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

an introduction to and overview of injury biomechanics, including sport injuries - Methods in Trauma Biomechanics - Cellular Injury Biomechanics of Central Nervous System Trauma - Head Injuries - Spinal Injuries - Application of mechanics to the study of human injury. Response of the human body to injurious conditions - Injury tolerance of the human body. Applications to child abuse, transportation safety and the medico-legal environment.

**References:**

*Kai-Uwe Schmitt, Peter F. Niederer, Duane S. Cronin, Markus H. Muser, Felix Walz, "Trauma Biomechanics: An Introduction to Injury Biomechanics", Springer, 2019.*

| Course title | Bioengineering Research Design and Methods | | | | Course Code | BME 623 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

Contents

Introduction to bioengineering research - Application of mechanics to the study of human injury. Response of the human body to injurious conditions. Injury tolerance of the human body. Applications to child abuse, transportation safety Focus on study designs & methodologies and their appropriate application. Emphasis placed on development of specific aims, testable hypotheses, and interpretation and communication of research findings. Data analysis concerns and strategies for parametric and non-parametric applications will be addressed using SPSS. The medico-legal environment.

**References**:


- *Ho Nam Chang, "Emerging Areas in Bioengineering", Wiley-VCH, 2018.*


| Course title | Healthcare Information Systems (HCIS) | | | | Course Code | BME 624 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Healthcare Informatics - Process Fundamentals: Motivation and modeling constructs - Metrics and methods -Process Enabled Information Technology (PEIT)Framework - Electronic Health Records (EHR): Definitions، content، and technology - Electronic Health Records (EHR): Adoption and use issues - Computerized Physician Order Entry (CPOE) - Healthcare Data and Standards - Data Analytics - Data Management and Data Warehousing - HIPAA and Health IT; Evaluation of Healthcare IT Applications - e-health technologies and applications – m-health technologies and applications - Health Information Exchanges

**References:**


- *K. Wager, "Health Care Information Systems: A Practical Approach for Health Care Management", Jossey-Bass; 4th edition, 2017.*


| Course title | Industrial Pharmacy | | | | Course Code | BME 625 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic techniques used in Pharmaceutical industries: Sterilization، Instrumentation in pharmaceutical industry - Instrumental methods of analysis - Preformulation studies - Optimization techniques in pharmaceutical formulation and processing - Compaction and compression - Effect of design of agitator system( shape factors) on the manufacturing of liquid products - Bio process - Materials of construction and prevention of corrosion - Production planning & control - Selection and evaluation of packaging materials for Solid /semisolid and liquid products - Finished product release، Quality review – Design، Construction، maintenance and sanitation for materials and products - industrial hazards.

**References:**


- *B. Chandakavathe, "Textbook of Industrial Pharmacy", Studium Press, 1st ed. 2019.*


| Course title | Clinical Pathology | | | | Course Code | BME 721 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Chemical Pathology and Related Studies: Examination of Urine - Renal Function Tests - Diabetes Mellitus - Liver Function Tests - Disorders of Lipids and Biochemical Cardiac Markers -

Examination of Cerebrospinal Fluid - Laboratory Hematology, Essentials of Clinical Pathology: hematopoiesis - Collection of Blood - Estimation of Hemoglobin - Packed Cell Volume - Total Leukocyte Count - Reticulocyte Count - Blood Smear - Red Cell Indices - Erythrocyte Sedimentation Rate - Diagnosis of Malaria and Other Parasites in Blood - Laboratory Tests in Anemia - Blood Group Systems: Blood Grouping - Collection of Donor Blood, Processing and Storage.

**References:**

- *S. Kawthalkar, "Essentials of Clinical Pathology", Jaypee Brothers Medical Publishers (P) Ltd., 2018*

| Course title | Medical Decision Support Systems (MDSS) | | | | Course Code | CSE 722 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Decision making process – Clinical Diagnostic Decision Support Systems—An Overview - Mathematical Foundations of Decision Support Systems - Testing System Accuracy - Hospital-Based Decision Support- Medical Education Applications - Decision Making under Certainty and Uncertainty - Linear Programming - Graphical LP solution - Simplex method - Representation of clinical knowledge، guidelines and recommendations; Interfaces for decision support; Search and ranking recommendations; - Methods for authoring and validation of clinical guidelines; Evaluation، efficacy and consistency - Precision medicine.

**References:**

- *E. Berner, "Clinical Decision Support Systems: Theory and Practice", Springer; 3rd edition, 2016*

| Course title | Introduction to Deep Learning | | | | Course Code | ECE 723 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Deep Learning - From Logic to Cognitive Science - Mathematical and Computational Prerequisites - Machine Learning Basics - Feed-forward Neural Networks - Modifications and Extensions to a Feed-Forward Neural Network - Deep Computer Vision -Deep Reinforcement Learning - Data Visualization for Machine Learning - Learning and Perception - Deep Sequence Modeling - Deep Generative Models - Limitations and New Frontiers - Biologically Inspired Learning - Applications of deep learning on biomedical images and biomedical signals.

**References:**

- *S. Skansi, "Introduction to Deep Learning", Springer; 1st edition, 2018*

| Course title | Internet of Medical Things (IoMT) | | | | Course Code | ECE 724 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Medical Big Data Analytics. Introduction to IoT Devices and Health Bioinformatics - IoT and Robotics in Healthcare - Implantable Electronics: Integration of Bio-interfaces, Devices and Sensors - Electronic Devices, Circuits and Systems for Non-Invasive Diagnosis - Internet of Things for Remote Healthcare and Health Monitoring - Medical Electronics, Biomedical Instrumentations - Surface Imaging for Bio-medical Applications. Radiofrequency Devices, Circuits and Systems for e-Medicine - Network Architectures and Frameworks for IoT Medical Applications. Medical Big Data Management Systems and Infrastructures - Disease Management, Auto-Administer Therapies - Telemedicine and Mobile Applications.

**References:**

- *A. Hassanien, "Medical Big Data and Internet of Medical Things: Advances, Challenges and Applications", CRC Press; 1st edition, 2018.*

| Course title | Joint Replacement Technology | | | | Course Code | PDE 725 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Joint Replacement Design and Technology - Properties of Materials Used in Orthopaedic Implant Systems - Failure Modes - The Design Process - The Ankle - The Hip - The Shoulder - The knee - Biomechanics of the Hip and knee - Hip Prostheses Design - Knee Prostheses Design - Mechanics and Tribology of Hip and Knee Prostheses - Wear of Hip and Knee Prostheses - Other Prostheses: May include: Shoulder, Elbow, Wrist, Finger, Ankle, Toe - Cemented and Uncemented Fixation and Failure of Joint Replacements

**References:**

- *Frederick F. Buechel, Michael J. Pappas, "Principles of Human Joint Replacement: Design and Clinical Application", Springer, 2015.*

| Course title | Biomedical Photonics | | | | Course Code | ECE 726 |
|---|---|---|---|---|---|---|
| Teaching hours | Lectures | | Tutorial | Practical | Credit hours | 3 Cr |
| | 2 | | 2 | 0 | | |
| Course grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to nano technology science - Wave Nature of Light - Dielectric Waveguides and Optical Fibers - biomedical photonics, spectroscopy and microscopy, the basic physical principles underlying the technology and its applications- Biophotonics of Photosynthesis: Structure of Pigment–Protein Complexes and Structure–Function Relationships - Key Concepts in Physics of Pigment–Protein Complexes - Fluorescence and Phosphorescence; Medical Photonics; Microscopy;

Nonlinear Optics; Ophthalmic Technology; Optical Tomography; Optofluidics; Photodynamic Therapy; Image Processing; Imaging Systems; Sensors; Single Molecule Detection; Futurology in Photonics.

**References:**


- *David L. Andrews, "Photonics, Volume 4: Biomedical Photonics, Spectroscopy, and Microscopy", John Willy & sons, 2015.*

## 14.4 : Diploma in Mechatronics Engineering

## 14.5 : MSc in Mechatronics Engineering

## 14.6 : Ph.D. in Mechatronics Engineering

# Diploma in Mechatronics Engineering

## Program description

The objective of this diploma degree program is to provide a high quality of the theoretical and practical aspects of Mechatronics Engineering. The program enables students to learn in-depth and apply the principles of power systems to mechatronics engineering applications, providing a basis for a professional role in industry or academia.

## Competencies for the diploma graduate

In addition to the general competencies of the Diploma in Engineering, a graduate of the Diploma in Mechatronics Engineering program must be able to:

1- Demonstrate the basic foundational knowledge required to conceptualize, design, manufacture, and operate mechatronics engineering systems.

2- Demonstrate knowledge and understanding of the basic components of an industrial control system.

3- Demonstrate a critical awareness of conceptual design concepts and their practical implementation in mechatronics systems.

4- Selecting and applying appropriate methods to improve the efficiency of mechatronic systems and adopt appropriate solutions to practical problems.

***Benchmark: Master of Technology in Industrial Automation & Robotics, MIT***

https://manipal.edu/mit/department-faculty/department-list/mechatronics.html

# Advanced Diploma in Mechatronics Engineering

## Program description

The objective of this program is to acquire the basic knowledge required to work in the field of mechatronics, along with mathematics and basic sciences, the program is suitable for graduates from the Mechatronics Engineering program and related programs (Electrical Engineering, Communication Engineering, Computer and Systems Engineering, Mechanical Power Engineering, Production Engineering, and Mechanical Design). It has been specifically designed to meet the needs of the expanding industry.

## Competencies for the diploma graduate

In addition to the general competencies of the Diploma in Engineering, a graduate of the Advanced Diploma in Mechatronics Engineering program must be able to:

1- Demonstrate a critical awareness of applying quality control and quality assurance procedures to meet regulatory standards and requirements.
2- Application of mathematics and mechatronics engineering fundamentals to analysis and problem solving, as well as design, maintenance, and repair of components, processes, and mechanical and electronic systems.
3- Demonstrate a critical awareness of conceptual design concepts and their practical application within energy systems.
4- Using current and emerging technologies to support the implementation of mechatronics engineering projects in accordance with health and safety regulations, in addition to standard practices and procedures.
5- Identify potential resources and determine the appropriate energy source at a specific site.

***Benchmark: Mechanical and Mechatronics Engineering, University of Waterloo***

https://uwaterloo.ca/mechanical-mechatronics-engineering/future-undergraduate-students/mechatronics-engineering/program-overview-0

# Master of Science in Mechatronics Engineering

## Program description

The objective of the master's degree program is to provide informed research knowledge in a broad range of specialized mechatronics engineering topics with application to industrial problems. This program provides a flexible structure that enables both recent graduates and more established engineers to tailor their learning experience to meet the needs of their future careers.

## Competencies for the program graduate

In addition to general competencies for the MSc. engineering program the graduate of Master of Science in Mechatronics Engineering program must be able to:

1- Demonstrate the ability to apply the acquired scientific knowledge to real mechatronics engineering problems.
2- Demonstrate the ability to conduct experiments or use mathematical skills in an intensive research assignment that deals with the fields of mechatronics.
3- Using appropriate computer-aided design (CAD) and analysis techniques to provide solutions to practical problems related to mechatronics systems.
4- Identify in-depth knowledge of a specific topic related to the fields of Mechatronics engineering as part of a research project.
5- Use of software packages and measuring equipment related to mechatronics systems.

***Benchmark: Mechatronics MSc program, Tallinn University of Technology***

https://old.taltech.ee/faculties/school-of-engineering/admission-87/masters-programmes-3/mechatronics-msc-2/

# Ph.D. program in Mechatronics Engineering

## Program description

The Ph.D. program in mechatronics engineering is a research-oriented degree program. It aims to enhance knowledge in the fields of Mechatronics and to provide students with the ability to conduct advanced studies and original research. The program prepares students for a research or teaching career in scientific research institutions, universities, industry, and government. The program focuses on the latest technological issues that transcend the boundaries of mechatronics.

## Competencies for the program graduate

In addition to general competencies for the Ph.D. program the graduate of the Ph.D. program in mechatronics engineering must be able to:

1. Demonstrate strong technical knowledge in mechatronics systems and develop the research skills needed to plan and conduct research.
2. Demonstrate the ability to learn independently and make an original contribution to knowledge in the chosen field of mechatronics.
3. Reaching the highest academic level with the potential to become a world leader among specialists and researchers in the fields of mechatronics.
4. Demonstrate the ability to generate new knowledge by completing creative work and writing a thesis.
5. The application of scientific principles in integrating the acquired knowledge in the previously studied courses in his thesis.

***Benchmark: Doctoral Programme in Materials, Mechatronics and Systems Engineering, University of Trento The Department of Industrial Engineering***

https://www.unitn.it/en/ateneo/1904/doctoral-programme-in-materials-mechatronics-and-systems-engineering

## Qualifying Courses - two semesters

## (For those who do not have a Bachelor of Mechatronics Engineering)

In the case of students who obtained a Bachelor’s degree in mechanical or electrical engineering, and applicants for a diploma or master’s degree in Mechatronics, studying (16) credit hours.

- Students who have obtained a Bachelor’s degree in mechanical engineering majors register (6) courses in Electrical specialization, and two courses in mechanical specialization, with the approval of the academic advisor.
- Students who have obtained a bachelor’s degree in electrical engineering majors register (6) courses in mechanical specialization, and two courses in electrical specialization, with the approval of the academic advisor.

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| CSE 411 | Automatic Control Systems | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| MTE 441 | Instrumentation and Measurements | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| ECE 561 | Digital Signal Processing | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 431 | Thermodynamics | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| ELE 551 | Power Electronics | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 421 | Non-Traditional Machining Processes | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 422 | Kinematics and Dynamics of Machines | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 432 | Fluid Mechanics | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| ECE 562 | Image Processing | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 333 | Heat Transfer | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| CSE412 | Microcontrollers and Operating Systems | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 413 | Embedded Systems | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 423 | Computer-Aided Design | 2 | 2 | - | 4 | 0 | 8 | 3 | 50 | - | 50 | 100 |

## List of level (500) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| CSE 511 | Sensors and Actuators | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 512 | Programmable Logic Controllers | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 513 | Modern Control Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 521 | Mechanical Design | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MTE 541 | Mechatronic Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MTE 542 | Introduction to Robotics | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 531 | Computational Fluid Dynamics | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 522 | Numerically Controlled Machines | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 532 | Introduction to Nanotechnology | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 514 | Artificial Intelligence | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 533 | Advanced Thermodynamics | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 534 | Refrigeration Cycles and Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 523 | Materials Engineering | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |

## List of level (600) Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| PDE 621 | Introduction to Continuum Mechanics | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 631 | Fluid Power Control Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MTE 641 | Fire Safety Engineering | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 622 | Finite Element Analysis | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 632 | Design of Thermo-Fluid Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MTE 642 | Micro-Electromechanical Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MTE 643 | Hybrid Vehicles | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MTE 644 | Aircraft Design | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MPE 633 | Fuel Cell Technology | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 611 | Power Electronics and Control | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 612 | Intelligent and Expert Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 613 | Modeling and Simulation of Control Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 614 | Digital Control Systems | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 623 | Robot Kinematics, Dynamics and Control | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 624 | Advanced Topics in Mechanical Systems Design | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 615 | Intelligent Robots | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 625 | Design of Experiments | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 626 | Mechanics of Materials | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MTE 645 | Selected Topics in Mechatronics Engineering | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |

## List of level (700) Courses

| Code | Course Title | Pre-requisite | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| CSE 711 | Optimal Control | CSE 613 | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 712 | Mobile Robots and Vision Systems | CSE 612 | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 713 | Smart Sensors and Actuators | | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 714 | Learning Algorithms and Neural Networks | CSE 612 | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 715 | Autonomous Mobile Robotics | MTE 542 | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 721 | Surface Modeling and Machining | | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 722 | Advance Micro-Electromechanical Systems | | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 723 | Advanced Robotics | PDE 623 | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 716 | Nonlinear Control Systems | | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| CSE 717 | Fault Analysis and Control | | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| PDE 723 | Additive Manufacturing | | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |
| MTE 741 | Advanced Topics in Mechatronics Engineering | MTE 648 | 2 | 2 | - | 4 | 3 | 8 | 3 | 50 | - | 50 | 100 |

# Summary of Courses Specification

## Level (400)

| Course title | Automatic Control Systems | | | | Course Code | CSE 411 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 0 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Fundamentals of Control - Mathematical Description of linear systems using Laplace transform – Modeling of electromechanical systems – State variables – Time and frequency domain system response – Stability of linear systems – Root locus – Introduction to PID controllers – Analysis using adequate SW - Stationary behavior of closed loop control - Frequency transformed methods - Control design - Optimum control - State-Space-Methods.

**References:**

1. Modern control engineering, Katsuhiko Ogata, 5th edition, September, 2009
2. Control systems engineering and design, S. Thompson, Novemeber 1989

| Course title | Instrumentation and Measurements | | | | Course Code | MTE 441 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 0 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Statistical analysis of experimental data - Uncertainty analysis - Various statistical distributions and test of goodness of fit, correlation coefficient and multivariable regression - Engineering instrumentation including types of passive/active transducers, electronics for instrumentation, computer-based data acquisition, and experiments on pressure, temperature, force measurements. Also electrical measurements such as voltage, current and resistance…etc.

**References:**

1. Ernest O. Doebelin, " Measurement Systems", McGraw – Hill, Singapore, 1990
2. R. S. Figliola and D. E. Beasley, " Theory and Design for Mechanical Measurements", John Wiley &Sons, Inc., U.S.A., 1995.

| Course title | Digital Signal Processing | | | | Course Code | ECE 561 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 0 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Signal and Systems - representation of the signals - sampling - intermittent signals - "Z" transform and inverse – Discrete Fourier transform – FFT – Random processes
Analog to Digital Conversion and Digital to Analog Conversion FIR and IIR Filter Design
Steps of digital filters Design, implement filters - coefficient retail, limited word length, Wiener filter - filters harmonization - data coding and compressing – Applications: signals regeneration.

**References:**

1. Diniz P.S.R., et al. Digital signal processing. System analysis and design (CUP, 2010)(ISBN 0521887755)
2. Chi-Tsong Chen - Digital signal processing _ spectral computation and filter design-Oxford University Press (2001)
3. Ashok Ambardar , Analog-and-Digital-Signal-Processing, Second Edition , Brooks/Cole Publishing Company , 1998

| Course title | Thermodynamics | | | | Course Code | MPE 431 |
|---|---|---|---|---|---|---|
| Teaching hours | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 0 |
| | — | — | | 2 | | |
| Course grades | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Basic concepts – Energy concepts – Thermodynamic properties of pure substance – First law – Second law – Entropy – Thermodynamic equilibrium – Thermodynamic properties of Mixtures and solutions – Thermodynamics of chemical reactions.

**References**:

1. Engineering Thermodynamics (Principles and Practices), D.S. Kumar, Kataria and Sons, New Delhi, 2012
2. Thermodynamics: An Engineering Approach, Yunus A. Çengel and Michael A. Boles, McGraw – Hill, Collumbus, 2010
3. Fundamentals of Engineering Thermodynamics, Michael J. Moran and Howard N. Shapiro, John Wiley and sons, Hoboken, Toronto, West Sussex, Singapore, 2006
4. Fundamentals of Thermodynamics, Richard E. Sonntag, Claus Borgnakke and Gordon J. Van Wylen; John Wiley and sons, Hoboken, Toronto, West Sussex, Singapore, 2002

| Course title | Power Electronics | | | | Course Code | ELE 551 |
|---|---|---|---|---|---|---|
| Teaching hours | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 0 |
| | — | — | | 2 | | |
| Course grades | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Conversion techniques of electric energy – Deign of electronic power devices and circuits - Applications of power electronics in electric machines – Applications of power electronics in Renewable energy systems.

**References**:

1. Issa Batarseh, "Power Electronic Circuits" by John Wiley, 2003.
2. S.K. Mazumder, "High-Frequency Inverters: From Photovoltaic, Wind, and Fuel-Cell based Renewable- and Alternative-Energy DER/DG Systems to Battery based Energy-Storage Applications", Book Chapter in Power Electronics handbook, Editor M.H. Rashid, Academic Press, Burlington, Massachusetts, 2010.
3. V. Gureich "Electronic Devices on Discrete Components for Industrial and Power Engineering", CRC Press, New York, 2008
4. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, 2nd Ed., Springer

| Course title | Non-conventional Machining Processes | | | | Course Code | PDE 421 |
|---|---|---|---|---|---|---|
| Teaching hours | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 0 |
| | — | — | | 2 | | |
| Course grades | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Introduction to non-conventional machining operations and their classifications - non-conventional mechanical operations (water jet machining, abrasive jet machining, abrasive water jet, abrasive jet finishing, ultrasonic machining and applications) - non-conventional electrical operations (electrochemical operation and applications), non-conventional thermal operations Conventional thermal (electrical discharge machining and its applications, electron beam machining, laser beam machining, plasma arc machining) - non-conventional chemical processes (chemical milling, photochemical milling).

**References**:

1. “ Modern Machining Process” by Pandey and Shah.
2. “ Advanced Analysis of Nontraditional Machining” by Hong Hocheng.
3. “ Nontraditional Machining Processes” by E Weller.
4. “ Non-Traditional Machining Processes” by Jagadeesha T.
5. “ Nontraditional Machining Processes: Research Advances” by J Paulo Davim

| Course title | Kinematics and Dynamics of Machines | | | | Course Code | PDE 422 |
|---|---|---|---|---|---|---|
| Teaching hours | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 0 |
| | — | — | | 2 | | |
| Course grades | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Fundamentals of Kinamatics - Position, Speed and acceleration Analysis of Mechanical Mechanisms - Mechanical Mechanics Design - Dynamics Fundamentals - Dynamic Force Analysis - Cam Design - Gear trains – Flywheel - Balancing Rotating and Reciprocating Machines - Computer Analysis and Design.

**References**:

1. R.S.Khurmi, JK. Gupta, "Theory of Machines and Mechanisms", McGrawHill,2005
2. M.Z. Kolovsky, A.N. Evgrafov, Yu.A.Semenov, A.V. Slousch, "Advanced Theroy of Mechanisms and machines", Springer, 2013.

| Course title | Fluid Mechanics | | | | Course Code | MPE 432 |
|---|---|---|---|---|---|---|
| Teaching hours | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 0 |
| | — | — | | 2 | | |
| Course grades | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Introduction to fluid dynamics - Physical laws in the field of fluid mechanics – Conservation equations – Mass, momentum and energy conservation equations - Analysis of some engineering applications using control volume analysis – Deducing Navier-Stokes equations and their applications - Marginal layer theory - Using von Karmen's equations to solve boundary layer problems - An introduction to turbulent flow.

**References**:

1. Fluid Mechanics, Frank White, 7th edition, McGraw Hill, 2010
2. Fundamentals of fluid mechanics, Munsen et al., Wiley, 2012

| Course title | Image Processing | | | | Course Code | ECE 562 |
|---|---|---|---|---|---|---|
| Teaching hours | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 0 |
| | — | — | | 2 | | |
| Course grades | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Contains digital imaging systems and digital images - image statistics -. Cleaning image -. Processes that rely on the principle of blobs, shared statistics and comparing images - shrugging operations - Fourier theory, which depends on the frequency and filters -. Restoration of images, and, reconstruction, encryption and compression. Ways to predict the values of the spatial locations and location and geometrical transformations.

**References**:

1. Geometric Methods in Bio-Medical Image Processing (Mathematics and Visualization), Dec 21, 2012 , Ravikanth Malladi
2. Advances in Mass Data Analysis of Signals and Images in Medicine, Biotechnology and Chemistry: International..., Jan 16, 2008, Petra Perner and Ovidio Salvetti
3. Petrou, Maria, and Costas Petrou. Image processing : the fundamentals. Chichester, U.K: Wiley, 2010.
4. Sonka, Milan, Vaclav Hlavac, and Roger Boyle. Image processing, analysis, and machine vision. Stamford, CT, USA: Cengage Learning, 2015

| Course title | **Microcontrollers and Operating Systems** | | | | **Course Code** | CSE 412 |
|---|---|---|---|---|---|---|
| Teaching hours | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 0 |
| | — | — | | 2 | | |
| Course grades | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Computer number systems, codes, and arithmetic functions; microprocessor and microcontroller functions, architecture, Busses, Memory, instruction sets, addressing modes, internal operations, PIA interfacing, and I/O operations. Assembly and Machine Language Programming: Branching, Loops, Subroutines, Interrupts, and Troubleshooting. Introduction to operating systems: process management, scheduling, memory management, device drivers, file systems and modern operating systems concepts (kernel/micro kernel designs, concurrency, synchronization, inter-process communication, security and protection)

**References**:

1. Ogata Modern_Control_Engineering_4th_Ed
2. McGraw-Hill - PIC Microcontroller Project Book by John Lovin
3. Microprocessor and Microcontroller System A. P. Godse and Mrs

| Course title | **Heat Transfer** | | | | **Course Code** | MPE 433 |
|---|---|---|---|---|---|---|
| Teaching hours | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 0 |
| | — | — | | 2 | | |
| Course grades | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Conduction heat and mass transfer – introduction to convective heat and mass transfer – Combined heat and mass transfer – Radiation – Desigh of heat and exchangers.

**References**:

1. Analysis of Heat Transfer" by E R G Eckerst and R M Drake.
2. Heat Transfer: A Practical Approach, Y. Cengel.

| Course title | **Embedded Systems** | | | | **Course Code** | CSE 413 |
|---|---|---|---|---|---|---|
| Teaching hours | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 0 |
| | — | — | | 2 | | |
| Course grades | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Examples of embedded systems which can be found as parts of many machines that we rely on every day, like household appliances, consumer electronics (DVD players, MP3s), vehicles, and so forth. Theoretical and practical solutions to typical problems that the students are expected to master and be able to apply to realistic case studies. Microcontroller and its use in the design of embedded systems. Hardware and software architectures of a microcontroller, its programming languages and its applications for a wide range of real-word applications

**References**:

1. "PIC Microcontroller Projects in C: Basic to Advanced", Ibrahim Dogan, Newnes, 2 edition, 2014
2. "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18", Muhammad Ali Mazidi, MicroDigitalEd, 2 edition,2016

<table>
<tr><td>Course title</td><td colspan="4">Computer-Aided Design</td><td>Course Code</td><td>PDE 423</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td colspan="2">Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">0</td></tr>
<tr><td>—</td><td colspan="2">—</td><td>2</td></tr>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

**Contents**

Introduction to 2D and 3D software - Create / edit documents, customize user interface, manage user settings - Draw details, define constraints - Create solid model parts, modify part features - Design (multi-part, multi-assemblies) - Drafting, Add / modify directions of view, generate dimensions - detailed dimensions, explanation of the drawing - surfaces: create wire engineering (points, lines, curves) - perform operations: joining, trimming, splitting, transforming, axes transformation - interfaces for finite element analysis.

**References**:

1. CAD/CAM : Computer-Aided Design and Manufacturing” by M Groover and E Zimmers
2. “Computer-Aided Tolerancing: Proceedings of the 4th Cirp Design Seminar the University of Tokyo” by Fumihiko Kimura
3. “Computer Aided Engineering Design” by Anupam Saxena

# Level (500)

<table>
<tr><td>Course title</td><td colspan="4">Sensors and Actuators</td><td>Course Code</td><td>CSE 511</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td colspan="2">Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>—</td><td colspan="2">—</td><td>2</td></tr>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

**Contents**

Operational Amplifiers and Signal Conditioning– Operational amplifier circuits - Conditioning and conversion systems – Switches, Relays, and Power Control Semiconductors - Transducers and sensors – Difference and instrumentation amplifiers – Active filters – Basic types of sensors and actuators.

**References**:

4. Christopher T. Kilian, "Modern Control Technology: Components and Systems by Christopher " 2nd edition, Delmar Thomson Learning, 2007.
5. Clarence W. de Silva, " Sensors and Actuators: Engineering System Instrumentation", 2nd Edition, CRC Press, 2015.
6. Robert H. Bishop, " Mechatronic Systems, Sensors, and Actuators: Fundamentals and Modeling ", (The Mechatronics Handbook, Second Edition), CRC Press, 2017.

<table>
<tr><td>Course title</td><td colspan="4">Programmable Logic Controllers</td><td>Course Code</td><td>CSE 512</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td colspan="2">Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>—</td><td colspan="2">—</td><td>2</td></tr>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

**Contents**

Ladder programming and input/output operations – Manipulate data using PLC instruction sets – Advanced motion control programming using instruction set – Designing, configuring and interfacing graphical screens for HMI (Human Machine Interface) units – Architecture and operation of Distributed Control systems – Design of a simple DCS system – Ability to design the overall DCS and process control system – Ability to specify, select and install DCS systems – Understanding of the key ergonomic issues in design of operator displays – Modern Distributed Control Systems – Application of advanced control strategies to plant control system – Alarm systems.

**References**:

1. Elvin Pérez Adrover, "Introduction to PLCs: A beginner's guide to Programmable Logic Controllers", 11th Edition, 2012.
2. Frank Petruzella, " Programmable Logic Controllers", 5th Edition, McGraw-Hill Education, 2016.

3. Max Rabiee, " Programmable Logic Controllers: Hardware and Programming", 4th Edition, Goodheart-Willcox, 2017.

| Course title | Modern Control Systems | | | | Course Code | CSE 513 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | Tutorial | Lectures | | Credit hours | 3 |
| | — | — | 2 | | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Multiple-input and multiple-output systems: State-space analysis – Similarity transformations – Eigenvalue and eigenvector decomposition – Stability in the sense of Lyapunov – Controllability, and observability, and pole placement – Quadratic optimization – Conditions for optimality – The minimum principle – Hamilton-Jacobi equation, structure, and properties of optimal systems – Recent application based on modern control systems.

**References**:

1. Richard C. Dorf and Robert H. Bishop, " Modern Control Systems", 13th Edition, Pearson, 2016.
2. Arie Nakhmani, " Modern Control: State-Space Analysis and Design Methods", 1st Edition, McGraw-Hill Education, 2020.
3. Ogata, " Modern Control Engineering", 5th Edition, Pearson India, 2015.

| Course title | Mechanical Design | | | | Course Code | PDE 521 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | Tutorial | Lectures | | Credit hours | 3 |
| | — | — | 2 | | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Introduction; Fundamentals of materials mechanics; Columns; Elements of Power Transmission Systems: Drives (belts, chains, ropes, pulleys, sprockets, power screws, and gears), Couplings, Clutches. Safety, reliability, and maintenance considerations in machine design; Machine design documentations, and configuration management; Accelerated testing of machines and their elements; Life cycle assessment and costing of machines; Essential software; Applications; Case studies; Recent topics.

**References**:

Childs, P.R., *“Mechanical design engineering handbook,”* Butterworth-Heinemann, 2013.

| Course title | Mechatronic Systems | | | | Course Code | MTE 541 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | Tutorial | Lectures | | Credit hours | 3 |
| | — | — | 2 | | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Introduction to mechatronic product development (analysis of user requirements, design constraints, analysis of alternatives) – Modular design – Mechatronics system design tools (CAD Software, Matlab/Simulink, PROTEUS) – Selection of sensors and actuators – Real-time and data acquisition systems – Mini-projects to implement the development of mechatronic systems.

**References**:

1. Shetty, D., Richard A.K., *“Mechatronics system design, SI version,”* Cengage Learning, 2010.
2. Janschek, K., *“Mechatronic systems design: methods, models, concepts,”* Springer Science & Business Media, 2011.
3. Boukas, E., AL-Sunni, F.M., “*Mechatronic Systems: Analysis, Design and Implementation*,” Springer, 2011.

| **Course title** | **Introduction to Robotics** | | | | **Course Code** | PDE 542 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | | **Tutorial** | **Lectures** | **Credit hours** | 3 |
| | — | | — | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Homogeneous transformations – Direct kinematics – Inverse kinematics – Velocity kinematics – Path planning – Static and stiffness analysis – Dynamics: Euler-Lagrange equations – Euler-Newton's iterative formulation – Motion control – Force control – Robotic arm with high degrees of freedom – Analysis of parallel robots – Qualitative design of parallel robots – Soft elements robots – Leg and wheeled robots – Micrometer and nanometric robots – Remote sensing and control robots – Exoskeleton robots to maximize human performance – Underwater robots – Flying robots – Space robots – Service and field robots – Robots that take care of human health and rehabilitation – Humanoid robots.

**References**:

Spong M.W., Hutchinson S., Vidyasagar M., "*Robot modeling and control*," 2006.

| **Course title** | **Computational Fluid Dynamics** | | | | **Course Code** | MPE 531 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | | **Tutorial** | **Lectures** | **Credit hours** | 3 |
| | — | | — | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Global and local balances – Detailed local mass, momentum and energy balances – Boundary layer theory – Turbulence modeling – 3D modeling of transport problems using simulation tools – Introduction to Finite Volume Method – Meshing – Boundary conditions.

**References:**

1. Versteeg, H. K.; Malalasekera, W, "An Introduction to Computational Fluid Dynamics", Pearson; 2nd Edition, 2007 .
2. John Anderson, "Computational Fluid Dynamics", McGraw-Hill Education; 1st Edition, 1995
3. Oleg Zikanov, "Essential Computational Fluid Dynamics", Wiley; 1st Edition, 2010

| **Course title** | **Numerically Controlled Machines** | | | | **Course Code** | PDE 522 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | | **Tutorial** | **Lectures** | **Credit hours** | 3 |
| | — | | — | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

The physical architecture of CNC machines and its common applications: Guide systems, transmission systems, motors – The CNC controller – Controller hardware: Enclosure, breakout board, drives, power supply, adjunct devices for controller hardware, pendant, wiring – Control software: Mach3 control software, enhanced machine controller, version 2 (EMC2) – G-code editors – Application software: The table or mill topology, Lathe/rotary topology, CAD and graphics, CAM software – Building or buying a CNC machine.

**References**:

Fitzpatrick, M., "*Machining and CNC technology,*" McGraw Hill Higher Education, 2013.

| Course title | Introduction to Nanotechnology | | | | Course Code | MPE 532 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Fundamentals of microfabrication – MEMS devices and packaging – MEMS modeling and design – Microfluidics – BioMEMS – Introduction to top-down and bottom-up nanofabrication – Introduction to the characterization of nanostructures.

**References:**

1. Charles P. Poole Jr., Frank J. Owens, "Introduction to Nanotechnology", Wiley-Interscience; 1st Edition, 2003.
2. Chris Binns, "Introduction to Nanoscience and Nanotechnology", Wiley; 1st Edition, 2010.

| Course title | Artificial Intelligence | | | | Course Code | CSE 514 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

The meaning of artificial intelligence – Tests of intelligence – Limits of artificial intelligence – Systems of artificial intelligence – Mathematical and programming branches used in artificial intelligence – Logic and probabilistic reasoning – Evidence theories – Systems of reasoning and learning – Knowledge representation – Clarity and some rules of induction – State spaces and research methods (Blind search, Depth-first search, Breadth-first search, Depth-limited search, Iterative search, Random search, Greedy search, Mountain-climb) – Reality fulfillment issues: Applications: Machine learning – Neural Natural language processing – Expert systems – Neural networks – Genetic algorithms, Image recognition using intelligence – Applications of artificial intelligence – The main structures used in artificial intelligence programs – Scientific use of artificial intelligence languages and applications.

**References:**

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 4$^{th}$ Edition, Pearson, 2020.
2. Melanie Mitchell, "Artificial Intelligence: A Guide for Thinking Humans", Farrar, Straus and Giroux, 2019.
3. Ramesh Sharda, Dursun Delen and Efraim Turban, " Analytics, Data Science, & Artificial Intelligence: Systems for Decision Support", 11$^{th}$ Edition, Pearson, 2019.

| Course title | Advanced Thermodynamics | | | | Course Code | MPE 533 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Introduction – Microscopic State of Matter – First and Second Laws of Thermodynamics – The Entropy – The Reversibility – The Statistical Analysis of Entropy – The Microscopic Definition of Work and Heat for the Macroscopic Properties – Applications.

**References:**

1. Cengel, Yunus A., and Michael A. Boles. Thermodynamics: An Engineering Approach, 6$^{th}$ Editon (SI Units). The McGraw-Hill Companies, Inc., New York, 2007.
2. Gupta, Sushil Chandra. Thermodynamics. Pearson, 2007.

| Course title | Refrigeration Cycles and Systems | | | | Course Code | MPE 534 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Vapor Compression Cycles – Refrigerants – Absorption System – Refrigeration by Steam Nozzles – Air Refrigeration – Thermoelectric Cooling – Gas Liquefaction – Ice Production – Salt Coolers – Defrosting – Cooling Towers – Refrigeration Applications.

**References:**

3. Arora, Chandra Prakash. Refrigeration and air conditioning. Tata McGraw-Hill Education, 2000.

| Course title | Materials Engineering | | | | Course Code | PDE 523 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Introduction; Types of materials; Structure of materials; Properties of Materials: Mechanical, Electrical, Magnetic, Optical, Thermal, Chemical, Metallurgical, Biological, Tribological. Change of properties; Corrosion; Degradation; Transport properties; Imperfections in solids; Diffusion; Deformation and strengthening mechanisms; Materials testing; Failures and failure mechanics of products; Reliability of material systems; Phase diagrams; Phase transformations; Thermodynamics of condensed phases; Kinetic processes; Synthesis, fabrication, and processing of materials; Treatment of Materials: Surface and heat treatment, Coating, Reinforcement. Materials selection and design; Numerical methods; Essential software; Engineering and industrial applications; Health and safety systems in materials engineering; Economic and environmental issues in materials engineering; Recycling of materials; Recent topics..

**References:**

1. Michael F. Ashby, Hugh Shercliff and David Cebon, " Materials: Engineering, Science, Processing and Design", 4th Edition, Butterworth-Heinemann, 2019.
2. William D. Callister Jr. and David G. Rethwisch, " Materials Science and Engineering: An Introduction", 9th Edition, Wiley, 2013.
3. Donald R. Askeland and Wendelin J. Wright, " The Science and Engineering of Materials", 7th Edition, Cengage Learning, 2015.

## Level (600)

| Course title | Introduction to Continuum Mechanics | | | | Course Code | PDE 621 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Mathematical preliminaries – Co-ordinate transformations – Introduction to tensors – Tensor fields and transformations – Integral theorems – Analysis of deformation – Deformation tensors and rates of deformation tensors and their mechanical significance – Convecting and rotating axes – Analysis of stress – Definition of stresses and their physical significance, Rates of stresses, Objective stress rates – Constitutive equations for elasticity and plasticity – Hardening laws and material rate sensitivity.

**References:**
1. Dill, E.H., "*Continuum mechanics: elasticity, plasticity, viscoelasticity,*" CRC press, 2006.
2. Coman, C.D., "*Continuum Mechanics and Linear Elasticity,*" Springer Netherlands, 2020.

| Course title | Fluid Power Control Systems | | | | Course Code | MPE 631 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Properties of hydraulic fluids – Design and function of conventional hydraulic and pneumatic circuits – Characteristics of flow and pressure control valves – Speed control in fluid power circuits – Performance of pumps and fluid motors – Hydrostatic and hydrokinetic transmission systems – Principles of sealing, filtration and heat control in hydraulic circuits.

**References:**
1. *Rabie, M.G., "Fluid Power Engineering", McGraw-Hill, 2009.*
2. *Manring, N.D., "Hydraulic Control Systems", 1st edition, Wiley, 2005*
3. *Abu Hanieh, A., "Fluid Power Control : Hydraulics and Pneumatics", Cambridge International Science Publishing, 2012.*
4. *Anderson, B.W., "The Analysis and Design of Pneumatic Systems", Krieger Pub Co; Corrected Edition, 2001*

| Course title | Fire Safety Engineering | | | | Course Code | MTE 641 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Fundamentals of fire behavior, fuels and flammability, heat transfer and fluid dynamics of fires and fire modeling – Applications of fire safety, fire control and hazard assessment in the design of buildings, industrial environments and transportation systems.

**References:**
1. Purkiss, J.A., "Fire Safety Engineering Design of Structures Butterworth-Heinemann; 2nd Edition, 2006.
2. A Maurice Jones Jr, "Fire Protection Systems", Jones & Bartlett Publishers, 2019
3. Zalosh, R. G., " Industrial Fire Protection Engineering", John Wiley & Sons, Ltd, 2003.

| Course title | Finite Element Analysis | | | | Course Code | PDE 622 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Finite element analysis – Domain discretization – Interpolation and shape functions - Element derivation and types – Element stiffness or property equations - Assembly procedure – Boundary conditions – Solution methods for the algebraic equation system – Applications in stress analysis, heat transfer and fluid flow.

**References:**
1. Madenci, E., Guven, I., "*The finite element method and applications in engineering using ANSYS®*" , Springer, 2015.
2. Zohdi, T.I., Zohdi, Ditzinger, "*A Finite Element Primer for Beginners*", Springer, 2018.
3. Zienkiewicz, O., Taylor, R., Zhu, J.Z. , "The Finite Element Method: Its Basis and Fundamentals", 7th Edition, Butterworth-Heinemann, 2013.

| Course title | Design of Thermo-Fluid Systems | | | | Course Code | MPE 632 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Design of power generation and refrigeration cycles, pump and piping systems, heat exchangers and heat exchanger networks, and air-conditioning and heating systems.

**References:**

1. Janna,W.S., "Design of Fluid Thermal Systems"; Cengage Learning; 4th Edition, 2014.
2. Andrè Garcia McDonald and Hugh Magande, "Introduction to Thermo-Fluids Systems Design", Hoboken, NJ : Wiley, 2012

| Course title | Micro-Electromechanical Systems | | | | Course Code | MTE 642 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Principles of Micro-ElectroMechanical Systems (MEMS): theory, design, and fabrication – Scaling law principles, micro-mechanical structures for micro-sensing and micro-actuations, electrostatic devices, micro-thermal devices, piezoresistive devices, piezoelectric devices, micro-magnetic devices, microfluidics, micro-optics, micro-assembly, and packaging – Case studies of actual MEMS devices, their operation, and their micro-fabrication.

**References:**

1. Allen,J.J., "Micro Electro Mechanical System Design (Mechanical Engineering)"; CRC Press; 1st Edition, 2005.
2. Zielke, D,, "Microsystems: Micro-Electro-Mechanical Systems (MEMS)", 2016
3. Qing-An Huang, "Micro Electro Mechanical Systems", Springer Nature Singapore Pte Ltd., 2018

| Course title | Hybrid Vehicles | | | | Course Code | MTE 643 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Hybrid electric vehicle (HEV) technology – Power plants, electric propulsion systems, transmissions, and onboard energy storage systems – Fuel cell vehicles – Vehicle performance modelling and simulation using advanced vehicle powertrain modelling tools – Design and optimization of HEV powertrain system – HEV design case studies.

**References:**

Denton, T., "*Electric and hybrid vehicles,*" Routledge, 2020.

| Course title | Aircraft Design | | | | Course Code | MTE 644 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Unmanned air vehicles and related systems – Aircraft multidisciplinary design optimization – Development, manufacturing and operating processes and procedures – Flight test principles, instrumentation, planning, and operation of aerospace vehicle flight testing – Flight test measurements, static-system calibration, rate-of-climb performance, and determination of vehicle flight dynamics.

**References:**

1. Raymer, D. P., “Aircraft Design: A Conceptual Approach"; Amer Inst of Aeronautics &; 5th Edition, 2012.
2. Thomas Eismin, “Aircraft Electricity and Electronics”, McGraw-Hill Education; 7th Edition , 2019

| Course title | Fuel Cell Technology | | | | Course Code | MPE 633 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Overview of current fuel cell technology – Operating principles, fundamental thermodynamics and electrochemistry – Types of fuel cells and applications – Proton exchange membrane fuel cells, components, performance, testing – Micro fuel cells – High temperature fuel cells – Modelling of transport phenomena in fuel cells – Hydrogen production and storage – Fuel cell systems and ancillaries.

**References:**

1. Nigel Samme, “Fuel Cell Technology "; Springer, London, 2006.
2. Behling, N., “Fuel Cells: Current Technology Challenges and Future Research Needs”, Elsevier 2012
3. Behling, N., “Hydrogen and Fuel Cells”, 2nd edition Academic Press, 2011

| Course title | Power Electronics and Control | | | | Course Code | CSE 611 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Modern power semiconductor devices, their characteristics, both static and switching – Modern power semiconductor devices, e.g., diodes, thyristors, MOSFETS, and other insulated gate devices such as the IGBT, MCT and the FCT – Static and switching characteristics, gate drive and protection techniques; their drive circuit design and protection techniques including the snubber – Topologies of power converter circuits: operation analysis, control characteristics, efficiency and other operational features – Applications in AC-DC, DC-DC, and DC-AC power converter circuits – Analyses of input and output waveforms of these circuits and their harmonic performance – Devices, circuit principles and implications in input/output waveform quality – Application considerations for remote and un-interruptible power supplies, and for computer systems, telecommunications, automobiles, traction and other industrial processes – Utility interaction, harmonic distortion, and power factor.

**References:**

1. Simone Buso and Paolo Mattavelli, "Digital Control in Power Electronics", 2nd Edition, Morgan & Claypool, 2015.
2. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics: Converters, Applications, and Design", 3rd Edition, Wiley, 2002.
3. Robert W. Erickson and Dragan Maksimović, "Fundamentals of Power Electronics", 3rd Edition, Springer, 2020.

<table>
<tr><td>Course title</td><td colspan="4">Intelligent and Expert Systems</td><td>Course Code</td><td>CSE 612</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td colspan="2">Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>—</td><td colspan="2">—</td><td>2</td></tr>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

**Contents**

Overview of topics in the field of artificial intelligence (AI) – Working knowledge of designing an expert system and applying expert system technology in designing and analyzing engineering systems – Knowledge representation including propositional calculus, predicate calculus, semantic networks, frame systems and production rules – Various search techniques – Fuzzy logic systems, neural network systems and computer vision systems – Languages for AI problem solving such as Prolog and/or LISP – Design of expert systems – Applications of expert systems in engineering system design and analysis – Case studies – Class project – Design of expert systems for students engineering applications, and utilization of expert shell to implement the design.

**References**:


1. I. Gupta and G. Nagpal, "Artificial Intelligence and Expert Systems", Mercury Learning and Information, 2020.
2. Darrel Ryan, "Expert Systems: Design, Applications and Technology (Computer Science, Technology and Applications)", Nova Science Pub Inc, 2017.
3. Geoff Hulten, "Building Intelligent Systems: A Guide to Machine Learning Engineering", 1st Edition, Apress, 2018.
4. Liebowitz, J., ed., *"The handbook of applied expert systems,"* CRC Press, 2019.


<table>
<tr><td>Course title</td><td colspan="4">Modeling and Simulation of Control Systems</td><td>Course Code</td><td>CSE 613</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td colspan="2">Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>—</td><td colspan="2">—</td><td>2</td></tr>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

**Contents**

Feedback elements – Frequency response using Bode diagram – Polar plot – Nichol's chart – Compensation principles, Lead, Lag, and Lead-Lag compensations, advanced nonlinear control methods.

**References**:


1. Craig A. Kluever, "Dynamic Systems: Modeling, Simulation, and Control", 1st Edition, Wiley, 2016.
2. Dean C. Karnopp, Donald L. Margolis and Ronald C. Rosenberg, "System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems", 5th Edition, Wiley, 2012.
3. Farid Golnaraghi and Benjamin Kuo, "Automatic Control Systems", 10th Edition, McGraw-Hill Education, 2017.

| Course title | Digital Control Systems | | | | Course Code | CSE 614 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Sample theory, z-transform, and other analysis tools that are used to analyze and design digital control systems – Analysis: state space and input/output representation, modeling and analysis of digital control systems – Synthesis: emulation, I/O mapping design, state feedback control, state observer design, observer based compensator design, LQ optimal control, Kalman filtering, LQG design – Implementation: quantization, sampling and noise of linear time-invariant (LTI) control system design and its extensions.

**References**:

1. Charles L. Phillips, Troy Nagle and Aranya Chakrabortty, "Digital Control System Analysis & Design", 4th Edition, Pearson, 2014.
2. M. Sami Fadali and Antonio Visioli, "Digital Control Engineering: Analysis and Design", 3rd Edition, Academic Press, 2019.
3. Farid Golnaraghi and Benjamin Kuo, "Automatic Control Systems", 10th Edition, McGraw-Hill Education, 2017.

| Course title | Robot Kinematics, Dynamics and Control | | | | Course Code | PDE 623 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Analysis and design of robotic systems including arms and vehicles – Kinematics, Inverse Kinematics, and Dynamics of robots – Trajectory planning, motion control and force control of robot – Case studies for solving real problems.

**References**:

Spong M.W., Hutchinson S., Vidyasagar M., "*Robot modeling and control*," 2006.

| Course title | Advanced Topics in Mechanical Systems Design | | | | Course Code | PDE 624 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | | Tutorial | Lectures | Credit hours | 3 |
| | — | | — | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Modeling of Electro-Mechanical Systems – Electro-Magnetic Bearing Design and Modeling – Nonlinear Friction, stick-Slip Friction modeling – Mechanical Power transmission systems – Vehicles – Road Dynamics – Parallel Mechanisms – Case studies using ADAMS software.

**References**:

1. Ambrósio, J.A., Eberhard, P. (Eds.), "*Advanced design of mechanical systems: from analysis to optimization* (Vol. 511)," Springer Science & Business Media, 2009.
2. McConville, J.B., "*Introduction to mechanical system simulation using Adams,*" SDC publications, 2015.
3. Hurmuzlu, Y., Nwokah, O.D. (Eds.), "*The mechanical systems design handbook: modeling, measurement, and control,*" CRC Press, 2017.

| **Course title** | **Intelligent Robots** | | | | **Course Code** | CSE 615 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 3 |
| | — | — | | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Design and development of intelligent machines with emphasis on sensor-based control of mobile robots – Mechanics, kinematics, and components – Sensor characterization, sensory perception – Motor sizing, motor control, and simple reactive behaviors – Combining multiple sensory inputs and multiple behaviors – Robot control, perception, localization, planning, mapping, navigation, and learning approaches – Control architectures for cooperative robots – Project.

**References**:

1. Siegwart, R., Nourbakhsh, I.R., Scaramuzza, D., “*Introduction to autonomous mobile robots,”* MIT press, 2011.
2. Fu, K., ed., “*Learning systems and intelligent robots,”* Springer Science & Business Media, 2012.

| **Course title** | **Design of Experiments** | | | | **Course Code** | PDE 625 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 3 |
| | — | — | | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Introduction; Statistical Basics: Basic statistical tests, Analysis of variance, and Analysis of covariance. Fundamentals: Measurements, Quality characteristics, Randomization, Replication, and Blocking. Interactions in Processes; Phases of Experimental Design: Planning phase, Design phase, Conducting phase, and Analyzing phase. Analytical tools for experimental design; Screening designs; Completely randomized designs; Block Designs: Randomized block design, Incomplete block designs, Latin’s square designs, Graeco-Latin’s square designs, and Youden’s square designs. Full factorial designs; Fractional factorial designs; Nested designs; Robust designs; Split-unit designs; Split-lot designs; Response surface designs; Repeated measures designs; Multiple responses; Essential software; Engineering and Industrial applications; Recent topics.

**References**:

1. Angela Dean, Daniel Voss and Danel Draguljić, "Design and Analysis of Experiments (Springer Texts in Statistics)", 2$^{nd}$ Edition, Springer, 2017.
2. Douglas C. Montgomery, "Design and Analysis of Experiments", 10$^{th}$ Edition, Wiley, 2020.

| Course title | Mechanics of Materials | | | | Course Code | PDE 626 |
|---|---|---|---|---|---|---|
| Teaching hours | Practical | Tutorial | | Lectures | Credit hours | 3 |
| | — | — | | 2 | | |
| Course grades | Final Exam | S. work | Practical | Oral | Total grads | 100 |
| | 50 | 50 | — | — | | |

Contents

Introduction; Stress and strain; Mechanical properties of materials; Axial load; Torsion; Bending; Transverse shear; Combined loadings and stresses; Stress transformation; Strain transformation; Deflection; Buckling; Energy methods for stress-strain problem solving; Systems of testing and measurements in mechanics of materials; Analysis of internal forces and moments of structures; Fatigue failure mode and effect analysis; Corrosion and materials mechanics; Role of materials’ mechanics in mechanical design; Micromechanics of materials; Fracture mechanics; Numerical methods and simulation of materials mechanics; Essential software; Applications on machinery and structures; Recent topics.

References:
1. Russell C. Hibbeler, " Mechanics of Materials", 10th Edition, Pearson, 2016.
2. Barry J. Goodno and James M. Gere, " Mechanics of Materials", 9th Edition, Cengage Learning, 2017.
3. Ferdinand Beer, E. Johnston, John DeWolf and David Mazurek, " Mechanics of Materials", 8th Edition, McGraw-Hill Education, 2019.

| **Course title** | Selected Topics in Mechatronics Engineering | | | | **Course Code** | MTE 645 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | **Lectures** | | **Credit hours** | 3 |
| | — | — | 2 | | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

Contents

Selected Topics in Mechatronics Engineering either in Mechanical or Electrical engineering tracks

References:
Selected scientific papers or book chapters depending on the subjects

## Level (700)

| **Course title** | **Optimal Control** | | | | **Course Code** | CSE 711 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | **Lectures** | | **Credit hours** | 3 |
| | — | — | 2 | | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Review of State Variable Representation of Systems - The Theory of optimal control -The Performance Measure- Calculus of Variations - Functional Involving Single Functions and Several Functions - Necessary Conditions for Optimal Control - Linear Regulator Problem-Continuous and Discrete - Pontryagin's Minimum Principle - Minimum Time Problem - Minimum Control Effort Problem - Dynamic programming - The Optimal Control Law - Computational Procedure for Solving Control Problems - Hamilton-Jacobi-Bellman Equations - Numerical Determination of Optimal Trajectories - Two Point Boundary Value Problems - Method of Steepest Descent - Model predictive control. LQR/LQG stochastic optimization- $H_\infty$ and robust control.

**References:**
1. Donald E. Kirk , "Optimal Control Theory-An Introduction", 1st Edition, Dover Publications, 2004.
2. Daniel Liberzon, " Calculus of Variations and Optimal Control Theory: A Concise Introduction", Princeton University Press, 2012.
3. Dimitri Bertsekas, " Dynamic Programming and Optimal Control", 4th Edition, Athena Scientific, 2017.

| **Course title** | **Mobile Robots and Vision Systems** | | | | **Course Code** | CSE 712 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 3 |
| | — | — | | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Topics in image understanding such as image representation, feature extraction, segmentation, optical flow, and structure from motion – Using the image information to control a robot – Robot control topics such as forward and inverse kinematics, camera calibration (to determine the relative position and orientation of the robot itself), visual servoing, and target tracking – Examples involving image processing, information extraction, and vision based control of mobile robots and manipulators.

**References**:

Corke, P., *“Robotics, vision and control: fundamental algorithms in MATLAB®,” 2nd edition,* Springer, 2017.

| **Course title** | **Smart Sensors and Actuators** | | | | **Course Code** | CSE 713 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 3 |
| | — | — | | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Silicon- and CMOS-based sensors and actuators – Basics of solid state physics, operating principles, embodiment and characteristics – Suitable design approaches for integrated circuits for readout and operation of such sensors and actuators – Integrated temperature sensors – PTAT- (proportional to absolute temperature-) circuits – Accuracy-limiting artifacts and their compensation – Electrothermal filters – Photodiodes and photodiode arrays for CMOS cameras – CCDs – Active pixels and their operating principles – CMOS imaging – Accelerometers and gyroscopes – MEMS technology – Digital mirror arrays – DLP technology for projectors.

**References**:

1. Gerard Meijer, Kofi Makinwa and Michiel Pertijs, "Smart Sensor Systems: Emerging Technologies and Applications", 1st Edition, Wiley, 2014.
2. Bob Tucker, "Smart Actuators and Smart Sensors", NY Research Press, 2015.
3. Bob Tucker, "Handbook of Smart Actuators and Smart Sensors", NY Research Press, 2015.
4. Burak Kantarci and Sema Oktug, " Wireless Sensor and Actuator Networks for Smart Cities", Mdpi AG, 2018.

| **Course title** | **Learning Algorithms and Neural Networks** | | | | **Course Code** | CSE 714 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 3 |
| | — | — | | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Classical and new techniques of neural networks in supervised, unsupervised and reinforcement learning schemes – Single perceptron and neurons – Feed-forward neural networks – Kohonen's maps – Associative memories – Hopfield's and many other recurrent networks – Primary and advanced examples in engineering applications.

**References**:

1. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", 1st Edition, Springer, 2018.
2. Martin T Hagan, "Neural Network Design", 2nd Edition, Martin Hagan, 2014.
3. Andriy Burkov, "The Hundred-Page Machine Learning Book", Andriy Burkov, 2019.

<table>
<tr><td>Course title</td><td colspan="4">Autonomous Mobile Robotics</td><td>Course Code</td><td>CSE 715</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td colspan="2">Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>—</td><td colspan="2">—</td><td>2</td></tr>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

**Contents**

Fundamentals of autonomous mobile robotics – Sensor modeling, vehicle state estimation using Bayes filters, Kalman filters, and Particle filters, and simultaneous localization and mapping – Vehicle motion modeling and control, reactive, graph based and optimal motion planning – Examples of recent autonomous mobile robotics.

**References:**

Nehmzow, U., "*Mobile robotics: a practical introduction,*" Springer Science & Business Media, 2012.

<table>
<tr><td>Course title</td><td colspan="4">Surface Modeling and Machining</td><td>Course Code</td><td>PDE 721</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td colspan="2">Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>—</td><td colspan="2">—</td><td>2</td></tr>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

**Contents**

Principles of the mathematical representation of surfaces in ways that are suitable for computers – Bezier, B-spline and NURBS representations for the surface properties, like curvature, shortest-distance algorithms, ray-intersection, surface sub-division, knot insertion, and degree elevation – Application of computer representations to computer-controlled machining processes – Three-, four- and five-axis methods, anti-gouging methods, and anti-interference checking and optimization theory.

**References:**

1. Davim, J.P. ed., "Surface integrity in machining," Springer, 2010.
2. Choi, B.K., Jerard, R.B., "Sculptured surface machining: theory and applications," Springer Science & Business Media, 2012.

<table>
<tr><td>Course title</td><td colspan="4">Advance Micro-Electromechanical Systems</td><td>Course Code</td><td>PDE 722</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td colspan="2">Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>—</td><td colspan="2">—</td><td>2</td></tr>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

**Contents**

MEMS Initial design considerations – Mechanical design, including using the finite element method – Computer-aided design in MEMS and Microsystems – MEMS assembly, packaging, and testing – Design of Passive Micromachined Mechanical Structures – Design of Sensors and Analysis Systems: case study (Pressure Sensors- Acceleration Sensors - Angular Rate Sensors and Gyroscopes - Micromachined Valves and Micropumps).

**References:**

Zhang, D., Wei, B. eds., "*Advanced mechatronics and MEMS devices II,*" Springer, 2016.

| **Course title** | **Advanced Robotics** | | | | **Course Code** | PDE 723 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 3 |
| | — | — | | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Screw Theory – Static force and compliance – Robot dynamics redundancy – Trajectory planning – Robot control – Robot sensing – Sensing systems for grippers including tactile and force sensing – Environmental perception applying sensors and computer vision.

**References:**

Siciliano, B., Khatib, O. eds., "Springer handbook of robotics," Springer, 2016.

| **Course title** | **Nonlinear Control Systems** | | | | **Course Code** | CSE 716 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 3 |
| | — | — | | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Mathematical models of nonlinear systems, differences between the behavior of linear and nonlinear systems – Equilibrium points, limit cycles and general invariant sets – Phase plane analysis, Lyapunov stability, Input-to-state stability, Input-Output stability, Passivity analysis the Describing Function Method – Nonlinear control design, including Lyapunov-based control, Energy-based control, Cascaded control, Passivity-based control, Input-Output linearization, Variable structure control systems and sliding mode control – Case studies with Matlab and LabView.

**References:**

1. Khalil, H.K., "*Nonlinear control,*" Pearson Higher Ed., 2015.
2. Boufadene, M., "*Nonlinear Control Systems Using MATLAB®,*" CRC Press, 2018.

| **Course title** | **Fault Analysis and Control** | | | | **Course Code** | CSE 717 |
|---|---|---|---|---|---|---|
| **Teaching hours** | **Practical** | **Tutorial** | | **Lectures** | **Credit hours** | 3 |
| | — | — | | 2 | | |
| **Course grades** | **Final Exam** | **S. work** | **Practical** | **Oral** | **Total grads** | 100 |
| | 50 | 50 | — | — | | |

**Contents**

Introduction; Essential dynamics and reliability methods for fault modeling and analysis; Faults of mechanical systems; Systems and techniques of maintenance; Systems for fault detection, diagnosis, and prognosis; Fault diagnosis of dynamic and nonlinear systems; Fault-Tolerant (linear/nonlinear) control systems; Fault estimation of stochastic systems; Fault diagnosis using Bayesian networks; Robust fault estimation; Fault isolation; Sensors and sensing strategies; Signal processing; Using database management systems in fault analysis; Intelligent Interfaces; Fault diagnosis and prognosis performance metrics; System logistics for performing maintenance operations; Essential hardware and software; Applications to machine tools, robotic, and autonomous systems; Recent topics.

**References:**

1. Mogens Blanke, Michel Kinnaert, Jan Lunze and Marcel Staroswiecki, "Diagnosis and Fault-Tolerant Control", 3rd Edition, Springer, 2015.
2. Nasser Tleis, "Power Systems Modelling and Fault Analysis: Theory and Practice", 2nd Edition, Academic Press, 2019.

<table>
<tr><td>Course title</td><td colspan="3">Additive Manufacturing</td><td>Course Code</td><td>PDE 723</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td>Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>—</td><td>—</td><td>2</td></tr>
</table>

<table>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

**Contents**

Introduction; Principles and evolution of additive manufacturing technology; Powder Metallurgy; Materials for additive manufacturing; Categories of additive manufacturing; Systems of additive manufacturing; Additive manufacturing process chain; Photopolymerization processes; Powder bed fusion processes; Extrusion-based systems; Printing processes; Sheet lamination processes; Direct write technology; Design for additive manufacturing; Process selection; Essential software; Applications; Case studies; Recent topics..

**References**:


1. Ian Gibson, David Rosen and Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.
2. Olaf Diegel, Axel Nordin and Damien Motte, "A Practical Guide to Design for Additive Manufacturing (Springer Series in Advanced Manufacturing)", 1st Edition, Springer, 2019.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 2nd Edition, CRC Press, 2019.


<table>
<tr><td>Course title</td><td colspan="3">Advanced Topics in Mechatronics Engineering</td><td>Course Code</td><td>MTE 741</td></tr>
<tr><td rowspan="2">Teaching hours</td><td>Practical</td><td>Tutorial</td><td>Lectures</td><td rowspan="2">Credit hours</td><td rowspan="2">3</td></tr>
<tr><td>—</td><td>—</td><td>2</td></tr>
</table>

<table>
<tr><td rowspan="2">Course grades</td><td>Final Exam</td><td>S. work</td><td>Practical</td><td>Oral</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>50</td><td>50</td><td>—</td><td>—</td></tr>
</table>

Contents

Advanced Topics in Mechatronics Engineering either in Mechanical or Electrical engineering tracks

References:

Selected scientific papers or book chapters depending on the subjects

## 14.7 Master of Science M.Sc. in Environmental Engineering, Management and Technology

## 14.8 Engineering science Ph.D. in Environmental Engineering, Management and Technology

# Higher Education in

# Environmental Engineering, management and Technology (ENV)

## Introduction

Without a doubt, we are living in interesting times, characterized by both continuous economic development and improved standard of living, but also uncertainty, increased pollution, and environmental degradation, which means that, now, more than ever, global and consistent action is needed in order to create a more sustainable future.

Environmental engineering education at universities is a rapidly changing field globally. Traditionally it has resided in the Civil Engineering Program addressing water and wastewater quality, treatment, design and regulatory issues.  In recent years Environmental Engineering has become a much broader field encompassing water, wastewater, soil pollution, air pollution, risk assessment, ecosystems, human health, toxicology, sustainable development, regulatory aspects and much more. At a time of significant global environment challenges and need for sustainable development, University education face a challenge to equip the graduates with theory, knowledge, and applications of sustainability.

The university education needs to be redesigned or reformulated to include these topics in engineering curriculum. Most universities and colleges have yet to address seriously the sustainability theories in curriculum. There is urgent need for graduates to acquire the knowledge and skills to provide innovative solutions to issues being faced. Engineering profession has a vital role to play in addressing the climate change and helping the society to sustainable development.
The Programs in Environmental Engineering management and Technology includes different study options:

- Industrial Environmental Engineering
- Sustainability
- Energy Systems
- Hydrology and Water Management
- Environmental management
- Solid waste management
- Air pollution control

## Master of Science M.Sc. in Environmental Engineering, Management and Technology

### Competencies for the program graduate

In addition to generic competencies for the M.Sc. in engineering, the graduate of Master of Science in Environmental Engineering, Management and Technology must be able to:

1. Be conversant with basic environmental legislation.
2. Prepare, review, and update environmental investigation reports.
3. Identify and value the effect of the pollutants on the environment: atmosphere, water and soil.
4. Analyze scientific data and do quality-control checks.
5. Design projects that lead to environmental protection, such as water reclamation facilities or air pollution control systems.

## Engineering science Ph.D. in Environmental Engineering, Management and Technology

### Competencies for the program graduate

In addition to generic competencies for the Ph. D. program, the graduate of Engineering science Ph.D. in Environmental Engineering, Management and Technology must be able to:

1. Analyze an industrial activity and identify the environmental problems.
2. Inspect industrial and municipal facilities and programs in order to ensure compliance with environmental regulations.
3. Plan strategies to control, reduce and monitor pollution.
4. Select the most appropriate technique to purify and/or control the emission of pollutants.
5. Advise corporations and government agencies about procedures for cleaning up contaminated sites.

**Table (1) List of level (500) Elective Courses**

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| BAS 511 | Numerical Analysis* | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 40 | 10 | 50 | 100 |
| ENV 511 | Introduction to Environmental Science* | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 40 | 10 | 50 | 100 |
| ENV 512 | Environmental Chemistry* | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 40 | 10 | 50 | 100 |
| ENV 513 | Environmental Economics and Legislation* | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 40 | 10 | 50 | 100 |
| ENV 514 | Applied Chemistry and Microbiology | 1 | 2 | 1 | 4 | 2 | 6 | 2 | 40 | 10 | 50 | 100 |
| ENV 515 | Environmental Measuring and Monitoring* | 1 | 0 | 1 | 2 | 1 | 6 | 2 | 40 | 10 | 50 | 100 |
| ENV 521 | Environmental impact assessment* | 1 | 1 | 0 | 2 | 1 | 4 | 2 | 50 | 0 | 50 | 100 |
| ENV 522 | Environmental Risk Assessment* | 1 | 1 | 0 | 2 | 1 | 4 | 2 | 50 | 0 | 50 | 100 |
| ENV 523 | Life Cycle Assessment | 1 | 1 | 0 | 2 | 1 | 4 | 2 | 50 | 0 | 50 | 100 |
| ENV 524 | Life Cycle Analysis | 1 | 1 | 0 | 2 | 1 | 4 | 2 | 50 | 0 | 50 | 100 |
| ENV 531 | Solid Wastes Management | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ENV 532 | Sludge Treatment | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ENV 533 | Clean production | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| PWE 511 | Water Pollution* | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| PWE 512 | Water Treatment | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| PWE 513 | Industrial Wastewater Treatment | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| MPE 511 | Atmospheric Physics* | 1 | 1 | 0 | 2 | 1 | 4 | 2 | 50 | 0 | 50 | 100 |

* **is a Core Courses**

## Table (2) List of level (600) Elective Courses

| Code | Course Title | Lectures | Tutorial | Practical | Contact Hours | Credit Hours | Student Workload | Wr. Exam Dur. | Semester Work | Practical/ Oral Exam | Written Exam | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BAS 612 | Numerical Analysis of Partial Differential Equations | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ENV 625 | Environmental Management systems* | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ENV 626 | Environmental Benchmarking * | 1 | 1 | 0 | 2 | 1 | 4 | 2 | 50 | 0 | 50 | 100 |
| ENV 634 | Hazard Wastes Management | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ENV 635 | Soil Remediation | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ENV 636 | Material Recovery | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ENV 637 | Selected Topics in Environmental Engineering I | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ENV 638 | Environmental Control Systems | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| PWE 614 | Advanced Water Treatment | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| PWE 615 | Water Quality Modeling | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| PWE 616 | Water Resources | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| PWE 617 | Wastewater reclamation and reuse | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| STE 611 | Green Pavement | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| STE 612 | Sustainable structures | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| MPE 612 | Air Pollution Control | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ELE 611 | Renewable energy and environment | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ELE 612 | Energy issues and environment | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ECE 611 | Geographical Information System | 1 | 2 | 0 | 3 | 2 | 6 | 3 | 50 | 0 | 50 | 100 |
| ECE 612 | Green Information and Communication Technologies | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |
| ARE 611 | Green architecture | 1 | 2 | 0 | 3 | 2 | 6 | 2 | 50 | 0 | 50 | 100 |

* **is a Core Courses**

## Table (3) List of level (700) Elective Courses

| Code | Course Title | Teaching Hours | | | | Credit Hours | Student Workload (SWL) | Wr. Exam Dur. | Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lectures | Tutorial | Practical | Contact Hours | | | | Semester Work | Practical/ Oral Exam | Written Exam | Total |
| ENV 739 | Selected Topics in Environmental Engineering II | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| PWE 718 | Water Treatment Technologies | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| PWE 719 | Wastewater Treatment Technologies | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ENV 713 | Atmospheric Dispersion Modeling | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ELE 713 | Renewable energy systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ELE 714 | Electrical power quality systems | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ECE 713 | Nano Electronics and Nano – Microfabrication | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ECE 714 | Computer Vision | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ECE 715 | Next Generation Networks | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ECE 716 | Information Theory | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| ARE 712 | Green buildings | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE 713 | Advanced Construction Materials | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |
| STE 714 | Sustainable Infrastructure & Building | 2 | 2 | 0 | 4 | 3 | 8 | 3 | 50 | 0 | 50 | 100 |

# Summary of Courses Specification

## Courses of Level 500

| Course Title | Numerical Analysis | | | | Course Code | BAS 511 |
|---|---|---|---|---|---|---|
| Contact Hrs | Lectures | | Tutorial | Practical | Credit Hrs | 3 |
| | 2 | | 2 | 0 | | |
| Course Grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Roots of nonlinear and transcendental equations, Solution of systems of linear algebraic equations (iterative and direct methods), Polynomial interpolation and curve fitting, cubic spline interpolation, Numerical differentiation, Numerical integration, multiple integrals, Numerical solution of ordinary differential equations, shooting method.

**References:**

- Walter Gautschi" Numerical Analysis" 2nd edition, Springer New York Dordrecht Heidelberg London, 2012

http://www.ikiu.ac.ir/public-files/profiles/items/090ad_1410599906.pdf

| Course Title | Introduction to Environmental Science | | | | Course Code | ENV 511 |
|---|---|---|---|---|---|---|
| Contact Hrs | Lectures | | Tutorial | Practical | Credit Hrs | 2 |
| | 1 | | 2 | 0 | | |
| Course Grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Ecosystems - Roles of species in ecosystems and how they interact - Environmental risks - Population Ecology- air pollution – water pollution – climate change.

**References:**

- Caralyn Zehnder, Kalina Manoylov, Samuel Mutiti, Christine Mutiti, Allison VandeVoort, Donna Bennett " Introduction to Environmental Science", 2nd Edition, University System of Georgia, 2018.

https://open.umn.edu/opentextbooks/textbooks/introduction-to-environmental-science-2nd-edition

| Course Title | Environmental Chemistry | | | | Course Code | ENV 512 |
|---|---|---|---|---|---|---|
| Contact Hrs | Lectures | | Tutorial | Practical | Credit Hrs | 2 |
| | 1 | | 2 | 0 | | |
| Course Grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Environmental Chemistry - chemical reaction kinetics - sources and structure of organic compounds - The chemistry of natural environmental processes - Effect of pollutant on the chemistry of the atmosphere.

**References:**

- Jorge G. Ibanez Margarita Hernandez-Esparza Carmen Doria-Serrano Arturo Fregoso-Infante Mono Mohan Singh " Environmental Chemistry", Springer International Publishing, 2017.
https://www.springer.com/gp/book/9783319509310

| **Course Title** | **Environmental Economics and Legislation** | | | | **Course Code** | ENV 513 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction: the environmental imbalance, the increasing concern about the problem causes and motives - The economic implications of the environmental problem: sustainable development, international trade, the environmental problem and the population problem (size and patterns of production and consumption) - Facing the environmental problem: using legal methods (internally, internationally), using economic methods (private property, licensing, taxation, other methods) – Evaluation of the effectiveness policies applied for environment protection.

**References:**

- Mathis, Klaus, Huber, Bruce R. " Environmental Law and Economics", Springer International Publishing, 2017.
https://www.springer.com/gp/book/9783319509310

| **Course Title** | **Applied Chemistry and Microbiology** | | | | **Course Code** | ENV 514 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 1 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 10 | 40 | 50 | | |

**Contents**

Introduction to Chemical Principles - Chlorine demand -Turbidity, coagulation and flocculation - Hardness and softening - Introduction to Microbiology - Bacterial Cells -Bacterial Respiration-Microbial Growth, Isolation and Culture -Waterborne pathogens and pathogen indicators - Bacterial Inactivation - Microbes in treatment processes.

**References:**

- Lester, J. N.; Birkett, J. W.; Sterritt, Robert M. " Microbiology and chemistry for environmental scientists and engineers", 2nd edition Amazon eBook, 1999.
https://rl.talis.com/3/surrey/lists/08F0D9D6-316E-AB01-5195-007B56C1F90E.html?lang=en

| **Course Title** | **Environmental Measuring and Monitoring** | | | | **Course Code** | ENV 515 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 1 |
| | 1 | | 0 | 1 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 10 | 40 | 50 | | |

**Contents**

Land and water investigation techniques - Investigation strategies -Formulation of monitoring programmes - Applied measurement techniques for dynamic and static processes - Flow measurements Field sampling techniques - Groundwater sampling and hydraulic field tests Physical properties of soil and water - Geophysical measurement techniques (a.o. electrical and electromagnetical measurements, seismic, ground penetrating radar, spectrometer) - Evaluation techniques - Statistical methods for time series and spatial analysis - Modelling of geophysical data - Evaluation of hydraulic tests.

**References:**

- Yuriy Posudin ” Methods of Measuring Environmental Parameters" John Wiley & Sons, Inc. All rights reserved, 2014.
https://onlinelibrary.wiley.com/doi/book/10.1002/9781118914236

| **Course Title** | **Water Pollution** | | | | **Course Code** | PWE 511 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Water Basics - water pollution and broader context - potential causes of water pollution from industrial, agricultural, domestic and mining discharges and from contaminated land and landfill - Pollution of the Aquatic Environment - The Effects of Pollutants on the Aquatic Environment - Principles of “self-purification” and “assimilative capacity“ of rivers.

**References:**

- Suresh T. Nesaratnam " Water pollution control, Wiley Online Library, 2014.
https://onlinelibrary.wiley.com/doi/book/10.1002/9781118863831

| **Course Title** | **Water Treatment** | | | | **Course Code** | PWE 512 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Characteristics of different water sources remove of water hardness, iron and manganese removal, ion exchange, different methods of desalination, chemical methods, adsorption, reverse osmosis, other technologies for water treatment.

**References:**

- Frank R. Spellman. " Hand Book of Water and Wastewater Treatment Plant Operations", 2nd edition, Lewis Publishers CRC Press LLC, 2003.
http://payesh.saba.org.ir/saba_content/media/image/2013/12/6069_orig.pdf

| **Course Title** | **Industrial wastewater treatment** | | | | **Course Code** | PWE 513 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Characteristics of industrial wastewater and steps required for treatment. Physical processes: screening, flash and the slow mixing filters, filtration, gaseous transfer including ventilation and scavenging, adsorption, membrane separation technology. Chemical treatment processes: coagulation, chemical precipitation, ion exchange. Advanced oxidation, anaerobic treatment.

**References:**

- Woodard & Curran " Industrial Waste Treatment Handbook", 2nd edition, Elsevier, 2005.
https://www.elsevier.com/books/industrial-waste-treatment-handbook/woodard-curran-inc/978-0-7506-7963-3

| **Course Title** | **Atmospheric Physics** | | | | **Course Code** | MPE 511 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 1 |
| | 1 | | 1 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction – Structure of the atmosphere – solar radiation and atmospheric interactions – Air circulation systems – Atmospheric stability – Atmospheric motion, Pollutants dispersion, adiabatic processes, Temperature gradient.

**References:**

- David G. Andrews "An Introduction to Atmospheric Physics", Cambridge University Press; 2nd Edition, 2010.
https://www.amazon.com/Introduction-Atmospheric-Physics-David-Andrews/dp/0521693187

| **Course Title** | **Solid Wastes Management** | | | | **Course Code** | ENV 531 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Sources and classification of solid waste, the negative effects of solid waste on the environment and public health, methods for collecting solid waste, final disposal methods, recycling and reuse of solid waste.

**References:**

- George Tchobanoglous, Frank Kreith "Handbook of Solid Waste Management", 2nd edition, McGraw-Hill Companies, Inc, 2002.
https://www.accessengineeringlibrary.com/content/book/9780071356237

<table>
<tr><td rowspan="1">Course Title</td><td colspan="4">Sludge treatment</td><td>Course Code</td><td>ENV 532</td></tr>
<tr><td rowspan="2">Contact Hrs</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">2</td></tr>
<tr><td colspan="2">1</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction – Estimating the quantities of sludge and its physical and chemical properties - - Sewage Treatment - Sludge Treatment and Disposal - Design collection and transition works of sludge, primary treatment processes: blending and thickening, aerobic and anaerobic sludge decomposition, stabilization, conditioning and sludge dewatering, drying operations, burning -Different uses of treated sludge.

**References:**

- Suresh T. Nesaratnam " Water pollution control", Wiley Online Library, 2014.
https://onlinelibrary.wiley.com/doi/book/10.1002/9781118863831

<table>
<tr><td>Course Title</td><td colspan="4">Clean production</td><td>Course Code</td><td>ENV 533</td></tr>
<tr><td rowspan="2">Contact Hrs</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">2</td></tr>
<tr><td colspan="2">1</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Basic Concepts of Cleaner Technologies -Formal Methods for Designing Clean Processes - Removing Obstacles in the Implementation of Cleaner Production - An Integrated Approach to Cleaner Production - Cleaner Production Case Studies - UNIDO Technical Assistance for Cleaner Production.

**References:**

- K. B. Misra " Clean Production", Springer Nature Switzerland AG., 2020.
https://link.springer.com/book/10.1007/978-3-642-79940-2

<table>
<tr><td>Course Title</td><td colspan="4">Environmental impact assessment</td><td>Course Code</td><td>ENV 521</td></tr>
<tr><td rowspan="2">Contact Hrs</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">1</td></tr>
<tr><td colspan="2">1</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Risk Theory and the Environmental Assessment Process - Assessing Long-Range Cumulative Impacts - The Impact of EIA on Decision making - Opportunities for the Social Sciences in Risk Analysis—An Engineer's Viewpoint - The Framing of Decisions and the Psychology of Choice - Psychological Perspectives on Technology as Societal Option, Source of Hazard and Generator of Environmental Impacts.

**References:**

- Covello, V.T., Mumpower, J.L., Stallen, P.J.M., Uppuluri, V.R.R. "Environmental Impact Assessment, Technology Assessment, and Risk Analysis", Springer-Verlag Berlin Heidelberg, 1985.
https://www.springer.com/gp/book/9783642706363

| Course Title | Environmental Risk Assessment | | | | Course Code | ENV 522 |
|---|---|---|---|---|---|---|
| Contact Hrs | Lectures | | Tutorial | Practical | Credit Hrs | 1 |
| | 1 | | 1 | 0 | | |
| Course Grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

An Introduction to Risk Assessment with a Nod to History - Perception, Planning, and Scoping, Problem Formulation, and Hazard Identifications - A Risk Analyst's Toolbox - Exposure Assessment - Hazard Characterization and Dose–Response Assessment - Risk Characterization.

**References:**

- Ted Simon " Environmental Risk Assessment: A Toxicological Approach", 2nd Edition, Taylor & Francis Group, 2019.
https://www.taylorfrancis.com/books/9780429286001

| Course Title | Life Cycle Assessment | | | | Course Code | ENV 523 |
|---|---|---|---|---|---|---|
| Contact Hrs | Lectures | | Tutorial | Practical | Credit Hrs | 1 |
| | 1 | | 1 | 0 | | |
| Course Grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Life cycle assessment: origins, principles and context - Basic Concept: the life cycle of products – Expected benefits from LCA – LCA methodology: goal and scope definition, inventory analysis, impact assessment, improvement assessment – The international standard ISO 14040 – Reliability of LCA: basic prerequisites.

**References:**

- Hauschild, Michael, Rosenbaum, Ralph K., Olsen, Stig" Life Cycle Assessment", Springer International Publishing, 2019.
https://www.springer.com/gp/book/9783319564746

| Course Title | Life Cycle Analysis | | | | Course Code | ENV 524 |
|---|---|---|---|---|---|---|
| Contact Hrs | Lectures | | Tutorial | Practical | Credit Hrs | 1 |
| | 1 | | 1 | 0 | | |
| Course Grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Measurement of environmental performance: basic definitions, incentives and benefits, measures and indicators – Environmental performance indicators: international standard ISO 14031, other international initiatives – Eco-efficiency: concept, driving forces and benefits, eco-efficiency indicators.

**References:**

- Hauschild, Michael, Rosenbaum, Ralph K., Olsen, Stig" Life Cycle Assessment", Springer International Publishing, 2019.
https://www.springer.com/gp/book/9783319564746

## Level 600

<table>
<tr><td rowspan="2">Course Title</td><td colspan="4" rowspan="2">Numerical Analysis of Partial Differential Equations</td><td rowspan="2">Course Code</td><td rowspan="2">BAS 612</td></tr>
<tr></tr>
<tr><td rowspan="2">Contact Hrs</td><td>Lectures</td><td colspan="2">Tutorial</td><td>Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">3</td></tr>
<tr><td>2</td><td colspan="2">2</td><td>0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
<tr><td colspan="7"><u>Contents</u><br>Classification of partial differential equations, Finite difference methods, Parabolic partial differential equations, hyperbolic partial differential equations, Partial differential elliptic equations, Finite element method.<br><br><u>References:</u><br>- Walter Gautschi" Numerical Analysis" 2nd edition, Springer New York Dordrecht Heidelberg London, 2012<br>http://www.ikiu.ac.ir/public-files/profiles/items/090ad_1410599906.pdf</td></tr>
</table>

<table>
<tr><td>Course Title</td><td colspan="4">Advanced water treatment</td><td>Course Code</td><td>PWE 614</td></tr>
<tr><td rowspan="2">Contact Hrs</td><td>Lectures</td><td colspan="2">Tutorial</td><td>Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">2</td></tr>
<tr><td>1</td><td colspan="2">2</td><td>0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
<tr><td colspan="7"><u>Contents</u><br>Nano- and Microcellulose Based Adsorption Materials in Water Treatment - Adsorption of Dyes on to Modified Titanium Dioxide- Novel Sorbents from Low-Cost Materials for Water Treatment - Hydrothermal Carbonization in the Synthesis of Sustainable Porous Carbon Materials - Hybrid Bio-Nanocomposites and their Application for the Removal of Rare Earth Elements.<br><u>References:</u><br>- Mika Sillanpaa " Advanced Water Treatment", 1st edition, Elsevier, 2020.<br>https://www.elsevier.com/books/advanced-water-treatment/sillanpaa/978-0-12-819216-0</td></tr>
</table>

<table>
<tr><td>Course Title</td><td colspan="4">Water Quality Modeling</td><td>Course Code</td><td>PWE 615</td></tr>
<tr><td rowspan="2">Contact Hrs</td><td>Lectures</td><td colspan="2">Tutorial</td><td>Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">2</td></tr>
<tr><td>1</td><td colspan="2">2</td><td>0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
<tr><td colspan="7"><u>Contents</u><br>Engineering and water quality, Reaction kinetics, Mass balance, steady state solution and response time, Particular solutions, Feed forward systems of reactors, Feedback systems of reactors, BOD modeling, DO modeling<br><u>References:</u><br>- Steven C. Chapra "Surface water Quality Modeling", Waveland Press, Inc, 1997.<br>https://www.researchgate.net/publication/48447645_Surface_Water-Quality_Modeling</td></tr>
</table>

| **Course Title** | Water Resources | | | | **Course Code** | PWE 616 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction: hydrological cycle, sustainable development and implications for water, river and coastal engineering, catchments management – Planning and management planning: its relationship with water pollution control, river and coastal engineering, fisheries and recreation and amenity, role of surface water and catchments management in water resources planning, yield of sources – Policy: overview of national water resources policy – Quality: the threats to the quality of water resources, the quantification of risk and measures taken to protect them.

**References:**

- A. K. Linsley aml J. B. Franzini " Water Resources Engineering ", McGraw-Hill, 1980.
https://kundoc.com/pdf-water-resources-engineering-.html

| **Course Title** | Wastewater reclamation and reuse | | | | **Course Code** | PWE 617 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Wastewater reclamation and reuse, public health and environmental issues in water reuse, risk assessment, water reclamation technologies, storage of reclaimed water, industrial water reuse, ground water recharge with reclaimed water, planned indirect and direct potable water reuse, reuse treated water for irrigation.

**References:**

-Donald R. Rowe, Isam M. Abdel-Magid, "Handbook of Wastewater reclamation and reuse", LEWIS, CRC press, Inc, 1995.
https://www.researchgate.net/publication/287205063_Handbook_of_Waste_Water_Reclamation_and_Reuse

| **Course Title** | Air Pollution Control | | | | **Course Code** | MPE 612 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The nature of air pollution – origin of air pollutants – Air quality standard – Emission standard – Stack height standard – Fuel standard – Information required prior to equipment design – Analyzing constituents of polluted air streams – Air pollution control programs and systems: pollution control by process change, pollution control by removal – purpose of control equipment – Specifying appropriate type of collection equipment – Factor affecting equipment specification – Cloth filter – Mechanical Collectors: cyclones, other mechanical collectors – Electrostatic precipitator – Wet Scrubber: venturi scrubber, other type of wet scrubbers – Determination of requirements – Operating costs and procedures of industrial air pollutant.

**References:**

- C. David Cooper, F. C. Alley "Air Pollution Control: A Design Approach", Waveland Press, 2010.
https://books.google.com.eg/books/about/Air_Pollution_Control.html?id=pdpdDwAAQBAJ&redir_esc=y

| **Course Title** | Hazard Wastes Management | | | | **Course Code** | ENV 634 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Hazard wastes - Household Hazardous Wastes – other special wastes – organic and toxic wastes - waste-to-energy combustion - ash management and disposal -emission control

**References:**

- George Tchobanoglous, Frank Kreith "Handbook of Solid Waste Management", 2nd edition, McGraw-Hill Companies, Inc, 2002.
https://www.accessengineeringlibrary.com/content/book/9780071356237

| **Course Title** | Soil Remediation | | | | **Course Code** | ENV 635 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction- Current treatment technologies: physical/chemical processes, biological processes in each the treatment process involves both soil treatment systems and leachate/ wastewater treatment systems – Factors affecting biodegradation in soil and water systems: chemical and physical factors, soil/environmental factors - Optimization of bioremediation: variation of soil factors, biological enhancement, contaminates alteration – Monitoring bioremediation – Treatment Trains: limitations of soil treatment systems, remediation guidelines, examples of the use of treatment trains.

**References:**

- Helmut Meuser " Soil Remediation and Rehabilitation: Treatment of Contaminated and Disturbed Land", Springer International Publishing, 2020.
https://link.springer.com/book/10.1007/978-94-007-5751-6

| **Course Title** | Materials Recovery | | | | **Course Code** | ENV 636 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 2 |
| | 1 | 2 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Generalized treatment processes for solid separation — Applications to materials processing and handling — Recycling and resources recovery from: solid waste, mining wastes, construction materials and debris, scrap materials — Economic considerations — Relevant material properties and bulk material analysis— Process system and Flow sheets analysis — solid/solid, solid/liquid, solid/gas, separation processes, liberation, concentration, and auxiliary processes — Design of separation machines: types and intensities of force involved, scaling-up factors.

**References:**

- Ernst Worrell and Markus A. Reuter " Handbook of Recycling ", Elsevier, 2014.
https://www.elsevier.com/books/handbook-of-recycling/worrell/978-0-12-396459-5

| **Course Title** | Renewable energy and environment | | | | **Course Code** | ELE 611 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 2 |
| | 1 | 2 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Prospects of Renewable Energy Sources - Solar Photovoltaic Power Plants: Necessity and Techno-Economical Development - Development of HTS Cable-Based Transmission Systems for Renewable - Advanced Electrical Machines for Oceanic Wave Energy Conversion - Wind Energy System with Matrix Converter - Control of Renewable Energy Systems.

**References:**

- Islam, Md. Rabiul, Roy, Naruttam Kumar, Rahman " Renewable Energy and the Environment", Springer Singapore, 2018.
https://www.springer.com/gp/book/9789811072864

| **Course Title** | Energy issues and environment | | | | **Course Code** | ELE 612 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 2 |
| | 1 | 2 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Importance of Energy, Overview of energy resources, Basic energy problems -Conventional and unconventional reserves and resources - Electric industry overview - Environmental impacts of Electric industry - The evidence for and emerging impacts of climate change - Renewable energy resources: Biofuels - Wind Energy - Solar Energy - Other Renewable: Geothermal and Ocean Energy- Hydro and Nuclear Energy -Nuclear Waste -Domestic and International Energy Policies.

**References:**

- S.W. Yuan "Energy, Resources and Environment" 1st edition, Pergamon, 1987.
https://www.elsevier.com/books/energy-resources-and-environment/yuan/978-0-08-029396-7

| **Course Title** | Hazard Wastes Management | | | | **Course Code** | ENV 634 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to Hazard wastes - Household Hazardous Wastes – other special wastes – organic and toxic wastes - waste-to-energy combustion - ash management and disposal -emission control.

**References:**

- George Tchobanoglous, Frank Kreith "Handbook of Solid Waste Management", 2nd edition, McGraw-Hill Companies, Inc, 2002.
https://www.accessengineeringlibrary.com/content/book/9780071356237

| **Course Title** | **Soil Remediation** | | | | **Course Code** | ENV 635 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction- Current treatment technologies: physical/chemical processes, biological processes in each the treatment process involves both soil treatment systems and leachate/ wastewater treatment systems – Factors affecting biodegradation in soil and water systems: chemical and physical factors, soil/environmental factors - Optimization of bioremediation: variation of soil factors, biological enhancement, contaminates alteration – Monitoring bioremediation – Treatment Trains: limitations of soil treatment systems, remediation guidelines, examples of the use of treatment trains.

**References:**

- Helmut Meuser " Soil Remediation and Rehabilitation: Treatment of Contaminated and Disturbed Land", Springer International Publishing, 2020.
https://link.springer.com/book/10.1007/978-94-007-5751-6

| **Course Title** | **Environmental Management systems** | | | | **Course Code** | ENV 625 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 2 |
| | 1 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Background to Environmental Management systems (EMS) Evolution – Options for an ISO 14001 2004, EMAS, B 8850 2000 – Establishing the environmental Performance of virtual activity, process or service

Establishing environmental significance (including different assessment methodologies and risk assessments) – Writing the EMS target, objective, and policies – Documentation a virtual system e.g. procedures and instructive – Virtual system audits – Critically evaluating the role of EMS's.

**References:**

- Christopher Sheldon , Mark Yoxon " Environmental Management systems", Routledge; 3rd Edition, 2006.

https://www.amazon.com/Environmental-Management-Systems-Step-Step/dp/1844072576

| **Course Title** | Environmental Benchmarking | | | | **Course Code** | ENV 626 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 1 |
| | 1 | 1 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic Concepts – Incentives and benefits – Benchmarking categories – Benchmarking methodology (the cycle of Benchmarking).

**References:**

- Francisco Szekely " Environmental benchmarking: Becoming green and competitive", Stanley Thornes, 1996.

https://www.amazon.com/Environmental-Benchmarking-Business-Performance-Improvement/dp/0748718486

| **Course Title** | **Geographical Information System** | | | | **Course Code** | ECE 611 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 2 |
| | 1 | 2 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction to GIS: principles of GIS, survey of GIS software and hardware, Review of cartographic mapping principles – GIS Applications: a number of prototype applications will be used to explore the different applications of GIS. the examples will include the following and will be directly related to water, air or solid waste problems – Environmental impact assessment (EIA): municipal facilities management, transportation planning, water resources planning, demographic studies and assessment – GIS project management factors: justification, database designs, data conversion, staffing and costing.

**References:**

- O. Huisman, R.A. de By " Principles of Geographic Information Systems (GIS): an Introductory Textbook", ITC Educational Textbook Series, 2009.

http://freecomputerbooks.com/Principles-of-Geographic-Information-Systems.html

| **Course Title** | Selected Topics in Environmental Engineering 1 | | | | **Course Code** | ENV 637 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | | **Practical** | **Credit Hrs** | 2 |
| | 1 | 2 | | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Different topics on various fields in environmental engineering.

**References:**

-According to selected topics

| **Course Title** | Environmental control systems | | | | **Course Code** | ENV 638 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | | **Practical** | **Credit Hrs** | 2 |
| | 1 | 2 | | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Basic information relating to the environment and site analysis - Design concepts for practical use - The materials include current examples for review and study, as well as a wealth of tables and calculation aids for application of the theories studied - How to evaluate a site's characteristics with regard to the environment.

**References:**

- Fuller Moore " Environmental control systems: heating, cooling, lighting", McGraw-Hill in New York, 2nd edition, 1993.
https://www.amazon.com/Environmental-Control-Systems-Heating-Lighting/dp/0070428891

| **Course Title** | Green architecture | | | | **Course Code** | ARE 611 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | | **Practical** | **Credit Hrs** | 2 |
| | 1 | 2 | | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Introduction - Product Analysis and Materials Specification - Energy Insulation Materials – Masonry - Timber- Composite - Timber Preservatives-Window Frames.

**References:**

- Tom Woolley " Green Building Handbook ", Taylor & Francis e-Library, 2005.
https://www.academia.edu/6669761/Green_Building_Handbook_Volume_1

<table>
<tr><td rowspan="1">Course Title</td><td colspan="4">Green Pavement</td><td>Course Code</td><td>STE 611</td></tr>
<tr><td rowspan="2">Contact Hrs</td><td>Lectures</td><td>Tutorial</td><td colspan="2">Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">2</td></tr>
<tr><td>1</td><td>2</td><td colspan="2">0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

Introduction - design considerations common to all permeable pavements - porous asphalt and permeable friction course overlays - pervious concrete - permeable interlocking concrete pavement - grid pavement- alternative technologies – maintenance.

**References:**

- Bethany Eisenberg; Kelly Collins Lindow, P.E.; and David R. Smith "Permeable Pavements", American Society of Civil Engineers, 2015.
https://ascelibrary.org/doi/book/10.1061/9780784413784

<table>
<tr><td>Course Title</td><td colspan="4">Green Information and Communication Technologies</td><td>Course Code</td><td>ECE 612</td></tr>
<tr><td rowspan="2">Contact Hrs</td><td>Lectures</td><td>Tutorial</td><td colspan="2">Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">2</td></tr>
<tr><td>1</td><td>2</td><td colspan="2">0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
</table>

**Contents**

The concept of green Information and Communications Technologies (ICT) relevant to environmental sustainability and ICT could be explained in numerous ways. Although this field with the term of ICT in the title, many general topics relevant to sustainability which are not even related to ICT could be addressed. Green ICT is an interdisciplinary field relevant to a number of fields and topics, such as information systems, computer science and technologies, communications and networking, power and energy systems, environmental and civil engineering, industrial engineering, economics and finance, business and administration, social sciences, and so on. Basically, two directions may be addressed: greening ICT and ICT for green objectives. The concepts, principles, mechanisms, designs, algorithms, analyses, and relevant research challenges could be addressed in this course. The students taking this course may understand and use relevant topics, categories, issues, technologies and solutions on the environmental sustainability relevant to information and communication technologies (ICT) systems, analyze and evaluate the sustainability and green issues in ICT as well as approaches relevant to ICT systems, develop and compare some new green principles, strategies and approaches, and evaluate the roles of relevant advanced green ICT technologies and approaches.

**References:**

- Mohammad Dastbaz Colin Pattinson Babak Akhgar " Green Information Technology". 1st edition, Morgan Kaufmann, 2015.
https://www.elsevier.com/books/green-information-technology/dastbaz/978-0-12-801379-3

| Course Title | Sustainable structures | | | Course Code | STE 612 |
|---|---|---|---|---|---|
| Contact Hrs | Lectures | Tutorial | Practical | Credit Hrs | 2 |
| | 1 | 2 | 0 | | |

| Course Grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
|---|---|---|---|---|---|---|
| | 0 | 0 | 50 | 50 | | |

**Contents**

Types of structures, sustainable construction materials, energy consumption in buildings, environmental impact of construction materials, long-term performance of different construction materials, durable structures, green building concept, life cycles assessment of sustainable materials, economic study on sustainable construction, case studies, energy efficiency in buildings.

**References:**

- Dirk M. Kestner, P.E.; Jennifer Goupil, P.E.; and Emily Lorenz, "Sustainability Guidelines for the Structural Engineer", ASCE library, 2020.
https://ascelibrary.org/doi/book/10.1061/9780784411193

**Level 700**

| Course Title | Atmospheric Dispersion Modeling | | | Course Code | MPE 713 |
|---|---|---|---|---|---|
| Contact Hrs | Lectures | Tutorial | Practical | Credit Hrs | 3 |
| | 2 | 2 | 0 | | |

| Course Grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
|---|---|---|---|---|---|---|
| | 0 | 0 | 50 | 50 | | |

**Contents**

Air quality molding – Air Pollutants Diffusion – The general dispersion model – The box model – statistical model of turbulent dispersion – Instantaneous point emission – Calculation of the ground level concentration.

**References:**

- Alex De Visscher" Air Dispersion Modeling: Foundations and Applications", Wiley, 2013.
https://www.wiley.com/en-us/Air+Dispersion+Modeling%3A+Foundations+and+Applications-p-9781118078594

| Course Title | Renewable energy systems | | | Course Code | ELE 713 |
|---|---|---|---|---|---|
| Contact Hrs | Lectures | Tutorial | Practical | Credit Hrs | 3 |
| | 2 | 2 | 0 | | |

| Course Grades | Oral | Practical | S. work | Final Exam | Total grads | 100 |
|---|---|---|---|---|---|---|
| | 0 | 0 | 50 | 50 | | |

**Contents**

Renewable Energy: Advantages and Challenges - Grid-connected, standalone and hybrid renewable energy - Solar Energy: Photovoltaic (PV) Cells, Main components of PV power system, sizing Design of PV cell array and the factors influencing on it, Control and Regulation of PV cell voltage, Accumulators and Inverters for PV Systems - Wind Energy: Extraction of Power from Wind, Main components of wind energy conversion system, Types of wind turbines, Wind Turbine Aerodynamics, Characterizing Parameters of wind energy conversion system, Basic Control Aspects, Wind Data and Energy Estimation.

**References:**

- Henrik Lund " Renewable Energy Systems: A Smart Energy Systems Approach to the Choice and Modeling of 100% Renewable Solutions 2nd Edition, Academic Press, 2014.

https://www.amazon.com/Renewable-Energy-Systems-Approach-Solutions/dp/0124104231

| **Course Title** | Electrical power quality systems | | | | **Course Code** | ELE 714 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 3 |
| | 2 | 2 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Concepts of power system quality, causes of power quality problems, harmonics, voltage sag and swell, flicker, interruption, nonlinear loads and their effects on power system quality, standard values for power quality indices, monitoring power quality, different methods for power quality treatment.

**References:**

- Ewald Fuchs, Mohammad A. S. Masoum " Power Quality in Power Systems and Electrical Machines" Academic Press; 1st Edition, 2008.

https://www.amazon.com/Power-Quality-Systems-Electrical-Machines/dp/0123695368

| **Course Title** | Nano Electronics and Nano –Microfabrication | | | | **Course Code** | ECE 713 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 3 |
| | 2 | 2 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 10 | 0 | 40 | 50 | | |

**Contents**

Nano Electronics and Nano Microfabrication course is designed to encompass all these aspects, viz., nano and micro regime design, simulation and fabrication and all types of IC's, microfludics. It is expected that, after undergoing this course, the students will acquire both theoretical knowledge and practical skills in diverse upcoming areas of current technology and will be able to get into any one of these areas or be a bridge between these advanced areas to face the upcoming challenges and up-liftment of society.

**References:**

- WR Fahrner "Nano Terchnology and Nano Electronics – Materials, devices and measurement Techniques", Springer, 2005.

https://www.springer.com/gp/book/9783540224525

| **Course Title** | Computer Vision | | | | **Course Code** | ECE 714 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 3 |
| | 2 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

This course provides an introduction to computer vision including fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification and scene understanding. We'll develop basic methods for applications that include finding known models in images, depth recovery from stereo, camera calibration, image stabilization, automated alignment, tracking, boundary detection, and recognition. The focus of the course is to develop the intuitions and mathematics of the methods in lecture, and then to learn about the difference between theory and practice in the projects.

**References:**

- Kenneth Dawson-Howe "A Practical Introduction to Computer Vision with Open CV- Wiley-IS&T Series in Imaging Science and Technology" 1st Edition, Wiley, 2014.

https://www.amazon.com/Practical-Introduction-Computer-Imaging-Technology/dp/1118848454

| **Course Title** | Next Generation Networks | | | | **Course Code** | ECE 715 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 3 |
| | 3 | | 0 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Several forms of convergence are currently occurring within the telecommunications and IT industry, notably: IT and entertainment, fixed and mobile communications, and voice and data. This module examines the concepts, technology and architecture of next-generation networks (NGN). It also considers the drivers for moving to an NGN, namely: the convergence of services and the associated integration of networks, and in particular addresses the shift of telephony to Internet-based networks. In addition to examining voice over IP technology, we consider the requirements of an integrated IP-based network supporting a range of converged voice and data services.

**References:**

- Jingming Li Salina, Pascal Salina" Next Generation Networks: Perspectives and Potentials" 1st Edition, John Wiley and Sons, 2008.

https://www.amazon.com/Next-Generation-Networks-Perspectives-Potentials/dp/0470516496

| **Course Title** | Information Theory | | | | **Course Code** | ECE 716 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 3 |
| | 2 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Information theory is the study of the fundamental limits of information transmission and storage. The concepts of information theory extend far beyond communication theory, however, and have influenced diverse fields from physics to computer science to biology. This course, intended primarily for advanced undergraduates and beginning graduate students, offers a broad introduction to information theory and its applications: Entropy and information; lossless data compression; communication in the presence of noise, channel capacity, and channel coding; lossy compression and rate-distortion theory; Kolmogorov complexity.

**References:**

- Richard West, Lynn Turner "Introducing Communication Theory: Analysis and Application" 6th Edition, McGraw-Hill Education, 2017.

https://www.amazon.com/Introducing-Communication-Theory-Analysis-Application/dp/1259870324/ref=zg_bs_107197011_3?_encoding=UTF8&psc=1&refRID=0V0M8JR6HPRZAB01WRDT

| **Course Title** | Water Treatment Technologies | | | | **Course Code** | PWE 718 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | | **Tutorial** | **Practical** | **Credit Hrs** | 3 |
| | 2 | | 2 | 0 | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Drinking water sources: groundwater, surface water, rain water, Characteristics of surface water and underground water, calculation of design flow rates required, drinking water quality requirements and standards. Collection works, drinking water purification units include coagulation, flocculation, sedimentation, filtration and disinfection. Design of water treatment units and identify residuals treatment methods.

**References:**

- Xuan-Thanh Bui, Chart Chiemchaisri, Takahiro Fujioka, Sunita Varjani " Water and Wastewater Treatment Technologies ", Springer Nature Switzerland AG., 2020.
https://link.springer.com/book/10.1007/978-981-13-3259-3

| **Course Title** | Wastewater Treatment Technologies | | | | **Course Code** | PWE 719 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 3 |
| | 2 | 2 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

The characteristics and flow discharge of wastewater treated effluent quality requirements, wastewater treatment techniques. Preliminary and primary treatment (equalization, screen, grit removal, flotation), sedimentation, secondary treatment including mass-transfer fundamentals of biological treatment, chemical treatment, sludge quantities and methods of its treatment, removal of phosphorus and nitrogen.

**References:**

- Xuan-Thanh Bui, Chart Chiemchaisri, Takahiro Fujioka, Sunita Varjani "Water and Wastewater Treatment Technologies ", Springer Nature Switzerland AG., 2020.
https://link.springer.com/book/10.1007/978-981-13-3259-3

| **Course Title** | Green buildings | | | | **Course Code** | ARE 713 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 3 |
| | 2 | 2 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Standards and metrics for green buildings – energy efficient and sustainable buildings – passive house systems – green construction and technologies – eco cities – future of sustainable design – heating and cooling in buildings.

**References:**

- Abe Kruger, Carl Seville "Green Building: Principles and Practices in Residential Construction (Go Green with Renewable Energy Resources", 1st Edition, Cengage Learning, 2012.
https://www.amazon.com/Green-Building-Principles-Residential-Construction/dp/1111135959

| **Course Title** | Advanced Construction Materials | | | | **Course Code** | STE 713 |
|---|---|---|---|---|---|---|
| **Contact Hrs** | **Lectures** | **Tutorial** | **Practical** | | **Credit Hrs** | 3 |
| | 2 | 2 | 0 | | | |
| **Course Grades** | **Oral** | **Practical** | **S. work** | **Final Exam** | **Total grads** | 100 |
| | 0 | 0 | 50 | 50 | | |

**Contents**

Low-carbon construction materials – low-energy consumption construction materials – low-fresh water consumption materials – new fabrication technologies of construction materials – alternative low-cost building materials- recycled construction materials.

**References:**

- Tanjina Nur "Advanced Building Construction and Materials", Arcler Press LLC, 2017
https://www.amazon.com/Advanced-Building-Construction-Materials-Handbook/dp/1680943774

<table>
<tr><td>Course Title</td><td colspan="4">Sustainable Infrastructure & Building</td><td>Course Code</td><td>STE 714</td></tr>
<tr><td rowspan="2">Contact Hrs</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
<tr><td colspan="7"><u>Contents</u><br>Introduction, Guiding principles, Understanding the building physics and behavioural principles, Planning for in-use to end-of-life, Managing the process, Assessment methodologies, targets and reporting requirements.<br><u>References:</u><br>- Elisabeth Green, Tristram Hope and Alan Yates, " Sustainable Infrastructure: Sustainable Buildings", ICE Publishing, 2020.<br>https://www.icevirtuallibrary.com/isbn/9780727758064</td></tr>
</table>

<table>
<tr><td>Course Title</td><td colspan="4">Selected Topics in Environmental Engineering II</td><td>Course Code</td><td>ENV 739</td></tr>
<tr><td rowspan="2">Contact Hrs</td><td colspan="2">Lectures</td><td>Tutorial</td><td>Practical</td><td rowspan="2">Credit Hrs</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">2</td><td>2</td><td>0</td></tr>
<tr><td rowspan="2">Course Grades</td><td>Oral</td><td>Practical</td><td>S. work</td><td>Final Exam</td><td rowspan="2">Total grads</td><td rowspan="2">100</td></tr>
<tr><td>0</td><td>0</td><td>50</td><td>50</td></tr>
<tr><td colspan="7"><u>Contents</u><br>Different topics on various fields in environmental engineering.<br><u>References:</u><br>-According to selected topics</td></tr>
</table>

## 5- References


1. Environmental Engineering, SURREY University, UK.
   https://www.surrey.ac.uk/postgraduate/water-and-environmental-engineering-msc-2020#structure
2. Environmental Engineering, KTH University, Sweden.
   https://www.kth.se/en/studies/master/environmental-engineering-sustainable-infrastructure?gclid=EAIaIQobChMIgfG9uJy76wIVqujtCh2kAgMOEAMYASAAEgLS6vD_BwE
3. Environmental Engineering, Clarkson University, USA
   https://www.clarkson.edu/undergraduate/environmental-engineering#row-id-2
4. Environmental Engineering (MSc), Queen University Belfast, UK
   https://www.qub.ac.uk/courses/postgraduate-taught/environmental-engineering-msc/#course
5. Environmental Engineering , Nottingham University, UK
   https://www.nottingham.ac.uk/pgstudy/course/taught/environmental-engineering-msc