B.S. Abdur Rahman
Crescent
Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

Regulations 2017
Curriculum and Syllabi

(Amendments updated upto June 2020)

B.Tech.
(Polymer Engineering)

REGULATIONS 2017

CURRICULUM AND SYLLABI

(Amendments updated upto June 2020)

B.TECH.

POLYMER ENGINEERING

VISION AND MISSION OF THE INSTITUTION

VISION

B.S.Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio-Economic progress of the Country in a sustainable manner.

MISSION

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

DEPARTMENT OF POLYMER ENGINEERING

VISION AND MISSION

VISION

To offer quality education and training in Polymer Engineering through well structured curriculum and syllabi to produce engineers with sound technical knowledge and expertise to meet the needs of the society.

MISSION

- To impart knowledge and skill in the field of Polymer Science and Engineering through well designed programs
- To equip the students with necessary skills for the development of polymers and polymeric products using appropriate techniques and software
- To promote engineering spirit for the product development through effective integration of design engineering and material technology
- To undertake research in multi- disciplinary polymer science and engineering and related areas and to encourage enterprise, innovation, growth and development in the emerging areas of new technology
- To develop analytical skills, leadership quality and team spirit through balanced curriculum and a judicial mix of co-curricular, extra-curricular and professional society activities
- To disseminate knowledge through seminars, conferences and research publications for the benefit of society

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

B.Tech. (Polymer Engineering)

PROGRAMME EDUCATIONAL OBJECTIVES

- To impart basic knowledge in mathematics, science and engineering principles required for understanding the concepts in polymer science and technology
- To provide broad exposure to various societal, ecological, ethical and commercial issues.
- To provide knowledge in synthesis & characterization of materials and design & manufacture of polymer products
- To impart practical skills in design, development and processing of polymer compounds and products
- To equip with necessary knowledge in developing advanced materials for engineering applications
- To provide necessary managerial and soft skills to become an effective professional

PROGRAMME OUTCOMES

On successful completion of the programme, the graduates will

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, research literature, and analyses complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- Use research –based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
- 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.

- Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
- Synthesis polymers by using various techniques and characterize their physical properties.
- Select polymers, formulate them for specific applications and characterize the performance properties.
- Process plastics, rubbers and composites materials to various components and products.

REGULATIONS - 2017
B.TECH. DEGREE PROGRAMMES
(With Amendments incorporated up to June 2020)
(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS & NOMENCLATURE

In these Regulations, unless the context otherwise requires:

i) **"Programme"** means B.Tech. Degree Programme.

ii) **"Branch"** means specialization or discipline of B.Tech. Degree Programme like Civil Engineering, Mechanical Engineering, etc.,

iii) **"Course"** means theory / practical / laboratory integrated theory / mini project / seminar / internship / project and any other subject that is normally studied in a semester like Mathematics, Physics, Engineering Graphics, Fluid Mechanics, etc.,

iv) **"Institution"** means B.S. Abdur Rahman Crescent Institute of Science and Technology.

v) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of B.S. Abdur Rahman Crescent Institute of Science and Technology.

vi) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of B.S. Abdur Rahman Crescent Institute of Science and Technology.

vii) **"Controller of Examinations"** means the Controller of Examination of B.S. Abdur Rahman Crescent Institute of Science and Technology who is responsible for conduct of examinations and declaration of results.

2.0 ADMISSION

2.1a) Candidates for admission to the first semester of the eight - semester B.Tech. degree programme shall be required to have passed the Higher Secondary Examination of the (10+2) curriculum (Academic stream) prescribed by the appropriate authority or any other examination of any University or authority accepted by the Institution as equivalent thereto.

2.1b) Candidates for admission to the third semester of the eight-semester B.Tech. programme under lateral entry scheme shall be required to have passed the Diploma examination in Engineering / Technology of the Department of Technical Education, Government of Tamil Nadu or any other examination of any other authority accepted by the Institution as equivalent thereto.

2.2 Notwithstanding the qualifying examination the candidate might have passed, the candidate shall also write an entrance examination prescribed by the Institution for admission. The entrance examination shall test the proficiency of the candidate in Mathematics, Physics and Chemistry on the standards prescribed for Ten plus Two academic stream.

2.3 The eligibility criteria such as marks, number of attempts and physical fitness shall be as prescribed by the Institution from time to time.

3.0 BRANCHES OF STUDY

3.1 Regulations are applicable to the following B.Tech. Degree programmes in various branches of Engineering and Technology, each distributed over eight semesters with two semesters per academic year.

B.TECH. DEGREE PROGRAMMES:

1. Aeronautical Engineering
2. Automobile Engineering
3. Civil Engineering
4. Computer Science and Engineering
5. Electrical and Electronics Engineering
6. Electronics and Communication Engineering
7. Electronics and Instrumentation Engineering
8. Information Technology
9. Mechanical Engineering
10. Polymer Engineering
11. Biotechnology
12. Artificial Intelligence and Data Science
13. Computer Science and Engineering(Cyber Security)
14. Computer Science and Engineering(Internet of Things)

4.0 STRUCTURE OF THE PROGRAMME

4.1 Every Programme has a curriculum with syllabi consisting of theory and practical courses such as,

i) Basic Sciences (BS)
ii) Humanities & Social Sciences (HS)
iii) Management Sciences (MS)
iv) Engineering Sciences Fundamentals (ESF)
v) Engineering Core Courses (EC)
vi) Professional Electives (PE)
vii) General Electives (GE)
viii) Workshop practice, laboratory work, industrial training, seminar presentation, project work, etc.

4.2 Each course is normally assigned certain number of credits :

- one credit per lecture period per week
- one credit per tutorial period per week
- one credit for two to three periods and two credits for four periods of laboratory or practical sessions
- one credit for two periods of seminar / project work per week
- one credit for two weeks of industrial training or 80 hours per semester.

4.3 Each semester curriculum shall normally have a blend of lecture courses, laboratory courses, laboratory integrated theory courses, etc., of total number of credits not exceeding 26.

4.4 For the award of the degree, a student has to earn a minimum total credits specified in the curriculum of the respective programme of study.

4.5 The medium of instruction, examinations and project report shall be in English, except for courses in languages other than English.

5.0 DURATION OF THE PROGRAMME

5.1 A student is ordinarily expected to complete the B.Tech. programme in eight semesters (six semesters in the case of lateral entry scheme), but in any case not more than 14 continuous semesters reckoned from the date of first admission (12 semesters in the case of lateral entry student).

5.2 Each semester shall consist of a minimum of 90 working days.

5.3 Semester end examination shall normally follow within a week after the last working day of the semester.

6.0 CLASS ADVISOR AND FACULTY ADVISOR

6.1 CLASS ADVISOR

A faculty member shall be nominated by the HoD as Class Advisor for the class throughout the period of study except first year.

The Class Advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

However, for the first and second semester, the class advisors (First year class advisors) are nominated by the first year coordinator.

6.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling, the Head of the Department of the students shall attach a maximum of 20 students to a faculty member of the department who shall function as faculty advisor for the students throughout their period of study. Such faculty advisor shall guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

7.0 COURSE COMMITTEE

7.1 Each common theory course offered to more than one group of students shall have a "Course Committee" comprising all the teachers teaching the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The Course Committee shall meet as often as possible and ensure uniform evaluation of the tests and arrive at a common scheme of evaluation for the tests. Wherever it is feasible, the Course Committee may also prepare a common question paper for the test(s).

8.0 CLASS COMMITTEE

A class committee comprising faculty members handling the classes, student representatives and a senior faculty member not handling the courses as chairman is constituted branch wise and semester wise

8.1 The composition of class committees for first and second semester is as follows:

i) The first year coordinator shall be the chairman of the class committee
ii) Faculty members of all individual courses of first / second semester
iii) Six student representatives (male and female) of each class nominated by the first year coordinator
iv) The class advisor and faculty advisors of the class.

8.2 The composition of the class committee for each branch from 3rd to 8th semester is as follows:

i) One senior faculty member preferably not handling courses for the concerned semester appointed as chairman by the Head of the Department
ii) Faculty members of all courses of the semester
iii) Six student representatives (male and female) of each class nominated by the Head of the Department in consultation with the relevant faculty advisors
iv) All faculty advisors and the class advisors.
v) Head of the Department

8.3 The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

8.4 During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process, curriculum and syllabi, etc.

8.5 The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

9.0 REGISTRATION AND ENROLLMENT

9.1 The students of first semester shall register and enroll at the time of admission by paying the prescribed fees.

9.2 For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

10.0 COURSE CHANGE / WITHDRAWAL

10.1 CHANGE OF A COURSE

A student can change an enrolled course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

10.2 WITHDRAWAL FROM A COURSE

A student can withdraw from an enrolled course at any time before the first continuous assessment test for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

11.0 TEMPORARY BREAK OF STUDY FROM PROGRAMME

A student may be permitted by the Dean (Academic Affairs) to avail temporary break of study from the programme up to a maximum of two semesters for reasons of ill health or other valid grounds. A student can avail the break of study before the start of first continuous assessment test of the ongoing semester. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 5.1). If any student is debarred for want of attendance or suspended due to any act of indiscipline, it shall not be considered as break of study. A student who has availed break of study has to rejoin in the same semester only.

12.0 CREDIT LIMIT FOR ENROLLMENT & MOVEMENT TO HIGHER SEMESTER

12.1 A student can enroll for a maximum of 32 credits during a semester including Redo / Pre-do Courses.

12.2 The minimum earned credit required to move to the higher semester shall be

- Not less than 20 credits, to move to the 3rd semester
- Not less than 40 credits, (20 for lateral entry) to move to the 5th semester
- Not less than 60 credits, (40 for lateral entry) to move to the 7th semester

13.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

13.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessments	Course Coverage in Weeks	Duration	Weightage of Marks
Assessment 1	1 to 6	1.5 hours	25%
Assessment 2	7 to 12	1.5 hours	25%
Semester End Examination	Full course	3 hours	50%

13.2 Appearing for semester end theory examination for each course is mandatory and a student should secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

13.3 Every practical course shall have 60% weightage for continuous assessments and 40% for semester end examination. However a student should have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

13.4 For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component. Grading shall be done for this consolidated mark. Assessment of theory component shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical component shall be through continuous assessment.

13.5 The components of continuous assessment for theory / practical / laboratory integrated theory courses shall be finalized in the first class committee meeting.

13.6 In the case of Industrial training, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship completion certificate issued by the industry / research organisation. The weightage for Industry internship report shall be 60% and 40% for viva voce examination.

13.7 In the case of project work, a committee of faculty members constituted by the Head of the Department will carry out three periodic reviews. Based on the project report submitted by the student, an oral examination (viva voce) shall be conducted as semester end examination by an external examiner approved by Controller of Examinations. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the Viva Voce examination.

13.8 Assessment of seminars and comprehension shall be carried out by a committee of faculty members constituted by the Head of the Department.

13.9 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall be ignored.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end examination for theory component. There shall be no arrear or improvement examination for lab component.

14.0 SUBSTITUTE EXAMINATIONS

14.1 A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the Department / Dean of School for that purpose. However there is no substitute examination for semester end examination.

14.2 A student shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of assessment test. However the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

15.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

15.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% (for genuine reasons such as medical grounds or representing the in approved events etc.) to become eligible to appear for the semester end examination in that course, failing which the student shall be awarded "I" grade in that course. The cases in which the student is awarded "I" grade, shall register and repeat the course when it is offered next.

15.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in that course to the Class Advisor. The Class Advisor shall consolidate and furnish the list of students who have earned less that 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department/ Dean of School. Thereupon, the Dean (Academic Affairs) shall announce the names of such students prevented from writing the semester end examination in each course.

15.3 A student who has obtained 'I' grade in all the courses in a semester is not permitted to move to next higher semester. Such student shall repeat all the courses of the semester in the subsequent academic year.

15.4 A student should register to redo a core course wherein "I" or "W" grade is awarded. If the student is awarded, "I" or "W" grade in an elective course either the same elective course may be repeated or a new elective course may be taken with the approval of Head of the Department / Dean of School.

15.5 A student who is awarded "U" grade in a course shall have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to redo the course in the evening when the course is offered by the department. Marks scored in the continuous assessment during the redo classes shall be considered for grading along with the marks scored in the semester end (redo) examination. If any student obtained "U" grade in the redo course, the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of arrear examination.

15.6 If a student with "U" grade, who prefers to redo any particular course, fails to earn the minimum 75% attendance while doing that course, then he / she is not permitted to write the semester end examination and his / her earlier "U" grade and continuous assessment marks shall continue.

16.0 REDO COURSES

16.1 A student can register for a maximum of two redo courses per semester in the evening after regular college hours, if such courses are offered by the concerned department. Students may also opt to redo the courses offered during regular semesters.

16.2 The Head of the Department with the approval of Dean Academic Affairs may arrange for the conduct of a few courses during the evening, depending on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

16.3 The number of contact hours and the assessment procedure for any redo course shall be the same as those during regular semesters except that there is no provision for any substitute examination and withdrawal from an evening redo course.

17.0 PASSING AND DECLARATION OF RESULTS AND GRADE SHEET

17.1 All assessments of a course shall be made on absolute marks basis. However, the Class Committee without the student members shall meet within 5 days after the semester end examination and analyze the performance of students in all assessments of a course and award letter grades. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	0
I	0
AB	0

"W" denotes withdrawal from the course.

"I" denotes inadequate attendance and hence prevention from semester end examination

"U" denotes unsuccessful performance in the course.

"AB" denotes absence for the semester end examination.

17.2 A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be repeated by the student for improvement of grade.

17.3 The results, after awarding of grades, shall be signed by the Chairman of the Class Committee and Head of the Department / Dean of the School and it shall be declared by the Controller of Examinations.

17.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fee, through proper application to Controller of Examination. Subsequently the Head of the Department / Dean of School offered the course shall constitute a revaluation committee consisting of Chairman of the Class Committee as Convener, the faculty member of the course and a senior member of faculty knowledgeable in that course. The committee shall meet within a week to revalue the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

17.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from first semester onwards.

GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If Ci, is the number of credits assigned for the i^{th} course and GPi is the Grade Point in the i^{th} course

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n}C_i}$$

Where n = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

“I” and "W" grades are excluded for calculating GPA.

"U", “I”, "AB" and **"W"** grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks shall be as follows:

Percentage Equivalent of Marks = CGPA X 10

17.6 After successful completion of the programme, the Degree shall be awarded with the following classifications based on CGPA.

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the prescribed period of 8 semester for normal entry and 6 semesters for lateral entry
First Class	6.50 and above and completing the programme within a maximum of 10 semester for normal entry and 8 semesters for lateral entry
Second Class	Others

However, to be eligible for First Class with Distinction, a student should not have obtained ‘U’ or ‘I’ grade in any course during his/her study and should have completed the U.G. programme within a minimum period (except break of study). To be eligible for First Class, a student should have passed the examination in all the courses within the specified minimum number of semesters reckoned from his/her commencement of study. For this purpose, the authorized break of study is not counted. The students who do not satisfy the above two conditions shall be classified as second class. For the purpose of classification, the CGPA shall be rounded to two decimal places. For the purpose of comparison of performance of students and ranking, CGPA will be considered up to three decimal places.

18.0 ELECTIVE CHOICE:

18.1 Apart from the various elective courses listed in the curriculum for each branch of specialization, the student can choose a maximum of two electives from any other specialization under any department, during the entire period of study, with the approval of the Head of the parent department and the Head of the other department offering the course.

18.2 ONLINE / SELF STUDY COURSES

Students are permitted to undergo department approved online courses under SWAYAM up to 20% of credits of courses in a semester excluding project semester with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses ratified by the respective Board of Studies shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

19.0 SUPPLEMENTARY EXAMINATION

Students of final year can apply for supplementary examination for a maximum of three courses thus providing an opportunity to complete their degree programme. Likewise students with less credits can also apply for supplementary examination for a maximum of three courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both Odd and Even Semester.

20.0 PERSONALITY AND CHARACTER DEVELOPMENT

20.1 All students shall enroll, on admission, in any of the personality and character development programmes such as NCC, NSS, NSO, YRC, Rotaract, etc., and undergo related activities during the period of study.

21.0 DISCIPLINE

21.1 Every student is expected to observe disciplined and decorous behaviour both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

21.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the HOD / Dean shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action.

22.0 ELIGIBILITY FOR THE AWARD OF DEGREE

22.1 A student shall be declared to be eligible for the award of B.Tech. degree provided the student has:

i) successfully completed all the required courses specified in the programme curriculum and earned the number of credits prescribed for the specialization, within a maximum period of 14 semester (12 semesters for lateral entry) from the date of admission, including break of study

ii) no dues to the Institution, Library, Hostels, etc.

iii) no disciplinary action pending against him/her.

22.2 The award of the degree must have been approved by the Institution.

23.0 MINOR DEGREES OFFERED FOR STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2020- 21

23.1 The students admitted in the following B.Tech. Programmes from the academic year 2020 – 21 can graduate with a minor degree, which is optional, along with a major degree:

• Civil Engineering	• Mechanical Engineering
• Electronics and	• Electrical and Electronics

Communication Engineering	Engineering
• Automobile Engineering	• Aeronautical Engineering
• Polymer Engineering	• Biotechnology Engineering
• Electronics and Instrumentation Engineering	• Computer Science and Engineering
• Information Technology	• Artificial Intelligence and Data Science
• Computer Science and Engineering (IoT)	• Computer Science and Engineering (Cyber Security)

23.2 The eligibility for choosing the minor degree is given as below:

Sl. No.	Minor Degree (Optional)	Eligible Major Degree Programmes (from other Departments)
1.	Artificial Intelligence and Machine Learning	Mechanical Engineering Aeronautical Engineering Polymer Engineering Automobile Engineering Civil Engineering Biotechnology Electrical & Electronics Engg. Electronics & Instrumentation Engg.
2.	Block Chain	
3.	Cyber Security	
4.	Data Science	
5.	Internet of Things (IoT)	
6.	Virtual and Augmented Reality	Mechanical Engineering Aeronautical Engineering Polymer Engineering Automobile Engineering Civil Engineering Biotechnology Electrical & Electronics Engineering Electronics & Instrumentation Engg. Electronics & Communication Engg.
7.	Sensor Technology	Mechanical Engineering Aeronautical Engineering Polymer Engineering Automobile Engineering Civil Engineering Biotechnology Electrical & Electronics Engg.
8.	Robotics	Artificial Intelligence and Data Science Computer Science & Engg. (Cyber Security) Computer Science & Engineering (IoT) Computer Science & Engineering

		Information and Technology Civil Engineering Biotechnology Electrical & Electronics Engg. Electronics & Instrumentation Engg.
9.	3D Printing	Artificial Intelligence and Data Science Computer Science & Engg. (Cyber Security) Computer Science & Engineering (IoT) Computer Science & Engineering Information and Technology Biotechnology Electrical & Electronics Engg. Electronics & Instrumentation Engg. Electronics & Communication Engg.
10.	Electric Vehicles	Artificial Intelligence and Data Science Computer Science & Engg. (Cyber Security) Computer Science & Engineering (IoT) Computer Science & Engineering Information and Technology Civil Engineering Biotechnology Electronics & Communication Engg.
11.	Industrial Automation	Artificial Intelligence and Data Science Computer Science & Engg. (Cyber Security) Computer Science & Engineering (IoT) Computer Science & Engineering Information and Technology Mechanical Engineering Aeronautical Engineering Polymer Engineering Automobile Engineering Civil Engineering Biotechnology Electronics & Communication Engg.
12.	GIS and Remote Sensing	Artificial Intelligence and Data Science Computer Science & Engg. (Cyber Security) Computer Science & Engineering (IoT) Computer Science & Engineering

		Information and Technology Mechanical Engineering Aeronautical Engineering Polymer Engineering Automobile Engineering Biotechnology Electrical & Electronics Engg. Electronics & Instrumentation Engg. Electronics & Communication Engg.
13.	Computational Biology	Artificial Intelligence and Data Science Computer Science & Engg. (Cyber Security) Computer Science & Engineering (IoT) Computer Science & Engineering Information and Technology Mechanical Engineering Aeronautical Engineering Polymer Engineering Automobile Engineering Civil Engineering Electrical & Electronics Engg. Electronics & Instrumentation Engg. Electronics & Communication Engg.

23.3 A student shall earn an additional 18 to 20 credits for the award of minor degree.

23.4 A student shall be awarded a minor degree only when he / she completes the requirements for the award of major degree stipulated in the respective programme.

24.0 POWER TO MODIFY

Notwithstanding all that has been stated above, the Academic Council has the right to modify the above regulations from time to time.

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B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY

B.TECH. POLYMER ENGINEERING
CURRICULUM & SYLLABUS, REGULATIONS 2017

SEMESTER I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	BS	MAC 1181	Differential Calculus and Geometry	3	1	0	4	
2.	HS	ENC 1181/ ISC 1181/ LNC 1181/ LNC 1182 / LNC 1183	English / Arabic / Mandarin / German / Japanese	3	0	0	3	
3.	BS	PHC 1182	Physics I	3	0	2	4	
4.	BS	CHC 1181	Chemistry	3	0	2	4	
5.	ESF	GEC 1101	Engineering Graphics	2	0	2	3	
6.	ESF	GEC 1102	Engineering Design	2	0	0	2	
7.	ESF	GEC 1103	Basic Engineering Practices Laboratory	0	0	2	1	
8.	ESF	GEC 1104	Computer Programming I	1	0	2	2	**23**

SEMESTER II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	MAC 1281	Advanced Calculus	3	1	0	4
2.	BS	-	Physics Elective	2	0	2	3
3.	BS	-	Chemistry Elective	2	0	2	3
4.	ESF	GEC 1211	Basic Engineering Mechanics	3	1	0	4
5.	BS	GEC 1212	Environmental Studies	2	0	0	2
6.	ESF	GEC 1213	Computer Programming II	1	0	2	2
7.	EC	PEC 1211	Basic Mechanical Operations	2	0	0	2

8.	EC	PEC 1212	Principles of Chemical Engineering	3	0	0	3	
9.	EC	PEC 1213	Chemical Engineering Laboratory	0	0	3	1	**24**

SEMESTER III

Sl. No.	**Course Group**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	
1.	BS	MAC2181	Partial Differential Equations and Transforms	3	1	0	4	
2.	HS	-	Humanities Elective I	2	0	0	2	
3.	HS	ENC 2181	Oral Communication	0	0	2	1	
4.	EC	PEC 2101	Chemistry of Macromolecules	3	0	0	3	
5.	EC	PEC 2102	Physics of Macromolecules	3	0	0	3	
6.	EC	PEC 2103	Plastic Materials Technology	3	0	0	3	
7.	ESF	EEC 2181	Introduction to Electrical and Electronics Engineering	3	1	0	4	
8.	EC	PEC 2104	Polymer Synthesis Laboratory	0	0	3	1	
9.	ESF	EEC 2182	Electrical and Electronics Laboratory	0	0	3	1	
10.	EC	PEC 2105	Machining Practice Laboratory	0	0	3	1	**23**

SEMESTER IV

Sl. No.	**Course Group**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1.	BS	-	Mathematics Elective I	3	1	0	4
2.	HS	-	Humanities Elective II	2	0	0	2
3.	HS	ENC2282	Written Communication	0	0	2	1
4.	EC	PEC 2211	Polymer Rheology	3	0	0	3
5.	EC	PEC 2212	Science and Technology of Rubbers	3	0	0	3

6.	EC	PEC 2213	Plastics Compounding Technology	3	0	0	3	
7.	EC	PEC 2214	Polymer Analysis and Characterization	3	0	0	3	
8.	EC	-	Programme Elective –I	3	0	0	3	
9.	PE	PEC 2215	Polymer Characterization Laboratory	0	0	3	1	**23**

SEMESTER V

Sl. No.	**Course Group**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	
1.	MS	MSC 3181 MSC 3182	Leadership and CEO Training/ Social Entrepreneurship	3	0	0	3	
2.	GE	-	General Elective I	3	0	0	3	
3.	HS	ENC3181	Communication and soft skill I	0	0	2	1	
4.	EC	PEC 3101	Plastics Process Engineering	3	0	0	3	
5.	EC	PEC 3102	Strength of Materials	3	0	0	3	
6.	EC	PEC 3103	Plastic and Rubber Testing Technology	3	0	0	3	
7.	PE	-	Programme Elective – II	1	0	0	1	
8.	PE	-	Programme Elective – III	2	0	0	2	
9.	PE	-	Programme Elective – IV	3	0	0	3	
10.	EC	PEC 3104	Plastics Processing Laboratory	0	0	3	1	
11.	EC	PEC 3105	Rubber Processing Laboratory	0	0	3	1	**24**

SEMESTER VI

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	MS	MSC 3181 MSC 3182	Leadership and CEO Training / Social Entrepreneurship	3	0	0	3	
2.	BS	-	Mathematics Elective II	2	0	0	2	
3.	HS	ENC3281	Communication and soft skill II	0	0	2	1	
4.	EC	PEC 3211	Plastic and Rubber Product Design	3	1	0	4	
5.	EC	PEC 3212	Process Control and Instrumentation	3	0	0	3	
6.	EC	PEC 3213	Polymer Reaction Engineering	3	0	0	3	
7.	PE	-	Programme Elective – V	1	0	0	1	
8.	PE	-	Programme Elective – VI	2	0	0	2	
9.	PE	-	Programme Elective – VII	3	0	0	3	
10.	EC	PEC 3214	Plastic Product Design using CAD	0	0	3	1	
11.	EC	PEC 3215	Polymer Testing Laboratory	0	0	3	1	**24**

SEMESTER VII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	GE	-	General Elective II	3	0	0	3
2.	EC	PEC 4101	Mould and Die Design	3	1	0	4
3.	EC	PEC 4102	Polymer Composite Engineering	3	0	0	3
4.	EC	PEC 4103	Polymer Nanocomposites	3	0	0	3
5.	PE	-	Programme Elective –VIII	1	0	0	1
6.	PE	-	Programme Elective – IX	2	0	0	2
7.	PE	-	Programme Elective –X	3	0	0	3

8.	PE	-	Programme Elective –XI	3	0	0	3	
9.	EC	PEC 4104	Mould Design and Flow Simulation Laboratory	0	0	3	1	
10.	EC	PEC 4105	Internship				1*	**24**

SEMESTER VIII

Sl. No.	**Course Group**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	
1.	EC	PEC 4211	Project Work	0	0	24	12	**12**

Total credits – 177

* Industrial training will be undertaken during the Third-year summer vacation. The credit will be awarded in the 7th Semester.

PROGRAMME ELECTIVES
GROUP I
(Materials)

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	PECX 001	Thermoplastic Polyesters	1	0	0	1
2.	PE	PECX 002	Thermoplastic Elastomers	1	0	0	1
3.	PE	PECX 003	Electroactive Polymers	1	0	0	1
4.	PE	PECX 004	Heat Resistant Polymers	1	0	0	1
5.	PE	PECX 005	Biodegradable Plastics	2	0	0	2
6.	PE	PECX 006	Bioplastics Technology	2	0	0	2
7.	PE	PECX 007	Medical Polymers	2	0	0	2
8.	PE	PECX 008	Ionic Polymers	2	0	0	2
9.	PE	PECX 009	Nanotechnology	3	0	0	3
10.	PE	PECX 010	Nanomaterials Technology	3	0	0	3
11.	PE	PECX 011	Polymers for Electronics	1	0	0	1
12.	PE	PECX 012	Polymers for Energy Technology	2	0	0	2

GROUP II
(Process Engineering)

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	PECX 013	PVC Technology	1	0	0	1
2.	PE	PECX 014	Nylon Fiber Technology	1	0	0	1
3.	PE	PECX 015	Latex Technology	1	0	0	1
4.	PE	PECX 016	Thermoforming Process	1	0	0	1

5.	PE	PECX 017	Injection Moulding Technology	2	0	0	2
6.	PE	PECX 018	Extrusion Technology	2	0	0	2
7.	PE	PECX 019	Blow Moulding Technology	2	0	0	2
8.	PE	PECX 020	Post Processing Operations	2	0	0	1
9.	PE	PECX 021	Rubber Product Manufacturing Technology	3	0	0	3
10.	PE	PECX 022	Rubber Process Engineering	3	0	0	3
11.	PE	PECX 023	Tyre Manufacturing Technology	3	0	0	3
12.	PE	PECX 024	Plastics Recycling	2	0	0	2
13.	PE	PECX 025	Plastic Waste Management	1	0	0	1
14.	PE	PECX026	Rapid Prototyping - 3D Printing	2	0	0	2

GROUP III
(Product & Mould Design)

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	PECX 027	Computer Aided Modelling	2	0	0	2
2.	PE	PECX 028	Computer Aided Manufacturing	2	0	0	2
3.	PE	PECX 029	Design of Composite Structures	2	0	0	2
4.	PE	PECX 030	Industrial Hydraulics and Pneumatics	2	0	0	2
5.	PE	PECX 031	Failure Analysis of Polymers	2	0	0	2
6.	PE	PECX 032	Mould Manufacturing Techniques	2	0	0	2

GROUP IV

(Blends, Composites, Adhesives and Coatings)

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	PECX 033	Biocomposite Technology	2	0	0	2
2.	PE	PECX 034	Mechanics of Composites	2	0	0	2
3.	PE	PECX 035	Analysis of Composite Structures	2	0	0	2
4.	PE	PECX 036	Polymer Blends and Alloys	2	0	0	2
5.	PE	PECX 037	Basics of Paint Technology	1	0	0	1
6.	PE	PECX 038	Basics of Adhesives Technology	1	0	0	1
7.	PE	PECX 039	Surface Coating Technology	2	0	0	2
8.	PE	PECX 040	Plastic Packaging Technology	3	0	0	3

Physics Elective Courses

(To be offered in II Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	PHCX 01	Fundamentals of Engineering Materials	2	0	2	3
2.	PHCX 02	Heat and Thermodynamics	2	0	2	3
3.	PHCX 03	Introduction to Nanoscience and Technology	2	0	2	3
4.	PHCX 04	Lasers and their applications	2	0	2	3
5.	PHCX 05	Materials Science	2	0	2	3
6.	PHCX 06	Non-Destructive Testing	2	0	2	3
7.	PHCX 07	Properties of Matter and Acoustics	2	0	2	3

8.	PHCX 08	Properties of Matter and Nondestructive Testing	2	0	2	3
9.	PHCX 09	Semiconductor Physics and Optoelectronics	2	0	2	3

Chemistry Elective Courses
(To be offered in II Semester)

Sl. No.	Course code	Name of the Courses	L	T	P	C
1.	CHCX 01	Analytical instrumentation	2	0	2	3
2.	CHCX 02	Corrosion and its control	2	0	2	3
3.	CHCX 03	Electrical materials and batteries	2	0	2	3
4.	CHCX 04	Engineering materials	2	0	2	3
5.	CHCX 05	Fuels and combustion	2	0	2	3
6.	CHCX 06	Fundamentals of physical chemistry	2	0	2	3
7.	CHCX 07	Green technology	2	0	2	3
8.	CHCX 08	Organic chemistry of biomolecules	2	0	2	3
9.	CHCX 09	Polymer science and technology	2	0	2	3

Maths Elective Courses
(To be offered in IV Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MACX 01	Discrete Mathematics And Graph Theory	3	1	0	4
2.	MACX 02	Probability And Statistics	3	1	0	4
3.	MACX 03	Random Processes	3	1	0	4
4.	MACX 04	Applied Numerical Methods	3	1	0	4

Maths Elective Courses
(To be offered in VI Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MACX 05	Mathematical Programming	2	0	0	2
2.	MACX 06	Statistical Methods for Data Analysis	2	0	0	2
3.	MACX 07	Numerical Methods for Integral and Differential Equations	2	0	0	2
4.	MACX 08	Mathematical Modelling	2	0	0	2
5.	MACX 09	Graph Theory	2	0	0	2

Humanities Elective I
(To be offered in III Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	SSCX 01	Fundamentals of Economics	2	0	0	2
2.	SSCX 02	Principles of Sociology	2	0	0	2
3.	SSCX 03	Sociology of Indian Society	2	0	0	2

Humanities Elective II
(To be offered in IV Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	SSCX 04	Economics of Sustainable Development	2	0	0	2
2.	SSCX 05	Industrial Sociology	2	0	0	2
3.	SSCX 06	Law for Engineers	2	0	0	2

General Elective
Group I Courses
(To be offered in V semester)

Sl. No.	Course Code	Course Title	Offering Department
1.	GECX 101	Disaster Management	Civil
2.	GECX 102	Total Quality Management	Mechanical
3.	GECX 103	Energy Studies	Mechanical
4.	GECX 104	Robotics	Mechanical
5.	GECX 105	Transport Management	Automobile
6.	GECX 106	Control Systems	EEE
7.	GECX 107	Introduction to VLSI Design	ECE
8.	GECX 108	Plant Engineering	EIE
9.	GECX 109	Network Security	CSE
10.	GECX 110	Knowledge management	CSE
11.	GECX 111	Cyber security	IT
12.	GECX 112	Genetic Engineering	LS
13.	GECX 113	Fundamentals of Project Management	CBS
14.	GECX 114	Operations Research	Mathematics
15.	GECX 115	Nano Technology	Physics / Chemistry
16.	GECX 116	Vehicle Maintenance	Automobile
17.	GECX 117	Fundamentals of Digital Image Processing	ECE

Group II Courses
(To be offered in VII semester)

Sl. No.	Course Code	Course Title	Offering Department
1.	GECX 201	Green Design and Sustainability	Civil
2.	GECX 202	Appropriate Technology	Civil / Mechanical
3.	GECX 203	Engineering System Modelling and Simulation	Mechanical
4.	GECX 204	Value Analysis and Engineering	Mechanical
5.	GECX 205	Industrial Safety	Mechanical
6.	GECX 206	Advanced Optimization Techniques	Mechanical
7.	GECX 207	Mat Lab Simulation	EEE
8.	GECX 208	Embedded Systems and its Applications	ECE
9.	GECX 209	Usability Engineering	CSE
10.	GECX 210	Supply Chain Management	CBS
11.	GECX 211	System Analysis and Design	CA
12.	GECX 212	Advanced Materials	Physics & Chemistry
13.	GECX 213	National Service Scheme	School of Humanities
14.	GECX 214	Automotive Pollution and Control	Automobile
15.	GECX 215	Motor Vehicle Act, Insurance and Policy	Automobile
16.	GECX 216	Principles of Communication Systems	ECE
17.	GECX 217	Lean Management	Civil

Sl. No.	Course Code	Course Title	Offering Department
18.	GECX 218	Spatial Data Modeling & Analysis	Civil
19.	GECX 219	Advanced Entreprenuership	MBA
20.	GECX 220	Electric Vehicles	EEE
21.	GECX 221	Artificial Intelligence and Evolutionary Computing using Matlab	EEE

SEMESTER I

MAC 1181	**DIFFERENTIAL CALCULUS AND GEOMETRY**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

The aims of this course are to

Introduce eigen values and eigenvectors of matrix algebra.

Make the student knowledgeable in the area of Three Dimensional Analytical Geometry.

Demonstrate the application of Differential Calculus.

Familiarize the student with the functions of several variables.

Develop the use of ODE solvable techniques necessary for engineering applications.

Motivate the students with some basic engineering application problems in ODE.

MODULE I MATRICES 8+2

Characteristic Equation- Eigenvalues and Eigenvectors of a real matrix –Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton Theorem (without proof) – Orthogonal matrices – orthogonal transformations of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

MODULE II THREE DIMENSIONAL ANALYTICAL GEOMETRY 7+3

Direction cosines and ratios – angle between two lines – equations of a plane – equations of a straight line, coplanar lines - shortest distance between skew lines - sphere – tangent plane – plane section of a sphere – orthogonal spheres.

MODULE III DIFFERENTIAL GEOMETRY 7+3

Curvature – Cartesian and polar coordinates – centre and radius of curvature – circle of curvature – involutes and evolutes – envelopes.

MODULE IV DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES 8+2

Functions of two variables – partial derivatives – total differential – Implicit Functions – Jacobian - Taylor's series expansion – Optima of two variables – Lagrange's multiplier method.

MODULE V ORDINARY DIFFERENTIAL EQUATIONS 8+2

Linear equations of second order with constant and variable coefficients – Simultaneous first order linear equations with constant coefficients – homogeneous equations of Euler's type – method of undetermined coefficients, method of variation of parameters

MODULE VI APPLICATIONS OF ORDINARY DIFFERENTIAL EQUATIONS 7+3

Solution of Ordinary Differential Equation Related to Electric Circuits – Bending of Beams- Motion of a Particle in a resisting medium – Simple harmonic motion.

L – 45; T – 15; Total Hours –60

TEXT BOOKS:

1. Ramana, B.V, "Higher Engineering Mathematics" Tata McGraw Hill Publishing Co. New Delhi, 2006.
2. Grewal B.S., "Higher Engineering Mathematics" (43^{rd} edition), Khanna Publishers, New Delhi, 2012.
3. John W. Cell "Engineering Problems Illustrating Mathematics" Mc Graw Hill Publishing Co., New York 1943.

REFERENCES:

1. Veerarajan.T., "Engineering Mathematics" (5th edition) Tata Mc Graw Hill Publishing Co. New Delhi, 2012
2. Kreyszig, E., "Advanced Engineering Mathematics", 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2001.
3. Peter V. O'Neil, "Advanced Engineering Mathematics", 7th edition, Cengage Learning, 2011.
4. Dennis G. Zill, Warren S. Wright, "Advanced Engineering Mathematics", 4th edition, Jones and Bartlett publishers, Sudbury, 2011.
5. Alan Jeffrey, "Advanced Engineering Mathematics", Academic Press, USA, 2002.
6. Venkataraman, M.K., "Engineering Mathematics", Volume I, 2nd edition, National Publishing Co., Chennai, 2003.
7. James Stewart ".Calculus" (7th edition),Brooks/Cole cengage learning,UK

OUTCOMES:

After completing the course, student will be able to

- Understand the matrix techniques and compute eigen values and eigenvectors of a given matrix.
- Do the problems based on three dimensional analytic geometry.
- Apply differential calculus in engineering problems.
- Differentiate more than one variable and their applications.
- Solve the differential equations with constant coefficient and variable coefficient.
- Form and solve differential equations.

ENC 1181	ENGLISH	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To train students to use appropriate vocabulary in academic and technical contexts.
- To facilitate students to speak effectively while exchanging ideas and making presentations.
- To develop students' listening skill for comprehending and analyzing information.
- To develop their reading skill through sub skills like skimming, scanning and critical reading of a text.
- To sharpen their academic writing skills.
- To expose them to the correct usage of language and help them to apply that knowledge appropriately.

MODULE I **8**

L: Listening for general information

S : Self Introduction, Introducing one another.

R: Predicting the content

W: Paragraph Writing

Language Focus: Affixes, Simple Present tense , Connective & Prepositions.

MODULE II **8**

L: Listening for specific information (from dialogues)

S:Exchanging opinion.

R: Skimming technical Passages

W: Argumentative Writing (using the concept of Flipped Learning), Letter to the Editor.

Language Focus: Idioms, use of Modals, Simple Past tense & use of "Wh" and question tags.

MODULE III **7**

L: Learning the ways of describing images and presenting specific information (focusing on note making)

S: Making Presentations using visuals.

R : Scanning short texts for gist of information

W: Letter of Invitation, Expository Writing

Language Focus: Homophones, Homographs, Simple Future & Collocations.

MODULE IV **7**

L: Understanding prepared presentation techniques through videos

S: Short Presentations.

R: Reading for coherence and cohesion

W: Letter seeking permission for Industrial Visit

Language Focus: S-V agreement, Euphemism

MODULE V **8**

L : Understanding Non- Verbal Communications while listening to narration of incidents.

S: Narrating an expereince

R: Inferential Reading

W: Process Description – Transcoding a Flow chart.

Language Focus: Interchange of Active & passive voice, Impersonal Passive voice.

MODULE VI **7**

L: Learning Story telling techniques (stories & visuals) through audio files

S: Discussion in groups

R: Reading for critical appreciation

W: Developing an idea, Slogan writing, Interpreting a Bar Chart.

Language Focus: If clause and phrasal verbs.

TOTAL HOURS :45

REFERENCES:

1. Carol Rosenblun perry(2011). The Fine Art of Technical Writing. Create Space Independent Publishing Platform, New Delhi.
2. Dutt, P.K. Rajeevan. G and Prakash , C.L.N. (2007) A course in Communication Skills. Cambridge Univesity Press, India.
3. Kala, Abdul & Arun Tiwari (2004). Wings of Fire: An Autobiography (Simplified and A bridged by Mukul Chowdhri). Hyderabad Univeristy Press.
4. Sen, Leena. (2004) Communication Skills. Prentice Hall, New Delhi.
5. Matt Firth, Chris Sowton et.al. (2012). Academic English: An Integrated Skills

Course for EAP. Cambridge University Press, Cambridge.

OUTCOMES:

After completion of the course, students will have the ability to

- Demonstrate their range of vocabulary in academic and technical contexts
- Exchange ideas and make presentations
- Comprehend and respond appropriately to listening tasks.
- Read a text efficiently and process information.
- Create and draft different kinds of academic documents
- Communicate effectively using grammatically correct expressions.

ISC1181 **ARABIC**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To read and write in Arabic language.
- To learn vocabulary of different fields
- To develop situational communication skills.

MODULE I PREPARATORY ARABIC **7**

Introducing Arabic Alphabets.
Listening and Reading.
Audio & Video aided listening, Tajweed listening,
Writing Arabic Alphabets (connected & unconnected).
Introducing words.
Reading simple sentences.
Learning names of the things in and around the class room.
Exercises.

MODULE II FUNCTIONAL ARABIC **7**

Listening Arabic texts, stories and action verbs
Communicating Simple sentences.
Jumla' Ismiyya and Jumla' Fi'liyya
Situational Conversation:
Greetings, Introduction.
Classroom, College, Picnic.
Dining and Kitchen.
Reading skills.
Exercises

MODULE III FUNCTIONAL ARABIC **8**

Implication of effective listening.
Audio aids.
Writing Simple sentences.
Communicating ordinal and cardinal numbers.
Situational communication:
Playground, library.
Forms of plural – Sample sentences.
Introduction to tenses.

Exercises.

MODULE IV FUNCTIONAL ARABIC 8

Communication:

Family, travel

Market, Prayer hall

Writing skills:

Note making.

Sequencing of sentences.

Developing answers from the questions.

Exercises.

MODULE V TECHNICAL ARABIC 8

Importance of technical communication.

Reading and writing skills.

Audio & Video aided listening.

Introduction to Arabic terms related to administration.

Situation communication:

Air travel, Office administration, passport, visa.

Exercises

MODULE VI TECHNICAL ARABIC 7

Situation communication:

Contractual work, machineries and equipments..

Computer, internet browsing.

Banking,

Exercises.

TOTAL HOURS :45

TEXT BOOKS:

1. Arabic for professionals and employees, Kilakarai Bukhari Aalim Arabic College, Chennai, India, 2013.

REFERENCES:

1. Arabic Reader for Non Arabs (Ummul Qura University, Makkah), Kilakarai Bukhari Aalim Arabic College, 2005.

OUTCOMES:

On successful completion of the course, the student will be able to:

- Write correct sentences in Arabic.
- Communicate in Arabic at primary level in working situations in the fields of engineering and administration.

LNC1181	**MANDARIN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To improve the proficiency of students in Mandarin language.
- To develop their knowledge of vocabulary.
- To train them in using appropriate grammatical forms during communications.
- To empower them for successful communication in social and academic contexts.
- To make them appreciate the language usage in real life situations.

MODULE I **8**

· General Introduction to Chinese • Pinyin and Tones • Introduction to the Writing System: basic strokes and stroke order · Numbers 1-100, song · Days of the Week · Months of the Year

MODULE II **8**

· Chinese names and related culture · Chinese family structures and values · Greetings

· Introducing Yourself · Family members · Occupations

MODULE III **7**

· Languages and Nationalities · Daily Routine · Chinese breakfast · Negative Sentences and Interrogative Sentences · Asking for Personal Information · The Verb *shi* and Basic Sentence Structures

MODULE IV **7**

· Answering an Affirmative-negative Question · Food and drinks · Transportation · Likes and dislikes · Adverbs *bu*, *jiu* and *dou* · Verb-absent Sentences

MODULE V **8**

·*Jisui* and *duoda* Questions · S+V+O Construction · Routines and Daily Activities ·*Haishi* Questions · Modal Verbs · Hobbies and Habits

MODULE VI **7**

· Making Suggestions with *haoma* ·Colors · Clothing · Body parts · Talking about Likes and Dislikes · Measurement Words in Chinese

TOTAL HOURS : 45

TEXT BOOKS:

1. Ma, Yanmin, and Li, Xinying. *Easy Steps to Chinese, Vol. 1 Textbook*. Beijing: Beijing Language and Culture University Press, 2006. Print.
2. Ma, Yanmin, and Li, Xinying. *Easy Steps to Chinese, Vol. 1 Workbook*. Beijing: Beijing Language and Culture University Press, 2006. Print.

OUTCOMES:

On completion of the course, students will be able to

- Exhibit proficiency in Chinese Language.
- Use vocabulary in appropriate contexts.
- Use appropriate grammatical forms effectively.
- Use the language in social and academic contexts.
- Appreciate the use of language forms.

LNC1182 **GERMAN**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To improve the proficiency of students in German language.
- To create awareness of using vocabulary among students.
- To expose them to correct grammatical forms of the language.
- To empower them for successful communication in social and academic contexts.

MODULE I **8**

Introduction to German alphabets, phonetics and pronunciation- Introducing themselves and others using simple sentences and answer to some basic personal questions-: Introduction to different types of articles and verbs, Nouns

MODULE II **8**

Understanding and responding to everyday queries like instruction, questions, - number & gender, pronouns, present and past tense.

MODULE III **7**

Short telephone messages, requests etc., if spoken slowly and clearly-- Detailed overview of articles, adjectives with/without articles, Prepositions

MODULE IV **7**

Ask and giving directions using simple prepositions- Ability to fill basic information on forms while registering for courses / classes.

MODULE V **8**

Ability to extract and understand relevant information in a public announcement, broadcast, newspaper, radio etc-- dative & accusative

MODULE VI **7**

Ability to describe about people, work, immediate environment, education and other topics related to personal needs in a concise manner-- Understanding of matters that are familiar and are encountered regularly like instances at school, work, at public places, places of leisure etc.

TOTAL HOURS :45

TEXT BOOKS:

1. Course book : Tangram aktuell 1 – Lektion 1–4 (Kursbuch + Arbeitsbuch mit Audio-CD zum Arbeitsbuch), Rosa-Maria Dallapiazza, Eduard von Jan, Til Schönherr, Hueber Publisher, ISBN 978-3-19-001801-7
2. Practice book: Tangram aktuell 1 – Lektion 1–4 (Kursbuch + Arbeitsbuch mit Audio-CD zum Arbeitsbuch), Rosa-Maria Dallapiazza, Eduard von Jan, Til Schönherr, Hueber Publisher, ISBN 978-3-19-001801-7.

REFERENCES:

1. NETZWERK A1 TEXTBOOK, Deutsch als Fremdsprache,Stefanie Dengler,Paul Rusch, Helen Schmitz, Tanja Sieber, Langenscheidt and Klett, ISBN : 9788183076968
2. STUDIO D A1 (SET OF 3 BOOKS + CD), Hermann Funk. Cornelsen, ISBN: 9788183073509
3. Willkommen! Beginner's course. Paul Coggle, Heiner Schenke. 2nd edition. (chapter 1 - 6) ISBN: 9781444165159 –
4. Willkommen! Beginner's course. Paul Coggle, Heiner Schenke. ISBN: 978-1-444-16518-0
5. An Introduction to the German Language and Culture for Communication, Updated Edition Lovik, Thomas A., J. Douglas Guy & Monika Chavez. Vorsprung -. New York, Houghton Mifflin Company, 1997/2002. ISBN 0-618-14249-5.

OUTCOMES:

On completion of the course, students will be able to

- Show their proficiency in German Language.
- Use appropriate vocabulary in real life contexts.
- Use appropriate grammatical forms while communicating with people.
- Effectively use the language in social and academic contexts.

LNC1183	JAPANESE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To train students to use appropriate vocabulary in academic and technical contexts.
- To facilitate students to speak effectively while exchanging ideas and making presentations.
- To develop their reading skill through sub skills like skimming, scanning and critical reading of a text.
- To sharpen their academic writing skills.
- To expose them to the correct usage of language and help them to apply that knowledge appropriately.

MODULE I **7**

Introduction of the Japanese writing system, i.e. *Hiragana*, *Katakana* and *Kanji*, word-building, writing foreign names and loan words in Katakana.

MODULE II **8**

Oral practice of pronunciation and intonation of Japanese sounds, Japanese greetings, self introduction, identifying things, time of the day, calendar; counting using Japanese numerical classifiers; describing things;

MODULE III **7**

Making comparisons; talking of daily activities, kinship terms used for address and reference, seasons, giving and receiving, shopping; making requests, talking of one's likes and dislikes.

MODULE IV **8**

Extensive practice of basic patterns at the lower intermediate level through drills and exercises.

MODULE V **7**

Comprehension of passages in simple Japanese and writing of composition in Japanese applying lower intermediate grammatical patterns.

MODULE VI **8**

Diverse texts based on Japanese culture, customs, history, food habits, and science etc, for the development of communicative competence of students; skimming, scanning of texts with emphasis on advanced sentence patterns, grammatical structures and idiomatic phrases, reading and writing of approximately

TOTAL HOURS :45

REFERENCES:

1. Nihongo I, Kokusaigakuyukai, and other supplementary material
2. Exersice book 1of Nihongo 1, and other supplementary material
3. Nippon, the Land and its People & Encyclopedia of Contemporary Japanese
4. Japani: Japanese Conversation for Improving Spoken Proficiency, By P.A. George, Inoue Yoriko and Itsuko Nandi, Books Plus.
5. Chukyu Nihongo, Tokyo Gaikokugo Daigaku; Nihongo II, Kokusaigakuyukai, and other supplementary material.

OUTCOMES:

After completion of the course, students will have the ability to

- Demonstrate their range of vocabulary in academic and technical contexts
- Exchange ideas and make presentations
- Comprehend and respond appropriately to listening tasks.
- Read a text efficiently and process information.
- Create and draft different kinds of academic documents
- Communicate effectively using grammatically correct expressions.

PHC 1182	PHYSICS I	L	T	P	C
		3	0	2	4

OBJECTIVES

To make students conversant with the

- basic concepts of crystal physics and its structures
- production and applications of ultrasonic waves
- study of thermal conductivities of good and bad conductors
- phenomenon of wave optics and its applications
- principle of fibre optic communication and its applications to sensors
- wave mechanics principle and its applications in electron microscopy
- green energy physics and its environmental impacts to society

MODULE I CRYSTAL PHYSICS 8

Crystalline and amorphous solids – Unit Cell – Seven Crystal Systems – Bravais Lattice – Miller Indices – Interplanar Spacing – Characteristics of Unit Cell - Calculation of Number of atoms per unit cell, Atomic Radius, Coordination Number and Packing Factor for SC, BCC, FCC and HCP and Diamond structures –Defects in crystals-Point defects –Edge and screw dislocations and their significance - Surface Defects.

MODULE II ULTRASONICS AND THERMAL PHYSICS 8

Introduction to Ultrasonics - Properties - Production methods - Magnetostriction Oscillator method- Piezoelectric Oscillator method – Detection of Ultrasonics – Thermal method – Piezoelectric method – Kundt's tube method – Applications of Ultrasonics – Acoustic Grating – SONAR – Depth of sea – Velocity of blood flow, Ultrasonic Flaw detector (qualitative).

Transmission of heat – Conduction, Convection and Radiation – Thermal Conductivity of good Conductor – Forbe's method- Thermal Conductivity of bad Conductor – Lee's Disc method.

MODULE III APPLIED OPTICS 8

Interference – Air Wedge – Michelson's Interferometer – Determination of wavelength of light and thickness of thin transparent sheet.

Introduction to Laser – Characteristics of Laser – Spontaneous and Stimulated Emissions – Einstein's Coefficients - Population inversion – Pumping Mechanism –

Laser Action – Types of Laser: He-Ne laser, CO_2 laser and Nd:YAG laser - Applications : Laser Materials Processing .

MODULE IV FIBRE OPTICS 7

Optical fibre – Principle and propagation of light in optical fibre – Numerical aperture and acceptance angle – Types of optical fibres – Attenuation – Absorption, Scattering losses, Bending losses and Dispersion in Optical fibres – Fiber Connectors and Couplers - Applications – Fibre optic communication system (block diagram only)- Fibre optic sensors - displacement and pressure sensors (qualitative) - Medical endoscope.

MODULE V QUANTUM MECHANICS 7

Black body radiation – Planck's theory of radiation – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory –Dual nature of matter – de Broglie's wavelength- Physical significance of wave function – Schrodinger wave equation – Time independent and time dependent wave equation – Particle in one dimensional box – Harmonic oscillator(qualitative).

MODULE VI MODERN ENGINEERING AND BIOMATERIALS 7

Modern Engineering Materials: Shape memory alloys - Metallic glasses – Advanced Ceramics – Composites.

Bio-materials: Classification of bio-materials (based on tissue response) – Comparison of properties of some common biomaterials – Metallic implant materials (stainless steel, cobalt-based and titanium-based alloys) – Polymeric implant materials (Polyamides, polypropylene, Acrylic resins and Hydrogels) – Tissue replacement implants – Soft and hard tissue replacements.

L:45 periods

PRACTICALS

1. Determination of Velocity of Ultrasonic waves in a given liquid using Ultrasonic Interferometer.
2. Determination of wavelength of ultrasonic waves using Kundt's tube method.
3. Determination of thickness of a thin wire using Air Wedge method.
4. Determination of wavelength of light using spectrometer diffraction grating.
5. Determination of angle of divergence of a laser beam using He-Ne laser.
6. Determination of particle size of lycopodium powder using semiconductor laser.
7. Determination of wavelength of laser light using semiconductor laser diffraction.

8. Determination of Acceptance angle and Numerical Aperture using fiber optic cable.
9. Determination of thermal conductivity of a good conductor by Forbe’s method.
10. Determination of thermal conductivity of a bad conductor by Lee’s disc method.
11. Determination of solar cell characteristics.

P: 30 periods
Total: 75 periods

REFERENCES:

1. Gaur R.K. and Gupta S.L., “Engineering Physics’’, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2013.
2. Palanisamy P.K., Physics for Engineers, Vol1 & Vol2, 2nd Edition, Scitech Publications, 2003.
3. Serway R.A. and Jewett, J.W. “Physics for Scientists and Engineers with Modern Physics”. Brooks/cole Publishing Co., 2010.
4. Tipler P.A. and Mosca, G.P., “Physics for Scientists and Engineers with Modern Physics”, W.H. Freeman, 2007.
5. Markert J.T., Ohanian. H. and Ohanian, M. “Physics for Engineers and Scientists”. W.W. Norton & Co. 2007.
6. Godfrey Boyle, “Renewable Energy: Power for sustainable future”, 2nd edition, Oxford University Press, UK, 2009.

OUTCOMES:

At the end of the course, students will be able to

- understand the different types of crystal structures
- apply the concept of ultrasonic principle in engineering and medical field
- calculate thermal conductivities of good and bad conductors
- differentiate the various laser systems and its applications in engineering and medical field
- apply the principle of fibre optics for communication and sensor applications
- formulate wave mechanics principle for applications in electron microscopy
- Correlate the different renewable energy sources for societal needs.
- To complement the knowledge acquired in the theory class.
- To correlate the experimental results for application.

CHC1181 **CHEMISTRY** **L T P C**
3 0 2 4

OBJECTIVES

To make the students conversant with

- the basic problems like hardness, alkalinity, dissolved oxygen associated with the water and treatment processes involved.
- types of electrodes, determination of pH, emf measurement, conductometric and potentiometric titration.
- the basic analytical techniques like colorimetry, UV-Visible, flame photometry and AAS.
- concepts of photochemistry related to physical processes and chemical reactions induced by photon absorption and their applications.
- the non-renewable sources such as thermal and nuclear energy, importance of renewable energy sources like solar, wind, biogas, biomass, geothermal, ocean with their advantages and limitations.
- the synthesis, properties and applications of nanomaterials.

MODULE I WATER TECHNOLOGY 9

Impurities present in water – hardness : types of hardness, demerits of hard water in boilers, estimation of hardness by EDTA method (problems) – alkalinity : estimation of alkalinity (problems) – dissolved oxygen: estimation of dissolved oxygen – conditioning methods : external treatment :– zeolite process (principle only), ion-exchange process – internal treatment :– colloidal, carbonate, phosphate and calgon methods – drinking water standards (BIS), treatment of domestic water {screening, sedimentation, coagulation, filtration and disinfection} – desalination by reverse osmosis.

MODULE II ELECTROCHEMISTRY 8

Types of electrodes (principle and working) : gas (SHE), metal/metal ion electrode, metal-metal insoluble salt (calomel electrode), ion-selective (glass electrode) – pH determination using glass electrode – concentration cells (problems) – standard cell (Weston-cadmium) – EMF measurement (problems) – conductometric titrations – potentiometric titrations.

MODULE III ANALYTICAL TECHNIQUES 7

Spectroscopy: (relation between interaction of electromagnetic radiation with matter and type of spectroscopy), electromagnetic spectrum – types of transitions – types of spectra (atomic and molecular) – Beer-Lamberts law (problems) – principles, instrumentation (block diagram only) and applications of: colorimetry (includes estimation of concentration of a solution) – UV-Vis spectrophotometer – atomic absorption spectroscopy – flame photometry (includes estimation of concentration of alkali metal).

MODULE IV PHOTOCHEMISTRY 7

Introduction: absorption and emission – laws of photochemistry: Grotthus-Draper law, Stark Einstein law – quantum efficiency – determination of quantum yield (problems) – photochemical decomposition of HI – photo physical processes: fluorescence and phosphorescence – Jablonski diagram (electronic states and transitions) – quenching – photosensitization: principle and applications – chemiluminescence – bioluminescence.

MODULE V ENERGY SOURCES 8

Renewable and non-renewable energy: comparison, advantages and limitations – non-renewable energy : thermal energy (principle only) – nuclear reactor (components and functions) – nuclear energy (problems) – renewable energy: needs of renewable energy – solar energy : solar photovoltaic, advantages and limitations – wind energy: wind resources, wind turbines, advantages and limitations – bioenergy: biogas generation, factors affecting biogas generation, biomass gasifier, advantages and limitations – geothermal energy: principle, types of geothermal resources, advantages, limitations and applications – ocean energy: tidal and ocean thermal energy (principle, advantages and limitations).

MODULE VI NANOCHEMISTRY 6

Introduction – distinction between molecules, bulk materials and nanoparticles – classification based on dimension with examples – synthesis :– top-down approach: chemical vapour deposition, laser ablation, electrodeposition – bottom-up approach: precipitation, thermolysis (hydrothermal and solvothermal) – properties and applications of nanomaterials.

L:45 periods

PRACTICALS

1. Estimation of hardness in the given water sample.
2. Estimation of the alkalinity of the given water sample.
3. Estimation of dissolved oxygen in the given water sample.
4. Determination of EMF of the cell.
5. Estimation of a strong acid by conductometry.
6. Estimation of Fe^{2+} present in the given sample by potentiometry.
7. Verification of Beer-Lamberts law and estimation of metal ion concentration of the given sample.

8. Estimation of sodium and potassium present in the given sample by flame photometry (demonstration).

P:30 periods

Total: 75 periods

REFERENCES

1. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India Ltd., New Delhi, 2011.
2. G.A. Ozin and A.C. Arsenault, “Nanochemistry: A Chemical Approach to Nanomaterials”, RSC Publishing, Thomas Graham House, Cambridge, 2005.
3. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).
4. S S Umare & S S Dara, A text Book of Engineering Chemistry, S. Chand & Company Ltd, New Delhi, 2014.
5. G.D.Rai, “Non conventional energy sources,” Khanna Publishers, New Delhi, 2011.
6. John Twidell and Tony Weir, “Renewable Energy Resources, Taylor & Francis Ltd, London, United Kingdom, 2005
7. Principles of molecular photochemistry: An introduction, Nicholas J. Turro, V.Ramamurthy and Juan C. Scaiano, University Science Books, Sausalito, CA, 2009.

OUTCOMES

The students will be able to

- solve problems related to hardness, alkalinity, dissolved oxygen associated with the water and describe the treatment processes.
- describe the various types of electrodes, determine pH, measure EMF, explain and determine the concentration of acid and ions using conductometric and potentiometric titrations.
- verify and derive Beer-Lambert’s law, state the principle and illustrate the instrumentation of various analytical techniques.
- apply the concepts of photochemistry to elaborate various photo-physical and photochemical reactions.
- describe the various components and functions of nuclear reactor, explain the principle and enumerate the advantages and limitations of various renewable energy sources.
- classify nanomaterials and discuss their properties & applications; and apply nanochemistry approach to synthesize the nanomaterials.

GEC 1101	ENGINEERING GRAPHICS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To introduce the students of all engineering programs, the basic concepts of engineering drawing, which is the basic communication medium for all engineers
- To provide practical exposure on important aspects like drawing analytic curves, orthographic projections, section of solids, development of surfaces, isometric projection, perspective projection and free hand drawing.
- To introduce computerized drafting.

MODULE I BASICS AND ENGINEERING CURVES 10

Drawing instruments, dimensioning, BIS conventions, types of lines, simple geometric constructions.

Conic sections: ellipse, parabola, hyperbola.

Special curves: cycloid, epicycloid, hypocycloid and involutes.

MODULE II ORTHOGRAPHIC PROJECTION 8

Orthographic projection – first angle, second angle, third angle and fourth angle projections –setup - assumptions, principle. Free hand sketching of orthographic views of simple machine parts as per first angle projection. Orthographic projection of points in all quadrants. Some commands and demonstration of drafting packages.

MODULE III PROJECTION OF STRAIGHT LINES AND PLANES 10

Projection of straight lines in first quadrant – true length and true inclinations – Rotating line and trapezoidal methods –traces of straight line.

Projection of plane lamina in first quadrant and its traces

MODULE IV PROJECTION OF SOLIDS 10

Projection of solids in first quadrant: Axis inclined to one reference plane only- prism, pyramid, cone, cylinder – change of position and auxiliary projection methods.

MODULE V SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES 12

Section of solids: prism, pyramid, cone, cylinder, and sphere – sectional view – true shape of section Solids in simple position and cutting plane inclined to one reference plane only.

Development of surface of truncated solids: prism, pyramid, cone cylinder – frustum of cone, pyramid and simple sheet metal parts.

MODULE VI PICTORIAL PROJECTIONS 10

Isometric projection: Isometric scale – isometric axes- iso sheet - Isometric projection and view of prism, pyramid, cylinder, cone, frustums, truncated solids and simple products

Perspective projection: station point – vanishing point – Perspective projection and views of prism, pyramid, cylinder and frustums by Visual ray method.

L – 30; P – 30; TOTAL HOURS – 60

TEXT BOOKS:

1. N.D. Bhatt, ‘Engineering Drawing’ Charotar Publishing house, 53rd Edtion, (2014)

REFERENCES:

1. K.V. Natarajan, ‘A text book of Engineering Graphics’, Dhanalakshmi publishers, Chennai. (2009)
2. Venugopal. K, and V. Prabhu Raja, Engineering Graphics, New Age International (P) Ltd., Publication, Chennai. (2011)

OUTCOMES:

- Students should be able to read the specifications and standards of technical drawing and able to draw conic sections and special curves.
- Students should be able to understand the insight of orthographic projection and to draw the various views of orthographic projection of a point and various components.
- Students should be able to draw the orthographic views of straight lines and plane figures.
- Students should be able to draw the orthographic views of simple solids.
- Students should be able to draw the sections of solids and development of solid surfaces.
- Students should be able to draw the isometric and perspective projection of simple solids and components.

GEC 1102	ENGINEERING DESIGN	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To understand the role of design in Engineering
- To understand the basic design concepts
- To understand the role of innovation in design

MODULE I DESIGN AS A CENTRAL ACTIVITY IN ENGINEERING 08

Product design – products and processes – product design methodology Design of systems; Software design

MODULE II NEED ANALYSIS AND CONCEPT DEVELOPMENT 07

Voice of customers – product specification - need analysis Bench marking Product architecture – concept generation and evaluation;

MODULE III CASE STUDIES IN ENGINEERING DESIGN 08

Product design – process design; system design; software design -Ergonomics – usability

MODULE IV INNOVATION AND DESIGN 07

Role of innovation in Engineering – incremental changes and systemic changes; scientific approach to driving innovation – case studies.

TOTAL HOURS – 30

REFERENCES:

1. Clive L. Dym and David C. Brown,“Engineering Design: Representation and Reasoning”, 2nd Edition, Cambridge University Press, New Delhi, 2011.
2. Daniel G. Dorner, G. E. Gorman and Philip J. Calvert, “Information Needs Analysis: Principles and practice in information organizations”, Published by Faced Publishing, London. 2015.
3. Cliff Matthews, “Case Studies in Engineering Design”, John Wiley & Sons Pvt. Ltd, New York, 1998.
4. Bengt-Arne Vedin, “The Design-Inspired Innovation Workbook”, World Scientific, 2011.
5. Navi Radjou, Jaideep Prabhu and Simone Ahuja, “Jugaad Innovation”, Published by Random House India, 2012.

OUTCOMES:

The students will be able to

- Apply the basic knowledge of design in engineering products / process / service.
- Analyse the problems and give innovative solutions.
- Correlate the basic knowledge of design in the real world problems
- Apply innovative approaches to engineering design.

GEC1103	BASIC ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To provide a practical exposure to basic engineering practices like carpentry, fitting, plumbing, welding and making of simple electrical and electronic circuits
- To have an understanding on the use of various tools, instruments and methods
- To enable the students to appreciate the practical difficulties and safety issues

CIVIL ENGINEERING PRACTICE

1. Study of plumbing in general household and industrial systems
2. Making a small window frame with Lap and Mortise & Tenon Joints
3. Introduction to power tools

MECHANICAL ENGINEERING PRACTICE

1. Fabrication of a small Table frame with Butt, Lap and Fillet Joints
2. Machining of a simple component like a table weight using lathe
3. Mold preparation for simple component

ELECTRICAL ENGINEERING PRACTICE

1. Comparison of incandescent, Fluorescent, CFL and LED lamps.
2. Study of Protection Circuits (small relay, fuse, MCB, HRC, MCCB, ECCB).
3. Familiarization of households Electrical Gadgets (Iron Box, Wet Grinder).
4. Understanding of Domestic and Industrial wiring.
5. Earthing and its significance.
6. Troubleshooting in Electrical Circuits.
7. Study of inverter fed UPS/Emergency lamp

ELECTRONICS ENGINEERING PRACTICE

1. Identifications symbolic representation of active and passive electronic components
2. Soldering and tracing of electronic circuits and checking its continuity
3. Assembling of A.C. to D.C, D.C to A.C. Circuits in bread Board and Mini project.

TOTAL HOURS – 30

OUTCOMES:

Upon the completion of the course, students should be able to

- Appreciate the practical skills needed even in making of simple objects, assemblies and circuits
- Attend minor defects especially in items used in day to day life
- Aware of the safety aspects involved in using tools and instruments

GEC 1104	COMPUTER PROGRAMMING I	L	T	P	C
		1	0	2	2

OBJECTIVES:

- To identify the hardware and software components of the computer.
- To know the basic concept of operating system and get knowledge about different operating systems.
- To learn various database concepts and operations
- To develop efficient algorithms for solving a problem.
- To implement the algorithms in C language.
- To use arrays in solving problems.

MODULE I COMPUTER FUNDAMENTALS 7

Introduction -. Number System - Planning the computer program - Computer Software - Basic operating system concepts - Database Operations

MODULE II PROGRAMMING IN C 8

Introduction to C Programming Language – Operators - Control statements - Iterative statements - Arrays.

LIST OF EXPERIMENTS:

1. Computer organization –Hardware in a typical computer Identification – Booting error messages and what it means
2. Types of Operating systems – Windows and Linux
3. Structure of a basic program - Hello world program – Debugging it
4. Data types: Type conversions
5. Input / Output: Formatted functions – Unformatted functions – Library functions
6. Properties of operators – Priority of operators – Arithmetic relational logical and bitwise operators
7. If – if else- nested if else- goto- switch case – nested switch case – for loops – nested for loops – while loop – do-while loop – break and continue statement
8. Arrays – Operation with arrays
9. Sorting and searching.

L – 15; P – 30; TOTAL HOURS – 45

REFERENCES:

1. Ashok N Kamthane, “Computer Programming”, Pearson Education, 2nd

Edition, ISBN 13: 9788131704370, 2012

2. Paul J. Deitel, Deitel & Associates, “C How to Program”, Pearson Education, 7th Edition, ISBN-13: 978-0132990448, 2012

OUTCOMES:

Students who complete this course will be able to

- Recognize Modular design, logic flow, data abstraction
- Analyze the working of the programming constructs, functions, and I/O.
- Write down programs for sorting and searching algorithms
- Write down programs developing cycle for different applications
- Debug the programs and solve some practical problems in programming
- Develop programs using arrays.

SEMESTER II

MAC 1281	**ADVANCED CALCULUS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

The aims of this course are to

- train the students in solving problems using multiple integration.
- provide knowledge in using special functions to find out the area and volume of a region.
- acquire knowledge in tangent and normal vectors.
- gain knowledge in finding the areas of a curve and surface using vector integration.
- learn about the analytic functions and their properties along with bilinear transformation.
- know complex integration using Cauchy's theorems.

MODULE I MULTIPLE INTEGRATION AND ITS APPLICATIONS 8+2

Multiple integrals– Cartesian and Polar coordinates – change of order of integration – Multiple integral to compute area and volume.

MODULE II TRANSFORMATION OF COORDINATES AND SPECIAL FUNCTIONS 7+3

Change of variables between Cartesian, polar, cylindrical and spherical coordinates - Beta and Gamma functions – Properties and applications.

MODULE III VECTOR DIFFERENTIATION 7+3

Operations on vectors – Scalar Product, Vector Product, Projection of Vectors - Angle between two vectors - Gradient, divergence and curl

MODULE IV VECTOR INTEGRATION 8+2

Line, surface and volume integrals – Green's Theorem, Gauss Divergence Theorem and Stokes Theorem (statement only) – verification and evaluation of integrals.

MODULE V ANALYTIC FUNCTION 8+2

Analytic function - Necessary and Sufficient condition (statement only) – Cauchy-Riemann equations in polar coordinates - properties of analytic function – determination of analytic function – conformal mapping (w = z+a, az and 1/z) and bilinear transformation.

MODULE VI COMPLEX INTEGRATION 7+3

Statement and application of Cauchy's integral theorem – Cauchy's integral formula – Taylor's series and Laurent's series expansion – singularities - classification – residues - Cauchy's residue theorem – contour integration – Unit circle and semi circular contours (excluding poles on the real axis).

L – 45; T – 15; TOTAL HOURS – 60

TEXT BOOKS:

1. Veerarajan.T., "Engineering Mathematics "(5th edition) Tata Mc Graw Hill Publishing Co. New Delhi, 2012
2. Grewal B.S., "Higher Engineering Mathematics" (43rd edition), Khanna Publishers, New Delhi, 2012.
3. John W. Cell "Engineering Problems Illustrating Mathematics" Mc Graw Hill Publishing Co., New York 1943

REFERENCES:

1. Kreyszig, E., "Advanced Engineering Mathematics", 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2001.
2. Peter V. O'Neil, "Advanced Engineering Mathematics", 7th edition, Cengage Learning, 2011.
3. Dennis G. Zill, Warren S. Wright, "Advanced Engineering Mathematics", 4th edition, Jones and Bartlett publishers, Sudbury, 2011.
4. Alan Jeffrey, "Advanced Engineering Mathematics", Academic Press, USA, 2002.
5. Ramana, B.V., "Higher Engineering Mathematics" Tata Mc Graw Hill Publishing Co. New Delhi, 2006.
6. Venkataraman, M.K., "Engineering Mathematics", Volume 2, 2nd edition, National Publishing Co., Chennai, 2003.
7. James Stewart ".Calculus" (7th edition),Brooks/Cole cengage learning,UK.

OUTCOMES:

After completing the course, student will be able to

- compute the area and volume using multiple integrals.
- apply special functions to solve integration problems.
- apply differentiation in scalar and vector fields.
- find area and volume of a region using vector integration.
- verify analyticity, conformity and bilinearity of complex functions.
- evaluate complex integrals.

GEC 1211	BASIC ENGINEERING MECHANICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To impart knowledge about the basic laws of statics and dynamics and their applications in problem solving
- To acquaint both with scalar and vector approaches for representing forces and moments acting on particles and rigid bodies and their equilibrium
- To give on exposure on inertial properties of surfaces and solids
- To provide an understanding on the concept of work energy principle, friction, kinematics of motion and their relationship

MODULE I VECTOR APPROACH TO MECHANICS 07

Introduction - Units and Dimensions- Vectors – Vectorial representation of forces and moments –Vector Algebra and its Physical relevance in Mechanics - Laws of Mechanics – Parallelogram and triangular Law of forces -Lame's theorem, Coplanar Forces – Resolution and Composition of forces- Equilibrium of a particle.

MODULE II EQUILIBRIUM OF PARTICLE 06

Forces in space - Equilibrium of a particle in space - Equivalent systems of forces – Principle of transmissibility – Single equivalent force

MODULE III EQUILIBRIUM OF RIGID BODY 06

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis –Vectorial representation of moments and couples – Scalar components of a moment –Varignon's theorem - Equilibrium of Rigid bodies in two dimensions –Examples

MODULE IV PROPERTIES OF SURFACES 08

Determination of Areas – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, Angle section, Hollow section by using standard formula – second and product moments of plane area – Physical relevance - Rectangle, triangle, circle from integration - T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia-

Mass moment of Area

MODULE V FRICTION 08

Introduction to friction- types of friction- Laws of Coloumb friction- Frictional force – simple contact friction – Rolling resistance –ladder friction

MODULE VI LAWS OF MOTION 10

Review of laws of motion – Newton’s law – Work Energy Equation of particles– Impulse and Momentum – Impact of elastic bodies.

L – 45; T – 15; TOTAL HOURS – 60

REFERENCES:

1. Beer, F.P and Johnston Jr. E.R, “Vector Mechanics for Engineers, Dynamics & Statics”, Third SI Metric Edition, Tata McGraw-Hill International Edition, 2001.
2. Hibbeller, R.C., Engineering Mechanics, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2000.
3. Irving H. Shames, Engineering Mechanics – Statics and Dynamics, IV Edition Pearson Education Asia Pvt. Ltd., 2003.

OUTCOMES:

On completion of this course students should be able

- Analyse and resolve forces, moments and solve problems using various principles and laws of Mechanics
- Apply the concept of equilibrium to particles and solve problems
- Apply the concept of equilibrium to rigid bodies and solve problems
- Analyse and determine the properties of surfaces
- Analyse and evaluate the fractional forces between the bodies
- Apply the laws of motion in solving dynamics problems

GEC 1212 ENVIRONMENTAL STUDIES **L T P C**
2 0 0 2

OBJECTIVES

To make the student conversant with the

- various natural resources, availability, utilisation and its current scenario
- different ecosystems, energy transfer, values, threats and conservation of biodiversity
- levels of different pollutants and its impact and the causes and effects of natural disasters
- impacts of human population, impact assessment, human rights and environmental acts and sustainable development

MODULE I NATURAL RESOURCES 8

Land resources: land degradation, soil erosion and desertification - Forest resources: use and over-exploitation, deforestation - Water resources: use and over-utilisation of surface and ground water, conflicts over water (inter-state and international), dams (benefits and problems), water conservation (rainwater harvesting and watershed management) - Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, mining - Food resources: world food problems, changes in land use by agriculture and overgrazing, modern agriculture and its effects, fertilizer and pesticide problems, water logging and salinity - Energy resources: increasing energy needs, renewable and non-renewable, use of alternate energy sources.

MODULE II ECOSYSTEM AND BIODIVERSITY 8

Ecosystem- energy flow in the ecosystem - food chains, food webs and ecological pyramids - characteristics, structure and function of (a) Terrestrial ecosystems (forest, grassland, desert) and (b) Aquatic fresh water ecosystems (pond, lake, river) (c) Aquatic salt water ecosystems (ocean, estuary) - ecological succession.

Biodiversity - genetic, species and ecosystem diversity – hot-spots of biodiversity – biogeographic classification of India - endangered, endemic, extinct and invasive species of India - red data book - values of biodiversity: consumptive, productive, social, ethical, aesthetic and option values - threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts - conservation of biodiversity: in-situ and ex-situ conservation of biodiversity

MODULE III ENVIRONMENTAL POLLUTION AND NATURAL DISASTER 8

Definition, cause, effects and control measures of (a) air pollution (b) water pollution (c) soil pollution (d) marine pollution (e) noise pollution (f) thermal pollution (g) nuclear hazards - ill-effects of fireworks and upkeep of clean environment - solid waste management: types (urban, industrial, biomedical and electronic wastes), collection, processing and disposal (incineration, composting and land-fill) - natural disaster and management: flood, cyclone, drought, landslide, avalanche, volcanic eruptions, earthquake and tsunami.

MODULE IV HUMAN POPULATION, HEALTH AND SOCIAL ISSUES 6

Population and population growth, population variation among nations, population explosion, family welfare programme.

Human health: air-borne, water borne diseases, infectious diseases, risks due to chemicals in food and environment.

Sustainable development - environmental legislation and laws: water act, air act, wildlife protection act, forest conservation act, environment protection act - environmental impact assessment, steps in EIA - human rights - women and child welfare.

Case studies related to current situation

L:30 periods
Total: 30 periods

TEXT BOOKS

1. Erach Bharucha, Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education for University Grants Commission, Orient Blackswan Pvt Ltd, Hyderabad, India, 2013.
2. Benny Joseph, Environmental Studies, Tata McGraw-Hill Education, India, 2009.
3. Ravikrishnan A, Environmental Science and Engineering, Sri Krishna Publications, Tamil Nadu, India, 2015.
4. Raman Sivakumar, Introduction to Environmental Science and Engineering, McGraw Hill Education, India, 2009.
5. Venugopala Rao P, Principles of Environmental Science and Engineering, Prentice Hall India Learning Private Limited; India, 2006.
6. Anubha Kaushik and Kaushik C.P., Environmental Science and Engineering, New Age International Pvt Ltd., New Delhi, India, 2009.

REFERENCES

1. Masters G.M., Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi, 1997.
2. Henry J.G. and Heike G.W., Environmental Science and Engineering, Prentice Hall International Inc., New Jersy, 1996.
3. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co. Boston, USA, 2016.

OUTCOMES

The student will be able to

- predict the scenario of various natural resources and suggest remedies to curb the exploitation of these resources.
- identify food chain and web and its role in various ecosystems, assess the impacts on biodiversity and provide solutions to conserve it.
- analyse the impacts of pollutants in the environment and propose suitable method to alleviate the pollutants and the natural disasters.
- assess on the impact of human population and the health related issues and the ethics to be followed for sustainable life.

GEC 1213	COMPUTER PROGRAMMING II	L	T	P	C
		1	0	2	2

OBJECTIVES:

- To provide knowledge about the benefits of Object Oriented Programming over Procedure oriented programming.
- To learn various File operations
- To expose fundamental concepts of object-oriented programming in classes, invoking methods and functions.
- To prepare students to get full use of code reusability using object oriented programming.
- To implement the basic concepts of object oriented programming using C++concepts.
- To focus on solving problems based on analyzing, designing and implementing programs in C and C++.

MODULE I PROGRAMMING IN C 7

Functions - Storage Classes - Structures and Unions – Pointers -Self Referential Structures and Linked Lists - File Processing.

MODULE II PROGRAMMING IN C++ 8

Programming in C++ - Overview of OOP in C – Inheritance - Polymorphism - Type Casting – Exceptions.

LIST OF EXPERIMENTS:

1. Functions
2. One dimensional arrays, Pointers
3. Recursion
4. Multi dimensional arrays, Linked lists.
5. Operating on Files.
6. Simple C++ program with Control statements.
7. Getting input from user console.
8. Classes, Object and Constructors.
9. Method overloading.
10. Inheritance

L – 15; P – 30; TOTAL HOURS – 45

REFERENCES:

1. Bjarne Stroustrup,” The C++ Programming Language”, Addison Wesley, 4th edition, ISBN-13: 978-0321563842, 2013.
2. Brian W. Kernighan and Dennis M. Ritchie, “ The C Programming Language”, Prentice Hall, ISBN 0-13-110362-8, 2015.
3. Bjarne Stroustrup, “ Programming: Principles and Practice Using C++ “, Addison Wesley, 2nd edition, ISBN-13: 978-0321992789, 2014.
4. Brian W. Kernighan and Dennis M. Ritchie, “ The C Programming Language (Ansi C Version)”, Prentice Hall India Learning Private Limited, 2nd edition, ISBN-13: 978-8120305960, 1990.

OUTCOMES:

Students who complete this course will be able to

- Develop efficient algorithms for solving problems
- Handle files in C
- Use simple data structures like arrays and linked lists in solving problems.
- Write simple programs using concepts of object oriented programming.
- Implement algorithms in C++ Language.
- Demonstrate the Object Oriented Programming concepts applied in networking, web development and Database applications.

PEC1211	BASIC MECHANICAL OPERATIONS	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To impart knowledge of heat treatment and metal cutting in mould manufacturing process.
- To provide understanding of machining operations in mould manufacturing.
- To introduce metrology and its applications in mould making.
- To enhance the understanding of electroforming and hobbing process in manufacturing processes.

MODULE I METAL CUTTING AND MACHINING OPERATIONS 8

Mechanics of metal cutting – types of chips, cutting tool geometry, types of tools, influence of tool angles, cutting fluids, tool materials used including coated tools. Study of various machining operations: Turning, drilling, shaping, planning.,Milling – horizontal / Vertical / ram / copy milling, Grinding – surface and cylindrical.

MODULE II ADVANCE MACHINING OPERATIONS 7

Electrical discharge machining – characteristics, physical processes, special technological features, design consideration and typical applications .Electro forming for mold manufacturing – process, materials and design. Hobbing for mold making – process & its advantages, elements of hobbing – hobbing punch, shape of hob, materials used for cavity blanks.

MODULE III POLISHING 8

Definition of surface roughness, basis of polishing technology. Polishing – lapping, lapping and polishing, ultrasonic finishing, principles of electro deposition in damaged molding surfaces, surface texturing of molds – process description, types of molds, types of patterns and mold shapes, metals that can be etched, mold preparation, limitations of chemical texturing.

MODULE IV METROLOGY 7

Metrology and inspection: Scope of inspection, procedures, choices of basic measuring instruments, vernier, micrometer, surface plates, angle plates, squares, vernier height gauges, depth gauges, slip gauges, dial gauges, surface roughness measurement, hardness testing, comparators, optical profiles projectors, tool makers microscope, optical flats – types and uses.

TOTAL HOURS – 30

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Workshop Technology", Vol. I and II, Media Promoters Pvt Ltd., Mumbai, 2007.
2. P.C. Sharma, "A Text Book of Production Technology", S. Chand and Company, X Edition, 2008.
4. P.N. Rao, "Manufacturing Technology", Tata McGraw-Hill Publishing Limited, II Edition, 2009.
5. HMT – "Production Technology", Tata McGraw-Hill, 2001.

REFERENCES:

1. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 2006.
2. Richerd R. Kibbe, John E. Neely, Roland O. Merges and Warren J. White, "Machine Tool Practices", Prentice Hall of India, 2003.

OUTCOMES:

At the end of the course, the students will be able to

- Explain the mechanics of metal cutting and machining operations involved in mold manufacturing.
- Compare the milling and hobbing processes for core and cavity manufacturing.
- Describe various polishing techniques involved in mold manufacturing.
- Identify the basic measuring instruments used in machine shop.

PEC1212	**PRINCIPLES OF CHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce the basic concepts of unit conversion systems.
- To provide knowledge in different heat and mass transfer systems*.*
- To impart knowledge in classification of dryers, with related examples.
- To equip students in understanding the various technologies of humidification.
- To develop the ability in identifying different types of crushers and grinders.
- To impart knowledge of separation processes practiced in various industries.
-

MODULE I HEAT TRANSFER 10

Unit conversion systems. Heat transfer - Modes of heat transfer, Fourier's law of heat conduction, steady state conduction across composite walls, cylinder and hollow sphere. Heat transfer by natural & forced convection, Radiation. Heat exchanger- Parallel, Countercurrent and Cross flow. Individual and overall heat transfer coefficients. Logarithmic mean temperature difference (LMTD**).** Heat exchanger (Equipment description & solution to simple problems).

MODULE II MASS TRANSFER 8

Mass Transfer - Principles of diffusion, theory of diffusion, Distillation - Industrial equipment for distillation, Adsorption - Principle and equipment for adsorption.

MODULE III DRYING 7

Principles and definitions, Equipments for drying, Classification of dryers- dryers for solids and pastes, dryers for solution and slurries, Drying - simple problems to find time for drying.

MODULE IV HUMIDIFICATION 5

Humidity, dry bulb and wet bulb temperatures, dew point, specific volume and enthalpy Equipment - Water - cooling towers.

MODULE V SIZE REDUCTION 5

Size reduction - Empirical relationships: Rittinger's and Kick's laws, bond crushing law and work index, principles, criteria and characteristics of comminuted products. Laws of crushing, Equipment classification - Crushers and Grinders.

MODULE VI SEPARATION PROCESSES 10

Membrane separation process - evaporation and reverse osmosis. Screening and screening equipments, Filtration - principle and filtration equipment (filter press, shell and leaf filter, rotary drum filter, centrifugal filter and centrifuges), filter media, filter aids. Gravity settlers, cyclones and hydro cyclones.

TOTAL HOURS – 45

TEXT BOOKS:

1. Mc Cabe W L , Smith J C and Peter Harriot Emeritus "Unit Operations of Chemical Engineering", - 7th edition McGraw Hill Chemical Engineering Series, New York (2004).
2. Introduction to Chemical Engineering, S.Puspavanam, PHI Learning Pvt. Ltd., 2012
3. Badger W L, Banchero JT, "Introduction to Chemical Engineering", McGraw Hill, UK, (1997).
4. Richardson and Coulson, "Chemical Engineering" Vol. 1 & Vol. 2, Asian Books Pvt. Ltd, India (1996)

REFERENCES:

1. Robert Perry H, Cecil Chilton H, "Chemical Engineer's Handbook (McGraw-Hill Chemical Engineering Series, McGraw-Hill, 5th edition, (1973).
2. Cengel and Ghajar, "Heat and Mass Transfer", McGraw-Hill, 4th edition,(2011).

OUTCOMES:

At the end of the course, the students will be able to

- Apply the unit conversion from one system to other systems.
- Outline the different types of heat exchangers.
- Explain the different systems of mass transfer.
- Demonstrate knowledge on drying and humidification processes.
- Identify the appropriate size reduction equipment and separation process.
- Analyze the processes and contribute to new designs in polymer engineering.

PEC1213	CHEMICAL ENGINEERING LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To impart skill to students in measuring the heat transfer coefficients for different modes of heat transfer.
- To train the students in assessing the flow performance of fluids through different systems.
- To familiarize students with the experimental determination of efficiency of particle size reduction.
- To provide skills for separating mixtures of liquids by using different distillation techniques.

LIST OF EXPERIMENTS

1. Flow through Fluidized Bed Reactor
2. Pressure Drop in Packed Bed Reactor
3. Flow through Rough and Smooth Pipes
4. Determination of Friction Factor Flow Through a Pipe
5. Calibration of Orifice Meter by Variable Head Method
6. Performance Test on Centrifugal Pump
7. Performance Test on Two Stage Air Compressor
8. Determination of Emissivity of Given Surface
9. Determination of Thermal Conductivity of Solids
10. Heat transfer in Lagged Pipe
11. Parallel / Counter Flow Heat Exchanger
12. Simple Distillation
13. Steam Distillation
14. Size reduction using Ball Mill and Jaw Crusher

TOTAL HOURS – 30

REFERENCES :

1. Warren L. McCabe, Julian C.Smith and Peter Harriott, "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill's Chemical Engineering Series, 2004.
2. Don W.Green and Robert H. Perry, Perry's Chemical Engineers Handbook, 8th Edition, McGraw Hill Book Company, 2007.
3. Rohsenow W.M and Choi H.Y.: Heat, Mass and momentum Transfer,

Prentice-Hall, U.K, 1961.
4. McAdams, William Henry, Heat Transmission, Krieger Publication Company, 3rd edition, 1985.
5. Mathur. D.S, “Heat & Thermodynamics”, S.Chand & Co., 2009.
6. Brijlal & Subramaniam, “Heat and Thermodynamics”, S.Chand & Co, Delhi., 2010.
7. Nag P. K, Engineering Theromodynamics, Tata McGraw-Hill Education, 2005.
8. Bansal, R. K., A Textbook of Fluid Mechanics, Firewall Media, 2005.

OUTCOMES:

At the end of the course, the student will have the knowledge and skills on the following:

- Analyzing the problems associated with fluid mechanics.
- Computing the flow of fluid using various devices.
- Evaluating the performance of pumps, compressors involved in various systems.
- Assessing the various parameters in different equipment associated with heat transfer.
- Knowledge of mass transfer in various chemical process industries.
- Operating Ball Mill and Jaw Crushers.

SEMESTER III

		L	T	P	C
MAC 2181	**PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS**	**3**	**1**	**0**	**4**

OBJECTIVES:

The aims of this course are to

- Familiarize in solving partial differential equation of first, second and higher orders.
- Introduce basics and engineering applications of Fourier series, Laplace Transform, Fourier Transform and Z- Transform.

MODULE: I PARTIAL DIFFERENTIAL EQUATIONS 10

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients.

MODULE: II FOURIER SERIES 10

Fourier Series and Dirichlet's conditions - General Fourier series - Half range Fourier series - Parseval's identity - Harmonic Analysis.

MODULE: III FOURIER TRANSFORMS 10

Fourier integral theorem (without proof) - Fourier transform pair - Fourier Inverse Transform – Properties - Convolution theorem - Parseval's identity.

MODULE: IV APPLICATIONS OF FOURIER SERIES AND FOURIER TRANSFORMS 10

Applications of Fourier series and Fourier Transform to solution of PDEs having constant coefficients with special reference to Heat & Wave equations, Discrete & point Spectrum and Single pulse.

MODULE: V Z – TRANSFORM 10

Introduction to Laplace transform - Existence of Laplace Transform - Properties of Laplace Transforms - Initial & Final Value Theorems - Inverse Laplace Transform - Convolution Theorem – Circuits to signal square wave: Integral equations with unrepeated complex factors – Damped forced vibrations: repeated complex factors

– Resonance - Solution of differential equations.

MODULE: VI REACTIONS OF POLYMERS 9

Introduction and Definition of Z-transform - Properties of Z- Transform - Convolution Theorem of Z-Transform - Inverse Z–transform - Convolution Theorem of Inverse Z-Transform - Formation of difference equations - Solving Difference Equations using Z-Transform.

L – 60; T – 0; Total Hours – 60

TEXT BOOKS:

1. Kreyszig .E., “Advanced Engineering Mathematics“, 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2001.
2. Grewal B.S., “Higher Engineering Mathematics”, 42nd edition, Khanna Publishers, New Delhi, 2012.
3. Ramana, B.V, “Higher Engineering Mathematics” Tata Mc Graw Hill Publishing Co. New Delhi, 2006.

REFERENCES:

1. Veerarajan.T., “Engineering Mathematics“, 5th edition, Tata Mc Graw Hill Publishing Co. New Delhi, 2012.
2. Peter V. O'Neil, “Advanced Engineering Mathematics**”**, 7th edition, Cengage Learning, 2011.
3. Dennis G. Zill, Warren S. Wright, “Advanced Engineering Mathematics”, 4th edition, Jones and Bartlett publishers, Sudbury, 2011.
4. Alan Jeffrey, “Advanced Engineering Mathematics”, Academic Press, USA, 2002.

OUTCOMES:

After completing the course, student will be able to

- Solve the partial differential equations.
- Derive a Fourier series of a given periodic function by evaluating Fourier coefficients.
- Apply integral expressions for the forward and inverse Fourier transform to a range of non-periodic waveforms.
- Solve wave equation and heat flow equation.
- Solve ordinary differential equations using Laplace transform.
- Solve difference equation using Z-transform.

ENC 2181	ORAL COMMUNICATION	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To help the students acquire efficiency in spoken English with due importance to stress, accent and pronunciation.
- To hone the listening skills and understand native accent.
- To enable them to make presentations effectively.
- To develop their ability to persuade and convince people to accept a point of view.
- To prepare them for placement interviews, group discussions.

MODULE: I PRESENTATION SKILLS 8

(i) Oral Communication – Implications in real life and work place situations
(ii) One–minute Presentations (JAM) on concrete and abstract topics that test their creative thinking
(iii) Prepared presentations and **extempore** presentations
(iv) Group project – presentation on any social issue. The group will have to research on the history of the problem, its cause, impact and outcome hoped for and then make a presentation
(v) Recording presentations and feedback - Peer and faculty evaluation

MODULE: II LISTENING 4

Listening to ESL Podcast – Viewing Multimedia – Listening to BBC News - Received Pronunciation (RP)/ VOA/ NDTV – exposure to paralinguistic features.

MODULE: III DEVELOPING PERSUASIVE SKILLS 6

Selling a product – marketing skills – the topics will be on advertising, convincing someone on social issues such as preservation of water, fuel, protection of environment, gender discrimination.

MODULE: IV DEBATES 9

Debates on pros and cons on topics of relevance like Nuclear Energy, Appropriate Technology, Internet, Social Media. This will be followed by Peer and Faculty feedback.

MODULE: V BRAINSTORMING 9

Think pair and share activity – Discussion etiquette – Assigning different roles in a GD (Note-taker, Manager, Leader and Reporter) Peer and faculty feedback.

MODULE: VI INTERVIEW SKILLS 9

- Assessing one's strengths and weaknesses, SWOC Analysis, Mock interview – Verbal and Non-verbal Communication – Types of Job Interview – Telephone Interview, Stress Interview.

L – 45; T – 0; Total Hours – 45

REFERENCES:

1. Hancock,Mark. "English Pronunciation in Use". Cambridge University Press, UK. 2005.
2. Anderson, Kenneth & et.al. "Study Speaking: A Course in Spoken English for Academic Purposes" (Second Edition). Cambridge University Press, UK. 2004.
3. Hurlock, B. Elizabeth. "Personality Development". Tata McGraw Hill, New York. 2004.

OUTCOMES:

- On completion of the course, the students will have the ability to speak confidently and effectively in presentations and group discussions.

PEC 2101	CHEMISTRY OF MACROMOLECULES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the basic concepts of macromolecules.
- To develop an understanding of mechanisms of different polymerization reactions.
- To impart knowledge on characters governing the physical properties of polymers
- To develop an understanding on various reactions of polymers.
- To provide knowledge on chemical and degradation reactions of polymers.
- To introduce the basic concepts of macromolecules.

MODULE: I INTRODUCTION TO MACROMOLECULES 5

Basic concepts of monomers and macromolecules - definition – classification- nomenclature of polymers. Thermoplastics – thermosets – homopolymers – copolymers. Natural and synthetic polymers. Biopolymers and biodegradable polymers. Crystalline and amorphous state. Polymerization reactions – functionality – chain growth- step growth and copolymerization reactions.

MODULE: II CHAIN GROWTH POLYMERIZATION 9

Mechanism and kinetics of free radical- cationic and anionic polymerization. Initiation – propagation –termination - chain transfer. Coordination polymerization – mechanism and kinetics. Copolymerization – Mechanism and Kinetics of free radical – Ionic copolymerization – types of copolymers – Copolymer composition – Determination of Monomer reactivity ratios.

MODULE: III STEP – GROWTH POLYMERIZATION 8

Step growth polymerization – Mechanism and kinetic of step growth polymerization – Bi-functional systems – Poly functional systems. Mechanism and kinetics of ring opening polymerization. Atom transfer polymerization.

MODULE: IV POLYMERIZATION TECHNIQUES 5

Bulk (Mass) Polymerization - Solution Polymerization - Suspension Polymerization - Emulsion Polymerization – mini and micro emulsion polymerization - Precipitation Polymerization - Interfacial and solution polycondensation reactions.

MODULE: V MOLECULAR WEIGHT DETERMINATION 9

Molecular weight – Molecular weight averages – Molecular weight distribution – polydispersity, degree of polymerization - Molecular weight determination - Basic concepts of end-group analysis, colligative properties, osmometry, light scattering, and gel permeation chromatography – Viscosity of polymers solutions.

MODULE: VI REACTIONS OF POLYMERS 9

Reactivity of macromolecules - addition reactions - rearrangement reactions - substitution reactions- cross-linking of thermoplastics, thermosets and rubbers - Graft copolymers - block copolymers. Polymer degradation - thermal degradation - hydrolytic degradation - oxidative degradation - photo-degradation -photo-oxidative degradations.

L – 45; T – 0; Total Hours – 45

TEXTBOOKS:

1. Andrew J. Peacock and Allison Calhoun, Polymer Chemistry: Properties and Application, Carl Hanser Verlag GmbH & Company, 2012.
2. Robert J. Young, Peter A. Lovell, Introduction to Polymers, Third Edition CRC Press, 2011.
3. A. Ravve, Principles of Polymer Chemistry, Springer-Verlag New York, 2012.
4. Joel R. Fried, "Polymer Science and Technology", Prentice Hall, 2014.
5. Premamoy Ghosh 'Polymer Science and Technology' Tata Mc Graw – Hill, 2011.
6. Charles E. Carraher Jr. Introduction to Polymer Chemistry, Fourth Edition, CRC Press, 2017.
7. Fred W. BillMeyer 'Textbook of Polymer Science' John Wiley & Sons, 2008.

REFERENCES:

1. Herman F. Mark, "Encyclopedia of Polymer Science and Technology", Wiley-Interscience; 3rd Edition, 2004.
2. R.J.Samuels, "Structured Polymer Properties", John Wiley & Sons, New York, 1974.

OUTCOMES:

At the end of the course, the students will have the

- Fundamental knowledge on polymers and polymerization reactions.
- Ability to demonstrate the knowledge on mechanism and kinetic of polymerization reactions.
- Ability to select suitable methods for the synthesis of polymers.

- Capability to apply knowledge in synthesizing copolymers.
- Ability to determine the molecular weight of polymers.
- Knowledge of reactions and degradation of polymers.

PEC 2102	PHYSICS OF MACROMOLECULES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide understanding of polymer chain conformation on its morphological behavior.
- To provide understanding of polymer chain configuration on its morphological behavior.
- To develop an understanding of the relationship between polymer structure and its properties.
- To introduce the basic principles of thermodynamic transitions in polymers
- .To impart the knowledge of mechanical and electrical properties of polymers.
- To impart the knowledge of optical and chemical properties of polymers.

MODULE: I POLYMER CHAIN CONFORMATION AND CONFIGURATION 8

Conformation of polymers – staggered and eclipsed states, configurations of polymers, Isomerism in polymers – structural and stereoisomerism.

Morphological aspects of polymers – polymer single crystals, lamellae, spherulites, fringed micelle model - degree of crystallinity, factors affecting crystallinity, Chain orientation – orientation in amorphous and crystalline polymers - properties of oriented polymers - birefringence.

MODULE: II POLYMER STRUCTURE AND PROPERTIES 7

Structure of polymers – linear, branched, crosslinked, and network polymers - homochain and hetero chain polymers – copolymers - linear and cyclic arrangement of polymers - prediction of polymer properties – group contribution techniques, topological techniques , volumetric properties – molar volume, density, Van der Waals volume - coefficient of linear thermal expansion and volumetric thermal expansion - pressure volume temperature (PVT) relationship.

MODULE: III MECHANICAL PROPERTIES OF POLYMERS 7

Mechanical properties – stress-strain properties of polymers – effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness – crazing in glassy polymers – ductile brittle transition. Effect of additives on mechanical properties of polymers – creep, stress relaxation, and fatigue.

MODULE: IV THERMODYNAMIC TRANSITIONS IN POLYMERS 8

Thermodynamic and transition properties – transition temperature in polymers, glass transition (Tg), melting temperature (Tm), relationship between Tg and Tm – other transitions like ß-transitions, upper and lower glass transition temperatures – prediction of Tg and Tm of polymers by group contributions. Calorimetric properties – heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy – calculation of heat capacities of polymers.

MODULE: V ELECTRICAL AND OPTICAL PROPERTIES OF POLYMERS 7

Electrical and optical properties – effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor – effect of frequency of voltage and temperature on dielectric properties – prediction of molar polarization and effective dipole moment. Effect of additives on electrical properties of polymers. Optical properties – effect of polymer structure on optical properties – clarity, transparency, haze, transmittance, reflectance, and gloss – prediction of refractive indices of polymers by group contributions.

MODULE: VI CHEMICAL PROPERTIES OF POLYMERS 8

Chemical Properties – cohesive energy, cohesive energy density, solubility parameter, determination of solubility parameter of polymers – prediction of solubility parameter – effect of polymer structure on solubility in solvents and oils – influence of structure in prediction of flame retardancy, water repellency – chemical resistance of polymers – polymer toxicity.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. E.L. Thomas, “Structure and Properties of Polymers” Wiley-VCH, December 2012. Robert J. Young, Peter A. Lovell, Introduction to Polymers, Third Edition CRC Press, 2011.
2. J.M.G Cowie, Valeria Arrighi, “Polymers: Chemistry and Physics of Modern materials, Third Edition, CRC Press,Taylor and Francis group, July 2007.
3. Yves Gnanou, Micheal Fontanille, “ Organic and Physical Chemistry of Polymers, Wiley Interscience, March 2008.
4. Alfred Rudin , Phillip Choi Ph.D. P.Eng , The Elements of Polymer Science

& Engineering, Third Edition, Academic Press; 3 edition December 28, 2012.
5. Hans - Henning Kausch, “Intrinsic Molecular Mobility and Toughness of Polymers II, Springer, Lausanne, September 2005.
6. S. F. Sun, Physical Chemistry of Macromolecules: Basic Principles and Issues, Wiley-Interscience; 2 edition, January 28, 2004.
7. Petr Munk , Tejraj M. Aminabhavi, Introduction to Macromolecular Science, Wiley-Interscience; 2 editions, March 5, 2002.
8. D.A.Seanor, ed., Electrical properties of polymers, Acadamic press, Newyork, 1982.
9. William Barford, Electronic and optical properties of conjugated polymers, Oxford University Press, USA, 2009.
10. Jozef.Bicerano, Prediction of Polymer Properties, Second Edition, Marcel Dekker Inc. Newyork, 1995.

REFERENCES:

1. Herman F. Mark, “Encyclopedia of Polymer Science and Technology”, Wiley-Interscience; 3rd Edition, 2004.
2. R.J.Samuels, “Structured Polymer Properties”, John Wiley & Sons, New York, 1974.
3. C.C.Ku & R.Liepins , “Electrical Properties of Polymers” , Hanser Publications, Munich, 1987.
4. Jwao Teraoka, “Polymer Solutions : An Introduction to Physical Properties”, Wiley Interscience, New York, 2002

OUTCOMES:

At the end of the course, the students will be able to

- Understand the conformation and configuration of polymers.
- Demonstrate the knowledge on thermodynamic transition in polymers.
- Correlate the structure and properties of various polymers.
- Predict the properties of newly synthesized polymers.
- Analyse the properties with respect to polymer structure.
- Identify polymers with desired properties for specific applications.

PEC2103	PLASTIC MATERIALS TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide fundamental knowledge in the synthesis of monomers for different plastics.
- To impart skills to understand the different polymerization methods involved in the manufacturing of various plastic materials.
- To be familiar with the different polymers, their structure-property relationship and applications.
- To demonstrate the skill to differentiate plastics based on structure property relationship.
- To choose plastics based on the application requirements.
- To impart knowledge on various industrial and high-performance plastics, their properties and applications.

MODULE I POLYOLEFINS 8

Polyethylene - Introduction and historical background - monomer preparation - catalyst systems for olefin polymerization - production technology - Polymerization Processes - High-Pressure Processes - Ziegler processes - The Phillips process - The Standard Oil (Indiana) process - Metallocene processes - structure and properties of polyethylene - applications.

Polypropylene - types of PP - homopolymers - block copolymers - random copolymers - homopolymers and copolymers produced by metallocene catalysis - Preparation of Polypropylene - Structure and Properties of Polypropylene - additives for PP – applications.

MODULE II VINYL PLASTICS 8

Vinyl Chloride Polymers - monomer preparation - polymerisation - Structure and Properties of PVC - Compounding ingredients - properties of PVC compounds - applications - poly (vinylidene chloride).Poly(vinyl acetate) - monomer preparation - polymerisation - structure, properties and applications.Polyvinyl alcohol - polymerization and processing technologies - molecular structure - solid state properties - solution properties - applications.

MODULE III ACRYLIC AND STYRENIC PLASTICS 8

Poly(methyl methacrylate) - preparation of monomer - polymerisation - structure, properties - commercial formulations and processing - Cast Sheet, PMMA Resin, beads - PMMA blends - applications.

Polyacrylonitrile - manufacture of acrylonitrile - polymerisation - structure and properties, thermoplastic blends, alloys, copolymers - applications.

Polystyrene - preparation of monomer - polymerisation - different grades of PS - structure and properties - modification of PS - HIPS, SAN, ABS - properties and applications.

MODULE IV POLYAMIDES 6

Aliphatic polyamides: : intermediates for aliphatic polyamides polymerization of aliphatic polyamides - nylon 6- nylon 6, 6 and other types of nylons - structure and properties of aliphatic polyamides – applications.

Aromatic polyamides - monomer synthesis - polymerisation - properties - processing - spinning - wet and dry, casting - applications.

MODULE V OTHER ENGINEERING PLASTICS 8

Manufacturing processes, properties and applications of polyethylene terephthalate – polybutylene terephthalate – polyacetals – polycarbonates - fluoroplastics.

MODULE VI SPECIALITY PLASTICS 7

Manufacturing processes, properties and applications of - Poly(ether ether ketone) (PEEK) - Polyphenylene sulphides - polysulphones - liquid crystalline polymers - polyimides.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. J.A.Brydson, “Plastics Materials”, Butterworth- Heinemann – Oxford Press, 2005.
2. Olagoke Olabisi, “Hand Book of Thermoplastics”, Marcel Decker, inc., 1997.

REFERENCES:

1. Irvin.I.Rubin, “Hand Book of Plastic Materials and Technology”, Wiley Interscience, NY, 1990.
2. Feldman.D and Barbalata.A, “Synthetic Polymers”, Chapman Hall, 1996.
3. S.L. Rosen, “Fundamentals Principles of Polymeric Materials”, John Wiley Publisher, 2nd edition, 1993.

4. Charles A. Harper, "Plastic Materials and Process ecncyclopedia", John Wiley & Sons, 2003.

OUTCOMES:

At the end of the course, the students will be able

- To demonstrate the synthesis of monomers for different plastics.
- To describe different polymerization methods involved in manufacturing of various plastic materials.
- To exhibit knowledge in different polymers, their structure property relationship and applications.
- To differentiate plastics based on structure property relationship.
- To identify plastics based on the application requirements.
- To explain industrial and high performance plastics, their properties and applications.

EEC 2181	**INTRODUCTION TO ELECTRICAL AND ELECTRONICS ENGINEERING**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

- Basic concepts of electrical circuits and their solutions
- Performance of Electrical machines, speed control and their use as drives.
- Basic knowledge on power system and various methods of power generation through renewable energy sources.
- The concepts of quantum theory of solids and semiconductor materials.
- Basis of understanding the characteristics, operation and limitations of semiconductor devices.

MODULE I DC AND AC CIRCUITS 12

Circuit Parameters-Sources- Kirchhoff's laws-Solution of simple circuits AC quantities – Phasor representation – Power-Real, Reactive and Apparent Power – Solution of Simple circuits.

Superposition, Thevenin's, Norton's and Maximum power transfer theorem-Network solution by Mesh current and Node Voltage method

MODULE II ELECTRICAL MACHINES AND DRIVES 8

DC generator and Motor – Working Principle and Operating Characteristics – Starters for DC motors and speed control – applications.

Transformers - Single phase and three phase transformers- Working Principle – EMF equation - equivalent circuit and performance calculations.

Three phase and single phase induction motors - Working Principle – Torque-Slip characteristics – Starting and speed control – use of induction motor as industrial drives

MODULE III ELECTRIC POWER SYSTEMS 10

Structure of Power system – Transmission and Distribution schemes – Power Quality – Indian Electricity Rules and Regulations.

MODULE IV SEMICONDUCTORS 10

Energy band theory – intrinsic semiconductors- extrinsic semiconductors – Calculation of location of Fermi level and free electron and hole densities in extrinsic semiconductors – N and P type semiconductors- Mobility, drift current and conductivity – Diffusion current – Continuity equation – Hall effect – Calculation of electron and hole densities.

MODULE V PN JUNCTION AND SPECIAL DIODES 10

Band structure of PN Junction – Current Component in a PN Junction – Derivation of diode equation – switching characteristics of diode – Mechanism of avalanche and Zener breakdown – Zener diode & its applications –Diode as Clipper & Clamper – Varactor diode – Backward diode – Tunneling effect in thin barriers – Tunnel diode – Photo diode – Schottky diodes

MODULE VI TRANSISTORS AND AMPLIFIERS 10

Bipolar junction transistor – CB, CE, CC configuration and characteristics – Comparison – Field effect transistor – Configuration and characteristic – SCR, DIAC, TRIAC, UJT – Characteristics and simple applications – MOSFET:PMOS.NMOS – Structure and characteristics.

L – 60; Total Hours – 60

TEXT BOOKS:

1. William H. Hayt Jr, Jack E. Kemmerly, and Steven M. Durbin, “Engineering Circuit Analysis”, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2002.
2. Vedam Subrahmanyam, "Electric Drives", McGraw-Hill Education (India) Pvt Limited, 2010.
3. Edward Hughes, “Electrical and Electronics Technology”, Pearson India, 9th Edition, 2007.
4. D.P.Kothari and I.J.Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill Publishing Co Ltd, 2nd Edition, 2002.
5. I.J .Nagrath and D.P.Kothari, ‘Power System Engineering’ , Tata McGraw Hill Publishing Co Ltd, 2nd Edition, 2007.

REFERENCES:

1. Ewald F.Fuchs and Mohammed A.S.Masoum, Elsevier Academic Press, 2008.
2. Indian Electricity Rules, 1956.
3. Jacob Millman & Christos C.Halkias, “Electronic Devices and Circuits” Tata McGraw–Hill, 1991.
4. Floyd, “Electronic Devices: Conventional Current Version, 7/E” Pearson

Education India, 2008.
5. S. Salivahanan, N.Sureshkumar and A.Vallavaraj, “Electronic Devices and Circuits”, Tata McGraw Hill Publishing Co Ltd, 1998.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- The basics of electrical circuits and their solution methods.
- The working of machines and their drives.
- The structure of power system and importance of power quality.
- Various methods of power generation from renewable energy sources.
- Working of PN junction diodes and special-purpose diodes.
  Characteristics of transistors both in ideal and non-ideal cases

PEC 2104 **POLYMER SYNTHESIS LAB**

L	T	P	C
0	0	3	1

OBJECTIVES:

- To impart practical skills in synthesizing various polymers using different polymerization techniques.
- To impart knowledge in identifying suitable method for polymerization of polymer.
- To develop an understanding on various methods of polymerisation and its structure property relationship.
- To impart knowledge of various process parameters affecting the polymerisation technique.
- To equip with the fundamental knowledge of mechanism of polymerization.
- To impart practical skills on modifying polymer properties for specific applications.

LIST OF EXPERIMENTS :

1. Preparation of phenol-formaldehyde (Novolac) resin.
2. Preparation of phenol-formaldehyde (Resol) resin.
3. Preparation of urea-formaldehyde resin.
4. Preparation of bisphenol – A epoxy resin.
5. Preparation of unsaturated polyester resin.
6. Preparation of polyester using diethylene glycol & adipic acid.
7. Bulk polymerization of styrene.
8. Emulsion polymerization of styrene.
9. Solution polymerization of acrylonitrile.
10. Solution polymerization of vinyl acetate.
11. Suspension polymerization of methyl methacrylate.
12. Copolymerization of styrene and methyl methacrylate

Total Hours – 45

REFERENCES:

1 Enrique Saldivar-Guerra “Handbook of Polymer Synthesis, Characterization, and Processing” Eduardo Vivaldo-Lima, 2013.

2 Dietrich Braun, Harald Cherdron, Matthias Rehahn,et al., “Polymer Synthesis: Theory and Practice: Fundamentals, Methods, Experiments”, springer ,5th edition, 2012.
3 Geofrey Boothroyd, “Fundamentals of Metal Machining and Machine Tools”, McGraw Hill, 2006.
4 Kalpakjian, “Manufacturing Engineering and Technology”, 4th edition, Addison Wesley Congmen Pvt. Ltd., Singapore, 2009.

OUTCOMES:

At the end of the course, the student will be able to

- Synthesize thermoplastics and thermosetting polymers.
- Develop new polymers and chemically modify the existing polymers based on specific property requirements.
- Relate structure and its property of polymers.
- Select a suitable technique for synthesizing polymers.
- Compare the advantages and disadvantages of polymerisation techniques.
- Develop a new polymer for advance applications.

EEC2182	ELECTRICAL AND ELECTRONICS ENGINEERING LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To understand, simulate and verify Thevenin's and Norton's theorem.
- To understand and verify the characteristics of various electrical machines
- To understand the three phase power measurement in AC circuits**.**
- To verify practically, the fundamental characteristics of electron devices.

LIST OF EXPERIMENTS :

1. Verification of Thevenin's theorem and Norton's theorem using MATLAB
2. Open circuit characteristics and Load Characteristics of Self Excited DC Generator
3. Load Test on DC Shunt and DC Series Motor
4. Load Test on Single Phase Transformer
5. Load Test on Three Phase Induction Motor
6. Measurement of 3 phase power using 2 wattmeter method
7. PN Junction Diode characteristics.
8. Zener Diode characteristics.
9. Input and Output characteristics of BJT in CE configuration**.**
10. Characteristics of JFET.
11. SCR Characteristics.

Total Hours – 45

TEXT BOOKS:

1. William H. Hayt Jr, Jack E. Kemmerly, and Steven M. Durbin, "Engineering Circuit Analysis", Tata McGraw Hill Publishing Co Ltd, New Delhi, 2002.
2. Vedam Subrahmanyam, "Electric Drives", McGraw-Hill Education (India) Pvt Limited, 2010.
3. Edward Hughes, "Electrical and Electronics Technology", Pearson India, 9th Edition, 2007.
4. D.P.Kothari and I.J.Nagrath, "Basic Electrical Engineering", Tata McGraw Hill Publishing Co Ltd, 2nd Edition, 2002.
5. I.J .Nagrath and D.P.Kothari, 'Power System Engineering' , Tata McGraw Hill Publishing Co Ltd, 2nd Edition, 2007.

REFERENCES:

1. Ewald F.Fuchs and Mohammed A.S.Masoum, Elsevier Academic Press, 2008.
2. Indian Electricity Rules, 1956.
3. Jacob Millman & Christos C.Halkias, “Electronic Devices and Circuits” Tata McGraw–Hill, 1991.
4. Floyd, “Electronic Devices: Conventional Current Version, 7/E” Pearson Education India, 2008.
5. S. Salivahanan, N.Sureshkumar and A.Vallavaraj, “Electronic Devices and Circuits”, Tata McGraw Hill Publishing Co Ltd, 1998.

OUTCOMES:

At the end of the course, the student should be able to:

- Construct and simulate any given simple electric circuits and verify theorems using MATLAB.
- Study and understand the performance of Electrical Machines.
- Measure the three phase power.
  Experimentally understand the characteristics of diodes, BJT’s and FET’s and SCR.

PEC 2105 MACHINING PRACTICE LAB

L	T	P	C
0	0	3	1

OBJECTIVES:

- To demonstrate the knowledge of machining principles and safe working practices.
- To equip how to set the machining parameters in accordance of machining requirement.
- To impart practical skills in metal cutting processes.
- To provide understanding of machining operations in mould manufacturing.
- To impart knowledge of various process parameters affecting the machining operations in mould manufacturing.
- To equip with the fundamental knowledge of metrology and its applications in mould making processes.

LIST OF EXPERIMENTS:

1. Exercise on Shaping machine – making square rod from round rod and cutting V- groove.
2. Exercise on Plain Milling.
3. Exercise on Vertical Milling.
4. Exercise on Surface Grinding.
5. Exercise on Slotting Machine.
6. Grinding of Cutting tools.
7. Study of different types of Cutting tools.
8. Exercise on EDM.
9. Study of Micrometer, Vernier calipers, Height gauge and Slip gauge.
10. Measurement of angles and tapers.
11. Checking of straightness using auto collimeter.

Total Hours – 45

TEXT BOOKS:

- HMT – “Production Technology”, Tata McGraw-Hill, 2001.
- Hajra Choudhury, “Elements of Workshop Technology”, Vol. I and II, Media Promoters Pvt Ltd., Mumbai, 2007.
- P.C. Sharma, “A Text Book of Production Technology”, S. Chand and Company, 10th Edition, 2008.

- P.N. Rao, “Manufacturing Technology”, Tata McGraw-Hill Publishing Limited, II Edition, 2009.
- Jain.R.K, “Production Technology : Manufacturing Processes, Technology and Automation”, 17th Edition, Khanna Publishers, 2011.

REFERENCES:

- Chapman.W.A.J, “Workshop Technology Vol. I and II”, Arnold Publisher, New Delhi, 2001.
- Richerd R. Kibbe, John E. Neely, Roland O. Merges and Warren J. White, “Machine Tool Practices”, Prentice Hall of India, 2003.
- Geofrey Boothroyd, “Fundamentals of Metal Machining and Machine Tools”, McGraw Hill, 2006.
- Kalpakjian, “Manufacturing Engineering and Technology”, 4th edition, Addison Wesley Congmen Pvt. Ltd., Singapore, 2009.

OUTCOMES:

At the end of the course, the students will be able to

- Mount the tools and workpieces in accordance with industry practice, worksite procedures, and safety guidelines.
- Set various machining parameters in accordance with job specifications and machine operating procedures.
- Operate the shaping machines to make square rod from round rod and V groove.
- Manufacture various components by milling operations.
- Polish the machined surface by grinding operations.
- Identify and use the basic measuring instruments used in machine shop.
- Measure and confirm that they meet the specified tolerances in accordance with job specifications.

Semester – IV

ENC2282	WRITTEN COMMUNICATION	L	T	P	C
		0	0	2	1

OBJECTIVES:

To develop their creative thinking skills and write reviews.

- To train them with the nuances of corporate correspondence
- To train them in writing official letters, technical reports and proposals.
- To expose them to the writing of Statement of Purpose.

MODULE: I WRITTEN COMMUNICATION 8

Written Communication – Introduction - process of writing – ABC of academic and professional writing – Writing an article.

MODULE: II CREATIVE WRITING 9

Creative Writing - Writing stories based on visuals - Preparing an outline for a story - Writing critical reviews on an article / a paper.

MODULE: III CORPORATE CORRESPONDENCE 7

Corporate Correspondence – Tone in formal writing – e-mail writing, memo, fax, agenda and minutes writing.

Lab: viewing e-mail etiquette, format and conventions of writing memo. ‘

MODULE: IV OFFICIAL LETTERS 7

Official Letters: Writing Statement of purpose, Letter of Application and Resume – Assessing one’s strengths and weaknesses – peer evaluation.

Lab: Resume writing – Viewing different types – Functional, Chronological - Writing one’s resume using wiki, Letter calling for interview and seeking promotion.

MODULE: V TECHNICAL WRITING 1 7

Describing an experiment, writing instructions and recommendations, Feasibility report and progress report, Synopsis – Group assignment – case study.

MODULE: VI TECHNICAL WRITING II 7

Writing a technical proposal – Format – cover page, executive summary, timeline chart, budget estimate, drafting, conclusion.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. Riordan & Pauley. 'Report Writing Today'. 9th Edition. Wadsworth Cengage Learning, USA. 2005.
2. Gerson, Sharon & Steven M. Gerson, 'Technical Writing: Process and Product' Pearson Education , New Delhi. 2004.

REFERENCES:

1. Riordan & Pauley. 'Report Writing Today'. 9th Edition. Wadsworth Cengage Learning, USA. 2005.
2. Gerson, Sharon & Steven M. Gerson, 'Technical Writing: Process and Product' Pearson Education , New Delhi. 2004.
3. *M* Ashraf Rizvi 'Effective Technical Communication'. Tata McGraw-Hill Education, 2005.
4. Sharma, R.C. & Krishna Mohan, "Business Correspondence and Report Writing". Tata MacGraw – Hill Publishing Company Limited, New Delhi. 2002.
5. Anderson, Durston & Pool. "Thesis and Assignment Writing". 4th Edition. John Wiley & Sons. Australia. 2002.

OUTCOMES:

On completion of the course, the students will have the ability to write all kinds of formal correspondence like letters, reports and proposals.

PEC2211	POLYMER RHEOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide understanding about the mechanical behavior of polymeric materials.
- To provide an understanding on mechanical models based on its properties.
- To impart knowledge in rheological behavior of polymer melts.
- To provide an understanding on various parameters influencing polymer rheology.
- To equip with the knowledge about the function of various rheometers.
- To apply the fundamentals of polymer rheology in different processing applications.

MODULE: I MECHANICAL BEHAVIOUR OF POLYMERIC MATERIALS 8

Introduction to Rheology – Types of mechanical deformation – Elastic materials – Viscous materials – Viscoelasticity – effect of rate of strain, temperature and time on mechanical behaviour of polymeric materials – creep – stress relaxation – Boltzman principle – time temperature super position principle – WLF equation.

MODULE: II MECHANICAL MODELS-VISCOELASTIC BEHAVIOUR 9

Mechanical models – stress strain response of spring and dashpot – viscoelstic models – Maxwell element – Voight kelvin element – response to creep and stress relaxation – four-parameter model – dynamic mechanical properties – behavior of Maxwell element and relaxation spectra.

MODULE: III PARAMETERS INFLUENCING POLYMER RHEOLOGY 7

Effect of pressure on viscosity, effect of temperature, activation energy effect of molecular weight and molecular weight distribution on viscosity, molecular at dependence of zero shear viscosity, effect of crosslinking, crystallinity branching, copolymerization, effect of fillers, fiber filled polymer melts, effect of plasticizers, shear rate dependence of viscosity.

MODULE: IV FLOW PROPERTIES OF POLYMER MELT 7

Fluid flow – types of fluid flow – time dependant fluids, shear rate dependant fluids, Newtonian and Non Newtonian fluids – laminar flow of Newtonian fluids - viscosity of polymer melts – shear thinning and shear thickening – zero-shear rate viscosity – laminar flow of Newtonian fluids- power law – general treatment of isothermal viscous flow in tubes – entrance and exit effects - elastic effects in polymer melt flow - die-swell and melt fracture – Weissenberg effect – normal stress difference – Elongational viscosity.

MODULE: V MEASUREMENT OF RHEOLOGICAL PROPERTIES 7

Measurements of rheological properties – capillary rheometers – melt flow index – cone and plate viscometrer – torque rheometers – Mooney viscometer – curemeters – Rheo – optical methods – birefringence

MODULE: VI APPLICATION OF POLYMER RHEOLOGY TO PROCESSING 7

Rheological behaviour of important thermoplastics PE, PVC, PS, PP, nylons and PC – Applications of rheology to polymer processing (injection moulding, extrusion and blow moulding).

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. Montgomery T. Shaw, "Introduction to Polymer Rheology", Wiley, Kindle Edition, 2012.Vikas Mittal, " High Performance Polymers and Engineering Plastics", Scrivener Publishing LLC, 2011.
2. Chang Dae Han, "Rheology and Processing of Polymeric Materials : Volume 2 : Polymer Processing", Oxford University Press, USA, 2007.
3. Tim Osswald and Natalie Rudolph Madison, "Polymer Rheology Fundamentals and Applications", Hanser Publishers, Munich, Cincinatti, USA, 2014.
4. Richard .G. Griskey, "Polymer Process Engineering ", Springer Science and Business Media, 2012.
5. J.A Brydson, "Plastics Materials", Butterworth-Heinemann; 8th Edition, UK, 2016

REFERENCES:

1. Herman F. Mark, "Encyclopedia of Polymer Science and Technology", Wiley; 4rd Edition, 2014.
2. Alexander Ya. Malkin, Avraam I. Isayev Rheology, "Concepts, Methods, and Applications", ChemTech Publishing, 2nd Edition, 2012.

OUTCOMES:

At the end of the course, the students will be able

- Construct a model for the different combination of viscoelastic polymer melts.
- Demonstrate the rheological behavior of thermoplastic materials.
- Analyze the flow properties of polymer melts.
- Critique the influence of rheology on different properties of the polymer.
- Explain the function of various rheological instruments and optimize its parameters.
- Apply the theory of rheology in the applications of polymer processing.

PEC 2212	SCIENCE AND TECHNOLOGY OF RUBBERS	L	P	T	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge in predicting and modifying the properties of rubber.
- To provide understanding on rubber compounding ingredients, their importance and technical classification of rubber mixes.
- To make students conversant with the manufacture of different rubbers.
- To develop an understanding on properties and application of various rubbers.
- To have fundamental knowledge on the mechanism of vulcanizing rubbers.
- To enhance their skill in developing formulation for desired properties of rubbers.

MODULE: I SCIENCE OF RUBBERS 6

Physics of Rubber Elasticity – Thermodynamics of rubber – Classification of rubbers – Effect of structure on Tg – Effect of chemical structure on the performance properties of rubbers – Effect of structure on processing properties of elastomers.

MODULE: II COMPOUNDING AND MIXING 7

General principles of rubber compounding – Various compounding ingredients and their classification – Preparation, properties and uses of carbon black – Non-black fillers, plasticizers, accelerators, activators, cross linking agents – Special purpose additives– Rubber mixing mechanism– Mixing machinery – Two roll mill, Internal mixer.

MODULE: III MOLDING AND VULCANISATION 5

Compression, transfer and injection molding of rubbers – Curing characteristics - Mechanism of crosslinking by different crosslinking agents – Vulcanisation techniques.

MODULE: IV SPECIAL PURPOSE RUBBERS 9

Manufacture, Properties and Application: IIR– EPRs– NBR– CR– HNBR– ACM– EMA–EVA– CSM– CM– epichlorohydrin rubbers – polysulphide rubbers.

MODULE: V GENERAL PURPOSE RUBBERS 9

Natural rubber latex, tapping – Conversion to dry rubber – Properties, grading and specifications of NR – Chemically modified NR – SBR : preparation, types, properties and appliations– BR: polymerization , properties and applications – IR: Manufacture, properties and appliations – poly alkenamers, poly norbornenes.

MODULE: VI HIGH PERFORMANCE AND THERMOPLASTIC ELASTOMERS 9

Manufacture, Properties and Application: Silicone Elastomers– Fluorocarbon rubbers – Polyurethane Rubbers – Requirements for thermoplastic elastomeric behavior – Different methods of preparation – SBS and SIS Block copolymers – Thermoplastic Polyurethane elastomers – Thermoplastic – co – polyesters – Thermoplastic elastomers based on Plastics – Rubber Blends – Dynamic Vulcanization.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1 Maurice Morton, “Rubber Technology”, Third edition, Springer Science & Business Media, 2012.
2 J John M. Funt, “Mixing of Rubber”, First Edition, Smithers Rapra Technology, 2009.
3 Jean-Maurice Vergnaud, Iosif-Daniel Rosca, “Rubber Curing and Properties”, First Edition, CRC Press, 2016 .
4 James E. Mark, Burak Erman, Frederick R. Eirich , “Science and Technology of Rubber”, Second Edition, Academic Press, 2014.
5 Jim White, J. R. White, “Rubber Technologist's Handbook, Volume 2”, Second Edition, Smithers Rapra Technology, 2009.
6 Anil K. Bhowmick, “Current Topics in Elastomers Research”, First Edition, CRC Press, 2008.

REFERENCES:

1 John S. Dick , “Rubber Technology: Compounding and Testing for Performance”, Second Edition, Carl Hanser Verlag GmbH & Company KG, 2014.
2 R. B. Simpson, “Rubber Basics”, First Edition, iSmithers Rapra Publishing, 2002 .
3 Anil K. Bhowmick, Howard Stephens, “Handbook of Elastomers”, Second Edition, CRC Press, 2000.

OUTCOMES:

At the end of the course, the students will be able to

- Predict the properties of rubbers based on their chemical structure and modify it as per property requirement.
- Demonstrate skills to use rubber processing machineries and develop a high quality rubber compound.
- Select proper vulcanization mechanism for particular rubber compound to meet desired product performance.
- Select suitable grade of general purpose rubbers for desired application.
- Apply the knowledge of various rubbers and select an appropriate rubber for a given application.
- Design a suitable formulation for products requiring high performance properties.

PEC 2213	PLASTICS AND RUBBER COMPOUNDING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop an understanding on the limitations aspect of polymeric materials during synthesis, manufacturing, service and emphasize the importance of various additives.
- To impart knowledge in selecting the various additives based on the performance and property requirements of the specific polymer.
- To provide knowledge on the chemistry and mechanism involved in incorporation of additives into polymeric materials.
- To impart skill in compounding of various thermoplastics to attain the desired performance.
- To impart skill in compounding of various thermosets and rubbers to attain the desired performance.
- To develop a formulation for various polymeric products.

MODULE: I INTRODUCTION TO COMPOUNDING 5

Introduction – limitations of polymeric materials. Additives: additives for plastics – technological requirements of additives. Compounding of plastics and rubber

MODULE: II ADDITIVES FOR COMPOUNDING 9

Types, mechanism, advantages and limitations of antioxidants – lubricants – heat stabilizers – UV stabilizers – plasticisers – fillers – reinforcements - flame retardants – processing aids – blowing agents – toughening agents – colorants – anti static and anti slip agent, oxidation techniques.

MODULE: III COMPOUNDING OF THERMOPLASTICS 7

Compounding of poly(vinyl chloride) – formulations for rigid and flexible PVC products – design of formulations. Compounding of polyolefins – polyethylene, XLPE ,polypropylene.

MODULE: IV COMPOUNDING OF THERMOSETS 8

Compounding of thermosets - unsaturated polyester resins – epoxy resins – compounding of moulding powders – phenol-formaldehyde – melamine formaldehyde.

MODULE: V COMPOUNDING OF RUBBERS 8

Vulcanizing agents - sulphur and peroxides – activators, accelerators, conventional and efficient vulcanization systems – retarders, promoters, antioxidants, antiozonants, processing aids, fillers – non black and carbon black – chemical blowing agents, latex compounding.

MODULE: VI EQUIPMENT FOR COMPOUNDING 8

Single screw extruders – twin-screw extruders – internal and external mixers - high speed fluidized mixer and cooler - mixing machineries for rubbers – two roll mill – internal batch mixers – continuous mixers – banbury mixer - operations and maintenance of mixing equipments.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. Natamai Subramanian Muralisrinivasan, "Introduction to Polymer Compounding: Raw Materials", Volume 1, published by Smithers Rapra Technology Ltd, Volume 1, 2014.
2. Dr.Muralisrinivasan Natama Subramanian, "Introduction to Polymer Compounding: Raw Materials", Volume 1, 2014.
3. Michael Schiller "PVC Additives: Performance, Chemistry, Developments, and Sustainability" Carl Hanser Verlag GmbH & Company KG, 2015.
4. Brendan Rodgers, "Rubber Compounding: Chemistry and Applications", Second Edition, edited by Taylor and Francis Group,2015.
5. Plastics Materials by J.A.Brydson, seventh edition, 2017.
6. John S.Dic, Annicelli.R.A. "Rubber Technology: Compounding and Testing for Performance" Hanser Gardner Publisication, 2001.
7. Plastics Additives, an A-Z reference, edited by Geoffrey Pritchard, 1998.
8. Chris Rauwendaal Polymer Mixing, A self-study Guide, Hanser Publisher, ed.1998.
9. Richard F.Grossman, The mixing of Rubbers, Chapman & Hall, 1997.
10. David B Todd, Plastic Compou Maurice Morton, Ed Rubber technology, Third Edition, Van Nostrand Reinhold, New York, 1987.
11. C.M.Blow and Hepburn, - Rubber Technology and Manufacture, 2nd edition, 1982.

REFERENCES:

1. Michael Bolgar, Jack Hubball, Joseph Groeger, Susan Meronek, "Handbook for the Chemical Analysis of Plastic and Polymer Additives", Second edition, 2015.

2. J.M.Martin, W.K.Smith, “Handbook of Rubber Technology”, CBS Publishers & Distributors, New Delhi, 2004.

OUTCOMES:

After completion of this course, students will be able to

- Suggest a suitable additive based on the performance and property requirement of the specific polymer.
- Apply knowledge in compounding of various thermoplastics to enhance proper dispersion and attain desired performance.
- Apply knowledge in compounding of various thermosets and rubbers to enhance proper dispersion and attain desired performance
- Select suitable equipment for compounding specific thermoplastic, thermoset and rubber.
- Select suitable additives for compounding polymers based on its properties and specific applications.
- Compound polymers for advance applications.

PEC 2214	POLYMER ANALYSIS AND CHARACTERIZATION	L	P	T	C
		3	0	0	3

OBJECTIVES:

- To impart the skill in identifying various polymers and validating their quality.
- To provide understanding on the usage of sophisticated instruments to analyze the morphology of polymers.
- To impart the knowledge of various techniques in characterizing the molecular structure of polymers.
- To impart the skills in handling various instruments and analyzing the test results.
- To develop an understanding on morphological characterization of polymers.
- To provide knowledge of rheological characterization and processability of polymers.

MODULE: I ANALYSIS OF THERMOPLASTICS 5

Preliminary Identification of thermoplastics – Chemical Identification of thermoplastics– Raw materials characterization - melting point, density, viscosity, melt flow index, K-value.

MODULE: II ANALYSIS OF THERMOSETS AND RUBBERS 8

Preliminary and chemical Identification of thermosets and rubbers – Raw materials characterization of thermosets - moisture content, particle size, apparent density, flow test , gel time and peak exothermic temperature - acid value, hydroxyl value, isocyanate index, epoxy equivalent. Analysis of latex - viscosity, TSC, DRC, alkalinity, volatile matter, KOH number, mechanical stability.

MODULE: III SPECTROSCOPIC CHARACTERIZATION 8

Instrumentation, Analysis and Interpretation:Vibrational Spectroscopy- Principle – UV- Visible Spectrophotometer – Raman – NMR – Mass Spectroscopy – Instrumentation – Fourier Transform Infrared Spectroscopy (FTIR) – Group frequencies and Finger Print Regions.

MODULE: IV THERMAL CHARACTERIZATION 8

Instrumentation, Analysis and Interpretation:Thermogravimetric analysis (TGA) – Differential scanning calorimetry (DSC) – Differential thermal analysis (DTA) – Dynamic mechanical analysis (DMA) – Thermomechanical analysis (TMA) – Dielectric thermal analysis (DETA).

MODULE: V MORPHOLOGICAL CHARACTERIZATION 8

Instrumentation, Analysis and Interpretation:X-RAY Diffraction – WAXD – SAXS – Crystal Structure – Birefringence – optical microscopy– scanning electron microscopy– transmission electron microscopy – Atomic Force Microscopy.

MODULE: VI RHEOLOGICAL CHARACTERISATION AND PROCESSALBILITY 8

Characterization of Shear and Elongational flow – Capillary Rheometers – Rotational Rheometers – Parallel plate Rheometers– Rheological Characterization of filled and unfilled Polymers – Tests for processability parameters of rubbers – ODR, scorch time, cure time, cure rate index, plasticity, mooney viscosity.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1 Vishu Shah, "Handbook of plastics testing and failure analysis", Third edition, John Wiley and Sons, 2007.
2 Roger Brown, "Physical test methods for elastomers", First Edition, Springer, 2017.
3 John M. Chalmers, Robert J. Meier, "Molecular Characterization and Analysis of Polymers", Volume 53 of Comprehensive Analytical Chemistry, Elsevier, 2008.
4 Edith Turi, "Thermal Characterization of Polymeric Materials", First edition, Elsevier, 2012.
5 Richard A. Pethrick, "Polymer Structure Characterization: From Nano to Macro Organization in Small Molecules and Polymer", First edition, Royal Society of Chemistry, 2013.
6 B.J. Hunt, M.I. James, "Polymer Characterisation", Third Edition, Springer Science & Business Media, 2012.

REFERENCES:

1 Dan Campbell, Richard A. Pethrick, Jim R. White, "Polymer

Characterization: Physical Techniques", Second Edition, CRC Press, 2000.
2 Luigia Sabbatini, "Polymer Surface Characterization" , First edition, Walter de Gruyter GmbH & Co KG, 2014.
3 Linda C. Sawyer, "Polymer Microscopy", First edition, Springer Science & Business Media 2012.
4 Wiley, "Characterization and Analysis of Polymers", First edition, John Wiley & Sons, 2008.

OUTCOMES:

After completion of this course, students will be able to

- Analyse the various plastics and rubbers by simple physical & chemical methods.
- Analyze morphological characterisctics of polymers and interpret their occurrence.
- Select suitable characterization techniques to analyse the thermal characteristics of polymers.
- Analyse the rheological characteristics of polymers.
- Interpret test results and create test reports.
- Analyse the quality of raw materials for suitable application and processing conditions.

PEC 2215	**POLYMER CHARACTERIZATION LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1**

OBJECTIVES:

- To provide skills in identification of plastics and rubbers by simple physical and chemical methods.
- To impart fundamental knowledge in analyzing various physical and chemical properties of the polymers.
- To equip with practical skill in analyzing the quality of natural rubber latex.

LIST OF EXPERIMENTS :

PART I

1. Identification of Plastics:
   PE, PP, PS, PVC, PVA, polyamides, Polyesters, PF, UF and MF.
2. Identification of Rubbers:
   NR, BR, SBR, CR, NBR and Silicone rubber.

PART II

1. Determination of molecular weight of polymers by viscosity method.
2. Determination of epoxy equivalent.
3. Determination of K – value of PVC resin.
4. Determination of moisture and water absorption in plastics.
5. Determination of gel time and peak exothermic temperature for thermosetting resins.
6. Determination of melt flow index of thermoplastic materials.
7. Determination of filler content in plastics / rubbers.
8. Determination of total solid, dry rubber content and total alkalinity of NR latex.

Total Hours – 45

TEXT BOOKS:

1 Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah, “Polymer Processing and Characterization: 1 (Advances in Materials Science)”,Apple Academic Press; 1 edition ,January 31, 2013.
2 V.A. Bershtein , G.C. Berry, et al, “Polymer Analysis and Characterization (Advances in Polymer Science)”,2013.
3 T.R. Crompton, “Practical Polymer Analysis”, 2012.
4 Joseph D. Menczel , R. Bruce Prime, “Thermal Analysis of Polymers”,

Fundamentals and Applications", Wiley; 1 edition , April 20, 2009.
5 Characterization and Analysis of Polymers, by Wiley, 2008.

OUTCOMES:

At the end of the course, the student will be able to

- Identify the plastics and rubbers by simple physical and chemical methods.
- Analyze and determine the various physical properties of plastics and rubbers.
- Analyze and determine the various chemical properties of plastics and rubbers.
- Compare the structure and its properties of various polymers.
- Determine the cure characteristics of the thermosetting resins.
- Characterize the quality of latex.

SEMESTER V

MSC3181	LEADERSHIP AND CEOTRAINING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course aims at

- Bringing about positive transformation in students' attitude.
- Building unique leadership competencies that would ensure successful transition of students across all career stages.
- Sensitizing students to identify their strengths & weakness and training them to deal with it
- Assisting students in enhancing their expressive ability and inducing a high level of self-confidence to manage both business and emotions
- Training students to become more adaptable and flexible to changing business environment

MODULE I INTRODUCTION TO LEADERSHIP 12

Leadership concept - meaning, definitions, importance of leadership, leadership traits. Leadership functions- general functions, listening, observing, managing and decision making. Components of leadership - leaders, followers and situation. Leadership theories – Trait theory, Skills theory, Style theory, Situational theory, Transformational theory, Transactional theory, Path Goal Theory and LMX. Assessing emotional intelligence and exploring the capabilities and inherent traits.through psychometric tests - Multi factor leadership questionnaire and personal reflections

MODULE II LEADERSHIP STYLE AND COMMUNICATION 8

Leadership styles-visionary, Coaching, Affiliative, Democratic, Pacesetting Commanding, Transformational, Transactional. Autocratic, Participative, Laissez-Faire Leader versus Managers. Leadership communication - Rationale, tactic, assertive, formal, informal, communication in crisis- leadership and negotiations, Leadership Presentations-convincing and impressive style

MODULE III LEADERSHIP ROLES 8

Facets of leadership- Leader as an individual – personality and leadership, values, attitudes and ethics of a leader. Leader as a relationship builderempowering people to meet higher order needs, initiating organization wide motivational programs, involvement with all stakeholders- focusing on organization growth. Leader as an inspirer- motivation and leadership, recognizing and appreciating contributions, empowering others to lead Leader as an innovator –leader's role in shaping culture and values in an organization. Leader as a Liaison- Leader as team player

MODULE IV LEADERSHIP CHALLENGES AND STRATEGIES 9

Challenges in leadership: Perception of organization culture and values, interpreting the power dynamics in the organization, establishing work life balance. Bad leadership – Reasons and impact. -Case Study of Marissa Mayer-Yahoo.Inc Organizational transformation through efficient leaders-Case study of Apple Inc. Blue Ocean Leadership-Steps to Blue ocean Leadership-Four Pillars of Blue Ocean leadership-Blue Ocean leadership grid

MODULE V LEADERSHIP AND CEO TRAINING 8

Leader as a CEO: Traits of a successful CEO, Key responsibilities of a CEO, the path to be a CEO, Training on Board Room Discussions, Meeting the CEO –Live sessions with industry CEO's. Requirements of Leadership: - Cognitive skills, Interpersonal skills, Business skills, Strategic skills. Role of Emotional Intelligence in taking up key-positions in the organization.

Teaching Pedagogy:

Nurturing – Based on the identified strengths and weaknesses, training will be given to enhance the strengths and overcome the weakness.

Assessment - Continuous evaluation will be effected through group discussions, oratory assignments and situational enactments. Pre-and post-training assessment through peer reviews and faculty feedback.

Sustained development – Training will be imparted for self-development and monitoring of leadership skills to ensure sustained applicability of the skills learnt.

Total Hours: 45

REFERENCES:

1. Andrew J DuBrin. "Leadership: Research Findings, Practice, and Skills", 8th Edition, South-Western College Pub, 2015.
2. Yukl G, "Leadership in Organisations", 8th Edition, Pearson Education, 2013.

3. Richard L Daft, "Leadership", 5th Edition, South Western Cengage Learning 2012.
4. Stephen P. Robbins and Timothy A. Judge. "Organizational Behaviour", 15th Edition, New Delhi: Pearson, 2013.
5. Fred Luthans, "Organizational Behavior, an Evidence Based Approach", 12th Edition, New Delhi: McGraw Hill Education, 2013.
6. Emotional Intelligence, Why it can matter no more than IQ by Daniel Goleman (include a book) Publisher: Bloomsbury Publishing India Private Limited; Latest edition (2017)
7. Primal Leadership: Unleashing the Power of Emotional Intelligence by Prof Daniel Goleman , Richard Boyatzis and McKee,Harvard Business Review Press

RECOMMENDED READINGS:

1. Jim Collins, (2001). "Good To Great: Why Some Companies Make the Leap...And Others Don't", Random House Publishers India Pvt.Ltd, New Delhi
2. George, B. with Sims, P. True North: Discover Your Authentic Leadership, The Times Group Books; First edition (1 October 2015)
3. Kim, W. C., & Mauborgne, R. A. (2014). Blue ocean strategy, expanded edition: How to create uncontested market space and make the competition irrelevant. Harvard business review Press
4. Leadership Wisdom by Robin Sharma Jaico Publishing House;

OUTCOMES:

The students will be able to

- Explore through self-introspection one's own leadership style, their strength and weakness
- Gain self-confidence to lead a team in the organization
- Realize the role of leadership in making or breaking of an organization
- Acquire the practice of self-introspection and development of leadership competencies thorough continuous efforts
- Manage their own emotions as well as other resulting in successful relationship building with all stakeholders

MSC 3182 SOCIAL ENTREPRENEURSHIP

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the fit between individual and their entrepreneurial ambitions.
- To identify the customers and find a problem worth solving.
- To create a business model for solving the problems of customer, forming solution and present the Business Model Canvas
- To develop a solution for customers' problem and analyze the problem solution fit & product market fit.
- To build and demonstrate a Minimum Viable Product (MVP) for startup.
- To analyze and understand the impact of social entrepreneurship on society and cases.

MODULE I SELF & OPPORTUNITY DISCOVERY 9

Finding the flow, Effectuation, Entrepreneurial Style, Business Opportunities, Problem Identification, Design Thinking, Potential solutions, Presentation of the problem- Case Study.

MODULE II CUSTOMER , SOLUTION AND BUSINESS MODEL 9

Customers and Markets, Identification of Customer Segment, Niche Segment, Customers Jobs, Pain and Gain, Early Adopters, Value Proposition Canvas, Basics of Business Model and Lean Canvas, Risk and Assumptions.

MODULE III VALIDATION AND MONEY 9

Blue Ocean Strategy, Solution Demo, Problem – Solution Fit, Minimum Viable Product- Product Market Fit, Prototype – Case Study. Cost, Revenues, Pricing, Profitability Checks, Bootstrapping, Initial Financing and Pitching.

MODULE IV TEAM BUILDING AND MARKETING 7

Shared Leadership, Hiring, Fitment , Team Role and Responsibilities , Collaboration Tools and Techniques, Positioning and Branding, Channels

MODULE V SALES & SUPPORT 6

Sales Planning, Selling Skills, Project Management, Project Tracking, Basic of Business Regulation, Startup.

MODULE VI IMPACT OF SOCIAL ENTREPRENEURSHIP ON SOCIETIES AND CASES 5

Impact of Social Entrepreneurship, NGO vs For-Profit Companies vs. Social Entrepreneurship. Procedures for registration of small scale industry, Overview of venture capital and angel investment, Social entrepreneurship report preparation by students. Case Study of Social Entrepreneurs.

Total Periods- 45

TEXT BOOKS

1. Entrepreneurship Rajeev Roy oxford, 2012.
2. Learn wise platform - Wadhwani Foundation, 2018
3. “Social Entrepreneurship and Social Business” Christine K Volkmann, Springer Gabler 2012.
4. The Process of social value creation: A multiple case study on Social Entrepreneurship in India, Archana Singh Springer 2016.

REFERENCES

1. Social Entrepreneurship” Manuel London, Routlege, 2012.
2. The Process of social value creation: A multiple case study on Social Entrepreneurship in India, Archana Singh Springer 2016.
3. Running Lean: Iterate From Plan A To a Plan That Works, Ash Maurya, "O'Reilly Media, Inc.", 28-Feb-2012.

OUTCOMES:

On completion of the course, students will be able to

- Build an entrepreneurial mindset and reach out the customer to identify the problem using design thinking process
- Craft solution to the problem through value proposition canvas and develop a business model using lean canvas
- Provide product solution demo and deliver a minimum viable product
- Work as a team and create brand strategy marketing for product/service
- Prepare, make an outstanding sale pitch for startup.
- Showcase the impact of Social Entrepreneurship on society and cases.

ENC3181	COMMUNICATION AND SOFT SKILLS-I CAREER CHOICE	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To create awareness of industrial trends and market demands.
- To encourage students to explore career opportunities in an industry and evaluate themselves in relation to industry preparedness.
- To train them in making presentations and writing statement of purpose effectively.

MODULE I **6**

Knowledge about specific industry-Discussion with industry experts --Self evaluating career prospects through survey questionnaire (based on his/her eligibility for taking up a job (industry preparedness)

MODULE II **6**

Knowing case studies of industries (pertaining to students' choice of career)-Reading and discussing about job markets-goal setting, working on creativity.

MODULE III **4**

SWOC analysis and discussing outcomes--exploring mini projects or case studies of latest industries.

MODULE IV **6**

Writing statement of purpose pertaining to career choice---- Outcomes

MODULE V **8**

Project or case study presentations (Presentation in pairs) -mini project report or case study report.

Total Hours: 30

REFERENCES:

1. Brown,D.(2002). Career Choice and Development. Wiley,J. & Sons.USA
2. Lore,N.(1998). The Pathfinder: How to Choose or Change Your Career for a Lifetime of Satisfaction and Success. Simon &Schuster.USA.
3. Shell, G.R.(2013). *Springboard Launching your Personal Search for*

SuccessPortfolio.USA.

OUTCOMES:

After the completion of the course, students would be able to

- Speak about their career choice.
- Self evaluate their strengths and weaknesses and speak about it.
- Make effective presentations on case studies or relating to projects.
- Write the statement of purpose relating to their career choice

PEC 3101	PLASTICS PROCESS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide fundamental knowledge of injection moulding process.
- To introduce advanced injection moulding process.
- To impart knowledge of extrusion molding process.
- To develop knowledge of processing thermoset materials by compression and transfer molding processes.
- To illustrate the various blow moulding process.
- To develop knowledge of thermoforming and rotational moulding processes.

MODULE I INJECTION MOLDING PROCESS 7

Principle of injection moulding - process sequence, moulding cycle - injection moulding machines - types, machine specification - clamp systems - process control - process optimization - machine startup and shut down procedure - trouble shooting.

MODULE II ADVANCED INJECTION MOULDING TECHNIQUES 8

Gas assisted injection moulding- Water Injection Techniques - injection foam moulding - thin wall moulding - micro injection moulding - in-mold labeling and decoration - Multi-Material Injection Molding - Insert Injection Molding Process.

MODULE III EXTRUSION MOLDING PROCESS 10

Fundamentals of extrusion process–basic operation of single screw and twin screw extruders - screw design– construction and operation, different type of screws. Extrusion of Pipes, profile, wire and cable coating - Film extrusion–blown film, cast film, flat film. Filament and fiber extrusion process, Coating and lamination, Co–extrusion - Process control variables, effect of process parameters on product.

MODULE IV BLOW MOULDING PROCESS 6

Principle of blow molding process - Types of Blow Moulding - Extrusion Blow Moulding System - molding head and die unit - parison adjustment - die shaping - parison programming - advanced extrusion blow molding - injection stretch blow molding process - machines - injection controls - trouble shooting.

MODULE V COMPRESSION & TRANSFER MOULDING 6

Types and procedure of compression molding process, moulding materials, bulk factor, effect of preheating, advantages and disadvantages of compression moulding process.

Basic principle of transfer moulding process and moulding cycle, Types of transfer molding, molding defects, process parameters and their effect on product quality, advantages and limitations.

MODULE VI MISCELLANEOUS POLYMER PROCESSING OPERATIONS 8

Principles of thermoforming - theory of forming process - forming characteristics - thermoforming methods- one-step forming - two-step forming - three-step forming - Methods of heating sheet - heating cycle time - sheet stretching and cooling - thermoforming machines - advantages and disadvantages of thermoforming.

Rotational molding process description - polymers for rotational moulding - grinding - particle size distribution- colouring - Powder Behavior - Characteristics of Powder Flow - Rheology of Powder Flow - Tack Temperature - Water Cooling - Pressurization - Part Removal - Liquid Rotational Molding - machines - trouble shooting.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. Musa R. Kamal, “Injection Moulding - Technology and Fundamentals", Hanser Publications, Inc., Cincinnati, 2009.
2. Suhas Kulkarni. "Robust process development and scientific molding : theory and practice", Hanser Publications, 2010
3. Chris Rauwendaal, "Polymer Extrusion" V edition, Hanser Publications, 2013.
4. M.L.Berins “Plastic Engineering Handbook”, Society of Plastic Industries, Chapman & Hall NY 1991.
5. Norman C. Lee, “Practical Guide to Blow Moulding", Rapra Technology Limited, 2006.
6. R. J. Crawford, James L. Throne, “Rotational Moulding Technology", Plastics Design Library William Andrew Publishing, 2002.
7. James L. Throne, "Understanding Thermoforming" II edition, Hanser Gardner Publications, Inc., 2008.

REFERENCES:

1. Chris Rauwendaul, “Polymer Extrusion”, Hanser Publication, Munich,1987.
2. Lee.N, “Blow Molding Design Guide”, 2nd edition, Hanser Publication, 2008.

OUTCOMES:

At the end of the course, the students will be able to,

- Describe the injection moulding process.
- Illustrate advanced injection moulding process.
- Demonstrate the extrusion molding process.
- Explain the processing of thermoset materials by compression and transfer molding processes.
- Compare various blow moulding process.
- Demonstrate thermoforming and rotational moulding processes.

PEC 3102	STRENGTH OF MATERIALS	L	P	T	C
		3	0	0	3

Objectives:

- To calculate the stresses induced in a material due to axial loading and temperature differences.
- To determine stresses and change in dimensions due to internal fluid pressure in thin and thick cylinders.
- To construct shear force and bending moment diagrams of beams with different loading situations.
- To locate the neutral axis and find the bending stresses induced in materials due to bending load.
- To design solid and hollow shafts to transmit power.
- To calculate maximum deflection in beams and the critical load in columns of different end conditions and deflection in beams.

MODULE: I TENSION AND COMPRESSION 8

Elasticity: Stress and strain, compressive, tensile, shear and bearing stress – Stress – strain diagram, Hooks law, modulus of elasticity, modulus of rigidity, bulk modulus of rigidity, bulk modulus, Poisson’s ratio. Relationship between elastic constants and temperature stresses, composite bars.

MODULE: II STRESSES IN THIN AND THICK CYLINDERS 8

Biaxial state of stresses – Stresses in thin cylinders and spheres - thick cylinders and spheres subjected to internal pressures. Change in dimensions of thin and thick cylinders.

MODULE: III SHEAR FORCE AND BENDING MOMENT 8

Types of beams: Supports and loads, shear force and bending moment – relationship between load shearing forces and bending moment. Bending moment and shear force diagrams for cantilever, simple supported and over hanging beams.

MODULE: IV BENDING STRESS IN BEAMS 7

Calculation of centroid, neutral axis, moment of inertia, modulus of section, radius of gyration with reference to structural shapes. Simple bending theory and its derivation– Problems on bending.

MODULE: V TORSION 7

Derivation torsion formula for solid and hollow shafts – Problems on solid and hollow shafts to calculate shear stress and angle of twist.

MODULE: VI DEFLECTION OF BEAMS AND COLUMNS 7

Deflection – deflection of beams in simple cases column and struts – long and short columns – axial loading – equivalent length and slenderness ratio – Euler's formula – simple problems on column and struts

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. Bansal.R.K ,"A Text Book of Strength of Materials", 6th Edition, Laxmi Publications(P), Ltd,New Delh, 2017
2. Jindal U.C, "Strenght of Materials",Pearson Education,2012

REFERENCES:

1. Hibbler.R.C, "Mechanics of Materials", Pearson Education,10th edition,2016
2. Beer F.P and Johnston R, "Mechanics of Materials", McGraw – Hill Book Co, Third Edition, 2012
3. Popov E.P, "Engineering Mechanics of Solids", Prentice – Hall of India, New Delhi, 1997.

OUTCOMES:

At the end of the course, students will be able to

- Calculate the stresses induced in a material due to axial loading and temperature differences.
- Determine stresses and change in dimensions due to internal fluid pressure in thin and thick cylinders.
- Construct shear force and bending moment diagrams of beams with different loading situations.
- Locate the neutral axis and find the bending stresses induced in materials due to bending load.
- Design solid and hollow shafts to transmit power.
- Calculate maximum deflection in beams and the critical load in columns of different end conditions and deflection in beams.

PEC3103	PLASTIC AND RUBBER TESTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide fundamental knowledge of basic concepts in testing.
- To develop an understanding of mechanical properties of polymers.
- To impart knowledge on rheological and thermal properties of polymers.
- To introduce various methods for testing of electrical and optical properties of polymers.
- To develop an understanding of weathering and permeation properties of polymers.
- To impart knowledge on testing new products for predicting product performance and to analyze the failure modes.

MODULE I BASIC CONCEPTS IN TESTING 5

Specification and Standards – National and International Standards – Advancement in testing technology – preparation of test specimens –conditioning and test atmospheres- Testing equipment and calibration methods.

MODULE II MECHANICAL PROPERTIES 10

Basic understanding of stress–strain behavior of plastic materials. Testing of Short term mechanical properties – tensile strength – compressive strength – impact strength – shear strength – abrasion resistance – fatigue resistance –hardness. Long term mechanical properties – creep – stress relaxation –permanent set.

MODULE III RHEOLOGICAL AND THERMAL PROPERTIES 10

Melt flow index, viscosity (Rotational viscometer, MPT, capillary rheometer and torque rheometer) Vicat softening temperature – heat distortion temperature – coefficient of expansion – thermal conductivity – brittleness temperature – flammability (LOI, Smoke Density, UL94, GWT).

MODULE IV ELECTRICAL AND OPTICAL PROPERTIES 6

Volume and surface resistivity - Dielectric strength – dielectric constant – dissipation factor – arc resistance – electromagnetic interference (EMI) – radio frequency interface (RFI) shielding – conductivity measurements.
Refractive index – light transmittance and haze – photo elastic properties –

color – gloss.

MODULE V WEATHERING AND PERMEATION PROPERTIES 6

Major environmental factors affecting plastics and rubbers– accelerated weathering test – outdoor weathering of plastics -microbiological resistance. Water absorption test – chemical resistance – environmental stress cracking resistance – gas permeability – moisture absorption – salt spray and staining resistance.

MODULE VI TESTING OF PRODUCTS 8

Plastic films & sheets – pipes – foams – containers – introduction to nondestructive testing of plastic products.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. Vishu Shah, “Handbook of Plastics Testing and Failure Analysis” - 3rd edition John Wiley, NY, 2007.
2. Roger.P.Brown, “Hand Book of Polymer Testing”, Marcel Dekker inc, New York,1999
3. Roger P. Brown, “Physical Testing of Rubber”, Interscience, New York, 1966.

REFERENCES:

1. Nicholas P.Cheremisinoff, “Product Design and Testing of Polymeric Materials”,Marcel Dekker, inc, New York, 1990

OUTCOMES:

At the end of the course, the students will be able to,

- Identify specification and standards and caliberation methods of plastics.
- Perform various tests for evaluating the mechanical and electrical properties of plastic materials.
- Perform various tests for evaluating theoptical properties of plastic materials.
- Perform various tests for evaluating the weathering and permeation properties of plastic materials.
- Identify the suitable test method for predicting product performance and to analyze the failures.
- Interpret and analyse the test results of various properties of polymers.

		L	T	P	C
PEC3104	**PLASTICS PROCESSING LAB**	**0**	**0**	**3**	**1**

OBJECTIVES:

- To develop the knowledge of various parameters influence the injection molding process
- To impart skill in setting up and optimizing injection molding process.
- To operate the compression molding press for manufacturing thermoset plastic products
- To equip with the fundamental knowledge of operating an extruder.
- To introduce to the nano fibers manufacturing technology
- To develop the skill in grinding and estimation of runner ratio to add with raw materials.

LIST OF EXPERIMENTS:

1. Understanding the principle of injection molding process by hand operated injection moulding machine.
2. Determination of influence of pressure in injection and clamping of semi – automatic injection moulding process.
3. Setting up of injection molding process in automatic injection moulding machine
4. Molding of thermoset resin by compression moulding process.
5. Understanding the principle of blow moulding by hand operated blow molding machine.
6. Determination of various parameters influence the automatic blow moulding process.
7. Manufacturing of plastic strands and pellets by extrusion moulding processes.
8. Manufacturing of nano-mat by electrospinning process.
9. Post processing operations like plating, buffing, etc.
10. Scrap grinding of runners and study of level of addition of regrind materials in to plastic raw materials.

L –0; T – 0; P – 30 Total Hours – 30

OUTCOMES:

At the end of the course, the students will be able to,

- Set the process parameters and run an injection molding machine.

- Calculate the process output and cycle time for different process.
- Demonstrate the extrusion molding process
- Manufacture polymer nano fibers by electrospinning process
- Identify defects in the manufactured plastic products and suggest necessary corrective actions.
- Grind the runners and determine the quantity of ground materials to be added in the raw material.

PEC3105	RUBBER PROCESSING LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To impart rubber compounding skills
- To develop the skill in curing characteristics study of a rubber compound.
- To operate the compression molding press to manufacture rubber product
- To equip with compound preparation of latex
- To introduce latex products manufacturing techniques
- To develop an understanding on properties of rubbers

LIST OF EXPERIMENTS:

1. Rubber Mixing - Compounding of rubbers using two roll mill (NR, SBR, NBR, EPDM, Silicone, etc)
2. Vulcanization studies using ODR
3. Moulding of Rubber Compounds in a hydraulic press
4. Study on optimizing the curing parameters
5. Manufacturing of rubber ball
6. Manufacturing of MCR
7. Latex compounding - Preparation of dispersion in a ball mill
8. Preparation of compounded latex.
9. Latex product manufacturing by dipping process - straight and coagulant dipping
10. Latex foam manufacturing

L –0; T – 0; P – 30 Total Hours – 30

OUTCOMES:

At the end of the course, the students will be able to,

- Compound different rubbers in a two roll mill
- Interpret curing characteristics rubber from a ODR curve.
- Operate the hydraulic press for manufacturing rubber products.
- Perform latex compounding.
- Produce latex products from dipping and other process.
- Formulate compounding recipe for rubbers.

SEMESTER VI

MSC3181	LEADERSHIP AND CEOTRAINING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course aims at

- Bringing about positive transformation in students' attitude.
- Building unique leadership competencies that would ensure successful transition of students across all career stages.
- Sensitizing students to identify their strengths & weakness and training them to deal with it
- Assisting students in enhancing their expressive ability and inducing a high level of self-confidence to manage both business and emotions
- Training students to become more adaptable and flexible to changing business environment

MODULE I INTRODUCTION TO LEADERSHIP 12

Leadership concept - meaning, definitions, importance of leadership, leadership traits. Leadership functions- general functions, listening, observing, managing and decision making. Components of leadership - leaders, followers and situation. Leadership theories – Trait theory, Skills theory, Style theory, Situational theory, Transformational theory, Transactional theory, Path Goal Theory and LMX. Assessing emotional intelligence and exploring the capabilities and inherent traits.through psychometric tests - Multi factor leadership questionnaire and personal reflections

MODULE II LEADERSHIP STYLE AND COMMUNICATION 8

Leadership styles-visionary, Coaching, Affiliative, Democratic, Pacesetting Commanding, Transformational, Transactional. Autocratic, Participative, Laissez-Faire Leader versus Managers. Leadership communication - Rationale, tactic, assertive, formal, informal, communication in crisis- leadership and negotiations, Leadership Presentations-convincing and impressive style

MODULE III LEADERSHIP ROLES 8

Facets of leadership- Leader as an individual – personality and leadership, values, attitudes and ethics of a leader. Leader as a relationship builder- empowering people to meet higher order needs, initiating organization wide motivational programs, involvement with all stakeholders- focusing on organization growth. Leader as an inspirer- motivation and leadership, recognizing and appreciating contributions, empowering others to lead Leader as an innovator –leader's role in shaping culture and values in an organization. Leader as a Liaison- Leader as team player

MODULE IV LEADERSHIP CHALLENGES AND STRATEGIES 9

Challenges in leadership: Perception of organization culture and values, interpreting the power dynamics in the organization, establishing work life balance. Bad leadership – Reasons and impact. -Case Study of Marissa Mayer-Yahoo.Inc Organizational transformation through efficient leaders-Case study of Apple Inc. Blue Ocean Leadership-Steps to Blue ocean Leadership-Four Pillars of Blue Ocean leadership-Blue Ocean leadership grid

MODULE V LEADERSHIP AND CEO TRAINING 8

Leader as a CEO: Traits of a successful CEO, Key responsibilities of a CEO, the path to be a CEO, Training on Board Room Discussions, Meeting the CEO –Live sessions with industry CEO's. Requirements of Leadership: - Cognitive skills, Interpersonal skills, Business skills, Strategic skills. Role of Emotional Intelligence in taking up key-positions in the organization.

Teaching Pedagogy:

Nurturing – Based on the identified strengths and weaknesses, training will be given to enhance the strengths and overcome the weakness.

Assessment - Continuous evaluation will be effected through group discussions, oratory assignments and situational enactments. Pre-and post-training assessment through peer reviews and faculty feedback.

Sustained development – Training will be imparted for self-development and monitoring of leadership skills to ensure sustained applicability of the skills learnt.

Total Hours: 45

REFERENCES:

1. Andrew J DuBrin. "Leadership: Research Findings, Practice, and Skills", 8^{th} Edition, South-Western College Pub, 2015.

2. Yukl G, “Leadership in Organisations”, 8th Edition, Pearson Education, 2013.
3. Richard L Daft, “Leadership”, 5th Edition, South Western Cengage Learning 2012.
4. Stephen P. Robbins and Timothy A. Judge. “Organizational Behaviour”, 15th Edition, New Delhi: Pearson, 2013.
5. Fred Luthans, “Organizational Behavior, an Evidence Based Approach”, 12th Edition, New Delhi: McGraw Hill Education, 2013.
6. Emotional Intelligence, Why it can matter no more than IQ by Daniel Goleman (include a book) Publisher: Bloomsbury Publishing India Private Limited; Latest edition (2017)
7. Primal Leadership: Unleashing the Power of Emotional Intelligence by Prof Daniel Goleman , Richard Boyatzis and McKee,Harvard Business Review Press

RECOMMENDED READINGS:

1. Jim Collins, (2001). “Good To Great: Why Some Companies Make the Leap...And Others Don't”, Random House Publishers India Pvt.Ltd, New Delhi
2. George, B. with Sims, P. True North: Discover Your Authentic Leadership, The Times Group Books; First edition (1 October 2015)
3. Kim, W. C., & Mauborgne, R. A. (2014). Blue ocean strategy, expanded edition: How to create uncontested market space and make the competition irrelevant. Harvard business review Press
4. Leadership Wisdom by Robin Sharma Jaico Publishing House;

OUTCOMES:

The students will be able to

- Explore through self-introspection one’s own leadership style, their strength and weakness
- Gain self-confidence to lead a team in the organization
- Realize the role of leadership in making or breaking of an organization
- Acquire the practice of self-introspection and development of leadership competencies thorough continuous efforts
- Manage their own emotions as well as other resulting in successful relationship building with all stakeholders

MSC 3182 SOCIAL ENTREPRENEURSHIP

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the fit between individual and their entrepreneurial ambitions.
- To identify the customers and find a problem worth solving.
- To create a business model for solving the problems of customer, forming solution and present the Business Model Canvas
- To develop a solution for customers' problem and analyze the problem solution fit & product market fit.
- To build and demonstrate a Minimum Viable Product (MVP) for startup.
- To analyze and understand the impact of social entrepreneurship on society and cases.

MODULE I SELF & OPPORTUNITY DISCOVERY 9

Finding the flow, Effectuation, Entrepreneurial Style, Business Opportunities, Problem Identification, Design Thinking, Potential solutions, Presentation of the problem- Case Study.

MODULE II CUSTOMER , SOLUTION AND BUSINESS MODEL 9

Customers and Markets, Identification of Customer Segment, Niche Segment, Customers Jobs, Pain and Gain, Early Adopters, Value Proposition Canvas, Basics of Business Model and Lean Canvas, Risk and Assumptions.

MODULE III VALIDATION AND MONEY 9

Blue Ocean Strategy, Solution Demo, Problem – Solution Fit, Minimum Viable Product- Product Market Fit, Prototype – Case Study. Cost, Revenues, Pricing, Profitability Checks, Bootstrapping, Initial Financing and Pitching.

MODULE IV TEAM BUILDING AND MARKETING 7

Shared Leadership, Hiring, Fitment , Team Role and Responsibilities , Collaboration Tools and Techniques, Positioning and Branding, Channels

MODULE V SALES & SUPPORT 6

Sales Planning, Selling Skills, Project Management, Project Tracking, Basic of

Business Regulation, Startup.

MODULE VI IMPACT OF SOCIAL ENTREPRENEURSHIP ON SOCIETIES AND CASES 5

Impact of Social Entrepreneurship, NGO vs For-Profit Companies vs. Social Entrepreneurship. Procedures for registration of small scale industry, Overview of venture capital and angel investment, Social entrepreneurship report preparation by students. Case Study of Social Entrepreneurs.

Total Periods- 45

TEXT BOOKS

1. Entrepreneurship Rajeev Roy oxford, 2012.
2. Learn wise platform - Wadhwani Foundation, 2018
3. “Social Entrepreneurship and Social Business” Christine K Volkmann, Springer Gabler 2012.
4. The Process of social value creation: A multiple case study on Social Entrepreneurship in India, Archana Singh Springer 2016.

REFERENCES

1. Social Entrepreneurship” Manuel London, Routlege, 2012.

2.The Process of social value creation: A multiple case study on Social Entrepreneurship in India, Archana Singh Springer 2016.

3.Running Lean: Iterate From Plan A To a Plan That Works, Ash Maurya, "O'Reilly Media, Inc.", 28-Feb-2012.

OUTCOMES:

On completion of the course, students will be able to

- Build an entrepreneurial mindset and reach out the customer to identify the problem using design thinking process
- Craft solution to the problem through value proposition canvas and develop a business model using lean canvas
- Provide product solution demo and deliver a minimum viable product
- Work as a team and create brand strategy marketing for product/service
- Prepare, make an outstanding sale pitch for startup.
- Showcase the impact of Social Entrepreneurship on society and cases.

ENC 3281	COMMUNICATION AND SOFT SKILLS - II CAREER CHOICE	L	T	P	C
		0	0	2	1

OBJECTIVES:
- To create awareness of industrial trends and market demands.
- To encourage students to explore career opportunities in an industry and evaluate themselves in relation to industry preparedness

MODULE I **6**

Knowledge about specific industry-Discussion with industry experts --Self evaluating career prospects through survey questionnaire (based on his/her eligibility for taking up a job (industry preparedness)

MODULE II **6**

Knowing case studies of industries(pertaining to students' choice of career)- Reading and discussing about job markets-goal setting, working on creativity.

MODULE III **4**

SWOC analysis and discussing outcomes--exploring mini projects or case studies of latest industries.

MODULE IV **6**

Writing statement of purpose pertaining to career choice---- Outcomes

MODULE V **8**

Project or case study presentations (Presentation in pairs) -mini project report or case study report.

Total Hours – 30

REFERENCES:
1. Brown,D.(2002). Career Choice and Development. Wiley,J. & Sons.USA
2. Lore,N.(1998). The Pathfinder: How to Choose or Change Your Career for a Lifetime of Satisfaction and Success. Simon & Schuster.USA.
3. Shell, G.R.(2013). Springboard Launching your Personal Search for Success.Portfolio.USA.

OUTCOMES:

After the completion of the course, students would be able to

- Speak about their career choice.
- Self evaluate their strengths and weaknesses and speak about it.
- Make effective presentations on case studies or relating to projects.
- Write the statement of purpose relating to their career choice.

		L	P	T	C
PEC 3211	**PLASTIC AND RUBBER PRODUCT DESIGN**	**3**	**1**	**0**	**4**

Objectives:

- To impart knowledge on product design methodology and product life cycle.
- To select the plastic materials based on end use applications of products
- To design plastic gears and bearings.
- To calculate the dimensions of springs and belts as per end use applications
- To design the vibration dampers for mechanical applications.
- To validate a plastic and rubber product design by using finite element methods

MODULE: I INTRODUCTION TO PRODUCT DESIGN 6

Introduction to product design, product design methodology, concurrent engineering, product life cycle, voice of customer, technical specification,concept generation, design for X, FMEA.

MODULE: II PRODUCT FUNCTIONALITY & MATERIAL SELECTION 12

Limits, fits and tolerances – type of fits. Design of ribs and bosses. Design considerations for wall thickness – fillets – sharp corners. Molded threads and their types. Material selection for strength and rigidity – design for stiffness – structural design of beams and other structural members., Mohrs circle, BIS standards, theories of failures.

MODULE: III PLASTIC GEAR & BEARING DESIGN 12

Fatigue loading – type of fatigue loading – S-N curve – simple problems by using fatigue equations – dynamic load response of polymers. Materials for gears – types – basic terminologies – molded and cut gears – design for strength and durability. Bearings – types of bearings – design consideration – materials – self lubricated plastic materials – p-v rating of bearings.

MODULE: IV DESIGN OF SPRINGS & RUBBER BELTS 10

Design of plastic springs – close coiled – Wahl’s equation. Couplings – types. Design of seals and O-rings -flat belts and V-belts. Snap – fit joints – Material selection and design

MODULE: V DESIGN FOR DAMPING – RUBBER MATERIALS 10

Vibration dampers: Basic vibration damping relations – octave rule for damped systems – under damping – over damping and critical damping, vibration isolation, vibration of single and two rotor systems.

MODULE: VI PLASTIC AND RUBBER PRODUCT DESIGN VALIDATION 10

Check for functionality, finite element analysis – introduction – type of analysis – requirement of approximation – weight residual, Ritz and Galerkin method – model building, post processing – simple problems on 2D. Understanding of flow analysis, optimum gate locations, pressure drops across runner, fill analysis, shrinkage and warpage.

L – 60; T – 0; Total Hours – 60

TEXT BOOKS:

1. Paul F.Mastro, "Plastics Product Design", Scrivener Publishing LLC,2016
2. James.C.Gerdeen, "Engineering Design with Polymers and Composites", CRC press, 2011.
3. Robert A. Malloy, "Plastic Part Design for Injection Moulding- An Introduction", Carl Hanser, 2010.
4. Kazmer.D, "Injection Mold Design Engineering", Hanser, 2007.
5. R.J.Crawford, Pergamon, "Plastics Extrusion Technology" Hanser, 1997
6. Miller.E, "Plastics Product Design Hand Book, Part A and B", Marcel Dekker, 1982.
7. R D Beck, "Plastic product design", Van Nostrand Reinhold Company
8. Alan N. Gent, How to Design Rubber Components (Hanser Publishers).

REFERENCES:

- Kuang-Hua Chang "Product Design Modeling using CAD/CAE", 1st Edition, Elsevier,e-book,2014.
- Natti S. Rao, Günter Schumacher "Design Formula for Plastic Engineers", Cincinnati, 2nd.Edition,2004.
- M.L. Berins, "Plastics Engineering Handbook", Society of the Plastic Industries, Champman and Hall, NY 1991.
- Charles A.Harper, "Modern Plastics Handbook", TataMcGraw-Hill, 1999.

OUTCOMES:

At the end of the course, the students will be able to

- Explain the product design methodology and product life cycle
- Select the plastic materials based on end use applications of products.
- Design plastic gears and bearings.
- Calculate the dimensions of springs and belts as per end use applications.
- Design the vibration dampers for mechanical applications.
- Validate a plastic and rubber product design by using finite element methods

PEC 3212	PROCESS CONTROL AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the general concepts of measurements.
- To impart knowledge on the construction, characteristics and operation of different variable resistance, capacitance and inductive transducers
- To develop knowledge in temperature, pressure, flow and level measurement
- To impart the basic concepts of instrumentation and control systems
- To understand process control systems with related examples
- To make familiarize with process control tools, control the process parameters in process industries.

MODULE I GENERAL CONCEPTS OF MEASUREMENTS 8

Variables and their measurements signals, the three stages of generalized measurement system, some common terms used in the measurement systems, mechanical loading, impedance matching, frequency response. Factors considered in selection of instruments – error analysis and classification, source of error. Transducer: classification, displacement & velocity transducers, potentiometer, LVDT, variable reluctance transducers, capacitive transducers, tachometer. Types of electric strain gauges – strain gauge bridges. Calibration of strain gauges.

MODULE II TEMPERATURE and PRESSURE MEASUREMENT 7

Temperature measurement: Platinum resistance thermometers, thermistors, thermocouple, TOTAL radiation pyrometers, optical pyrometer, temperature measuring problems in flowing fluids.

Pressure measurement: Manometers, Elastic transducers, elastic diaphragm transducers, McLeod gauge, thermal conductivity gauges, calibration of pressure gauge using dead weight tester, dynamic characteristics of pressure measuring systems.

MODULE III LEVEL DENSITY and VISCOSITY MEASURING INSTRUMENTS 6

Level measuring instruments: Introduction, classification, direct and indirect methods, solid level measurement.

Viscosity Measurements of polymer solutions and polymer melt, and density measurements systems

MODULE IV FLOW MEASUREMENTS 8

Flow measuring instruments: Introduction, classification (rate of flow and total flow meters), pressure head- type flow meters (orifice plate, venturi tube, flow nozzle, pitot tube), variablearea flow meters (rotameters), electromagnetic, mechanical (positive displacement and turbine- type), anemometer, ultrasonic- type, vortex-flow type, thermal-type, laser anemometers,mass flow meters.

MODULE V CONTROL SYSTEMS 8

Open loop and closed loop controls, elements of closed loop control systems. Mathematical models for mechanical & electrical systems, transfer function, block diagram representation, signal flow graphs, control system components.

MODULE VI PROCESS CONTROL IN POLYMER PROCESING SYSTEMS 8

Introduction to polymer processes (injection molding, blow molding, melt spinning, batch polymerization), Control of continuous and batch polymerization processes. Advanced Process Control Systems: Introduction to Advanced process control systems, Feed forward, cascade, ratio control with different applications, Introduction to digital control systems, Programmable Logic Control (PLC), Supervisory control and data acquisition systems (SCADA). Distributed control systems (DCS).

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. T.G. Beckwith and N.L. Buck, Mechanical measurements, Addition Wesley Publishing company ltd. 1995.
2. Ernest O Doebelin, Measurements systems Application & design, McGraw-Hill Publishing, 1996.
3. Rangan, Mani & Sharma, Instrumentation, Tata McGraw Hill, New Delhi, 1997.
4. I.J. Nagarath and M. Gopal, Control systems engineering, 2nd Ed. New Age International Pvt. Ltd., 2009.
5. R. K. Jain, Mechanical & Industrial measurements, Khanna Publishing, 2008.
6. R.P. Brown, Handbook of Plastics Test Method, Handbook of Plastic Testing Technology, A. Wiley - Inter science Publication, Third Edition, 1990.
7. D.M. Considine, “Process / Industrial Instruments and Control Handbook”,

McGraw – Hill, [1st edition] , 2006.

OUTCOMES:

At the end of the course, the students will be able to

- Select the instrument for a specific measurement
- Acquire knowledge in usage of instruments for measurements
- Effectively carry out operation and maintenance of pressure and temperature instruments
- Describe the functions of flow measurement devices
- Obtain the mathematical model of physical system also to analyse physical systems using block diagram algebra and SFG (Signal Flow Graph)
- Understand the role of process control in polymer machineries

PEC 3213 POLYMER REACTION ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce the basic concepts of reaction engineering.
- To familiarize the students with the fundamentals, applications of reaction engineering with related examples.
- To develop design principles in the reaction engineering.
- To develop the ability in analysing the processes and contribute to new designs.
- To design the reactor of any batch and flow system of heterogeneous kind.
- To impart knowledge of kinetics in any polymerization reactors.

MODULE I KINETICS OF REACTIONS 8

Elements of Chemical Reaction Engineering: Introduction to chemical kinetics. Representation of expression for reaction rate, rate constant. Temperature dependent and concentration dependent theory. Comparison of theories with Arrhenius law

MODULE II INTERPRETATION OF BATCH REACTOR DATA 8

Interpretation of batch reactor data for various types of reactions taking place in constant volume and variable volume batch reactors. Irreversible reactions in series, parallel. Differential method of analysis of data, Integrated rate equation for zero, first and second order reactions.

MODULE III DESIGN OF SINGLE IDEAL REACTORS 8

Reactors-Batch and flow type, Material and energy balance over an element of reactor volume, Performance equation first, second-order reactions, holding time and space time for flow reactors.

MODULE IV DESIGN FOR SINGLE AND MULTIPLE REACTIONS 6

Size comparison of single reactors, Comparison of CSTR with PFR for first and second order reactions, Multiple reactor systems, PFR, CSTR-series and parallel, Recycle reactors, Autocatalytic reactions. Multiple Reactions-Reactions in Parallel, Quantitative treatment of product distribution and reactor size-batch, plug flow and mixed flow reactor.

MODULE V SOLID CATALYSED REACTIONS 8

Heterogeneous reacting systems-Catalyst, activity and specificity of catalyst, Pore diffusion resistance combined with surface kinetics, Heat effects during reaction, Performance equations for different type of reactors containing porous catalysts-Experimental methods for determining rates-application to design

MODULE VI POLYMERIZATION REACTORS 7

Polymerization reactors – by free radical mechanism – characterization of mixtures of polymers – mechanism – rate equations – design of reactors for free radical polymerization – stepwise addition and condensation polymerization and copolymerization – analysis of rate equation – polymerization in batch reactors – flow reactors.

L – 45; T – 0; Total Hours – 45

TEXTBOOKS:

1. Octave Levenspiel, "Chemical Reaction Engineering", Wiley, 3rd edition, 2006.
2. Mark E. Davis, Robert J. Davis, "Fundamentals of Chemical Reaction Engineering", 2003.
3. Asua J. M, "Polymer Reaction Engineering", Blackwell Publishing Ltd, UK, 2007.
4. Scott Fogler H, "Elements of Chemical Reaction Engineering", Prentice Hall International, 2016.
5. Mark E. Davis and Robert J.Davis, "Fundamental of Chemical Reaction Engineering", Dover Publications, New York, 2012.
6. Martin Schmal, "Chemical Reaction Engineering: Essentials, Exercises and Examples", CRC Press, 2014.

REFERENCES:

1. Anil Kumar and Gupta R P, "Fundamentals of Polymer Science and Engineering", McGraw Hill, 1998.
2. Tapio O. Salmi, Jyri-Pekka Mikkola, Johan P. Warna, "Chemical Reaction Engineering and Reactor Technology", CRC Press, 2010.
3. L.K. Doraiswamy, Deniz Uner, "Chemical Reaction Engineering: Beyond the Fundamentals", CRC Press, 2013.
4. Miller Gt, "Chemical Reaction Engineering", CBS Publisher, 2005.

OUTCOMES:

At the end of the course, the students will be able to

- Evaluate the kinetics and reaction rate.
- Intrepret the batch reactor data for a particular reaction system
- Identify the various types of reactors used in industries.
- Select a reactor, determine its size, conversion for a given application.
- Predict the optimization of performance of reactors.
- Apply the different types of reactors used in polymerization.

PEC3214 PLASTICS PRODUCT DESIGN LAB L T P C
0 0 3 1

OBJECTIVES:

- To impart skill with the codes and specifications of BIS.
- To introduce the concepts of limits, fits and tolerances in design.
- To develop skill of assembly drawings of various components using design software.

ASSEMBLY DRAWING USING CAD 15

Parts drawing and preparation of assembled views given part details for components using a suitable drafting package. Joints-Cotter joints, Knuckle joints, Flange coupling

PLASTIC PRODUCT DESIGN USING CAD 30

Design of Plastic Product using CAD

1. Injection moulded plastic parts
2. Compression moulded plastic parts
3. Blow moulded plastic parts
4. Thermoforming plastic parts
5. Design of Plastic Gear
6. .Design of Plastic Bearing

Total Hours: 45

REFERENCES:

1. Malloy.R, “ Plastic Part Design for Injection MMolding”, 2E, 2010, Hanser Publications,
2. James.C.Gerdeen, “Engineering Design with Polymers and Composites”, CRC press, 2011.
3. Kazmer.D, “Injection Mold Design Engineering”, Hanser, 2007.
4. Kuang-Hua Chang “Product Design Modeling using CAD/CAE”, 1st Edition, Elsevier,e-book,2014
5. Natti S. Rao, Günter Schumacher “Design Formula for Plastic Engineers”, Cincinnati, 2nd.Edition,2004.

OUTCOMES:

At the end of the course, the students will be able to

- Use international drawing standards in design.
- Read the part and assembly drawings.
- Develop a solid model which is to be used for stress analysis.
- Provide limits, fits and tolerances in product design.
- Design plastic products using CAD

PEC32215	POLYMER TESTING LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To emphasize the importance of testing the mechanical and thermal characterization of polymers.
- To emphasize the importance of testing electrical and optical characterization of polymers.
- To provide an understanding of various properties of polymers.
- To provide an understanding of the working principle and specifications of the apparatus/equipment used for testing.
- To introduce test procedures of international standards.
- To impart skills in interpreting the test results.

LIST OF EXPERIMENTS :

TESTING OF MECHANICAL PROPERTIES OF PLASTICS AND RUBBERS

1. Tensile strength.
2. Compression strength.
3. Flexural strength.
4. Tear strength.
5. Izod and Charpy impact strength.
6. Falling dart impact strength,
7. Hardness – Rockwell and Shore
8. Abrasion resistance
9. Rebound resilience
10. Flex resistance.

TESTING OF THERMAL PROPERTIES

1. Vicat softening point.
2. Heat distortion temperature.

TESTING OF ELECTRICAL PROPERTIES.

1. Volume and surface resistivity.
2. Arc resistance
3. Comparative tracking index.
4. Dielectric strength.
5. Dielectric constant.

TESTING OF OPTICAL PROPERTIES

1. Refractive index.
2. Haze.
3. Gloss

TESTING OF MISCELLANEOUS PROPERTIES

1. Environmental stress crack resistance
2. Chemical resistance.
3. Thermal ageing resistance.
4. Flammability.
5. Mould shrinkage

Total : 45 hrs

TEXT BOOKS:

1 Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah, "Polymer Processing and Characterization: 1 (Advances in Materials Science)",Apple Academic Press; 1 edition ,January 31, 2013

2 V.A. Bershtein , G.C. Berry, et al, "Polymer Analysis and Characterization (Advances in Polymer Science)",2013

3 T.R. Crompton, "Practical Polymer Analysis", 2012.

4 Joseph D. Menczel , R. Bruce Prime, "Thermal Analysis of Polymers", Fundamentals and Applications", Wiley; 1 edition , April 20, 2009.

5 Characterization and Analysis of Polymers, by Wiley, 2008.

OUTCOMES:

At the end of the course, the student will be able to

- Identify the test methods to evaluate the properties of a product/sample.
- Execute various tests to verify the quality of the products.
- Interpret the data from the test results.
- Compare the structure and properties of polymers.
- Analyze the properties of polymers based on application.
- Handle various instruments to perform the test.

SEMESTER – VII

PEC 4101	MOULD AND DIE DESIGN	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To calculate dimensions of runner and gates in an injection mould.
- To select proper ejection techniques and cooling systems in injection moulds.
- To determine the split movement in various split movement techniques and use mold flow analysis in the design of injection mould.
- To design compression and transfer moulds for plastic components.
- To design blow moulds based on product design specifications
- To classify various types of dies and determine the dimensions of dies

MODULE I INTRODUCTION TO INJECTION MOLD 10

Selection of mould materials, Classification of injection molds – two plate mould, three plate mould,hot runner and cold runner mould,number of cavities – selection of injection molding machine – layout of cavities in multi impression moulds. Feed systems – type of runners –design of runners – runner efficiency. Gates – sprue gate, tab gate, overlap gate, fan gate, diaphram gate, ring gate, pin gate, submarine gate, design rules – use of mold flow for gate design.

MODULE II DESIGN OF INJECTION MOLD 10

Ejection systems – constructional features of ejector grid, ejector grid lay out, type of ejector elements – pin ejector, valve ejector, D-P – pin ejector, stripper plate ejection techniques, calculation of ejector force, type of sprue pullers. Cooling systems – insert cooling systems, baffle cooling systems, bubbler cooling systems, heat rod and heat pipe systems, cooling time calculation and cooling channel layout.

MODULE III DESIGN OF SPLIT MOULD 10

Design and construction features of two and three plate molds, mold materials. Split actuation techniques – finger cam, dog leg cam, cam track actuation, split movement calculations, Understanding of flow analysis by simulation and its use for injection mold design.

MODULE IV COMPRESSION & TRANSFER MOLD DESIGN 10

Classification of compression moulds – factors that influence thermo setting molding – design and construction features of compression molds – mold materials – design of mold cavity. Transfer molding – types, design of pot and plunger, feed system, economic determination of number of cavities, loading chamber design, heat and energy requirement to heat the mold, advantages and disadvantages of compression and transfer molds.

MODULE V BLOW MOLD DESIGN 10

Blow mold design – material selection, mold cooling, mold venting, pinch-off, parison diameter calculation, wall thickness, blow ratio. Molds for blow molding, molds for injection stretch blow molding, molds for thermo forming and rotational molding. Design and constructional features of different type of parison dies. Design of Hot and Cold runner mold.

MODULE VI EXTRUSION DIE DESIGN 10

Extrusion die design: Basic consideration in die design, constructional features of rod die, cross head pipe die, offset pipe die, centre fed blown film die, spiral mandrel blown film die, flat film dies, sheet dies, fish tail die, coat hanger die and various type of profile dies.

L – 60; Total Hours – 60

TEXT BOOKS:

1. Dangel.R “Injection Moulds for Beginners”, Hanser Publications,2016
2. Beaumont.J, “Runner and Gating Design Handbook”,2E, Hanser Publications,2007
3. Sanjay K Nayak, “Fundamentals of Plastic Mould Design”, Mcgraw Higher Ed, 1st edition, 2012
4. R.G.W.Pye, “Injection Mould Design”, SPE Publication, 2002.
5. Menges Mohren, “How to Make Injection Molds” Hanser Publication, New York, Second Edition, 2001.
6. Walter Michaeli, “Extrusion Dies for Plastics and Rubber”, Carl Hanser Verlag GmbH & Co; 2nd Revised edition edition December 1992
7. Laszlo Sors and Imre Balazs, “Design of Plastics Moulds and Dies”, Elsevier, 1989.

REFERENCES:

1. Kazmer.D, “Injection Mould Design Engineering”,2E, Hanser Publications,2016
2. Unger.P, “Hot Runner Technology”, Hanser Publications,2006
3. Gastrow, Unger.P, “Injection Molds for Engineers”, Hanser Publications, 2006.
4. Rees, H., Catoen, B, “Selecting Injection Moulds”, Hanser Publications, 2006.
5. J.Harry Dubois, “Plastics Mold Engineering Handbook” Wayne.I.Pribble Publisher, Nergi Bossi.Spa, 1987.

OUTCOMES:

At the end of the course the students will be able to

- Calculate dimensions of runner and gates in an injection mould.
- Select proper ejection techniques and cooling systems in injection moulds.
- Determine the split movement in various split movement techniques and use mold flow analysis in the design of injection mould.
- Design compression and transfer moulds for plastic components.
- Design blow moulds based on product design specifications
- Classify various types of dies and determine the dimensions of dies.

PEC 4102	POLYMER COMPOSITE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce basic fundamentals of polymer composites.
- To impart knowledge of reinforcements and matrix systems used in polymer composites.
- To develop an understanding on processing of polymer composites.
- To gain knowledge in fracture mechanics and failure analysis of composites.
- To impart skills in analyzing and characterizing the polymer composite material for various applications.
- To provide an understanding in usage of polymer composites in various fields.

MODULE I INTRODUCTION 7

Introduction – classification- theory of composites – macromolecular behaviour of laminates – stress strain relationships – other mechanical properties.

MODULE II MATERIALS FOR POLYMER COMPOSITES 8

Various reinforcements and matrix materials used in polymer composites: Glass fibres – forms – reinforcements – carbon and kevlar fibres – inorganic fibres-natural fibres – polyester resins – epoxy resins – phenolic resins – other resins systems- curing of the resins – carbon – carbon composites.

MODULE III PROCESSING METHODS 7

Hand lay up – spray lay up – reaction injection moulding –filament winding – pultrusion – Resin transfer moulding - autoclave moulding.

MODULE IV PROCESSING METHODS 7

Bulk moulding compounds – compounding of polyester resin – machinery and equipment – SMC, BMC. Compression - injection moulding and forming of thermoplastic composites.

MODULE V TESTING OF COMPOSITES 8

General test methods for tension – flexural – interlaminar shear stress – compression tests – impact strength – elevated temperature tests – determination of void content – resin content and fibre content. Factors affecting strength of composites – fracture mechanics – debonding and delamination – failure analysis.

MODULE VI APPLICATIONS OF COMPOSITES 8

Application in windmill, aerospace – automotive industry – marine industry – civil engineering applications – electrical industry etc.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. P.K. Mallick, Processing of Polymer Matrix Composites: Processing and Applications, Taylor and Francis group, 2017.
2. Klaus Friedrich, Ulf Breuer, Multifunctionality of Polymer Composites: Challenges and New Solutions, 2015.
3. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, "Analysis and Performance of Fiber Composites,3rd edition, John Wiley & Sons, 2006.
4. L.holloway Hand Book of Composites for Engineers, Technomic, Lancaster, Pa, 1994.
5. Kevin Potter, An Introduction to Composites Products, Chapman And Hall Madras India 1997.
6. S.T.Peter, Hand Book of Composites, Chapman and Hall Chennai 1998.
7. Lin/Pearce, High Performance Thermosets, Hanser Publishers, Munich, New York, 1993.

REFERENCES:

1. B. Tomas Astrom, Manufacturing of Polymer Composites, Chapman And Hall, 2002.
2. Composites Materials: Engineering and Science by F.L. Mattews and R.D. Rawlings, Published by CRC Woodhead Publishing Limited, 2002.
3. Guneri Akovali, Handbook of Composite Fabrication, Rapra Technology Ltd, 2001.
4. Mathews F.L., and Rawlings, "Composite Material Engineering Science", Chapman and Hall, London, 1994.

OUTCOMES:

At the end of the course, the student will be able to

- Gain fundamental knowledge on polymer composites.
- Identify suitable materials for preparing polymer composites based on property requirement.
- Fabricate polymer composites.
- Analyze the failure mechanism and characterize polymer composites.
- Execute various tests to verify the quality of products.
- Select polymer composites for particular application.

PEC 4103	POLYMER NANOCOMPOSITES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain an understanding of materials commonly used in polymer nanocomposites.
- To equip with the knowledge on processing of polymer nanocomposites.
- To impart skills in characterization methods of polymer nanocomposites.
- To study the various methods employed for the dispersion of nanomaterials in polymers.
- To provide knowledge in nanocomposite technology.
- To understand the properties and applications of polymer nanocomposites.

MODULE I INTRODUCTION TO POLYMER NANOCOMPOSITES 8

Introduction to polymer nanocomposites – layered silicates – carbon nanotubes – inorganic nanofillers – polymer filler interfaces – modification of interfaces – ceramic/polymer nanocomposites – metal/polymer nanocomposites – natural nanobiocomposites – biomimetic nanocomposites – biologically inspired nanocomposites.

MODULE II POLYMER - LAYERED SILICATE NANOCOMPOSITES 7

Polymer – layered silicate nanocomposites: types of nanoclays – thermoplastics and thermosets and elastomer matrices. Preparation of polymer layered silicate nanocomposites – solution – melt mixing – latex mixing methods – techniques for achieving dispersion of nanofillers – intercalation and exfoliation.

MODULE III POLYMER - CNT NANOCOMPOSITES 7

Carbon nanotube (CNT) – reinforced polymer nanocomposites: structure of carbon nanotubes – dispersion properties of CNT nanocomposites – interfacial bonding properties – mechanical properties and conductivity of nanotube – polymer nanocomposites.

MODULE IV PROPERTIES OF POLYMER NANOCOMPOSITES 8

Properties of polymer nanocomposites: influence of nanofillers on properties of polymer nanocomposites. Mechanical properties – stress and strain and toughness – electrical properties – conductivity – resistivity – permittivity and breakdown strength – thermal properties – thermal stability and flammability – optical properties and gas barrier properties.

MODULE V PROCESSING OF POLYMER NANOCOMPOSITE 8

Processing of polymer nanocomposites – direct mixing – melt mixing – solution mixing – In-situ polymerization – In-situ particle processing – ceramic/polymer composites – metal/polymer nanocomposites – natural nanobiocomposites.

MODULE VI APPLICATIONS OF POLYMER NANOCOMPOSITES 7

Applications of polymer nanocomposites: automobiles – aerospace – injection molded products – coatings and adhesives – fire retardants – packaging materials – microelectronic packaging – dielectrics – drug delivery – membranes – medical devices and consumer goods.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. Chaudhery Mustansar Hussain, Ajay Kumar Mishra, New Polymer Nanocomposites for Environmental Remediation, Elsevier publication, 2018
2. Ahmad Fauzi Ismail, Pei Sean Goh, Carbon-based Polymer Nanocomposites for Environmental and Energy Applications, Elsevier publication, 2018.
3. Joseph H. Koo, Fundamentals, Properties, and Applications of Polymer Nanocomposites,2016.
4. Vikas Mittal, Polymer Nanocomposite Coatings, Taylor and Francis group,2014.
5. Lloyd M.Robeson, “Polymer Blends” Hanser gardner publications, U.S.A, 2007.
6. P. M. Ajayan, L. S. Schadler, P. V. Braun, “Nanocomposite Science and Technology”, WILEY-VCH Verlag GmbH, 2003.

REFERENCES:

1. Jyotishkumar Parameswaranpillai, Nishar Hameed, Thomas Kurian, Yingfeng Yu, Nanocomposite Materials: Synthesis, Properties and Applications, Taylor and Francis group,2017.

2. Aravind Dasari, Zhong-Zhen Yu, Yiu-Wing Mai, Polymer Nanocomposites: Towards Multi-Functionality, by springer, 2016.
3. Rakesh K. Gupta, Elliot Kennel, Kwang-Jea Kim, Polymer Nanocomposites Handbook, Taylor and Francis group,2010.
4. C.B. Bucknall and D. R. Paul, “Polymer Blends: Volumes 1 and 2”, John Wiley and Sons, New York, 2000
5. Polymer Blends and Alloys, “Gabriel O. Shonaike and George P. Simon”, editors. Marcel Dekker, 1999.

OUTCOMES:

At the end of the course, students will be able to

- Explain the basic principles and types of polymer nanocomposites.
- Select the appropriate nanofillers for the synthesis of nanocomposites with novel polymer to achieve synergistic properties.
- Analyze and characterize polymer nanocomposites.
- Select appropriate techniques for processing of polymer nanocomposites.
- Suggest suitable technique for the dispersion of nanomaterials in polymers.
- Gain knowledge on the properties and applications of polymer nanocomposites.

PEC4104 MOULD DESIGN & FLOW SIMULATION LAB

L	T	P	C
0	0	3	1

OBJECTIVES:

- To impart basic knowledge and skill in using design software in mold design.
- To develop proficiency in computer-aided design software for die design.
- To develop the ability to analyze the design of a mould.
- To impart skill in using mold flow software for mold design.

MODULE I INJECTION MOULD DESIGN 8

Design Calculations; No. of cavities, Selection of injection moulding machine, Shot capacity, clamping force, Injection pressure and tool strength calculation for Two Plate and Three Plate moulds.

MODULE II COMPRESSION MOULD DESIGN 8

Design calculations: Economic determination of number of cavities, design of mould cavity and loading chamber related to Open type and Semi-Positive type compression moulds.

MODULE III TRANSFER MOULD DESIGN 7

Design Calculations: Pot calculation, runner and gate dimensions, bulk factor and shrinkage allowances for thermo set plastics related to Pot transfer and Plunger transfer mould.

MODULE IV BLOW MOULD DESIGN 7

.Design Calculations: Clamping force, Pinch-off, head die design and Parison diameter calculations related to blow moulds.

MODULE V EXTRUSION DIE DESIGN 7

Design calculations for pipe and profile dies.

MODULE VI MOULD FLOW ANALYSIS 8

Three dimension modeling using Mould Flow software – Flow analysis, Cooling analysis, Shrink/ Wrap analysis and Stress analysis

Total Hours: 45

REFERENCES:

1. R.G.W.PYE, “Injection Mould Design”, SPE Publications, 2002.
2. J.Harry Dubois, “Plastics Mold Engineering Handbook” Wayne.I.Pribble Publisher, Nergi Bossi.Spa, 1987.
3. Herbert Rees, “Mold Engineering” by Hanser Publishers, Munich Vienna, N.Y1995.
4. Gastrow, Unger.P, “Injection Molds for Engineers”, Hanser Publications, 2006.

OUTCOMES:

At the end of laboratory course the students will be able to

- Identify the various parts of a two and three plate injection mould.
- Assemble the parts of injection mould.
- Model and assemble the various parts of compression and transfer mould. Using software.
- Design and assemble the different parts of blow molds and dies.
- Identify the failures in mold and die design.
- Analyze flow, cooling provisions, shrinkage and stress level in plastic products using software.

PEC4105	INTERNSHIP	L	T	P	C
		0	0	0	1

OBJECTIVES:

Students must undergo two weeks industrial training in the industries relevant to Polymer Engineering and submit a report based on the internship.

OUTCOMES:

At the end of the internship, students will be able to

- Analyze suitable polymeric materials for advanced applications.
- Troubleshoot various defects in polymer products.
- Examine various processing techniques to develop polymer products.
- Characterize and interpret data based on various polymeric products.
- Analyze and learn industrial practices.
- Acquire collaborative skills through working in a team to achieve common goals.

SEMESTER VIII

PEC4211	PROJECT WORK	L	T	P	C
		0	0	24	12

OBJECTIVES:

- To explore the knowledge and acquired skills from all courses and implement them in project work.
- To develop individual responsibility and team work in students.

Students should do a project which involves themselves with innovative ideas of design, fabrication, analysis, Industrial problem solving and new development of products. Frequently, progress in the project work is evaluated by conducting reviews. In the end semester, students should appear for their project viva-voce and submit the reports.

OUTCOMES:

At the end of the project, students will be able to

- Analse product feasibility and develop a real time working model.
- Troubleshoot various factors during the development of innovative polymer products.
- Analyze and characterize polymeric materials for advance applications.
- Examine appropriate techniques for processing of polymeric materials.
- Communicate effectively and present ideas clealy and coherently in both written and oral forms.
- Explore knowledge through team work.

PROGRAMME ELECTIVES
GROUP I (Materials)

		L	T	P	C
PECX001	**THERMOPLASTICS POLYESTERS**	**1**	**0**	**0**	**1**

OBJECTIVES:

- To provide fundamental knowledge in the synthesis of thermoplastic polyesters.
- To impart knowledge in polyester fiber manufacturing, properties, applications.

MODULE I POLY (ETHYLENE TEREPHTHALATE) 8

Poly(ethyle terephthalate)- polymerization process - catalyst - PET synthesis - solid-state polymerization - properties and applications, Green PET.

Poly(butylene terephthalate) - raw materials - polymerization process - properties and applications. Highly aromatic linear polyesters -synthesis - properties and applications. Liquid Crystal Polyesters.

MODULE II POLYESTER FIBRES 7

Polyester Fibers - chemical compositions, structure, property and processing - mechanical properties, chemical, optical of thermal properties, Recycling.

Fibre and yarn manufacturing-spinning process – Rheology, spinning equipment, spinning and drawing, drawing theory, drawing procedure, stable yarn manufacture, lubrication, analysis and testing methods.

Polyester films: Introduction – structure properties – manufacture – grades – commercial applications.

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1. J.A Brydson, “Plastics Materials”, Fifth edition, Elsevier, 2013
2. Olagoke Olabisi, “Hand Book of Thermoplastics”, Marcel Decker, inc., 1997.

REFERENCES:

1. Sabu Thomas and Visakh P.M., “Handbook of Engineering and Specialty Thermoplastics”, Volume 3, Scrivener Publishing LLC., 2011.

OUTCOMES:

At the end of the course, the students will be able

- To demonstrate the synthesis of thermoplastic polyesters like PET, PBT.
- Identify the manufacturing process for the development of polyester based products

PECX 002	THERMOPLASTIC ELASTOMERS	L	P	T	C
		1	0	0	1

OBJECTIVES:

- To impart knowledge about the various approaches to develop, process and characterize thermoplastic elastomers.
- To provide understanding on recent developments and applications of thermoplastic elastomers.

MODULE: I DEVELOPMENT OF THERMOPLASTIC ELASTOMERS 8

Approaches to develop TPE – Classification of TPE – Processing of TPE – Characterization of TPE – Styrenic Block copolymers – Polyolefin based TPE – polyurethane based TPE – Polyamide based TPE –Polyester based TPE Miscellaneous TPE, TPV.

MODULE: II APPLICATIONS AND RECYCLING 7

Applications of Styrenic Thermoplastic Elastomers – Thermoplastic Vulcanizates – Thermoplastic Polyolefin elastomers – Melt-Processable Rubber – Thermoplastic Polyurethanes –Polyamide Thermoplastic Elastomers – Recycling of Thermoplastic Elastomers.

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1 Jiri George Drobny, “Handbook of Thermoplastic Elastomers” Second Edition, Elsevier Science & Technology Books, 2014.
2 William Woishnis, Sina Ebnesajjad, “Chemical Resistance of Thermoplastics” First Edition, William Andrew, 2011
3 Stoyko Fakirov, “Handbook of Condensation Thermoplastic Elastomers” First Edition, John Wiley & Sons, 2006.
4 Hans R. Kricheldorf and Roderic P. Quirk, “Thermoplastic Elastomers” Third Edition, Hanser Publishers, 2004.

REFERENCES:

1 Anil K. Bhowmick , “Current Topics in Elastomers Research” First Edition, CRC Press, 2008.
2 P. W. Dufton, “Thermoplastic Elastomers”, First Edition, iSmithers Rapra Publishing, 2001.

3 Geoffrey Holden, “Understanding Thermoplastic Elastomers” First Edition, Hanser, 2000.

OUTCOMES:

On completion of this course students should be able

- Develop and process thermoplastic elastomers for suitable application.
- Analyze the morphology of thermoplastic elastomer and modify it as per requirement.

PECX 003	ELCTROACTIVE POLYMERS	L	P	T	C
		1	0	0	1

OBJECTIVES:

- To impart the knowledge of electrical conduction mechanism in electro-active polymers.
- To develop understanding of synthesis, properties and applications of conducting polymers.

MODULE: I SYNTHESIS TECHNIQUES 8

Introduction to electroactive polymers, Synthesis of conducting polymers: Chemical synthesis – electrochemical synthesis – template synthesis – precursor synthesis – soluble polymers (colloids and dispersions) – advantages and disadvantages of various synthesis methods.

MODULE: II CHARACTERIZATION METHODS AND APPLICATIONS 7

Characterization methods: elemental analysis for dopants – IR – UV (electro chemical), measurement of conductivity.

Applications : rechargeable batteries, lights emitting diodes – gas sensors – bio sensors – photo voltaic energy devices – micro electronics (PCB fabrications).

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1. R. G. Linford, “Electro Chemical Science and Technology of Polymers”, Elsevier applied sciences, London,1990.
2. M. Schlvxinger and M. Paunovic, “Modern Electro Plating”, John Wiley and sons Inc., New York, 2000.

REFERENCES:

1 Hari Singh Nalwa (ed.), “Handbook of Organic Conductive Molecules and Polymers”, John Wiley & sons, England, 1997.

OUTCOMES:

At the end of the course students will have the ability to

- Demonstrate knowledge of mechanism of electrical conduction in electroactive polymers.
- Analyse the properties of conducting polymers with respect to the structure.
- Choose conducting polymers for specific applications.

PECX 004	HEAT RESISTANT POLYMERS	L	P	T	C
		1	0	0	1

OBJECTIVES:

- To develop an understanding on the properties and applications of high temperature resistant speciality polymers.
- To provide an insight of the various applications of heat resistant polymers.
- To impart knowledge on process and application of polymer concrete.

MODULE: I HEAT RESISTANT POLYMERS 9

Introduction to heat resistant polymers -fluoropolymers, aromatic polymers, polysulphide, polysulphones, polyesters, polyamides, polyimides, polyketones, heterocyclic polysiloxanes, liquid crystalline polymers.

MODULE: II CHARACTERISATION & APPLICATIONS OF HEAT RESISTANT POLYMERS 6

Characterisation of heat resistant polymers – TGA, DTA, DSC, electrochemical impedance measurements, Applications - Polymers in automobile, telecommunication and power transmission applications - polymers in aerospace application, coatings.

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1 J.P Critchley, G.J. Knight , W.W. Wright, “ Heat resistant Polymers: Technologically useful Materials, October 1983.
2 Sabu Thomas and Visakh P.M, “ Handbook of Engineering and Speciality Thermoplastics, John Wiley & Sons, Massachusetts, 2011.
3 Manas Chanda, Salil.K.Roy, “Industrial Polymers, Specialty Polymers, and Their Applications (Plastics Engineering)”, CRC Press, 2012.
4 Gennady E Zaikov, “Polymers for Advanced Technologies : Processing, Characterization and Applications”, CRC Press, 2013.
5 R.W. Dyson, “Specialty Polymers”, Chapman & Hall, 2nd edition, 1998.
6 D.Gerry Walters, “Polymer Concrete” , Volume 137, American Concrete Institute, November 2007.

REFERENCES:

1 Abbas Hamrang, Bob A Howell, Foundations of High Performance Polymers : Properties ,Performance and Applications, CRC Press, 2013.

2 H.F.Mark, (Ed), “Encyclopedia of Polymer Science & Engineering”, John Wiley & Sons, New York, 1989.
3 J A Brydson, “Plastics Materials”, Butterworth-Heinemann, 1999.Munich, 1987.

OUTCOMES:

At the end of the course, the students will be able to

- Select suitable polymer for high temperature applications.
- Modify the structure of polymers for high temperature resistant properties.

PECX 005	BIODEGRDABLE PLASTICS	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To provide knowledge on biodegradable plastics.
- To develop understanding on mechanism of biodegradation of plastics.
- To impart knowledge on natural and synthetic biodegradable plastics.
- To equip with knowledge on biodegradation testing

MODULE: I INTRODUCTION 6

Biodegradable polymers and the environment - biodegradable plastics - naturally biodegradable polymers - synthetic biodegradable polymers - modified naturally biodegradable polymers. Mechanism of biodegradation - biological degradation of polymers- non-biological degradation. Abiotic degradation - biotic degradation, Commercially available biodegradable plastics.

MODULE: II NATURAL BIODEGRADABLE POLYMERS 7

Starch polymer - starch-filled plastics - thermoplastic starch – production methods- physical and chemical properties- applications. Synthesis, properties and applications of starch-based materials- cellulose and derivatives - chitin and chitosan - alginic acid - collagen- proteins- gelatin.

MODULE: III POLYHYDROXYALKANOATES & POLY(LACTIC ACID) 9

Various types of PHAs - mechanisms of biosynthesis of PHA - methods of production - mechanism of biodegradation– extracellular degradation - intracellular degradation- structure and properties - applications. Poly (lactic acid) - homopolymers - copolymers -functionalized polymers – structure and properties – mechanism of biodegradation - physical and chemical Properties – Applications.

MODULE: IV EVALUATION OF BIODEGRADABILITY 8

Test methods and standards for bio-degradable plastics – Criteria used in evaluation of biodegradable plastics – Description of current test methods – Scanning test for ready biodegradability – Test for inherent biodegradability – Test for simulation studies – Other methods for assessing polymer biodegradability.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

1. Emo Chiellini, Roberto Solaro, 'Biodegradable Polymers and Plastics', Springer Science, 2002.
2. Joseph P. Greene, Sustainable Plastics, Wiley, 2014.
3. Jie Ren, 'Biodegradable Poly (Lactic Acid)', Springer, 2010.
4. Stoyko Fakirov, Biodegradable Polyesters, Wiley VCH Verlag GmbH & Co, 2015.
5. G,Griffin,'Chemistry and Technology of Biodegradable Polymers' Springer Netherlands, 2012.
6. Gary P. Felton, 'Biodegradable Polymers: Processing, Degradation and Applications' Nova Science Publishers, 2011.
7. Xiang Cheng Zhang, 'Science and Principles of Biodegradable and Bioresorbable Medical Polymers' Elsevier Ltd., 2017.
8. P. Halley, L. Averous , 'Starch Polymers: From Genetic Engineering to Green Applications' Elsevier 2014.
9. Ray Smith, 'Biodegradable polymers for industrial applications' CRC Press, 2005.

REFERENCES:

10. Sina Ebnesajjad 'Handbook of Biopolymers and Biodegradable Plastics' Elsevier, 2013
11. Catia Bastioli, 'Handbook of Biodegradable Polymers' Rapra Technology Limited, 2005

OUTCOMES:

At the end of the course, the students will have the

- Knowledge on biodegradable plastics and mechanism of biodegradation of plastics
- Knowledge on the synthesis of biodegradable plastics
- Understanding of evaluation of biodegradability of plastics

PECX 006	BIOPLASTICS TECHNOLOGY	L	P	T	C
		2	0	0	2

OBJECTIVES:

- To introduce the types of bioplastics.
- To impart knowledge on the synthesis and properties of bioplastic materials
- To develop an understanding of the surface modification of biomaterials for improved functionality.
- To provide an understanding of applications of bioplastics.

MODULE: I INTRODUCTION TO BIOPLASTICS 7

Definition of Biopolymers and types of biopolymers, definition of bioplastics, Types of bioplastics such as starch based, cellulose based plastics and some aliphatic polyesters (PLA, PHB), polyamides, Bio-Based Composites from Soybean Oil and Chicken Feathers, bio-derived polyethylene and genetically modified bioplastics.

MODULE: II SYNTHESIS AND PROPERTIES OF BIOPLASTICS 7

Definition of Bio-Based Plastics - Direct Biosynthesis of Biopolymers - Modification of Renewable Feedstocks. Synthesis and properties of Cellulose Polymers, Cellulose Regenerates- Cellulose Ethers- Cellulose Esters- Polysaccharide Polymers . Synthesis and properties of Starch Polymers , Denatured Thermoplastic Starch (TPS)- Starch Acetate. Synthesis and properties of Vegetable Oil-based Biopolymers Chitin- Chitosan - Casein Plastics - Gelatins, lignin.

MODULE III SURFACE MODIFICATION OF BIOMATERIALS FOR IMPROVED FUNCTIONALITY 8

Enhancement of biocompatibility by the use of Corona discharge and plasma processes. Surface coatings Silver/silver oxide silicone hydrogels UV curable systems PC coatings Heparin loaded systems

MODULE IV APPLICATIONS OF BIOPLASTICS 8

Packaging - packaging materials - fibers and nets. Foams - biodegradable hot melt adhesive compositions. Food applications chewing gum medical applications - drug delivery – electrospinning - drug release from electrospun fibers - tissue engineering - scaffolds for tissue engineering – hydrogels – implants – stents - wound dressings. Personal care and sanitary goods - breathable biodegradable hot melt composition - sanitary goods - superabsorbent materials. Biopolymer used as cosmetic implants, controlled drug delivery system artificial heart valves, bone replacement, artificial organs, dental applications.

L – 30; T – 0; Total Hours - 30

TEXTBOOKS:

1 Syed Ali Ashter, 'Introduction to Bioplastics Engineering' Elsevier, 2016.
2 Michael Niaounakis, 'Biopolymers: Reuse, Recycling, and Disposal' Elsevier, 2013.
3 David Plackett, 'Biopolymers: New Materials for Sustainable Films and Coatings'Wiely, 2013.
4. Susheel Kalia, Luc Avérous, 'Biopolymers: Biomedical and Environmental Applications', John Wiley & Sons, 2011.

REFERENCES:

1. Srikanth Pilla, Handbook of Bioplastics and Biocomposites Engineering Applications, Wiley 2011.
2. Stoyko Fakirov, **'**Handbook of Engineering Biopolymers: Homopolymers, Blends and Composites'Hanser, 2015.
3. Sanjay Kumar Sharma, Ackmez Mudhoo, A Handbook of Applied Biopolymer: Technology Synthesis, Degradation and Applications, Royal Society of Chemistry, 2011.

OUTCOMES:

At the end of the course, the students will be able

- Identify and extract bioplastics from natural sources.
- To synthesis and analyze properties of bio-based plastic materials.
- To analyze and enhance biocompatibility with various surface modification methods.
- To identify bioplastic materials for specific applications.

PECX007	MEDICAL POLYMERS	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To impart knowledge of biomaterials and their compatibility with the human body system.
- To introduce to the various biomaterials used for manufacturing implants and contact lenses.
- To be familiar with synthesis and processing of biomedical polymers.
- To equip with knowledge of biomaterials used in dental, orthopedics, vascular, urogenital and drug delivery systems.

MODULE I BIOMATERIALS AND BIOCOMPATIBILITY 10

Biocompatibility, blood and tissue compatibility - approaches for enhancing blood and tissue biocompatibility of the implants, biocompatibility testing - in-vitro testing, in-vivo testing for biocompatibility, clinical trials of biomedical implants, surface modifications for improving biocompatibility.

MODULE II POLYMERIC IMPLANTS 5

Implants - biological responses to implants, requirements of implants, implant design and applications. Types of biomaterials for implants - metals, ceramics, polymers, composites.

MODULE III MEDICAL POLYMER PROCESSING 10

Polymers used as biomaterials, properties, synthesis and their biomedical applications, processing of polymers for biomedical devices, fabrication of polymer films - solution casting, melt pressing, melt extrusion. Solvent-Based Processing of Biomaterials - wet spinning, melt spinning, electrospinning. Hollow Fiber Membranes, Porous Scaffolds, thermoforming, extrusion, injection moulding. Rapid prototyping - Stereolithography (SLA), Fused Deposition Modeling (FDM) .

MODULE IV POLYMERIC MATERIALS IN DENTAL APPLICATIONS 5

Dental Polymers - Features of Dental polymers , Function, Materials, Benefits, polymers used for Dental and Maxillofacial Surgery, dental sealants - Material Types.

L – 30; T – 0; Total Hours – 30

TEXT BOOKS:

1. A.K. Bajpai, Jaya Bajpai, "Smart biomaterial devices - Polymers in Biomedical Sciences", CRC Press, 2017.
2. Vinod B. Damodaran, Divya Bhatnagar, N. Sanjeeva Murthy "Biomedical Polymers Synthesis and Processing", SpringerBriefs in Applied Sciences and Technology, 2016.
3. Munmaya K. Mishra, "Encyclopedia of Biomedical Polymers and Polymeric Biomaterials, 11 Volume Set", CRC Press, 2015.
4. C. M. Agrawal, "Introduction to biomaterials basic theory with engineering applications", Cambridge University Press, 2014.
5. Shalaby W. Shalaby, "Polymers for vascular and urogenital applications", CRC press, 2012.

REFERENCES:

1. Toyoichi Tanaka, “Experimental Methods in Polymer Science: Modern Methods in Polymer Research and Technology (Polymers, Interfaces and Biomaterials)”, Academic Press, 1999.

OUTCOMES:

At the end of the course, the students will be able

- Define biomaterials and their compatibility with the human body system.
- Describe the design, manufacture and requirements of various biomaterial implants.
- Select suitable methods to synthesis and process polymers for biomedical applications.
- Choose polymeric materials for dental applications.
- Distinguish biomaterials used for contact lenses and drug delivery systems.

PECX 008	IONIC POLYMERS	L	P	T	C
		2	0	0	2

OBJECTIVES:

- To develop an understanding of the synthesis, properties and applications of ionic polymers.
- To introduce the students with various methods for imparting conductivity in polymers.
- To provide knowledge on characterization techniques of conducting polymers.
- To equip with the knowledge of various applications of conducting polymers.

MODULE: I INTRODUCTION TO IONIC POLYMERS 8

Ionic polymers - Synthesis, physical properties and applications, Ionomers based on poly styrene, polyethylene, PTFE and electrometric, ionomers with polyaromatic backbones, polyelectrolytes for ion exchange and based on carboxylates, polyelectroyte complexes.

MODULE: II CONDUCTING POLYMERS 8

Conducting polymers, light sensitive -photo conducting polymers, polymers in non linear optics, polymers with piezoelectric, pyroelectric and ferroelectrics properties, photo resist for semiconductor fabrication, polymer coating in electronics.

MODULE: III CHARACTERISATION OF CONDUCTING POLYMERS 7

Electroanalytical techniques – cyclic voltammetry, linear sweep voltammetry, Impedance spectroscopy, chronoamperometry and chronocoulometry.

MODULE: IV APPLICATIONS OF CONDUCTING POLYMERS 7

Conducting polymers in microelectronics, EMI shielding, Light emitting diodes, rechargeable batteries, artificial muscles, electrochromic devices.

L – 30; T – 0; Total Hours – 30

TEXT BOOKS:

1 Charles A. Harper, Handbook of Plastics Technologies", Mc-Graw Hill Companies, USA, 2006.

2 Manas Chanda, Salil.K.Roy, "Industrial Polymers, Specialty Polymers, and Their Applications (Plastics Engineering)", CRC Press, 2012.
Cotts, D.B.; Reyes, Z, "Electrically Conductive Organic Polymers for Advanced Applications" , William Andrew Publishing/Noyes,March 1986.

3 R.W. Dyson, "Specialty Polymers", Chapman & Hall, 2nd edition, 1998.

4 Gordon G. Wallace, Peter R. Teasdale, Geoffrey M. Spinks Leon A. P. Kane-Maguire, "Conductive Electroactive Polymers: Intelligent Materials Systems", Second Edition, CRC Press, 2002.

5 Manas Chanda, Salil.K.Roy, "Plastics Technology Handbook", 2nd edition, Marcel Dekker, New York, 1993.

6 Zhiqun Lin, Yingkui Yang, Aiqing Zhang (eds.), "Polymer-Engineered Nanostructures for Advanced Energy Applications" Springer International Publication, July 2017.

REFERENCES:

1 Johannes Karl Fink, "High Performance Polymers", Elsevier, 2014.

2 Abbas Hamrang, Bob A Howell, Foundations of High Performance Polymers : Properties ,Performance and Applications, CRC Press, 2013.

3 H.F.Mark, (Ed), "Encyclopedia of Polymer Science & Engineering", John Wiley & Sons, New York, 1989.

4 J A Brydson, "Plastics Materials", Butterworth-Heinemann, 1999.Munich, 1987.

OUTCOMES:

- Identify specific method to synthesize ionic polymers for electrical and electronic applications.
- Develop polyelectrolyte membranes for advance applications.
- Analyze electrical properties of conducting polymers.
- Interpret data based on electroanalytic techniques.
- Identify specific method to synthesize polymers for electrical and electronic applications.

PECX 009 NANOTECHNOLOGY

L	P	T	C
3	0	0	3

OBJECTIVES:

- To introduce the basic concepts of Nanoscience through quantum mechanical theories and solid state physics
- To provide knowledge about the various synthesis methods applicable to different nano materials
- To enrich the knowledge of students in various characterisation techniques and application in nano devices and sensors fabrication
- To provide knowledge on applications of poymer based nano materials in bio technology.

MODULE: I INTRODUCTION TO NANOSCIENCE & NANOTECHNOLOGY 7

Introduction to Nanoscience & Nanotechnology : Definition – overview-Quantum Mechanics: Review of classical mechanics- de Broglie's hypothesis-Heisenberg uncertainty principle- Pauli’s exclusion principle - Schrödinger's equation - Properties of the wave function -Application: quantum well, wire, dot -Quantum cryptography.

MODULE: II SOLID STATE PHYSICS 8

Solid State Physics: Structure and bonding-Application: carbon nanotube - Electronic band structure-Electron statistics -Application: Optical transitions in solids.

MODULE: III NANOMATERIAL FABRICATION 8

Nanomaterial Fabrication: Bottom-up vs. top-down -Epitaxial growth -Self-assembly- nanoparticle synthesis -RF plasma, thermolysis, chemical induced, and pulse laser. The synthesis of carbon nanotubes- electrodeposition, gas atomization, preparation of quantum nanoparticles MEMS and NEMS -Fabrication -Modeling -Applications

MODULE: IV NANOMATERIAL CHARACTERIZATION 8

Nanomaterial Characterization:Structural characterization- X-Ray diffraction, electron microscopy-TEM, SEM, STM, Atomic Force Microscopy , Chemical characterization- Infrared Spectroscopy, Raman Spectroscopy- Optical characterization.

MODULE: V NANODEVICES & SENSORS 7

Single-Electron Devices, Nano scale MOSFET – Resonant Tunnelling Transistor – Single Electron Transistors; Single-Electron Dynamics; Molecular nanowires- Organic LED, Organic FETs- CNT and Graphene FTE, SiNW FET - Micro and nano-sensors, Fundamentals of sensors, biosensor, micro fluids, MEMS and NEMS.

MODULE: VI NANO BIO TECHNOLOGY 7

Bioactive nanomaterials in bone grafting and tissue engineering. Inorganic /polymer nano composites for dental restoration and bone replacement applications. Polymers nanofibers and their applications in bioengineering – Functional polymers for bone tissue engineering - Self-assembling nanostructured injectable polymeric gels for drug delivery - Engineering surface erodable polyanhydrides with tailored microstructure for controlled drug and protein delivery.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1 Nanotechnology: Global Strategies, Industry Trends and Applications, Jurgen Schulte, Wiley 2005.
2 Understanding Nanotechnology, edited by editors in Scientific American, Scientific American, 2002.
3 Nanotechnology: basic science and emerging technologies, Mick Wilson, Kamali Kannangara, Geoff Smith, and Michelle Simmons, Chapman & Hall/CRC; I edition, 2002.
4 Nanotechnology: An introduction to nanostructuring techniques, Michael Köhler and Wolfgang Fritzsche, Wiley-VCH; 2Rev Ed edition, 2007.
5 Challa S.S.R. Kumar (Ed) Biological and pharmaceutical nanomaterials : Wiley - VCH Verlag GmbH& Co, KgaA..

REFERENCES:

1 Ninmeyer C.M, Mirkin C.A (Eds) 2005. Nanobiotechnology .
2 H.S. Nalwa (Ed) Handbook of Nanostructured Bioaterials and their applications in nanobiotechnology, American Scientific Publishers.2005.

OUTCOMES:

At the end of the course, students will be able to

- Apply the knowledge of theories of quantum mechanics and solid state physics to calculate the energy levels of nano sized and quantum dot materials.
- Synthesize nano particles with appropriate methods applicable to individual materials.
- Acquire the knowledge of various methods of characterization of nano materials.
- Fabricate advanced semiconductors and electro-optic devices and sensors with nano materials by the knowledge acquired on different methods.
- Acquire knowledge on various nano materials and their functional properties from performance of the devices.
- Apply the knowledge on properties of various polymer based nano materials in biotechnology.

		L	P	T	C
PEC X010	**NANO MATERIALS TECHNOLOGY**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To introduce the concept of nano sized particles and their importance in modern material technology.
- To impart the knowledge on process technologies for production
- To give a comprehensive account on critical characterization techniques of nano materials
- To introduce the diversity of applications of the nano particles for advanced, improved devices and smart materials.

MODULE: I BACKGROUND 6

Background to nanoscience and nanotechnology - scientific revolutions - nanosized effects –- surface to volume ratio– atomic structure – molecular and atomic size - quantum effects - molecules & phases - formation of nano sized particles – energy at the nanoscale.

MODULE: II PHYSICAL & MECHANICAL METHODS OF PREPARATION 7

Preparations of Nanomaterials by mechanical and physical methods : – High energy ball milling –severe plastic deformation – melt quenching and annealing – vapour deposition – Pulsed laser deposition – Laser ablation - Magnetron sputtering- –Microwave plasma evaporation. Control of grain size. Scale up process. Handling of nano particles - Health hazards – Precautions.

MODULE: III PREPARATION METHOD - CHEMICAL 8

Chemical Methods of Preparation : Sol-gel method –Gel combustion - Co-precipitaion hydrolysis – Sonochemical method-combustion- Electrodeposition-Electrospinning – Arc method for carbon nanotubes – Chemical methods with organic precursors for carbon nanotubes, nanofibres and rods – synthesis of Graphene- Scale up methods with precautions.

MODULE: IV CHARACTERISATION TECHNIQUES 8

Characterisation of Nanomaterials: SEM - FEG-SEM - TEM – AFM – Nano-Indentor – mechanical deformation in small scale - XRD – UV-VIS spectroscopy – FTIR, FT-Raman, Photoluminescence, NMR, ESR and Light Scattering methods -

Dielectric characterization – Magnetic characterization – Chemical analysis.

MODULE: V PROPERTIES AND APPLICATIONS 9

Properties and application of nanomaterials – Optical - Mechanical – Electronic And Electrical - Quntum Dot (QD) Sensitized Solar Cells (QD-SSC) - Smart Coatings (Self Cleaning) - Superhyrophobic Coating For Drag Reduction – Application Of Polymer-Nanocomposites For Improvement In Properties - Smart Sensors.

MODULE: VI CARBON NANO MATERIALS & POLYMER NANOFIBRES 7

Applications of Carbon based nanomaterials (CNT, CNF, Graphene) - Polymers nanofibers and their applications in bioengineering – Functional polymers for bone tissue engineering applications – DNA- RNA- Nanoproducts.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1 Introduction to Nanoscience and Nanotechnology, Gabor .L et al,

2 A. Roth, Vacuum Technology North – Holland Pub.,II Edition (1982.)

REFERENCES:

1 Challa S.S.R. Kumar (Ed) Biological and pharmaceutical nanomaterials : Wiley - VCH Verlag GmbH& Co, KgaA..

2 H.S. Nalwa (Ed) Handbook of Nanostructured Bioaterials and their applications in nanobiotechnology, American Scientific Publishers.2005.

OUTCOMES:

At the end of the course, the students will be able to

- Acquire the knowledge of formation of nano sized particles and size dependency of material properties and their energy levels.
- Apply the knowledge on physical, mechanical and chemical methods of production of nano materials.
- Apply the knowledge of various critical and advanced techniques to characterize nano particles..
- Apply the knowledge gained in different types of nanomaterials for various engineering applications.
- Synthesize, characterize and apply the knowledge of the various nano carbons and polymer nano fibres in advanced material technologies and bio engineering.

PECX 011 POLYMERS FOR ELECTRONICS

L	P	T	C
1	0	0	1

OBJECTIVES:

- To introduce the students to the subject of polymeric materials having widely varying electrical, electronic, electro-optic, piezo and pyro-electric properties.
- To introduce the students to the application of various polymers and their desired properties for suitability in each electronic systems such as encapsulates, IC chips, PCBs, optical frequency modulators, optical wave guides, piezosensors and pyro sensors.

MODULE: I INTRODUCTION 7

Introduction of Polymer Classification: Insulators, Ionically conducting polymers - Electronically conducting polymers – Conductivity Ranges. Mechanism of electrical behavior: concept of band gaps, electron hopping- ion transport. Definitions of dielectric properties, pyroelectric & piezoelectric properties. Definition of Optoelectric and electromechanical properties. Examples in each type.

MODULE: II MATERIALS FOR VARIOUS APPLICATIONS 8

Chemistry of Interconnect polymers: Poyimides-advanced polyimides-Benzocyclobutane (BCB) , LCP – Alternate Polymers. Processing technology – Spin Coating Curing –Etching. Characterisation: Electrical, mechanical, thermal, chemical resistance & moisture sensitivity. Adhesion – metal-polymer interface. Polymeric Materials for encapsulation and Inmold Electronics.

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1. Polymers for Electronic & Photonic Application : Edited by: C. P. Wong, ISBN: 978-0-12-762540-9.
2. Polymers for Electricity and Electronics: Materials, Properties, and Applications, Author(s): Jiri George Drobny, ISBN: 9780470455531, Online ISBN: 9781118160121, DOI: 10.1002/9781118160121. John Wiely & Sons, Inc.

REFERENCES:

1 Conducting Polymers – A new era in Electrochemistry – G. Inzelt, Ed. F. Scholz, Springer.

2 Handbook of Conducting Polymers – Second Edition, Terje A. Skotheim, CRC Press, 24-Nov-1997 - Technology & Engineering.

OUTCOMES:

At the end of the course, the students will be able to

- Apply the knowledge gained to differentiate the requirement of diverse properties of polymers for various applications in electronic and opto-electronic industry.
- Select, modify, design materials and apply acquired knowledge in processing technology to deliver the relevant item for electronic Industries.
- Develop new advanced technologies and materials for fast changing electronic field.

PECX 012	POLYMERS FOR ENERGY TECHNOLOGY	L	P	T	C
		2	0	0	2

OBJECTIVES:

- To impart knowledge to the students on the emerging technologies of polymer for harnessing energy.
- To render comprehensive account of types of energy storage devices and polymers for near future application in energy conversion techniques.
- To equip the students with the knowledge of latest developments in the field of flexible electronic devices and systems

MODULE: I Energy Harvesting Based on Polymers 7

Photovoltaic device – Polymer Solar Cell – Dye-Sensitized Solar Cell – Perovskite Solar Cell – Polymer as Charge Transport Material – Thermoelectric Generator Piezoelectric Transducer

MODULE: II Energy Storage Based on Polymers 7

Lithium-Ion Batteries – Polymers as Active Materials in Electrode – Polymers as Separators – Polymers as Electrolytes – Supercapacitor – Polymer-Based Electrode– Polymer-Based Electrolyte

MODULE: III Light Emitting and Sensing Devices Based on Polymers 7

Light-Emitting Conjugated Polymers – Poly(p-phenylene vinylene) – Polyfluorene – Poly(p-phenylene) – Polycarbazole – Photophysics of Conjugated Polymer – Polymer Light-Emitting Diodes – structure and mechanism

MODULE: IV Flexible Energy and Electronic Devices Based on Polymers 7

Flexible Solar Cells – Flexible Piezoelectric Devices – Flexible Supercapacitors – Flexible Lithium-Ion Batteries – Flexible Light-Emitting Devices – Flexible Electrochromic Devices

L – 30; T – 0; Total Hours – 30

TEXT BOOKS:

1 Huisheng Peng, Xuemei Sun, Wei Weng, Xin Fang, “Polymer Materials for Energy and Electronic Applications”, Academic Press, 2016.
2 G. Inzelt, Ed. F. Scholz “Conducting Polymers – A new era in Electrochemistry” Springer,2008.
3 Terje A. Skotheim, “Handbook of Conducting Polymers – Second Edition”, CRC Press, 1997.
4 Ed. S.M. Javaid Zaidi & Takeshi matsuura, “Polymer Membranes for Fuel Cells “, Springer, 2008.

REFERENCES:

1 Francois Beguin, Elzbieta Frackowiak, “Supercapacitors: Materials, Systems and Applications”, John Wiley & Sons, 2013.
2 Frederik C. Krebs, “Polymer Photovoltaics: A Practical Approach”, Society of Photo Optical, 2008.

OUTCOMES:

At the end of the course, the students will be able to

- Develop novel electrodes and electrolytes based on polymers for energy harvesting and storing devices.
- Apply the knowledge gained in selecting polymeric materials for appropriate energy storing/generating devices
- In principle design electrical energy source with the knowledge gained on polymer based components of power devices
- Innovate/modify material technology for energy systems with higher conversion efficiency.

GROUP II (PROCESS ENGINEERING)

PECX 013	PVC TECHNOLOGY	L	P	T	C
		1	0	0	1

OBJECTIVES:

- To provide knowledge in manufacturing and properties of PVC
- To impart knowledge on PVC compounds
- To equip with the knowledge of copolymers of PVC and applications.

MODULE: I VINYL CHLORIDE POLYMERS 7

Introduction – Preparation of Vinyl Chloride – Polymerisation, K value of PVC– Compounding – Properties of PVC Compounds- Processing – Plasticised PVC – Unplasticised PVC – Pastes-Copolymers, Lead free PVC compounds.

MODULE: II APPLICATIONS 8

Applications of PVC – Missceleneous Products – Crystalline PVC- Chlorinated PVC – Graft polymers based on PVC –Vinyl chloride – propylene copolymers –Vinyl chloride- N- cyclohexylmaleimide copolymers.

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1 J.A Brydson, "Plastics Materials", Fifth edition, Elsevier, 2013

2 M.V. Titow, "PVC Technology", Springer Science & Business Media, 2012

REFERENCES:

1 Nicholar P. Chermisinof, "Hand Book of Engineering Polymeric Materials", Marcel Dekker inc. N.Y. 1997.

OUTCOMES:

At the end of the course, the students will have the ability to

- Identify the manufacturing process for the development of PVC for specific applications.
- Select PVC based on the properties for various applications.
- Compare the properties of various types of modified PVC.
- Modify PVC for specific applications.

PECX 014 NYLON FIBER TECHNOLOGY

L	P	T	C
1	0	0	1

Objectives:

- To provide knowledge in manufacturing and properties of nylons
- To impart knowledge on fibre spinning process
- To equip with the knowledge of chemical modification and blending of nylons.

MODULE: I PHYSICAL STRUCTURE AND CHARACTERISATION 7

Structure properties relationship – crystallizing, melting temperature, Tg, solubility, molecular weight, melt viscosity, degradation and stabilization, Electrical and mechanical properties.

Characterisation: Identification, composition/moisture analysis, separation techniques, BGGmolecular mass and distribution, IR, NMR and X-ray diffraction.

MODULE: II MELT SPINNING AND FIBRE PROCESSING 8

Fundamentals of Melt Processing: Measurements of viscosity, PVT relationships, importance of moisture, effect of molecular mass, shear, temperature, additives and channel shape. Applications of Rheological data to flow situation.

Processing techniques of melt processing: Processing reagents, material handling and drying, injection moulding, extrusion, blow moulding and monomer processing.

Other processing Techniques: Powder coating, blending and solution coatings. Secondary Treatments: Assembly, Moisture conditioning, mechanical surface.

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1 J.A Brydson, “Plastics Materials”, Fifth edition, Elsevier, 2013
2. J E McIntyre, “Synthetic Fibres: Nylon, Polyester, Acrylic, Polyolefin”, Elsevier, 2004
3. Malvin I. Kohan, “Nylon Plastics Hand Book”, Hanser publisher, 1995.

REFERENCES:

1 Gajanan Bhat, “Structure and Properties of High-Performance Fibers”, Woodhead Publishing, 2016
2 Nicholar P. Chermisinof, “Hand Book of Engineering Polymeric Materials”,

Marcel Dekker inc. N.Y. 1997

OUTCOMES:

At the end of the course, the students will have the ability to

- Identify the manufacturing process for the development of nylons for specific applications.
- Select nylon based on the properties for various applications.
- Compare the properties of various types of nylons.
- Analyse the various parameters employed in the fibre spinning process.

PECX 015	LATEX TECHNOLOGY	L	T	P	C
		1	0	0	1

OBJECTIVES:

1. To provide fundamental knowledge of NR latex in terms of collection, storage and conversion in to useful form.
2. To impart knowledge of various latex product manufacturing process and synthetic latex.

MODULE I NATURAL RUBBER LATEX 6

Tapping – methods, Latex collection and storage, preservation and concentration– Conversion to marketable forms – RSS, crepe rubber, field coagulam, Technically specified rubber (TSR). Latex compounding.

MODULE II LATEX PRODUCT MANUFACTURING AND SYNTHETIC LATEX 9

Dipping process for manufacturing gloves - Latex casting – Latex foam – Thread – Foam and Adhesives.
Synthetic lattices – SBR latices, Nitrile lattices, Polychloroprene and PVC lattices.

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1. Rani Joseph, “Practical Guide to Latex Technology”, Smithers Rapra Technology Ltd, 2013.
2. A.K. Bhowmick, M.M. Hall and H.A. Benaney, “Rubber Products Manufacturing Technology”, Marcel Dekker Inc, New York, 1994.

REFERENCES:

1. Blow. C.M. and Hepburn C, “Rubber Technology and Manufacture”, Butterworths, 1982.

OUTCOMES:

At the end of the course, the students will be able to,

- Apply the knowledge of latex in collecting, preserving and converting them in to a useful form.
- Suggest process to manufacture latex rubber products
- Explain synthetic lattices.

PECX 016	THERMOFORMING PROCESS	L	T	P	C
		1	0	0	1

OBJECTIVES:

- To provide fundamental knowledge of thermoformed part design.
- To introduce thermoforming machinery.

MODULE I THERMOFORMING 8

Introduction to Thermoforming - General Forming Concepts - Part Design - Part Design Philosophy - Design Protocol, Project Protocol, Parameters Affecting Part Design, Product Design - Corner versus Chamfer, Draft Angles, Thermal Expansion, Dimensional Tolerance, improving Dimensional Tolerance, Part Surface Quality, Trim Line Location, In-Mold Decorating and Labeling, Seal Designs on Twin-Sheet Thermoformed Parts, Guidelines to Successful Part Design.

MODULE II MACHINERY FOR THERMOFORMING PROCESS 7

Machinery for the Thick-Gauge Forming Process - Shuttle Press, Cabinet Press, The Elements of Heavy-Gauge Machinery - Sheet Handling, Sheet Clamping, The Forming Press, etc.

Machinery for the Light-Gauge Forming Process - Standard Roll-Fed Machine, Contact Heater Machines, Form-Fill-Seal Operation, Elements of Light-Gauge Machinery - Sheet Take-off or Unwind Station, The Forming Press, etc.

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1. M.L.Berins “Plastic Engineering Handbook”, Society of Plastic Industries, Chapman & Hall NY 1991.
2. James L. Throne, "Understanding Thermoforming" II edition, Hanser Gardner Publications, Inc., 2008.

REFERENCES:

1.Chris Rauwendaal, "Polymer Extrusion", 5th edition, Hanser Publications, 2014.

OUTCOMES:

At the end of the course, the students will be able

- Apply the knowledge of thermoformed part design.
- Classify thermoforming machinery.

PECX 017	INJECTION MOULDING TECHNOLOGY	L	P	T	C
		2	0	0	2

OBJECTIVES:

- To impart knowledge of injection molding process and the parameters affect the process.
- To introduce computer aided engineering and their use in injection molding process.
- To develop knowledge of auxiliary equipment and their role in injection molding process.
- To equip with knowledge of costing involved in injection molding process.

MODULE: I UNDERSTANDING THE INJECTION MOLDING PROCESS 8

Injection Molding Process - Categorizing the parameters - temperature, pressure, time, distance - the need for process controls - controlling shrinkage - the effects of temperature adjustments, the effects of pressure adjustments, post-mold shrinkage, minimizing molded-in stress.

MODULE: II CAE IN INJECTION MOLDING 9

CAE and its types, simulation and polymer processing - injection molding - physics of injection molding - material complexity, geometric complexity, process stability, value of simulation - current technology for injection- molding simulation - filling and packing analysis, cooling analysis, fiber orientation analysis, predicting fiber orientation, warpage analysis, optimization.

MODULE: III AUXILIARY EQUIPMENT 8

Need for auxiliary equipment - material handling - factors to consider - bulk resin conveying systems - vacuum conveying system, pressure conveying systems, combination systems - blending systems - regrind systems - material drying.

MODULE: IV INJECTION MOLDING COSTS 5

Outline of injection molding cost - Material Costs, Labor Costs, Machine Costs, Tooling Costs - Secondary Operations cost.

L – 30; T – 0; Total Hours – 30

TEXT BOOKS:

1. Douglas M. Bryce " Plastic Injection Molding Volume II: Fundamentals of Injection Molding series", Society of Manufacturing Engineers, 1997.
2. Charles A. Harper, " Modern plastics handbook", McGraw-Hill, 2000.

REFERENCES:

1. Jay Shoemaker, "Moldflow Design Guide - A Resource for Plastics Engineers", Moldflow Corporation, 2006.
2. Suhas Kulkarni," Robust process development and scientific molding : theory and practice", Carl Hanser Verlag, Munich, 2010.

OUTCOMES:

At the end of the course the students will have the knowledge on

- Demonstrate the injection molding process and the parameters affect the process.
- Apply the knowledge of computer aided engineering and their use in injection molding process.
- Identify and select auxiliary equipment for injection molding process.
- Estimate the cost involved in injection molding process.

PECX 018	EXTRUSION TECHNOLOGY	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To impart knowledge of extrusion molding process.
- To equip with knowledge of flow mechanism and analysis of an extruder.
- To develop knowledge of mixing types and their influence on product property.
- To introduce the necessary of instrumentation and control system in an extruder.

MODULE I TYPES OF EXTRUDERS 6

The single screw extruder - vented extruders, rubber extruders, high-speed extrusion - multiscrew extruder - twin screw extruder, multiscrew extruder with more than two screws, gear pump extruder - disk extruders - viscous drag disk extruders - ram extruders.

MODULE II MELT FLOW IN EXTRUDER 8

General features of extruder - mechanism of flow - analysis of flow in extruder - extruder die characteristics - other die characteristics

MODULE III MIXING IN SINGLE SCREW EXTRUSION 8

The need for good mixing in single screw extrusion - examples of mixing problems - polyethylene pipes and cables, blow moulded bottles, chalk filled polypropylene pipe, blown film, etc - dispersive mixing - dispersive mixing mechanisms - distributive mixing - measurement of mixing - influences of mixing on product properties.

MODULE IV INSTRUMENTATION AND CONTROL 8

Instrumentation requirements - pressure measurement, temperature measurement, other measurements - power measurement, rotational speed, extrudate thickness, extrudate surface conditions - temperature control - on-off control, controllers, time-temperature characteristics, tuning of the controller parameters - total process control.

L –30; T – 0; Total Hours – 30

TEXT BOOKS:

- R.J. Crawford, "Plastics Engineering, Third Edition", Butterworth-Heinemann, 2002.
- Chris Rauwendaal, "Polymer Extrusion", 5th edition, Hanser Publications, 2014.
- Martin Gale, "Mixing in Single Screw Extrusion", iSmithers, 2009.

REFERENCES:

- M.L.Berins “Plastic Engineering Handbook”, Society of Plastic Industries, Chapman & Hall NY 1991.
- Charles A. Harper, " Modern plastics handbook", McGraw-Hill, 2000.

OUTCOMES:

At the end of the course, the students will be able to,

- Demonstrate the extrusion molding process
- Apply the knowledge of flow mechanism and analysis during setting up of process parameters of an extruder.
- Describe mixing types and their influence on product property.
- Identify and use necessary instrumentation and control system in an extruder.

PECX 019	BLOW MOULDING TECHNOLOGY	L	P	T	C
		2	0	0	2

OBJECTIVES:

- To impart fundamental knowledge of blow molding process.
- To equip with knowledge of extrusion blow molding process.
- To develop knowledge of injection stretch blow molding process.
- To illustrate the various trouble shooting process of blow molding.

MODULE: I BLOW MOULDING 5

Basic process - Types of Blow Moulding - Material Considerations and selection - Basic Design and Design Considerations - Bottle and Container Design - Structural Design - Design Details.

MODULE: II EXTRUSION BLOW MOULDING 7

Extruder - Extrusion Blow Moulding Head and Die Unit - Centre-Feed Die, Side-Feed Dies - Wall Thickness, Accumulator Head, Die and Mandrel, Die Swell, Parison Adjustment, Die Shaping, Parison Programming, Blow-up Ratio. Co-Extrusion Blow Moulding - Three-Dimensional Blow Moulding, Suction Blow Moulding, Parison Manipulation - Double Walled Parts and Containers.

MODULE: III INJECTION STRETCH BLOW MOLDING 8

The injection process - process characteristics - one step process, two step process - The blowing process - reheating preforms, blowing bottles, mold closed, stretch rod engages, preblow engages, stretch rod at base insert, high-pressure blow, mold opening - air valve control - injection stretch blow molding machines - two-stage stretch blow moulding machine, single stage blow moulding machine.

MODULE: IV TROUBLESHOOTING OF BLOW MOLDING PROCESS 10

General guidelines - starting a new process - preblow pressure control - changing preform temperatures - output control - troubleshooting of specific problems - internal folding in the neck area, candle stick, off-center gate, haze in bottle walls, stress whitening, deformed necks, underblown bottle, flats on bottle split-line, rings forming in bottle body, wall thickness over circumference of bottle not uniform, excessive changes in bottle volume with age, bottle fails burst test, uneven axial wall distribution, cracked gates, drop impact failure, top load test failure.

L – 30; T – 0; Total Hours – 30

TEXT BOOKS:

1. Michael L Berins, “Plastics Engineering Handbook of the Society of the Plastics Industry (SPI), Inc.”, Van Nostrand Reinhold, 1991.
2. Belcher, Samuel L., Practical guide to injection blow molding, CRC Press, 2007.

REFERENCES:

1. Norman C. Lee, “Practical Guide to Blow Moulding”, Rapra Technology Limited, 2006.

OUTCOMES:

At the end of the course the students will be able to

- Demonstrate the different types of blow molding process.
- Describe the parison wall thickness control and parison Programming process.
- Demonstrate the various steps involved in stretch blow molding Process and compare the EBM and SBM techniques.
- Identify and use relevant trouble shooting procedure to solve the molding defects.

PECX 020 POST PROCESSING OPERATIONS

L	P	T	C
1	0	0	1

OBJECTIVES:

- To provide understanding of post processing operations.
- To introduce different painting, printing and coating methods.
- To impart knowledge on assembly of plastic parts, plating and painting.

MODULE: I MACHINING AND FINISHING 8

Deflashing, smoothing and polishing, Routing, milling and turning, Filing grinding and sanding, sawing and cutting, drilling, taping and threading, cleaning and annealing.

MODULE: II ASSEMBLY OF PLASTIC PARTS 7

Mechanical fastening, Adhesive bonding, Thermal welding, Solvent cementing, Welding / Sealing: Hot gas, hot bar, high frequency dielectric, ultrasonic, rotations frictions, vibration, electromagnetic radiation, Microwave, infrared, orbital, friction stir, impulse, bond, hotwire, hot knife & contact – self fastening – press fit, snap fit – adhesive bonding.

L – 15; T – 0; Total Hours – 15

TEXT BOOKS:

1. Rodger Talbert, “Paint Technology Handbook”, CRC Press ,September 13, 2012.
2. Arthur A. Tracton ,”Coatings Materials and Surface Coatings”, CRC Press,2006.
3. Arthur A. Tracton,”Coatings Technology: Fundamentals, Testing, and Processing Techniques”, CRC Press, November 7, 2006.
4. Zeno W. Wicks Jr. , Frank N. Jones , S. Peter Pappas, Douglas A. Wicks, “Organic Coatings: Science and Technology”, Wiley-Interscience; 3rd edition,1993.
5. Charles A. Harper, “Modern Plastics Handbook”, McGraw-Hill, 1999.
6. Akira Kobayashi, **“**Machining of Plastics”, McGraw-Hill, 1990.

REFERENCES:

1. Modern Plastic World Encyclopedia – 2000, Modern Plastics International.
2. Walter Michaeli, “Plastic Processing, an Introduction”, Hanser publications – Munich, 2005.

OUTCOMES:

At the end of the course the students will be able to

- Identify machining and finishing operation for different plastic products.
- Select suitable printing and coating methods based on application.
- Design post processing method for polymer products.

PECX021	RUBBER PRODUCT MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop fundamental knowledge of rubber mixing machineries.
- To impart knowledge of latex compounding and product manufacturing.
- To provide knowledge of belt manufacturing technology.
- To illustrate the cable and hose manufacturing process.
- To develop knowledge of footwear and sport goods manufacturing processes.
- To introduce reverse engineering concepts of rubbers.

MODULE I COMPOUND MIXING AND PROCESSING . 7

Mixing machinery for rubber - two-roll mills, internal batch mixers, continuous mixers. Processing - calendering, extrusion, molding - compression molding, transfer molding, injection molding, injection molding of tpes.

MODULE II LATEX PRODUCT MANUFACTING 8

Latex compounding ingredients, preparation of aqueous dispersions and emulsions, dispersion of water insoluble solids, evaluation of the quality of dispersion, preparation of emulsions. Dipping and casting - types of dipping processes, glove production - batch dipping process, continuous dipping process, defects and remedies. Latex casting - latex casting using plaster mould, latex casting using a metal mould. Latex foam rubber - the Dunlop process, the Talalay process, testing of latex foam. Latex rubber thread - latex adhesives.

MODULE III BELT MANUFACTURING TECHNOLOGY 10

Conveyor belt – raw materials, belt construction, different grades of belts with their properties and applications, belt selection, manufacturing, vulcanization – belt joining process. V-Belt – raw materials – processing of various components – rubber, cord, canvas – method of processing of various v-belts.

MODULE IV HOSE AND CABLE MANUFACTURING 6

Hose manufacturing - High Pressure Hydraulic Hose, Wire Braid Hoses, Spiral Hoses Automotive Hose - Coolant Hoses, Power Steering Hoses, Fuel Hoses - Industrial Hose - Air, Water, and Welding Hose, Steam Hose.

Cable Technology - Constructional Elements of Polymer-Insulated Cables, Polymeric Materials for Cable Insulation- Compound Design, Manufacturing

Techniques - Extrusion, Curing Processes - special purpose cables.

MODULE V FOOT WEAR & SPORTS GOODS MANUFACTURING 6

Types of foot wear – plimsolls – build up shoes – all rubber shoes – DVP shoes – dip shoes – plastic foot wear manufacturing by slush molding – injection molded PVC shoes - injection molding of sole and heel units – expanded micro cellular soling – methods of manufacturing microcellular soling – trouble shooting.

Golf ball and tennis ball manufacturing.

MODULE VI DESIGNING RUBBER PRODUCTS 8

Reverse engineering concepts - chemical techniques - solvent extraction, ash content determination, chromatographic separation, chemical digestion. Analytical techniques - thermogravimetric analysis, differential scanning calorimetry, infrared spectrophotometry, etc. Formula reconstruction with example - sample preparation - flowchart of material reverse engineering - formula reconstruction - comparison of reconstructed formulation with actual recipe - numerical problem on reverse engineering and case studies

L – 45; T – 0; Total Hours – 45

TEXTBOOKS:

1. Richard F. Grossman, "The Mixing of Rubber", Chapman & Hall, 1997.
2. Rani Joseph, "Practical Guide to Latex Technology", Smithers Rapra Technology Ltd, 2013.
3. Saikat Dasgupta, " Reverse Engineering of Rubber Products, Concepts, Tools, And Techniques", Taylor & Francis Group, 2014
4. A.K. Bhowmick, M.M. Hall and H.A. Benaney, “Rubber Products Manufacturing Technology”, Marcel Dekker Inc, New York, 1994.

REFERENCES:

1. Blow. C.M. and Hepburn C, “Rubber Technology and Manufacture”, Butterworths, 1982.
2. C.W. Evans, “Hose Technology”, Elsevier Applied Science Publishers, 1979.

OUTCOMES:

At the end of the course, the students will be able to,

- Identify suitable rubber mixing machinery for rubber compounding.
- Compound latex as per requirements and manufacture latex products
- Demonstrate the belt manufacturing process.
- Describe cable and hose manufacturing methods.
- Explain the footwear and sport goods manufacturing processes.
- Illustrate the reverse engineering concepts of rubbers.

PECX022 RUBBER PROCESS ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To develop fundamental knowledge of rubber mixing machineries.
- To impart knowledge of mixing procedure for different compounds.
- To provide knowledge of calendaring and extrusion process .
- To illustrate the molding process used in processing rubbers.
- To develop knowledge of different vulcanisation methods used in rubber processing.
- To introduce processing methods for various rubber products.

MODULE I COMPOUNDING AND MIXING OPERATIONS 7

Mixing machinery for rubber - two-roll mills, internal batch mixers, continuous mixers. Mixing cycles - unit operations in mixing - single-pass versus multiple-pass mixing - types of mix cycle - late oil addition, upside-down mixing, sandwich mixes.

MODULE II MIXING PROCEDURES FOR SPECIFIC COMPOUNDS 8

EPDM expansion joint cover - SBR/IR belt cover - EPDM low voltage electrical connector - peroxide-cured black-filled EPDM compounds - EPDM concrete pipe gasket - SBR insulation - injection-molded NBR gasket - CR/SBR blend - NBR/PVC cable jacket - Chlorobutyl/NR blend.

MODULE III FORMING OPERATIONS 10

Calendering - Calender configurations and operations - roll deflection and methods of correction - feeding; sheet cooling, and batch-off equipment.

Extrusion; Ram type – Screw type – L/D ratio and its influence – Hot & cold feed extruders – Pin barrel extruder – piggy back extruders - Twin screw extruder – Criteria for machine selection.

MODULE IV MOULDING OPERATIONS 6

Injection molding of rubbers - machine construction, screw design, mold construction, molding defects and rectification.

Compression, transfer molding - Blanks & pre-heating technique and manufacturing techniques.

MODULE V VULCANISING TECHNIQUES 6

Autoclaves, Hot air chambers, curing of built up articles, continuous vulcanization, L.C.M. (Liquid Curing Media), Fluidized Bed, microwave curing. Hand building and forming equipment for tank, pipe lining, roller covering.

MODULE II PROCESSING METHODS FOR VARIOUS RUBBER PRODUCTS 8

Tyres and tubes – Belting and hoses – Cables – Footwear – Sports goods – Molded products – Latex products – Rubber – To-Metal bonding – Coated fabric.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. Richard F. Grossman, "The Mixing of Rubber", Chapman & Hall, 1997.
2. A.K. Bhowmick, M.M. Hall and H.A. Benaney, “Rubber Products Manufacturing Technology”, Marcel Dekker Inc, New York, 1994.
3. Bernie Stritzke, "Custom Molding of Thermoset Elastomers", Hanser Publications, 2009
4. John G. Sommer, Engineered Rubber Products, Introduction to Design, Manufacture and Testing, Hanser Publishers, 2008.
5. B.G. Crowther, "Rubber Extrusion Theory and Development", Rapra Technologies Ltd, 1998

REFERENCES:

1. Blow. C.M. and Hepburn C, “Rubber Technology and Manufacture”, Butterworths, 1982.
2. Stevens.M.J., Extruder Principles and Operations, Elsevier Applied Science, New York, 1985.

OUTCOMES:

At the end of the course, the students will be able to,

- Operate rubber mixing machineries.
- Identify and suggest suitable mixing procedure for different compounds.
- Demonstrate calendaring and extrusion process .
- Explain injection, transfer and compression molding of rubbers.
- Describe different vulcanisation methods used in rubber processing.
- Suggest processing methods for various rubber products.

PECX023	TYRE MANUFACTUING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart interest and sense of appreciation of all about pneumatic tyre.
- To educate the students in respect of tyre components and construction of a pneumatic tyre.
- To provide insight to the mechanics of tyre.
- To develop knowledge of tyre reinforcements with respect to tyre cords.
- To illustrate the tyre manufacturing and retreading processes.
- To introduce tyre testing and evaluation procedures.

MODULE I TYRE COMPOUNDING 7

Introduction to tyre technology – tyre compound and fundamental properties – compound development – raw materials for compounding- different tyre components – designing the compound matrix for the reinforced composite.

MODULE II TYRE COMPONENTS AND STRUCTURE 8

Tyres – Function – Construction – Basic tyre design-Tyre Components and their functions, Tyre Materials, Tyre Nomenclature and Structural Dimensions, Classification of tyres based on applications and its requirements. Tubeless Tyre-Function, Construction, Materials and advantages.

MODULE III TYRE MECHANICS 8

Mechanics of rubber – cord rubber composite and its properties, failure mechanism of cord reinforced rubbers composites. Inflation pressure – contact area, tyre deflections – design factors and principles. Rolling resistance, friction, mechanical loss on tyre behavior.

MODULE IV TYRE CORD REINFORCEMENTS 8

Tyre cords – Physical Properties of tyre-cords- Rayon, Nylon, Polyester, Fibre glass, Aramid, Steel Wire-Cord Processing – Heat Treatment, Adhesive treatment, Bonding systems, Rubber to Cord Mechanism, Tyre Cord Construction, Evaluation of adhesive systems.

MODULE V TYRE AND TUBE MANUFACTURING 8

Tyre manufacturing – tyre building – green tyre – curing methods – post curing inflation – finishing. Retreading – criteria – methods of retreading.

Tubes: Principles of tube design – manufacturing of tubes by extrusion, valve jamming, inflation & curing in presses, tube testing.

MODULE VI TYRE TESTING 6

Tyre Testing – Destructive and Non-destructive Testing of Tyres, Plunger Tests (Breaking energy), Pulley wheel test Field Tract Testing – Braking, Acceleration, mileage, Regulations, Tyre Labelling.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

- A.K. Bhowmick, M.M. Hall and H.A. Benaney, "Rubber Products Manufacturing Technology", Marcel Dekker Inc, New York, 1994.
- Tyre Technology, Tom French, Adam Hilger, 1989
- Mechanics of Pneumatic Tyres, (ed) Samuel K Clark, US Dept of Transportation.
- Tyre Technology, F J Kovac, The Goodyear Tyre & Rubber Company, 1973.

REFERENCES:

- Blow. C.M. and Hepburn C, "Rubber Technology and Manufacture", Butterworths, 1982.
- James E. Mark, Burak Erman "Science and Technology of RUBBER", Academic Press, 2005
- R.A. Ridha and M. Theves, "Advances in tyre mechanics", Rapra Technology Limited, 1997.

OUTCOMES:

At the end of the course, the students will be able to,

- Identify suitable compounding ingredients for pneumatic tyre.
- Explain tyre components and construction of a pneumatic tyre.
- Apply the mechanics of tyre in tyre design.
- Describe the tyre reinforcements with respect to tyre cords.
- Illustrate the tyre manufacturing and retreading processes.
- Suggest suitable tyre testing and evaluation procedures.

PECX024 **PLASTICS RECYCLING**

L	P	T	C
2	0	0	2

OBJECTIVES:

- To facilitate the students for selecting suitable recycling technique for polymer waste.
- To enable the students in designing simple techniques for conversion of plastic waste back to usable products. .
- To impart knowledge on degradation and stabilizationmechanism.
- To demonstrate the various techniques of recycling thermoplastics.

MODULE: I IDENTIFICATION AND SEPERATION 6

Plastics production and consumption – Plastic wastes generation source and types – Plastic waste composition , quantities – Plastics identification methods physical , chemical and instrumental – sorting and separation technologies – disposal alternatives.

MODULE: II METHODS OF RECYCLING 6

Size reduction of recycled plastics – cutting / shredding, densification, pulverization and chemical size reduction processes – municipal solid waste and composition – recycling of plastics from urban solid wastes – household waste.

MODULE: III DEGRADATION AND STABILIZATION OF RECYCLED POLYMER 10

Melt Filtration of Contamination in Recycled Polymers, degradation mechanisms, additives for closed loop recycling, stabilization mechanisms, various types of stabilisers, additives to improve property of recyclate.

MODULE: IV RECYCLING OF THERMOPLASTICS 8

Recycling of polyolefins – polyethylene films – Polypropylene battery recycling– Recycling of HDPE fuel tanks – PET recycling methods – PET film recycling – Applications of polyolefin and PET recycling – PVC recycling.Engineering thermoplastics and their major areas where engineering polymers are recycled – PC, PBT, Nylon, PPO, ABS and polyacetals and their blends.

Total 30 hrs.

TEXTBOOKS:

1 Michael Tolinski, “Plastics and Sustainability”, John Wiley & Sons, 2011.
2 Dr. Anandhan Srinivasan “Recycling of Polymer Wastes” VDM Publishing, 2010
3 Güneri Akovali, “Frontiers in the Science and Technology of Polymer Recycling”, Springer Netherlands, 2010.
4 Manas Chanda, “Plastics Fabrication and Recycling”, CRC Press, 2008
5 John Scheirs, “Feedstock recycling and pyrolysis of waste plastics”, J. Wiley & Sons, 2006.

REFERENCES:

1 Ann – Christine Albertson and Samuel J.Huang, “Degradable Polymers, Recycling and Plastic Waste Management”, Taylor & Francis, 1995.
2 Nabil Mustafa, “Plastics Waste Management”, Marcel Dekker, 1993.

OUTCOMES:

At end of the course, the students will be able to

- Identify and analyse the various forms of plastic wastes.
- Select suitable recycling method for various polymer wastes.
- Demonstrate the knowledge of various recycling processes for plastics.
- Apply recycling techniques for various applications.

PECX 025	PLASTIC WASTE MANAGEMENT	L	T	P	C
		1	0	0	1

OBJECTIVES:

- To impart knowledge on the recycling of thermoset materials.
- To develop an understanding on the recycling of elastomers.

MODULE: I RECYCLING OF THERMOSETS 8

Recycling of Polymer thermoset composites – regrind processes – SMC scrap – pyrolysis and energy recovery –Types of rubber products – rubber grinding methods – tyre grinding – rubber crumb applications – Reclaiming and de-vulcanization processes – tyre derived fuel and energy recovery – Pyrolysis of scrap tyres

MODULE: II RECYCLING OF ELASTOMERS 7

Rubber products Size Reduction, Ground Rubber Crumb Applications, Ground rubber tyre, recycling of rubber tyres, polymer composites, Reclaiming and Devulcanization, application of recycled rubber products – filler , ground rubber products, ribber crumb with thermoplastic binder.

L – 15; T – 0; Total Hours –15

TEXT BOOKS:

1. Michael Tolinski, “Plastics and Sustainability”, John Wiley & Sons, 2011.
2. Dr. Anandhan Srinivasan “Recycling of Polymer Wastes” VDM Publishing, 2010.
3. Güneri Akovali, “Frontiers in the Science and Technology of Polymer Recycling”, Springer Netherland.
4. Manas Chanda, “Plastics Fabrication and Recycling”, CRC Press, 2008.
5. John Scheirs, “Feedstock recycling and pyrolysis of waste plastics”, J. Wiley & Sons, 2006.

REFERENCES:

1. Ann – Christine Albertson and Samuel J.Huang, “Degradable Polymers, Recycling and Plastic Waste Management”, Taylor & Francis, 1995.
2. Nabil Mustafa, “Plastics Waste Management”, Marcel Dekker, 1993.

OUTCOMES:

At the end of the course, students will be able to

- Recycle plastic wastes and converts them to energy.
- Select suitable recycling methods for thermoset and elastomers.
- Demonstrate the knowledge of various recycling processes for thermoset and elastomeric wastes.

PECX026	RAPID PROTOTYPING - 3D PRINTING	L	P	T	C
		2	0	0	2

OBJECTIVES:

- To review the fundamental knowledge of prototyping
- To impart knowledge of liquid based prototyping systems
- To explain the basic fundamentals powder based rapid proto typing systems
- To list out the various applications 3D printing.

MODULE: I INTRODUCTION 6

Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.

MODULE: II LIQUID-BASED RAPID PROTOTYPING SYSTEMS 9

Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Laser engineered net shape and laser based additive processing

MODULE: III POWDER BASED RAPID PROTOTYPING SYSTEMS 9

Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling , Classification: Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting,

MODULE: IV 3D PRINTING 6

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Selective Laser Melting, Electron Beam Melting.

L – 30; T – 0; Total Hours – 30

TEXT BOOKS:

1. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific publications , Third Edition, 2010.
2. Rapid Manufacturing - D.T. Pham and S.S. Dimov, Springer , 2001

REFERENCES:.

1. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, second edition, World Scientific Publishers, 2010.
3. Gebhardt, A., “Rapid prototyping”, Hanser Gardener Publications, 2003.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications : A tool box for prototype development”, CRC Press, 2011.
5. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
6. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

OUTCOMES:

At the end of the course the students will be able to:

- Explain the various terminology used in rapid proto typing
- Apply Fused Deposite Model in rapid proto typing
- Design proto type models using powder based proto typing systems
- Use the rapid proto typing technique in various field of Engineering

GROUP III (Product & Mould Design)

PECX027	**COMPUTER AIDED MODELING**	**L**	**P**	**T**	**C**
		2	**0**	**0**	**2**

OBJECTIVES:

- To make a list of computer hardware requirement for executing computer aided modeling.
- To impart knowledge on various computer graphics techniques used for computer aided designing.
- To prepare and explain different types of geometric modeling techniques used for computer aided modeling.
- To demonstrate the various techniques of drafting in computer aided modeling.

MODULE: I INTRODUCTION 6

Computers in industrial Manufacturing, Product cycle, CAD/CAM Hardware, Basic structure, CPU, Memory types, input devices, display devices, hard copy devices, storage devices.

MODULE: II COMPUTER GRAPHICS 6

Computer Graphics: Raster scans graphics coordinate system, database for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections, clipping, hidden surface removal

MODULE: III GEOMETRIC MODELLING 10

Geometric modeling: Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modeling facilities desired

MODULE: IV DRAFTING 8

Drafting and Modelling systems: Basic geometric commands, layers, display control commands, editing, dimensioning, solid modeling, constraint based modeling.

Total 30 hrs.

TEXT BOOKS:

1 P.N.Rao, “CAD/CAM Principles and Applications” - 3rd edition, Tata McGraw Hill, 2010.
2 Ibrahim Zeid/R.Siva Subramanian, “CAD/CAM Theory and Practice” - 2nd edition, Tata McGraw Hill, 2009.
3 J.Y.H.Fuh, “Computer Aided Mold Design and Manufacture”, Marcel Dekker Publication, 2004.

REFERENCES:

1 John. M. Nicholas, “Lean Production Competitive Advantage”, A Productivity Press Book, 2011.
2 P.Radhakrishnan and S.Subramanian, “CAD/CAM/CIM”, 3rd edition. New Age International, 2009.

OUTCOMES:

- To prepare a list of computer hardware requirement for executing computer aided modeling.
- To demonstrate the knowledge on various computer graphics techniques used for computer aided designing.
- To explain different types of geometric modeling techniques used for computer aided modeling.
- To demonstrate the various techniques of drafting in computer aided modeling.

PECX028	**COMPUTER AIDED MANUFACTURING**	**L**	**P**	**T**	**C**
		2	**0**	**0**	**2**

OBJECTIVES:

- To list out the basic computer hardware required for computer aided manufacturing.
- To draw the structure of an NC and CNC machine and to schedule the CNC part programming.
- To prepare production planning for the material requirement and manufacturing resources.
- To evaluate the benefits of computer integrated manufacturing in industrial applications.

MODULE: I INTRODUCTION 5

Computers in Industrial Manufacturing, Product cycle, CAD/CAM Hardware, Basic structure, CPU, Memory types, input devices, display devices, hard copy devices, storage devices.

MODULE: II COMPUTER AIDED MACHINING 10

Numerical control, NC modes, NC elements, NC machine tools, structure of CNC machine tools, features of machining center, turning center, CNC part programming: fundamentals, manual part programming methods

MODULE: III COMPUTER AIDED PRODUCTION PLANNING 10

Part family, coding and classification, production flow analysis, advantages and limitations, Computer Aided Process Planning, Etrival type and generative type. Material requirement planning, manufacturing resources planning.runner mold.

MODULE: IV FLEXIBLE MANUFACTURING SYSTEMS 10

Flexible manufacturing systems-FMS equipment, system layouts, FMS control, CIM: Integration, CIM implementation, major functions in CIM, Benefits of CIM, Lean manufacturing, Just-in-time.

Total :30 hrs.

TEXT BOOKS:

1 P.N.Rao, “CAD/CAM Principles and Applications” - 3rd edition, Tata McGraw Hill, 2010.

2 Ibrahim Zeid/R.Siva Subramanian, “CAD/CAM Theory and Practice” - 2nd edition, Tata McGraw Hill, 2009.
3 J.Y.H.Fuh, “Computer Aided Mold Design and Manufacture”, Marcel Dekker Publication, 2004.

REFERENCES:

1 John. M. Nicholas, “Lean Production Competitive Advantage”, A Productivity Press Book, 2011.
2 P.Radhakrishnan and S.Subramanian, “CAD/CAM/CIM”, 3rd edition. New Age International, 2009.

OUTCOMES:

At the end of the course, the students will be able to:

- Prepare a list of hardware requirement for computer aided manufacturing
- Draw the structure of NC and CNC machine and explain the parts of these machines
- To prepare a production planning for material requirement and manufacturing resources.
- To predict the benefits of computer integrated manufacturing in industrial applications.

PECX 029	DESIGN OF COMPOSITE STRUCTURES	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To introduce the various materials for a composite structure.
- To equip with the knowledge of sandwich structure technology.
- To provide knowledge in fracture mechanics of composites.
- To impart knowledge in fatigue and damping capacity of composite materials.
- To provide an understanding of various manufacturing/fabricating techniques for composite structures.

MODULE: I INTRODUCTION 8

Definition and classification – materials for composite structure – metals, ceramics, glasses, polymers, elastomers and composites

MODULE: II SANDWICH AND CORE STRUCTURE TECHNOLOGY 7

Applications – wind energy, oilfield, marine, transportation, corrosion, pressure vessels, aircraft, space technology, etc.

MODULE: III MECHANICAL PROPERTIES 8

Strength – tensile, impact, flexural – Hardness – Fatigue- toughness, damping capacity, creep – thermal shock resistance – wear- corrosion. Prediction of mechanical properties.

MODULE: IV REINFORCEMENT 7

Reinforcement materials – type and nature – inorganic and organic – glass fiber, silicon carbide, rock fiber, aramid, boron fiber- matrix interface – metal matrix composites – ceramic matrix Composites – polymer matrix composites.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

1. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, "Analysis and Performance of Fiber Composites,3rd edition, John Wiley & Sons,2006.
2. Autar K.Kaw, "Mechanics of Composite Materials", CRC Press, 2005.
3. Robert Jones, "Mechanics of Composite Materials", McGraw Hill Company, 1998.
4. P.K.Mallick, "Fiber Reinforced Composite", Marcel Deckar,1988.

REFERENCES:

1. J. Barbero, “Introduction to Composite Materials Design, Second edition Taylor & Francis Group LLC, 2011.
2. Composites Materials: Engineering and Science by F.L. Mattews and R.D. Rawlings, Published by CRC Woodhead Publishing Limited, 2002.
3. Material Selection in Mechanical Design” by M.F. Ash, Pergamon Press, 1992

OUTCOMES:

At the end of the course, the students will be able to

- Select various materials for designing composite structures.
- Apply knowledge of fracture mechanics of composites during designing of composite structures.
- Analyze critically the damping capacity of composite materials.
- Correlate various manufacturing/fabricating techniques for composite structures based on design.

PECX030	INDUSTRIAL HYDRAULICS AND PNEUMATICS	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To impart knowledge of hydraulic principles and hydraulic pumps.
- To equip with knowledge of hydraulic actuators and valves.
- To develop knowledge of hydraulic mechanisms and circuits.
- To introduce pneumatic systems.

MODULE I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS 8

Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids- Properties of fluids – Basics of Hydraulics – Pascal's Law- Principles of flow – Friction loss- Work, Power and Torque. Problems.

Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps-Problems.

MODULE II HYDRAULIC ACTUATORS AND VALVES 8

Hydraulic Actuators: Cylinders– Types and construction, Application, Hydraulic cushioning - Hydraulic motors Control Components: Direction control, Flow control and Pressure control valves- Types, Construction and Operation- Servo and Proportional valves - Applications – Types of actuation. Accessories: Reservoirs, Pressure Switches- Applications- Fluid Power ANSI Symbols – Problems

MODULE III HYDRAULIC MECHANISMS AND CIRCUITS 7

Hydraulic mechanisms – advantages and disadvantages of hydraulic systems. Hydraulic oil requirement – lubricating properties, viscosity, effect of low viscosity, maintenance of hydraulic oil – filtration circuit, connectors – maintenance of connectors, water hammer, packing and seals, fluid power calculations.

Hydraulic circuits – clamp control, injection control circuits and reciprocating screw circuits.

MODULE IV PNEUMATIC SYSTEMS 7

Properties of air– Perfect Gas Laws- Compressors- Filter, Regulator, Lubricator, Muffler, Air 56 control Valves, Quick Exhaust valves, Pneumatic actuators, Design of pneumatic circuit cascade method- Electro pneumatic circuits, Introduction to Fluidics, Pneumatic logic circuits

L –30; T – 0; Total Hours – 30

TEXTBOOKS:

1. Irvin I. Rubin, "Injection Molding: Theory and Practice", Wiley, 2013.

REFERENCES:

1. M.L.Berins “Plastic Engineering Handbook”, Society of Plastic Industries, Chapman & Hall NY 1991.
2. Charles A. Harper, “Modern plastics handbook", McGraw-Hill, 2000.

OUTCOMES:

At the end of the course, the students will be able to,

- Explain the hydraulic pumps and their working mechanism.
- Describe the functions of hydraulic actuators and valves.
- Apply the knowledge of hydraulic mechanisms and circuits in troubleshoot problems in the injection molding process.
- Appreciate the fundamentals of pneumatic systems.

PECX031	FAILURE ANALYSIS OF POLYMERS	L	P	T	C
		2	0	0	2

Objectives:

- To identify the weaknesses of failure in plastic products.
- To interpret the failure of plastic products due to environmental stress cracking.
- To predict the failure of plastic materials due to thermo – oxidation issues.
- To evaluate the failure of plastic materials due to chemical attack.

MODULE: I INTRODUCTION TO FAILURE ANALYSIS 7

Introduction, Identification of strategic weaknesses, Identification of human and material weaknesses, Identification of product testing weaknesses, Priorities for future consideration, Failure Analysis of Engineering Materials, Tools to Failure Analysis. Case Studies DFMEA, PFMEA.

MODULE: II FAILURE DUE TO ENVIRONMENTAL STRESS CRACKING 8

Introduction, Crazing and cracking in air, Crazing and cracking in active fluids, Performance of specific materials, Case studies: Nylon 6 fire hose valve, Acrylonitrile-butadiene-styrene pipe fittings, Polycarbonate instrument housing, High density polyethylene screw caps and Blow moulded polyvinyl chloride bottles

MODULE: III FAILURE DUE TO THERMO - OXIDATION 7

The influence of polymer chemistry, the efficacy of stabilising additives, the influence of stress, Oxidising medium. Case studies: Low density polyethylene insulation covers, Rubber expansion joints, Vehicle tyres, Lift pump diaphragms, Acrylic bulkhead light covers and Flexible hose.

MODULE: IV FAILURE DUE TO CHEMICAL ATTACK 8

Solvation effects, Oxidation, Acid induced stress corrosion cracking, Hydrolysis, Case studies: Stress corrosion cracking of acetal, Thermoplastic elastomers in hot water, Acetal pipe fittings, Polyurethane oil seals and Corrosion cracking of composite insulators.

Total 30 hrs.

TEXT BOOKS:

1. David Wright “Failure of Plastics and Rubber Products”, Rapra Technology Limited, 2006.

REFERENCES:

1. Charlie R. Brooks, Ashok Choudhury " Failure Analysis of Engineering Materials" McGraw- Hill Education, 2002.

OUTCOMES:

At the end of the course, the students will be able to:

- To identify the weaknesses of failure in plastic products.
- To interpret the failure of plastic products due to environmental stress cracking.
- To predict the failure of plastic materials due to thermo – oxidation issues.
- To evaluate the failure of plastic materials due to chemical attack.

		L	P	T	C
PECX032	**MOULD MANUFACTURING TECHNIQUES**	**2**	**0**	**0**	**2**

OBJECTIVES:

- To select the proper mould materials and metal cutting method to manufacture an injection mould.
- To demonstrate the advance mould manufacturing techniques like EDM and Electroforming.
- To develop the Hobbing process for the use of mould manufacturing.
- To prepare an NC Part Programming Manual for computer aided manufacturing.

MODULE: I INTRODUCTION TO MOULD MANUFACTURING 6

Introduction of mold parts, Mechanism of metal cutting, types of tools, influence of tool angles, Cutting fluids, Tool materials used including coated tools. Mould material, Material selection for mould making, Properties of steels for moulds . Non-ferrous metals for moulds - Zinc base alloys and aluminium alloys, Beryllium Copper, Polyesters, Epoxies, Silicones. Review of various machining operations.

MODULE: II ADVANCED MOLD MANUFACTURING TECHNIQUES 10

Jig boring, Pentograph, Profile grinding, Electrical discharge machining - Characteristics, physical processes, special technological features, types of EDM, design consideration & functions and technological planning. Applications of wire cut EDM in mold making. Electroforming for mold manufacturing - discussion of the process, materials for electroforming, machining for electroformed blanks

MODULE: III HOBBING PROCESS OF MOULD MANUFACTURING 6

Hobbing for mold making – Discussion of the hobbing process & its advantages, elements of hobbing like hobbing punch, shape of the hob, materials used for cavity, lubrication, and depth of hobbing, Hobbing presses, Hobbing operations & its economy with examples.

MODULE: IV COMPUTER AIDED MANUFACTURING AND MEASUREMENT 8

Introduction to CAM; Automated Manufacturing system; Need of automation, classification of NC machine tools, NC Part Programming Manual (word address format) programming- APT programming. Geometry, Motion and Additional statements, Macro- statement Open and closed loops. Control of point to point systemsIncremental open loop control, Incremental close loop, Absolute close loop; Control loop in contouring systems;

Total 30 hrs.

TEXT BOOKS:

1 P.N.Rao, “CAD/CAM Principles and Applications” - 3rd edition, Tata McGraw Hill, 2010.
2 Ibrahim Zeid/R.Siva Subramanian, “CAD/CAM Theory and Practice” - 2nd edition, Tata McGraw Hill, 2009.
3 J.Y.H.Fuh, “Computer Aided Mold Design and Manufacture”, Marcel Dekker Publication, 2004.
4 How To Make Injection Molds, Hanser Publishers.

REFERENCES:

1 John. M. Nicholas, “Lean Production Competitive Advantage”, A Productivity Press Book, 2011.
2 Anupam Saxena & B. Sahay “Computer Aided Engineering Design” Anamaya Publishers
3 P.Radhakrishnan and S.Subramanian, “CAD/CAM/CIM”, 3rd edition. New Age International, 2009.

OUTCOMES:

At the end of the course, the students will be able to:

- Select the proper mould materials and metal cutting method to manufacture an injection mould.
- Demonstrate the advance mould manufacturing techniques like EDM and Electroforming.
- Develop the Hobbing process for the use of mould manufacturing
- Prepare an NC Part Programming Manual for computer aided manufacturing.

GROUP IV (Blends, Composites, Adhesives and Coatings)

PECX 033 BIOCOMPOSITE TECHNOLOGY

L	T	P	C
2	0	0	2

OBJECTIVES:

- To develop an understanding of biopolymers.
- To introduce methods of polymer biodegradation.
- To introduce the surface preparation methods for biopolymers.
- To impart knowledge on the applications of biopolymers.

MODULE: I INTRODUCTION 8

Definition of Biopolymers and types of biopolymers, definition of bioplastics, Types of bioplastics, such as starch based, cellulose based plastics and some aliphatic polyesters (PLA, PHB), polyamides, Bio-Based Composites from Soybean Oil and Chicken Feathers, bio-derived polyethylene and genetically modified bioplastics. Environmental impact such as Bioplastics and biodegradation.

MODULE: II POLYMER BIODEGRADATION 7

Biodegradable polymer classes, Natural biodegradable polymer, Synthetic biodegradable polymer and modified naturally biodegradable polymer. Non-biological and biological degradable polymer. Measuring of biodegradation of polymers- Enzyme assays, Plate test, Respiratory test, Natural environment, Field trial, Gas evolution test (CO_2 & CH_4) Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with estrogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

MODULE: III SURFACE MODIFICATION OF BIOMATERIALS 8

Enhancement of biocompatibility by the use of Corona discharge and plasma processes. Surface coatings Silver/silver oxide silicone hydrogels UV curable systems PC coatings Heparin loaded systems, automotive finishes, coil coatings, can coatings, marine coatings, aircraft coatings.

MODULE: IV APPLICATIONS BIO PLASTICS 7

Use of Bio materials for manufacture of plastic films, various types of films and applications; usage of biological friendly plastics in homes, industry, etc. with specific applications. Mixing of biomaterials with plastics: equipment details, process details etc

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

1. Syed Ali Ashter, 'Introduction to Bioplastics Engineering' Elsevier, 2016.
   Michael Niaounakis, 'Biopolymers: Reuse, Recycling, and Disposal' Elsevier, 2013.
2. David Plackett, 'Biopolymers: New Materials for Sustainable Films and Coatings'Wiely, 2013.
3. Susheel Kalia, Luc Avérous, 'Biopolymers: Biomedical and Environmental Applications', John Wiley & Sons, 2011.

REFERENCES:

1. Srikanth Pilla, Handbook of Bioplastics and Biocomposites Engineering Applications, Wiley 2011.
2. Stoyko Fakirov, 'Handbook of Engineering Biopolymers: Homopolymers, Blends and Composites'Hanser, 2015.

OUTCOMES:

At the end of the course, students will be able to

- Identify genetically modified bioplastics.
- Identify relevant surface preparation methods and application techniques based on biodegradation.
- Identify various methods to assess the quality of biodegradability.
- Select a suitable type of biomaterials for specific applications.

PECX 034 MECHANICS OF COMPOSITES

L	T	P	C
2	0	0	2

OBJECTIVES:

- To introduce the basics of macro and micromechanical behavior of a lamina.
- To impart knowledge about failure mechanism in composites.
- To enhance the knowledge in design and testing procedures of composites.

MODULE: I MACRO MECHANICAL BEHAVIOUR OF LAMINA 8

Stress-strain relations for anisotropic materials, stiffness, compliances and engineering constants for orthotropic materials, elastic constants of isotropic and orthotropic material, stress-strain relations for plane stress in an orthotropic material

MODULE: II MICRO MECHANICAL BEHAVIOUR OF LAMINA 7

Mechanics of material approach to stiffness i.e. determination of engineering constants for the lamina, Halpin-Tsai equations, elasticity approach to stiffness, mechanics of materials approach to strength, tensile and compressive strength in fiber direction.

MODULE: III MACRO MECHANICAL BEHAVIOUR OF LAMINATE 8

Classical lamination theory, laminate code, symmetric laminates, theoretical and experimental angle – ply laminate stiffness, anti symmetric laminates, non symmetric laminates, balanced laminates, quasi-isotropic laminates.

MODULE: IV FAILURE THEORIES 7

Biaxial strength criteria for an orthotropic lamina; maximum stress failure criteria, maximum strain failure criteria, Tsai-Hill failure criteria,Hoffman Failure Criteria,Tsai-Wu tensor failure criteria, hygrothermal stresses and strains in unidirectional and angle lamina.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

1. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, “Analysis and Performance of Fiber Composites,3rd edition, John Wiley & Sons, 2006.

2. Autar K.Kaw, “Mechanics of Composite Materials”, CRC Press, 2005.
3. Robert Jones,”Mechanics of Composite Materials”, McGraw Hill Company, 1998.
4. P.K.Mallick, “Fiber Reinforced Composite”, Marcel Deckar,1988.

REFERENCES:

1. M.Mukhopadhyay, “Mechanics of Composite Materials and Structures”, Universities Press, 2005.

OUTCOMES:

At the end of the course, students will be able to

- Analyze the stress - strain relationships of macro and micromechanical behavior of composites.
- Analyze and predict various failure modes of composites.
- Design composite structures based on different loading conditions

PECX 035 ANALYSIS OF COMPOSITE STRUCTURES **L T P C**
2 0 0 2

OBJECTIVES:

- To introduce the various materials and fabrication methods for composite structure.
- To provide knowledge in fracture mechanics of composites.
- To impart skill in analyzing the properties of composite materials.
- To enhance the knowledge in non destructive testing of composites**.**

MODULE I INTRODUCTION 7

Definition and classification – materials for composite structure – metals, ceramics, glasses, polymers, elastomers and composites. Fabrication methods - hand layup, vacuum bagging, pultrusion, resin infusion processes.

MODULE II MECHANICS 8

Fracture mechanics and toughening mechanisms: Energy analysis, local stresses, fracture initiation, impact, toughening mechanisms.

MODULE III TESTING OF COMPOSITES 8

Infrared thermal testing, Laser Shear -O- Graphy, Holography and Micro Wave Testing. Mechanical property tests: Various tests for compressive and tensile properties – fixtures and methods, three point and four point bending flexural test methods, in-plane shear test methods, inter-laminar shear strength, fatigue tests, pin bearing properties–special test methods.

MODULE VI NON DESTRUCTIVE TESTING OF COMPOSITES 7

Testing of Composites: Non - destructive evaluation methods for composites visual, tap test, ultrasonic methods, X-Ray imaging, thermography, neutron radiography.

L – 30; T – 0; Total Hours : 30

REFERENCES:

1. Ever J. Barbero, “Introduction to Composite Materials Design, Second edition Taylor & Francis Group LLC, 2011.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, “Analysis and Performance of Fiber Composites,3rd edition, John Wiley & Sons, 2006.
3. Autar K.Kaw, “Mechanics of Composite Materials”, CRC Press, 2005.

4. P.K.Mallick, “Fiber Reinforced Composite”, Marcel Deckar,1988

OUTCOMES:

At the end of the course, the students will be able to

- Select reinforcement and matrix materials for the manufacturing of composites for specific applications.
- Apply knowledge of fracture mechanics of composites during designing of composite structures.
- Analyze and identify the property requirements of composites for various applications.
- Design composite structures based on different loading conditions.

PECX 036	POLYMER BLENDS AND ALLOYS	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To provide understanding on the miscibility of polymers and phase morphology of blends
- To provide understanding on the characteristics and toughening mechanism of blends.
- To impart knowledge on techniques of blending polymers.
- To impart knowledge on the properties and applications of polymer blends and alloys.

MODULE: I INTRODUCTION 8

Definition for blends, alloys and copolymers, Reason for blending, classification of polymer blends, and methods of blending, selection criteria of blending; Design of polymer blends.

MODULE: II POLYMER MISCIBILITY 7

Introduction, miscible blends and immiscible blends, difference between blends and alloys, properties of miscible and immiscible blends, Phase equilibria calculation, Huggins-Flory theory.
Factors affecting miscibility: Thermodynamics, compatibility, solubility parameter, interaction parameter, composition, molecular weight, transition temperature, Popular Compatabilisation techniques- Maleic anhydride, acrylates.

MODULE: III COMMERCIAL BLENDS AND ALLOYS 8

PC/PET, PC/PBT, PC/ABS; PPO/HIPS properties and applications.
Interpenetrating Polymer Networks (IPNs): Introduction, classification, method of formation of IPNs, properties and uses, role of cross links, and their importance.

MODULE: IV MORPHOLOGY 7

Introduction, mechanism of phase separation (nucleation and growth and spinodal decomposition), semi-crystalline polymer blends, polymer crystallization, crystallization in miscible polymer blends, influence of liquid/liquid phase separation on the crystallization and morphology.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

1. 1. Lloyd M.Robeson, "Polymer Blends", Hanser gardner publications, U.S.A, 2007.
2. Leszek A. Utracki, "Polymer Alloys and Blends: Thermodynamics and Rheology", Hanser Gardner Publications, 1989.
3. M.J .Folkes and P.S.Hope,Blackiebn, "Polymer blends and alloys", Academic and Professional , Glasgow, 1993.

REFERENCES:

1. C.B. Bucknall and D. R. Paul, "Polymer Blends: Volumes 1 and 2", John Wiley and Sons, New York, 2000.
2. Gabriel O. Shonaike and George P. Simon, "Polymer Blends and Alloys", Marcel Dekker, 1999.

OUTCOMES:

At the end of the course students will have the

- Prospective to select the appropriate combination of polymers to have required synergistic property in the polymer blend.
- Ability to predict the suitable compatibilizer for enhancing the miscibility of immiscible blends.
- Understanding of phase morphology of miscible and immiscible blends.
- Knowledge of selecting right choice of equipment for thorough blending of polymers.

  Ability to analyse and characterize the morphological behavior of polymer blends

PECX 037	BASICS OF PAINT TECHNOLOGY	L	T	P	C
		1	0	0	1

OBJECTIVES:

- To facilitate the students for selecting suitable recycling technique for polymer waste.
- To enable the students in designing simple techniques for conversion of plastic waste back to usable products.

MODULE: I — INTRODUCTION TO PAINTS — 8

Introduction: Components of paints - paint preparation, formulation - factors affecting- pigment dispersion - preparation of pigment dispersion –manufacture –pigments- pigment properties, different types, selection - dispersion and color matching of pigments, extenders – solvents - solvent properties- oil, driers, resins, diluents, additives, factors affecting: viscosity interfacial tensions, chemical reaction, living micro-organisms.

MODULE: II — PROPERTIES OF PAINT FILM — 7

Light: reflection, refraction, diffraction, colour science, additive color mixing, subtractive color mixing, gloss, specular gloss, bloom gloss, surface uniformity, chromaticity diagrams for color measurement.

L – 15; T – 0; Total Hours –15

TEXT BOOKS:

1. Swaraj Paul, “Surface Coatings: Science and Technology”, Wiley – Interscience 1985.
2. R.Lambourne. “Paint and Surface Coatings – Theory and Practice”, Ellis Horwood Chichester 1987.

REFERENCES:

1. Arthur A. Tracton, Coating Technology Handbook, Third Edition, Taylor and Francis, 2005.

OUTCOMES:

At the end of the course students will be able to

- Demonstrate knowledge in manufacturing technology of paints.
- Identify various characterization methods to assess the quality of paints and coatings.

PECX 038	BASICS OF ADHESIVES TECHNOLOGY	L	T	P	C
		1	0	0	1

OBJECTIVES:

- To impart knowledge of various types of adhesives.
- To provide basic concepts of adhesive joint designs.
- To introduce the surface preparation methods for adhesive joints

MODULE: I CONCEPTS AND TERMINOLOGY 8

Adhesives – concepts and terminology : functions of adhesives, advantages and disadvantages of adhesive bonding, theories of adhesion – mechanical theory, adsorption theory, electrostatic theory, diffusion theory, weak-boundary layer theory, Requirements for a good bond, criteria for selection of adhesives.

MODULE: II ADHESIVES TYPES 7

Adhesives types: Structural adhesives, Urethane structured adhesives, Modified acrylic structural adhesives, phenolic adhesives and modifiers, anaerobic adhesives, cyanoacrylate adhesives, Hot melt adhesives, pressure sensitive adhesives, RTV Silicone adhesives, sealants, water based adhesives. Specialty adhesives, adhesives in aerospace, adhesive in automobile industry, conductive adhesives, adhesives in building construction, adhesive in electrical industry.

L – 15; T – 0; Total Hours –15

TEXT BOOKS:

1. Gerald L. Schreberger, “Adhesive in manufacturing”, Marcel Dekker Inc., New York, 1983
2. W.C. Wake, “Adhesion and the formulation of adhesives” Applied Science Publishers, London, 1976.
3. Swaraj Paul, “Surface Coatings”, John Wiley & Sons, NY, 1985.

REFERENCES:

1. George Mathews, “Polymer Mixing Technology”, Applied Science Publishers. London, 1982.
2. Sheilds, “Hand book of adhesives”, Butterworth’s, 1984.

OUTCOMES:

At the end of the course, students will be able to

- Suggest suitable adhesives and joint design for specific applications
- Select appropriate coatings for specific applications
- Identify the defect in coatings and suggest suitable solutions

PECX 039	SURFACE COATING TECHNOLOGY	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To impart knowledge on the polymer-based coatings.
- To develop an understanding of the mechanism of coatings.
- To introduce the surface preparation methods for adhesive joints.
- To introduce methods of characterizing coatings.

MODULE: I POLYMER BASED COATINGS 8

Types: classification based on polymeric resin, emulsion, oil and alkyd paints, acrylic paints, epoxy coatings, polyurethanes, silicones, formaldehyde-based resins, chlorinated rubbers, acrylics, and hydrocarbon resins. Classification based on application. fluoropolymers, vinyl resins, appliance finishes, automotive finishes, coil coatings, can coatings, marine coatings, aircraft finishes.

MODULE: II SURFACE PREPARATION 7

Surface cleaning methods, chemical conversion treatments, paint application, brushing, dip coating, flow coating, roller coating, spray painting, electrodeposition, chemiphoretic deposition.

MODULE: III SURFACE COATING METHODS 8

Different types of paints – classification based on polymeric resin, emulsion, oil and alkyd paints, acrylic paints, epoxy coatings, polyurethane, silicones, formaldehyde based resins, chlorinated rubbers, hydrocarbon resins. Classification based on application, fluropolymers, vinyl resins, appliance furnishes, automotive finishes, coil coatings, can coatings, marine coatings, aircraft coatings.

MODULE: IV CHARACTERISATION TECHNIQUES 7

Film preparation, barrier properties, mechanical properties and optical properties of coatings - color, gloss, hiding power, ageing properties -factors affecting viscosity of paints - effect of rheological behavior on paint performance. Adhesion properties of coatings - factors affecting adhesive bond - thermodynamics of adhesion - destructive methods - non destructive methods - properties such as floating, silking, cratering, foaming, skinning, flame retardancy, slip resistance and storage stability.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

1. Swaraj Paul, "Surface Coatings: Science and Technology", Wiley – Interscience 1985.
2. R.Lambourne. "Paint and Surface Coatings – Theory and Practice", Ellis Horwood Chichester 1987.
3. Sheilds, "Hand book of adhesives", Butterworth's, 1984.

REFERENCES:

1. Arthur A. Tracton, Coating Technology Handbook, Third Edition, Taylor and Francis, 2005.
2. George Mathews, "Polymer Mixing Technology", Applied Science Publishers. London, 1982.

OUTCOMES:

At the end of the course, students will be able to

- Analyze appropriate coatings for specific applications.
- Identify relevant surface preparation method and application techniques based on the coatings.
- Identify various characterization methods to assess the quality of coatings.
- Select suitable type of coating methods for specific applications.

PECX040	PLASTIC PACKAGING TECHNOLOGY	L	P	T	C
		3	0	0	3

OBJECTIVES:

- To introduce the need and importance of plastic packaging.
- To provide knowledge of various packaging materials
- To impart knowledge on flexible rapid packaging.
- To impart knowledge on rapid packaging.
- To develop knowledge of various standards for testing.
- To provide understanding on testing of packaging materials.

MODULE: I FUNDAMENTALS OF PACKAGING 7

Definition, Functions Of Packaging, Types And Selection Of Package, Packaging Hazards, Interaction Of Package And Contents, Materials And Machine Interface, Environmental And Recycling Considerations – Life Cycle Assessment Package Design – Fundamentals, Factors Influencing Design, Stages In Package Development, Graphic Design, Structural Design – Simulation Softwares

MODULE: II PACKAGING MATERIALS 10

Polyethylene – Linear and Branch Polymers (HDPE, LLDPE, LDPE, EVA, EAA, Ionomers, Polypropylene – Homo and copolymer (Oriented and Biaxially Oriented), Polystyrene, Polyvinyl chloride (PVC), Poly Vinylidene Chloride (PVDC), Polystyrene (PS), Polyvinyl Alcohol (PVOH) and Ethylene Vinyl Alcohol (EVOH), Nylon, Polyester – Polyethylene Terephthalate (PET), Polyethylene Naphthalate (PEN) – Polycarbonate (PC), Fluoropolymers, Styrene-Butadiene Copolymers, Acrylonitrile Copolymers, Thermoplastic Elastomers : Cellophane and Cellulosic Plastics, Polymer Blends : Thermosets – Acrylics, Phenolics, Alkyds, Epoxies and Urethanes.

MODULE: III FLEXIBLE PACKAGING 12

Material Selection, additives and compounding processing – Sheet and Film, Extrusion and Extruders – Cast film, Blown Films, Stretch and Shrink wrap, Film and Sheet Co-extrusion, Co-extruders film, Laminated film, metallized film, Intelligent / Smart films, oriented polystyrene film, microwavable films, Edible and soluble films, Packaging types – Bags, Pouches, Collapsible tubes, Bag-in-box, Flexible cans, sacks and case study.

MODULE: IV RIGID PACKAGING 6

Material selection, additives and compounding, Injection molding-closures, Rotational Molding, Compression molding, Blow molding-Extrusion, Injection, Stretch, and Aseptic Blow molding – Plastic bottles, tubes, Plastic pallets, Drums, Barrels, Jerry cans and shipping containers, Plastic Foams – Polyolefin foams, Polyurethane, Polystyrene and bio-based foams, Thermoforming – types-Drape, Vacuum and pressure forming and case study.

MODULE: V MECHANICAL TESTING 5

Thickness, Strength Properties – Tensile, Puncture, Tear, Burst, Impact and Flexural, Surface Properties – Surface energy, friction, abrasion and dart impact, Optical Properties – Haze and Gloss, Colour, Clarity, Barrier Properties, National and International Standards for testing.

MODULE: VI OPTICAL TESTING 5

Optical – Gloss, Haze And Clarity; Chemical Resistance Test – Solvents And Chemicals, Solubility Test, Burning Test, Solvent Retention; Hardness And Corrosion Test For Metals; Clarity And Brittleness Test For Glass.

L – 45; T – 0; Total Hours – 45

TEXTBOOKS:

1. Mark J.Kirwar, “Paper And Paperboard Packaging Technology”, Blackwell Publishing, 2005
2. “Handbook Of Package Design Research”, Water Stem Wiley Intrascience, 1981.
3. Paine, “Packaging Development”, PIRA International, 1990.
4. Arthur Hirsch, “Flexible Food Packaging”, Van Nostor And Reinhold, New York, 1991.
5. Susan E.M.Salke & Et Al, Plastics Packaging, Hansar, 2nd Edition 2004.
6. Bill Stewart, “Packaging Design Strategies”, Pira International Ltd, 2nd Edition 2004.

REFERENCES:

1. Aaron L. Brody and Kenneth S. Marsh, “The Wiley Encyclopedia of Packaging Technology”, 2nd Edition, Wiley, 1997 .

2. Walter Soroka, ”Fundamentals of packaging technology”, 3rd Edition, Institute of packaging professionals, 2002
3. A.S. Athayle, “Handbook of packaging plastics”, Multi-Tech publishing co, First edition, 1999.

OUTCOMES:

At the end of the course, students will be able to

- Perform various tests for evaluating the properties of plastic packaging materials.
- To modify various polymer properties for packaging.
- Identify the suitable test method for predicting product performance and to analyze the failures in packaging.
- To select suitable polymer material for packaging.
- To select suitable polymer material and technology for manufacturing of a specific type of packaging.
- Analyze the quality of the packaging.

Physics Elective Courses
(To be offered in II Semester)

		L	T	P	C
PHCX 01	**FUNDAMENTALS OF ENGINEERING MATERIALS**	**2**	**0**	**2**	**3**

OBJECTIVES:

- To familiarize students with basic ideas of nanomaterials and its electrical, electronic, mechanical and magnetic properties.
- To help students acquire the properties and applications of magnetic materials and dielectric materials.
- To familiarize students with basics ideas about the properties of dielectric and its applications
- To enable the students to correlate theoretical principles with practical applications.

MODULE I CONDUCTING AND SEMICONDUCTING MATERIALS 7

Conductors: properties, Fermi distribution function, Fermi energy in metals- density of states- conducting polymers-properties-applications, semiconductors: intrinsic and extrinsic semiconductors-carrier concentrations, conductivity and energy band gap, semiconducting polymers- properties- applications.

MODULE II DIELECTRIC MATERIALS 8

Polarization- dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation – Internal field -Clausius Mosotti relation - dielectric loss – dielectric breakdown – applications of dielectric materials (capacitors and transformers) – Pyroelectricity, Piezoelectricity, ferroelectricity and applications in FERAM - multiferroic materials and its applications.

MODULE III MAGNETIC MATERIALS 7

Origin of magnetism-magnetic moment, susceptibility, permeability – Bohr magneton –Dia, Para and Ferro magnetism –Spontaneous magnetization- Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials – Ferrites and its application -Giant Magneto-resistance effect(GMR) - Magnetic resonance imaging(MRI).

MODULE IV NANOMATERIALS 8

Properties of nanomaterials – size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties – quantum confinement – classification of nanomaterials –quantum well, quantum wire, quantum dot - nanoporous materials - carbon nanotubes, grapheme - nanocomposites – applications.

PRACTICALS

1. Determination of energy band gap of a semiconductor.
2. Determination of resistivity of metals by four point probe method.
3. Determination of dielectric constant of dielectric material.
4. Determination of time constant of a capacitor using RC circuit.
5. Determination of paramagnetic susceptibility of given liquid.
6. Determination of hysteresis loss in a transformer using BH curve.
7. Analysis of size effect on the absorption spectrum of nanomaterials.

L : 30 periods, P: 30 periods, Total: 60 periods

REFERENCES:

1. William D.Callister, Material Science and Engineering, Wiley Publications, 2006.
2. Raghavan, V., Materials Science and Engineering, 5th edition, Printice Hall of India Pvt Ltd. New Delhi, 2004.
3. Wahab.M.A, Solid State Physics: Structure and Properties of Materials, Narosa Publishing House Pvt. Ltd., New Delhi , 2nd Edition, 2010.
4. Pillai, S.O., Solid State Physics, New Age International, New Delhi, 2005.
5. Charles P.Poole and Frank J. Owens, ”Introduction to nanotechnology”, Wiley (India), 2009.
6. Pradeep. T., “Textbook of Nanoscience and Nanotechnology”, McGraw Hill Education (India) Private Limited, New York, 2012.

OUTCOMES:

On completion of this course, the student will be able to

- Differentiate between the properties of the nanomaterials compared to bulk materials.
- Comprehend the significance of properties of magnetic materials and derive these properties from synthesized materials.
- Apply the concepts of conducting and semiconducting materials for solid state devices.
- Complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 02	HEAT AND THERMODYNAMICS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To familiarize students with basic concepts of heat.
- To help students acquire the fundamentals of heat conduction and radiation.
- To enable students acquaint with the basics of thermodynamic concepts.
- To make students understand the fundamentals of heat based experiments.

MODULE I CONCEPTS OF HEAT 10

Definition of temperature, thermal and thermodynamic equilibrium- relationship between temperature and kinetic energy- definition of solid, liquid, gas- Introduction to phase transitions, critical and triple points- definition of heat capacity, mechanical equivalent of heat -Joule's calorimeter- latent heat- Microscopic model of ideal gas- equation of state, internal energy, equipartition theorem- equation of state for non-ideal gases.

MODULE II CONDUCTION AND RADIATION 10

Thermal conductivity – rectilinear flow of heat – thermal conductivity of a good conductor – Forbe's method – thermal conductivity of a bad conductor – Lee's disc method – conduction of heat through compound media-radiation – Planck's law blackbody radiation – Wien's law – Stefan's law – Newton's law of cooling from Stefan's law – Solar constant – Pyrometry.

MODULE III FUNDAMENTALS OF THERMODYNAMICS 10

Thermodynamic equilibrium – zeroth law of thermodynamics – first law of thermodynamics – Reversible and irreversible processes – second law of thermodynamics -Heat engine – Carnot's engine – Carnot's theorem – Internal combustion engines – petrol and diesel engines(qualitative) – Entropy – entropy and available energy – temperature – entropy diagram for Carnot's cycle - Third Law of thermodynamics(qualitative).

L : 30 periods

PRACTICALS

1. Determination of mechanical equivalent of heat by Joule's calorimeter.
2. Relation between temperature of a body and time by plotting a cooling curve- Newton's law of cooling.

3. Determination of specific heat capacity of liquid by cooling.
4. Determination of thermal conductivity of a bad conductor-Lee's disc method
5. Determination of thermal conductivity of a good conductor-Forbe's method

P: 30 periods
Total: 60 periods

REFERENCES :

7. Mathur. D.S, “Heat & Thermodynamics”, S.Chand & Co., 2009.
8. Brijlal & Subramaniam, “Heat and Thermodynamics”, S.Chand & Co, Delhi., 2010.
9. Gupta. A.B and Roy. H, “Thermal Physics”, Books and Allied Ltd., 2002.
10. Sharma. J.K and Sarkar. K.K, “Thermodynamics and statistical Physics”, Himalaya Publishing House, 1988.

OUTCOMES:

On completion of this course, the student will be able to

- Understand the concepts of heat and its properties.
- Comprehend the ideas governing the conduction and radiation processes.
- Understand and apply the ideas of laws of thermodynamics in thermodynamic systems.
- Perform heat based experiments and determine its various properties.

PHCX 03 INTRODUCTION TO NANOSCIENCE AND TECHNOLOGY

L	T	P	C
2	0	2	3

OBJECTIVES:

- To acquire basic knowledge about the nanomaterials and applications.
- To learn about the imaging techniques of nanomaterials.
- To gain the basic concepts of fabrication techniques.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I NANOMATERIALS AND APPLICATIONS 10

Properties of nanomaterials – size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties – quantum confinement – classification of nanomaterials –quantum well, quantum wire, quantum dot- nanoporous materials-zeolite, mesoporous materials, carbon nanotubes, graphene- nanocomposites - applications (qualitative): Molecular electronics-nanoelectronics – nanophotonics - single electron transistor-drug delivery.

MODULE II SYNTHESIS AND IMAGING TECHNIQUES 12

Top-down and bottom up approaches – mechanical alloying and mechanical ball milling-sol-gel approach-hydrothermal method-precipitation method-spray pyrolysis-spin coating-self assembled monolayer (SAM)-Chemical vapour deposition method – Physical vapour deposition method: laser ablation method, sputtering method.

Optical microscopy – Phase contrast and interference microscopy –confocal microscopy- high resolution Scanning electron microscope (HRSEM)- high resolution Transmission electron microscope (HRTEM)-Atomic force microscope-Scanning Tunnelling microscope (STM).

MODULE III NANOFABRICATION 8

Photolithgraphy - electron beam lithography - X-ray and Ion beam lithography-nanoimprint lithography - soft lithograpy - nanoelectromechnical systems (NEMS) - nanoindentation principles.

L : 30 periods

PRACTICALS

1. Synthesis of nanomaterials by sol-gel method.
2. Synthesis of nanomaterials by hydrothermal method.

3. Synthesis of nanomaterials by solid state reaction method.
4. Synthesis of nanomaterials by chemical bath deposition method.
5. Synthesis of nanomaterials by co-precipitation method.
6. Synthesis of nano thin films by spray pyrolysis method.
7. Synthesis of nano thin films by pulsed laser deposition (PLD) method.
8. Analysis of size effect on the absorption spectrum of nanomaterials.
9. SEM characterization of nanomaterials.
10. AFM characterization of nano thin films.
11. Phase confirmation by XRD.

P: 30 period
Total: 60 periods

REFERENCES:

1. Charles P.Poole and Frank J. Owens, ”Introduction to nanotechnology”, Wiley (India), 2009.
2. Cao. G., “Nanostructures & Nanomaterials: Synthesis, Properties & Applications”, Imperial College Press, 2004.
3. Gaddand. W., Brenner. D., Lysherski. S. and Infrate. G.J., “Handbook of NanoScience, Engineering and Technology”, CRC Press, 2002.
4. Pradeep. T., “Textbook of Nanoscience and Nanotechnology”, McGraw Hill Education (India) Private Limited, New York, 2012.
5. Chris Mack, “Fundamental Principles of Optical Lithography: The Science of Microfabrication”, John Wiley & Sons, 2008.
6. Bandyopadhyay A.K., “Nano Materials”, New Age International Publishers, New Delhi, 2008.

OUTCOMES:

At the end of the course, the students will be able to

- Understand the importance and basic concepts of the nanomaterials.
- Comprehend the imaging techniques for nanomaterials.
- Illustrate the various nanofabrication techniques.
- Complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 04	LASERS AND THEIR APPLICATIONS	L	T	P	C
		2	0	2	3

OBJECTIVES

- To recognize the fundamentals of laser and its characteristics.
- To comprehend and compare the different laser systems.
- To apply lasers in metrology and material processing.
- To understand the working of laser instrumentation.
- To correlate the experimental results for applications.

MODULE I LASER THEORY 8

Spontaneous and stimulated emission - Population inversion – Einstein’s A & B coefficients - Threshold condition – super-radiance Laser – Three level and four level laser systems -conditions for CW and pulsed laser action. Q-Switching - experimental methods - cavity dumping - Mode locking - experimental methods - Spatial and Temporal coherence.

MODULE II DIFFERENT LASER SYSTEMS 8

Laser systems – General description - Laser structure - excitation mechanism - Different laser systems- He-Ne laser, Carbon-dioxide laser - Excimer laser – Free electron laser- Alexandrite laser - Ti-Sapphire laser – Semiconductor diode laser - Diode pumped solid state laser - Pulsed-CW dye laser- Fibre laser.

MODULE III METROLOGICAL AND MATERIAL PROCESSING APPLICATIONS 8

CW and Pulsed laser beam characteristics and its measurements - Beam focusing effects - spot size - Power and Energy density Measurements - Distance measurement - Interferometric techniques - LIDARS - different experimental arrangements - Pollution monitoring by remote sensing - Laser gyroscope - Laser welding, drilling, machining and cutting - Laser surface treatment - Laser vapour deposition – Biophotonic applications.

MODULE IV LASER INSTRUMENTATION 6

Laser for measurement of length, current and voltage – Laser Doppler Velocimetry - Holography and speckle in displacement and deformation measurements - Laser for communication with fiber optics as channel.

L : 30 periods

PRACTICALS

1. Tuning of Dye Laser using DFDL Arrangement
2. Determination of Brewster Angle using He-Ne laser
3. Study of transversely Pumped Dye Lasers
4. Study of longitudinally Pumped Dye Lasers
5. Determination of power and wavelength using Distributed Feedback Dye Laser (DFDL)
6. Determination of fibre optic losses using semiconductor laser.
7. Bandgap determination of a semiconductor diode.

P: 30 periods

Total: 60 periods

REFERENCES:

1. William T. Silfvast, “Laser Fundamentals”, Cambridge University Press, 2009.
2. Ghatak. A. & Thyagarajan. K. “Optical Electronics”, Cambridge University, 1994.
3. Laud.B.B., “Laser and Non-Linear Optics”, Second Edition, New Age International (p) Limited Publishers, 2011.
4. Nambiar. K.R., “Lasers Principle, Types and Applications”, New Age International (p) Ltd, 2004.
5. Wilson. J. & Hawkes. J.F.B., “Opto Electronics - An Introduction”, Prentice Hall, 1992.
6. William M.Steen, ”Laser Material Processing”, Springer-Verlag, Berlin, Third Edn., 2005.

OUTCOMES:

At the end of the course, the students will be able

- To complement the knowledge acquired in the theory class.
- To work with dye lasers for tunability of laser wavelength
- To measure the loss of information involved in fibre optic communication
- To correlate the results for application.

PHCX 05 MATERIALS SCIENCE

L	T	P	C
2	0	2	3

OBJECTIVES

- To gain basic knowledge in conducting and semiconducting materials and their properties.
- To provide a basis for understanding properties and applications of dielectric materials.
- To impart knowledge on magnetic and optical materials and their properties & applications.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I CONDUCTING AND SEMICONDUCTING MATERIALS 8

Quantum free electron theory of metals and its importance - Energy distribution of electrons in metals - Fermi distribution function - Density of energy states and carrier concentration in metals - Fermi energy – Classification of solids into conductors, semiconductors and insulators on the basis of Band theory – Introduction to Elemental and Compound semiconductors - Carrier concentration derivation for Intrinsic semiconductors - Density of electrons in conduction band & Density of holes in valence band- intrinsic carrier concentration - Fermi energy & Variation of Fermi energy level with temperature - Mobility and electrical conductivity - Band gap determination.

MODULE II DIELECTRIC MATERIALS 7

Introduction to dielectric materials & basic definitions – Electronic, Ionic, Orientation & space charge polarizations - Total polarization – Frequency and temperature dependence of polarization - Internal field in a dielectric material - Deduction of Clausius - Mosotti's relation - dielectric loss & loss tangent – Different types of dielectric breakdown – Applications of dielectric materials : Capacitors and Transformers.

MODULE III MAGNETIC MATERIALS 7

Introduction to magnetic materials & origin of magnetic moment - Different types of magnetic materials and their properties - Ferromagnetism & Domain theory of ferromagnetism - Hysteresis, Soft and Hard magnetic materials - Antiferromagnetic materials - Ferrites and its applications – Applications of magnetic materials : Data storage.

MODULE IV OPTICAL MATERIALS 8

Optical properties of semiconductors - Direct and Indirect bandgap semiconductors – Traps, recombination centre, color center and exciton – Luminescence : Fluorescence and Phosphorescence - Liquid crystal display : twisted nematic crystal display – Applications of Optical materials - Optical Sources : light emitting diode and laser diode - Photo detectors : PIN photodiode and Avalanche Photodiode - Pyroelectric devices - Electro optic effect : Kerr effect and Faraday effect.

PRACTICALS

1. Resistivity measurement of a semiconductor using four point probe method.
2. Determination of band gap of a semiconductor diode.
3. Determination of Hall coefficient of a given semiconductor material.
4. Determination dielectric constant of a given non-polar liquid.
5. Determination of magnetic susceptibility of a given paramagnetic liquid using Quincke's method.
6. Determination of energy loss of a given transformer core using hysteresis method.
7. To study the I-V characteristics of a photodiode.

L : 30 periods, P: 30 periods

Total: 60 periods

REFERENCES

1. Palanisamy P.K., ''Physics II'', Material Science for ECE, Scitech Publications (India) Pvt Ltd., 2006.
2. Kasap. S.O., ''Principles of Electronic materials and devices'', McGraw Hill Publishers, 3rd Edition, 2007.
3. Arumugam. M, "Physics II'', Material Science for ECE, Anuradha Publishers, 5th Edition, 2005.
4. Sze. S.M., ''Semiconductor Devices – Physics and Technology'', John Wiley, 2nd Edition. 2002.
5. Raghavan. V, ''Materials Science and Engineering'', Prentice Hall of India, 5th Edition, 2004.

OUTCOMES

On the completion of this course, the students will be able to

- Gain knowledge about fundamentals of conducting and semiconducting materials
- Understand the concepts and applications of Dielectric, Magnetic materials
- Familiarize Optical materials and their applications in Engineering and Medical fields.
- Complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 06 NON-DESTRUCTIVE TESTING

L	T	P	C
2	0	2	3

OBJECTIVES:

- To study the process and applications of ultrasonic inspection method.
- To understand the basic concepts of radiographic inspection method.
- To acquire the knowledge about the various surface Non-Destructive Testing (NDT) techniques.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I ULTRASONIC INSPECTION METHOD 10

Ultrasonic Testing- Principle of operations- types of sound waves -types of Transducers-transmission and pulse-echo method- straight beam and angle beam, instrumentation- calibration methods-ultrasonic testing technique- data representation, A Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction-thickness determination-, advantages, disadvantages and applications.

MODULE II RADIOGRAPHIC INSPECTION METHOD 10

Radiographic testing- Principle-Interaction of X-ray with matter-X-ray radiography-method of generation-industrial radiography inspection techniques- Equipment-Exposure charts-Types of films-Fluoroscopy- Xero-Radiography –Limitations-Gamma radiography-Equipment, radiation sources- method of generation- film processing- interpretations of radiography-safety in industrial radiography.

MODULE III SURFACE NDT TECHNIQUES 10

Liquid Penetrant Testing – Principles, Characteristics and types of liquid penetrants-developers- advantages and disadvantages of various methods- Inspection Procedure and Interpretation of results. Applications of Liquid Penetrant testing.

Magnetic Particle Testing- Principle-magnetizing technique-procedure –equipment-Interpretation and evaluation of test indications-.applications and limitations-demagnetization.

L : 30 periods

PRACTICALS

1. Inspection of welds using solvent removable visible dye penetrant.
2. Inspection of welds using solvent removable fluorescent dye penetrant.

3. Inspection on non magnetic materials by eddy current method.
4. Inspection on magnetic materials by eddy current method.
5. Inspection of welds by Eddy current Testing.
6. Inspection of welds by Magnetic Particle Testing - Dry method.
7. Inspection of welds by Magnetic Particle Testing - Wet method.
8. Ultrasonic flaw detector- Inspection of defects.
9. Demonstration of Radiographic inspection.

P: 30 periods

Total: 60 periods

REFERENCES:

1. Baldev Raj., Jayakumar T.,Thavasimuthu., “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Ravi Prakash., “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.
3. ASM Metals Handbook of Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, Volume-17, 2000.
4. Paul E Mix.,”Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005.
5. Charles J., Hellier, “Handbook of Nondestructive evaluation”, McGraw Hill, New York, 2001.

OUTCOMES:

Upon completion of this course, the students will be able to

- Illustrate the ultrasonic inspection methods of NDT.
- Understand the basic concept of radiographic inspection method.
- Test the surfaces by the various surface NDT techniques.
- Complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 07	PROPERTIES OF MATTER AND ACOUSTICS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To understand principles and properties of elasticity.
- To understand the basic concepts and application of viscosity.
- To analysis acoustic of building.
- To know about photoelasticity and its applications.

MODULE I ELASTICITY **8**

Stress and strain - Hooke's Law of elasticity - Elastic moduli - Stress-Strain Diagram - Poisson's Ratio - Relation between elastic constants - Work done in stretching and twisting a wire - Twisting couple on a cylinder- Expression for bending moment - Cantilever–Expression for depression - Uniform bending and Non-uniform bending of beams (theory & experiment) - I form Girders (qualitative treatment) and applications.

MODULE II VISCOSITY **8**

Viscosity- Newton's formula for viscous flow- Streamline and turbulent motion- Reynolds number - Poiseuille's formula- Determination of coefficient of viscosity- factors affecting viscosity - capillary flow method - Stoke's formula- viscosity of highly viscous liquids – Stoke's method - Lubricants and its applications –viscosity measurements- Viscometer- Variation of Viscosity with Temperature.

MODULE III ACOUSTICS OF BUILDING **7**

Basic requirement for the acoustically good halls - Reverberation and time of reverberation – Sabine's formula for reverberation time - Absorption coefficient and its measurement -Transmission of sound and transmission loss - Factors affecting the architectural acoustics and their remedy-sound absorbing materials-vibration and noise control systems for buildings.

MODULUE IV PHOTOELASTICITY **7**

Polarization- double refraction-Theory of Plane, Circularly and Elliptically polarized light- Quarter wave plate and half wave plate- photo elasticity- Theory of photo-elasticity- Stress optic relations- model materials-analysis techniques- Photo elastic bench.- Three dimensional photo elasticity-Digital photo elasticity- Photo elastic coatings.

L : 30 periods

PRACTICALS

1. Determination of viscosity of liquid by Poiseuille's method.
2. Determination of viscosity of liquid by Stoke's method.
3. Analysis of stress by photo elastic method.
4. Verification of Hooke's law by spring method.
5. Determination of Young's modulus of the cantilever beam.
6. Determination of rigidity modulus by static torsion method.
7. Visit to acoustically good auditorium and identifying the sound absorbing materials in the auditorium.

P: 30 periods

Total: 60 periods

REFERENCES:

1. Mathur D.S., "Elements of Properties of Matter", S.Chand & Co, Delhi, 2009.
2. Gaur R.K., Gupta S.L.,"Engineering Physics", Dhanpat Rai Publishers, 2010.
3. Brijlal and Subramaniam.," Properties of Matter", Eurasia Publishing Co, New Delhi, 2002.
4. Smith C.J.," General Properties of Matter", Orient & Longman,1960.
5. Kenneth G. Budinski and Michel K., Budinski, "Engineering Materials Properties and Selection", Pearson, Singapore, 2002.

OUTCOMES:

Upon completion of this course, the students will be able to

- Understand the basic concepts of the elasticity of materials.
- Comprehend the concepts of viscosity of liquid and measurement.
- Demonstrate the acoustical aspects of building and its importance in construction.
- Illustrate the fundamental concept of photo elasticity and its use for the stress analysis of the object.

PHCX 08	**PROPERTIES OF MATTER AND NONDESTRUCTIVE TESTING**	**L T P C** **2 0 2 3**

OBJECTIVES:

- To impart knowledge about the principles and properties of elasticity.
- To learn the laws governing the dynamic of rigid bodies.
- To acquire the knowledge of the various techniques of Non-Destructive Testing (NDT) of materials.
- To understand the principle and basic concept of low temperature applications.

MODULE I ELASTICITY 8

Stress and strain - Hooke's Law of elasticity - Elastic moduli - Stress-Strain Diagram - Poisson's Ratio - Relation between elastic constants - Work done in stretching and twisting a wire - Twisting couple on a cylinder- Expression for bending moment- Cantilever–Expression for depression - Uniform Bending and Non-uniform bending of beams (theory & experiment) - I form Girders (qualitative treatment) and applications.

MODULE II DYNAMICS OF RIGID BODIES 8

Rigid bodies - angular acceleration - Torque on a particle - angular momentum - law of conservation of angular momentum - moment of inertia and its significance - Theorem of parallel and perpendicular axis - moment of inertia of a thin uniform bar - moment of inertia of a rectangular lamina - moment of inertia of uniform circular disc - Moment of inertia of hollow and solid cylinders – flywheel (qualitative) - kinetic energy of rotating body – Routh rule.

MODULE III NDT TECHNIQUES 6

Ultrasonic Testing- types of Transducers-transmission and pulse-echo method- Radiographic testing- Principle-Interaction of X-ray with matter-X-ray radiography- method of generation-industrial radiography inspection techniques- Liquid Penetrant Testing**-** Inspection Procedure and Interpretation of results.

MODULE IV LOW TEMPERATURE PHYSICS 8

Definition of Refrigeration and Air-Conditioning - Types of **Refrigeration Systems-** Applications- Comfort Air Conditioning, Industrial Refrigeration, Food processing and food chain - **Cryogenic treatment - Low temperature properties of engineering materials: Mechanical properties, Thermal properties, Electrical properties.**

L : 30 periods

PRACTICALS

1. Verification of Hooke's law by spring method.
2. Determination of Young's modulus of the beam by bending method.
3. Inspection of welds using solvent removable visible dye penetrant.
4. Inspection of welds using solvent removable fluorescence dye penetrant.
5. Inspection of welds by Magnetic Particle Testing.
6. Determination of moment of inertia of the disc by torsion pendulum method.
7. Determination of moment of inertia of the disc by static torsion method.
8. Demonstration of working of flywheel.

P: 30 periods

Total: 60 periods

REFERENCES:

1. Mathur D.S.,"Elements of Properties of Matter", S.Chand & Co, Delhi, 2009.
2. Brijlal & Subramaniam," Properties of Matter", Eurasia Publishing Co, Delhi,2002.
3. Gaur R.K., Gupta S.L., "Engineering Physics" Dhanpat Rai Publishers, 2010.
4. Baldev Raj.,Jayakumar T., Thavasimuthu M.,"Practical Non-Destructive testing", Narosa Publishing House, 2009.
5. Brijlal & Subrahmanyam., "Heat and Thermodynamics" S.Chand & Company Ltd, 2002.
6. Paul E Mix.," Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition, New Jersey, 2005.
7. Charles J., Hellier.," Handbook of Nondestructive evaluation", McGraw Hill, New York, 2001.

OUTCOMES:

Upon completion of this course, the students will be able to

- understand the basic of concept of elasticity of materials.
- comprehend the basic concepts of motion of rigid bodies and its applications.
- Demonstrate the various NDT techniques and its importance.
- Illustrate the low temperature systems and its applications.

PHCX 09 **SEMICONDUCTOR PHYSICS AND OPTOELECTRONICS**

L	T	P	C
2	0	2	3

OBJECTIVES:

- To understand the Physics of Semiconductor devices.
- To make the students learn the fundamentals of Photoluminous - semiconductors, Optoelectronic devices, Optical modulators/detectors.
- To make them understand the technology behind latest Display devices like LCD, Plasma and LED Panels.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I PHYSICS OF SEMICONDUCTORS 8

Elemental and compound semiconductors – Drift and diffusion current - Intrinsic semiconductors – Carrier concentration (derivation) – Fermi energy – Variation of Fermi energy level with temperature – Mobility and electrical conductivity – Band gap determination – Extrinsic semiconductors – Carrier concentration in n-type and p-type semiconductor (derivation) – Variation of Fermi level with temperature and impurity concentration – Variation of Electrical conductivity with temperature – Hall effect – Experiment and applications of Hall effect.

MODULE II OPTOELECTRONIC DEVICES 7

Light Emitting Diodes (LED) – power and efficiency - double hetero LED - LED structure - LED characteristics - White LED – Applications. Liquid crystal displays – Dynamic scattering and Twisted nematic display, Semiconductor Lasers, Homojunction and Heterojunction laser diodes - Optical processes in semiconductor lasers.

MODULE III OPTICAL MODULATORS 7

Modulation of light – birefringence –Modulation Techniques - Electro optic effect – Electro optic materials –Types of Electro optic Modulators : Kerr and Pockel modulators –- Magneto optic effect - Magneto optic Modulators – Acousto Optic modulators.

MODULE IV OPTICAL DETECTORS 8

Photo detectors - photodiodes - phototransistors - noise characteristics - PIN diode – Avalanche Photodiode (APD) characteristics - APD design of detector arrays –

Charged Couple Device - Solar cells - Materials and design considerations, Thin film solar cells, amorphous silicon solar cells.

L : 30 periods

PRACTICALS

1. Resistivity measurement of a semiconductor using four point probe method.
2. Determination of band gap of a semiconductor diode.
3. Determination of Hall coefficient of a given semiconductor material.
4. Determination of the wavelength of a given laser source using diffraction grating.
5. Determination of Planck's constant using LED.
6. To study the I-V characteristics of photodiode and phototransistor.
7. To study the characteristics of a solar cell.

P: 30 periods

Total: 60 periods

REFERENCES:

1. Arumugam. M, "Physics II", Anuradha Publishers, 5th Edition, 2005.
2. Sze. S.M., "Semiconductor Devices – Physics and Technology", 2nd edn. John Wiley, 2002.
3. Wilson & J.F.B. Hawkes, "Optoelectronics – An Introduction", Prentice Hall, India, 1996.
4. Bhattacharya, "Semiconductor optoelectronic devices", Second Edn, Pearson Education, 2002.
5. Safa O. Kasap, "Optoelectronics & Photonics:Principles & Practices", Second Edn, Pearson Education,2013.
6. Palanisamy P.K., "Semiconductor physics and optoelectronics" Scitech Publications, 2003.

OUTCOMES:

On completion of this course, the student will be able to

- Understand the principles of Physics behind semiconductor devices.
- Choose the correct semiconductors for electronic devices and display.
- Differentiate the working principle of LED and Diode Laser.
- Apply the knowledge of modulation of light for different types of optical modulators.
- Select suitable photodetectors for different types of applications.
- Complement the knowledge acquired in the theory class and correlate the results for applications.

Chemistry Elective Courses
(To be offered II Semester)

CHCX01	**ANALYTICAL INSTRUMENTATION**	**L T P C**
		2 0 2 3

OBJECTIVES

To make the student conversant with

- principles, instrumentation and applications of different electroanalytical techniques
- different chromatographic techniques
- principles, instrumentation and applications of various types of absorption and emission spectroscopy
- different thermal analytical methods and their applications

MODULE I ELECTROANALYTICAL TECHNIQUES 7

Principle and applications: conductometric titrations – potentiometrIc titrations, ion-selective electrodes and pH-metry – coulometry – voltammetry - polarography, amperometric titrations.

MODULE II CHROMATOGRAPHY 8

Basic concepts of chromatography – paper chromatography – column chromatography – thin layer chromatography – gas chromatography – high performance liquid chromatography – gel permeation chromatography.

MODULE III SPECTROSCOPY 8

Absorption spectroscopy (principle, instrumentation and applications): Colorimetric analysis – UV-Visible spectroscopy – FTIR spectroscopy - Emission Spectroscopy (principle, instrumentation and applications): fluorescence, phosphorescence and chemiluminescence – Atomic absorption spectroscopy – flame emission spectroscopy.

MODULE IV THERMAL ANALYSIS 7

Principle, instrumentation and applications: Thermogravimetric analysis – Differential thermal analysis – Differential scanning calorimetry

L: 30 periods

PRACTICALS

1. Conductometric titrations: acid-base and precipitation titrations
2. Potentiometric titrations
3. Determination of pH of the unknown solution
4. Estimation of alkali metals using flame emission spectroscopy
5. Estimation of metal ions of coloured solutions using colorimetric analysis
6. Separation of compounds using gas chromatography
7. Separation of compounds using high performance liquid chromatography
8. Analysis of the given sample and interpretation of the data using IR, UV-Visible spectroscopy
9. Demonstration of TGA/DTA and DSC and interpretation of data.

P:30 periods

Total: 60 periods

REFERENCES

1. Skoog D.A., West D.M., Holler F.J. and Crouch S.R., Fundamentals of Analytical Chemistry, 8th Edition, Thomson Brooks/Cole Publication., Singapore, 2004.
2. Willard H.H., Merritt L.L., Dean J.A. and Settle F.A., Instrumental Methods of Analysis, 7th Edition, CBS Publication, New Delhi Reprint, 2004.
3. A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Prentice Hall, London, 2008.
4. Christian G.D., Analytical Chemistry, 6th Edition, John Wiley, Singapore, 2003.
5. Fifield F.W. and Kealey D., Principles and Practice of Analytical Chemistry, 5th Edition, Blackwell Publication, London, 2000.
6. Settle F. (Editor), Handbook of Instrumental Techniques for Analytical Chemistry, Pearson Education, Singapore, 2004.

OUTCOMES

The student will be able to

- state the principle and applications of various electro-analytical techniques
- identify the right separation method for a given sample using different chromatographic techniques
- explain the principle, instrumentation & applications of various spectroscopic methods and also to interpret the data
- elaborate the principle, instrumentation and applications of various thermal analytical techniques and interpret the data.

CHCX02	**CORROSION AND ITS CONTROL**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES

To make the student conversant with

- Basic concepts, principles and factors affecting corrosion
- Types and mechanism of corrosion
- Control measures of corrosion by material selection, proper design and by applying organic coatings
- Control of corrosion by applying inorganic coatings

MODULE I BASIC CONCEPTS OF CORROSION 8

Corrosion – causes and impacts of corrosion – mechanism of corrosion: Dry corrosion- oxidation corrosion - corrosion by other gases – Pilling-Bedworth rule- Corrosion by hydrogen: hydrogen blistering, hydrogen embritttlement, decarburization and hydrogen attack – corrosion of silver and copper by sulphur compounds – liquid metal corrosion (embritttlement or cracking) – Wet corrosion : hydrogen evolution – presence and absence of oxygen and absorption of oxygen – difference between dry and wet corrosion-factors influencing corrosion-polarization-passivity-emf series and galvanic series- corrosion current -rate of corrosion.

MODULE II FORMS OF CORROSION 7

Forms of corrosion-conditions for electrochemical corrosion –galvanic corrosion – differential aeration corrosion: pitting, water line, wire fencing, crevice and filiform corrosion – stress corrosion – Intergranular corrosion- erosion corrosion – soil corrosion – microbiological corrosion- fretting corrosion- corrosion in composites.

MODULE III CORROSION CONTROL AND ORGANIC COATINGS 8

Corrosion control – selection of materials and designing- cathodic protection – sacrificial anode and impressed current cathodic protection – corrosion inhibitors: anodic, cathodic and vapour phase inhibitors.

Organic protective coatings – paints: constituents – functions – varnishes : types- constituents – functions – lacquers : constituents – functions –enamels- constituents – functions – special paints : fire retardant, water repellant, heat resistant, temperature indicating and luminous paints.

MODULE IV INORGANIC COATINGS 7

Treatment of metal surface-inorganic coatings- classification- metallic coatings : anodic and cathodic coatings-hot dipping : galvanizing and tinning- electroplating—

electroless plating – cementation (diffusion) : sherardizing, calorizing and chromizing – metal cladding-metal spraying – non metallic coatings (chemical conversion coatings) : phosphate, chromate, oxide coatings and anodizing – comparison of anodic and cathodic protection.

L : 30 periods

PRACTICALS

1. Determination and comparison of rate of corrosion of metals in the presence of acid, base and neutral medium by weight loss method.
2. Determination of rate of corrosion of iron in the presence of various acids by weight loss method.
3. Determination of rate of corrosion of iron in the presence and absence of anodic Inhibitor by weight loss method.
4. Determination of rate of corrosion of iron in the presence and absence of cathodic Inhibitor by weight loss method.
5. Electroplating of base metal with copper.
6. Electrolessplating of base metal with copper
7. Chemical conversion coatings such as chromate and phosphate coatings.
8. Demonstration on the study of rate of corrosion by using cyclic voltametry.

P:30 periods

Total: 60 periods

REFERENCES

1. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).
2. S S Umare & S S Dara, A text Book of Engineering Chemistry, S. Chand & Company Ltd, New Delhi, 2014.
3. M.G. Fontana and N.G. Green, Corrosion Engineering, McGraw Hill Book Company, NewYork, 1984.
4. S. Banerjee, A.K. Tyagi, Functional Materials- Preparation, Processing and Applications, ELSEVIER Publications, London ; Waltham, MA : 2011

OUTCOMES

The students will be able to

- explain the mechanism, compare and enumerate the factors affecting corrosion
- describe and identify the place and types for a given situation.
- choose and elaborate the suitable organic coating method for a given real time situation.
- apply a suitable metallic coating for a given situation

CHCX03 ELECTRICAL MATERIALS AND BATTERIES

L	T	P	C
2	0	2	3

OBJECTIVES

To make the student conversant with

- preparation, properties and applications of plastics used in electrical and electronic applications
- properties and uses of electrical engineering materials
- classification and description of different types of batteries.
- classification and types of fuel cells

MODULE I POLYMERS FOR ELECTRICAL AND ELECTRONIC APPLICATIONS 8

Preparation, properties and applications **:** polyethylene, polypropylene, EPDM, Nylon-6,6, PVC, PTFE, polycarbonates, ABS, phenol formaldehyde, urea formaldehyde, epoxy resins – polymer blends and alloys.

MODULE II ELECTRICAL ENGINEERING MATERIALS 7

Conductors**:** Silver, Copper, Gold, Aluminum **–** Semiconductors: Germanium, Silicon, Gallium Arsenic **–** Insulating Materials: Rubbers, Mica, Plastics, Ceramics, Insulating papers **–** Magnetic Materials**:** ferromagnetic materials, paramagnetic materials, diamagnetic materials, antiferromagnetic materials, ferrites

MODULE III BATTERIES 7

Electrochemical and electrolytic cell – batteries**:** types (primary, secondary and flow cell) – primary batteries**:** dry cells, alkaline batteries – secondary batteries**:** nickel-cadmium cell – lead acid storage cell, lithium battery**:** primary and secondary type – solar cell – dye sensitized solar cell.

MODULE IV FUEL CELLS 8

Difference between batteries and fuel cells - chemistry of fuel cells - types of fuel cell (based on temperature and electrolyte) – principle, characteristic features, advantages, disadvantages and applications of polymer electrolyte membrane or proton exchange membrane fuel cell (PEMFC), direct methanol fuel cell (DMFC), alkaline fuel cell (AFC), phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC) and solid oxide fuel cells (SOFC).

L:30 periods

PRACTICALS

1. Free radical polymerization of styrene.
2. Free radical polymerization of PMMA.
3. Preparation of phenol-formaldehyde.
4. Preparation of urea-formaldehyde.
5. Synthesis of epoxy resin.
6. Demonstration of mechanical properties of insulating materials using UTM
7. Demonstration of electrical properties of insulating materials
8. Construction of batteries using natural resources
9. Measurement of EMF for different batteries.

P:30 periods

Total: 60 periods

REFERENCES

1. Jain P.C. and Renuka Jain, Engineering Chemistry, Dhanpat Rai Publication Co. (P) Ltd., New Delhi, 2013.
2. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapman and Hall, New York, 1991.
3. H.F. Mark and N. Gaylord, Encyclopedia of Polymer Science and Technology, Vol. 1 to XIV Interscience, 2nd Ed. 1988.
4. Gowarikar V.R., Viswanathan N.V and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras, 1981.
5. R.K. Rajput, A Textbook of Electrical Engineering Materials, Firewall Media, 2004
6. Vladimir S. Bagotsky, Fuel Cells: Problems and Solutions, 2nd Edition, John Wiley and Sons, 2012.
7. B. Viswanathan and M. Aulice Scibioh, Fuel Cells: Principles and Applications, Taylor and Francis Group, 2007.

OUTCOMES

The student will be able to

- summarise the preparation, properties and applications of plastics used in electrical and electronic applications
- enumerate the properties and uses of electrical engineering materials
- illustrate various types of batteries with the aid of a diagram
- classify the fuel cells and elaborate the different types of fuel cells.

CHCX04 ENGINEERING MATERIALS **L T P C**
2 0 2 3

OBJECTIVES

To make the student conversant with

- properties and uses of different types of refractories and abrasives
- adhesives, cements and lime, setting of cements and their chemical behaviors.
- types, properties and uses of lubricants.
- various types of composite materials.

MODULE I REFRACTORIES AND ABRASIVES 8

Introduction refractory: -classification - based on chemical nature- characteristic and selection of good refractory - general manufacture of refractory- preparation properties and uses of: silica refractory - magnesite refractory - zirconia refractory, properties of refractories: refractoriness - refractoriness under load - thermal spalling - porosity and dimensional stability, Cermets - super refractory.

Abrasives : introduction - Moh's scale - natural abrasives: diamond – corundum – emery - garnet and quartz, synthetic abrasives: preparation properties and uses: carborundum (silicon carbide)– alundum - boron (norbide) carbide

MODULE II ADHESIVES AND BINDING MATERIALS 8

Introduction - classification of adhesives –advantage –limitation of adhesive bonding –development of adhesive- factors influencing adhesive action: chemical and physical, application techniques of adhesive – Lime: classification – manufacture - setting and hardening, Gypsum: -Manufacture and properties and uses - Cement : chemical composition- Manufacture – setting and hardening – concrete – weathering of cement and concrete and its prevention- special cements: high alumina cement - sorel cement - white portland cement – water proof cement.

MODULE III LUBRICANTS 7

Introduction –functions of lubricant- mechanism of lubrication - classification of lubricant – liquid lubricant: vegetable and animal oils – mineral oils, semisolid: grease(calcium, lithium, aluminium) – petroleum jelly, solid lubricant: graphite - molybdenum disulphide, Properties of lubricant: viscosity - viscosity index - flash point and fire point - cloud point and pour point – oiliness - aniline point - carbon residue.

MODULE IV COMPOSITE MATERIALS 7

Introduction – advantageous characteristics of composites, applications of composites, main constituent of composites, types and applications of composites: RCC fibre-reinforced plastics (glass , carbon and aramid) - particulate composite - metal matrix composite - layered composites - failures in fibre-reinforced composites, ceramic matrix composites (CMC) – properties and applications.

L:30 periods

PRACTICALS

1. Preparation of refractory bricks
2. Preparation of abrasive papers/cloth
3. Preparation of simple adhesives
4. Estimation of alkalinity in cements
5. Determination of cloud point and pour point
6. Determination of flash point and fire point
7. Preparation of fibre-reinforced composite

P:30 periods

Total: 60 periods

REFERENCES

1. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).
2. B.Sivasnakar, “Engineering Chemistry”, Tata McGrow-Hill Publication Limited, New Delhi, second reprint 2008.
3. Engineering Chemistry, Wiley India Editorial Team, Willey India Publisher, New Delhi, 2011.
4. S S Umare & S S Dara, A text Book of Engineering Chemistry, S. Chand & Company Ltd, New Delhi, 2014.

OUTCOMES

The student will be able to

- classify and describe the manufacture the refractories and enumerate the properties and uses of abrasive materials.
- elaborate the manufacture, properties and uses of various adhesives and binding materials.
- classify lubricants and describe the properties and uses of them
- enumerate the properties and uses of various composite materials.

CHCX05 **FUELS AND COMBUSTION** **L T P C**
2 0 2 3

OBJECTIVES

To make the students conversant with the

- three types of fuels available and the different processes involved in it.
- analysis of fuel characteristics and manufacture of fuels
- calculations involved in calorific values and minimum air requirement for complete combustion.
- classification, functions, mechanism and properties of lubricants.

MODULE I SOLID FUELS 7

Characteristics of good fuel. Solid fuel – Wood, Coal – Ranking of coal – selection of coal. Analysis of coal – Proximate analysis. Pulverized coal – Metallurgical coke – Carbonization of coal – types. Manufacture of metallurgical coke – Beehive oven and Otto Hoffman's by-product oven methods.

MODULE II LIQUID AND GASEOUS FUELS 8

Liquid fuel: Petroleum: Refining of petroleum, Liquid fuels derived from petroleum – Cracking: Thermal (Liquid and Vapour phase) – Catalytic (fixed bed and moving bed cracking – Synthetic petrol: Fischer-Tropsch method– Knocking in petrol and diesel engine: octane number and antiknocking – cetane number and improvement of cetane number – biodiesel (trans-esterification) – Gaseous fuels: Compressed natural gas (CNG) – LPG – oil gas – producer gas – water (blue) gas – biogas.

MODULE III COMBUSTION 8

Calorific value: Gross and net caloric value – Bomb Calorimeter, Gas calorimeter - Definition of combustion – calculation of minimum requirement of air (problems) – theoretical calculation of calorific values (Dulong's formula), Gross and net calorific values ((problems) – Analysis of flue gas: Orsat's gas analysis method, explosive range, Ignition temperature. Introduction to air pollution from IC (Internal combustion) engines, photochemical smog, primary and secondary pollutants.

MODULE IV LUBRICANTS 7

Friction and wear – lubricants: definition, functions and mechanism of lubrication (thick film and thin film) –classification: liquid lubricants: animal and vegetable origin, mineral oil, blended oils, lubricating emulsions and silicones – properties of lubricating oils: viscosity and viscosity index; Flash and fire-point, Cloud and pour point, oiliness, emulsification number, volatility, carbon residue, aniline point – semisolid lubricant: greases and waxes – solid lubricant: graphite and molybdenum disulphide –nanolubricants.

L:30 periods

PRACTICALS

1. Testing of fuels - proximate analysis (moisture, volatile matter, ash content and fixed carbon present in coal, coke, charcoal etc)
2. Ash content and carbon residue test
3. Biodiesel synthesis by trans-esterification method (from coconut, groundnut, mustard oil, palm oil)
4. Determination of calorific value of a solid fuel using Bomb calorimeter (coal, charcoal, coke etc)
5. Determination of calorific value of a liquid fuel using Bomb calorimeter (petrol, diesel, biodiesel etc)
6. Determination of cloud point and pour point of a lubricant
7. Determination of flash and fire point of diesel.
8. Aniline Point of diesel
9. Viscosity Index of lubricants and Fuels by Viscometer
10. Flue gas analysis by Orsat's gas analysis method – Demonstration
11. Working of internal combustion engine - Demonstration

P:30 periods

Total: 60 periods

REFERENCES

1. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi, 2001.
2. Engineering Chemistry, Wiley India Editorial Team, Willey India Publisher, New Delhi, 2011.
3. John Griswold, Fuels Combustion and Furnaces, Mc-Graw Hill Book Company Inc. University of Michigan, 1946.
4. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Editions, 1989.
5. Bahl B.S., Tuli and Arun Bahl, Essentials of Physical Chemistry, S. Chand and Company Ltd., New Delhi, 2004.

OUTCOMES

The students will be able to

- compare and contrast the solid, liquid and gaseous fuels and also describe the processes involved in liquid and gaseous fuels.
- analyse the fuel properties such as moisture, votalite matter, ash content, calorific value etc
- calculate minimum air required for complete combustion and calorific values of fuels.
- categorize different lubricants into three types, explain the preparation and determine their properties.

CHCX06 FUNDAMENTALS OF PHYSICAL CHEMISTRY **L T P C**
2 0 2 3

OBJECTIVES

To make the student conversant with the

- various thermodynamic terms and relate the laws of thermodynamics in chemical processes
- molecularity and order of reaction and derive the rate constant for different order of reactions
- basics of adsorption of different materials and propose mechanisms and surface area measurement
- conditions for equilibrium and learn different components at equilibrium

MODULE I BASIC THERMODYNAMICS 8

Introduction - Thermodynamic terms - Thermodynamic equilibrium and processes - 1^{st} law of thermodynamics: internal energy, enthalpy, heat capacity, isothermal and adiabatic expansion, Joule-Thomson effect - Zeroth law of thermodynamics: absolute temperature - 2^{nd} law of thermodynamics: - spontaneous and cyclic process, Entropy in isothermal, isobaric and isochoric processes, work and free energy function, Maxwell's relation - 3^{rd} law of thermodynamics

MODULE II CHEMICAL KINETICS 8

Rate of chemical reaction - order and molecularity of a reaction - Rate constant - kinetics of opposing, parallel and consecutive and chain reactions - isotope effects - effect of temperature on reaction rate - collision theory - absolute reaction rate theory - kinetics in enzyme catalysis

MODULE III SURFACE SCIENCE AND CATALYSIS 8

Adsorption - adsorption isotherms - uni and bimolecular adsorption reactions - parahydrogen conversion - factors affecting adsorption – Langmuir adsorption isotherm - Hinshelwood mechanism and *Eley-Rideal* mechanism with example - adsorption of gases on solids and surface area measurement by BET method - Terms in catalysis - homogeneous and heterogeneous and enzyme catalysis with example

MODULE IV PHASE RULE 6

Terms involved - Conditions for equilibrium - application of phase rule to water, lead-silver system, freezing mixtures, thermal analysis: cooling curves.

L:30 periods

PRACTICALS

1. Determination of the heat capacity of benzoic acid, internal energy of combustion of camphor using Bomb calorimeter. Calculation of enthalpy of combustion and formation for camphor.
2. Determination of adsorption isotherm of (i) acetic acid on charcoal (ii) oxalic acid on charcoal.
3. *Kinetics of first and second order reactions.*
4. Phase rule experiments with organic compounds: (i) naphthalene and p-dichloro benzene (ii) naphthalene and diphenyl (iii) m-dinitrobenzenzene and p-nitro toluene.

P:30 periods

Total: 60 periods

REFERENCES

1. Rajaram J. and Kuriacose J.C., Chemical Thermodynamics: Classical, Statistical and Irreversible, Pearson Education, India, 2013.
2. Samuel Glasstone, Thermodynamics for Chemists, Read Books, United Kingdom, 2007.
3. James E. House, Principles of Chemical Kinetics, 2nd Edition, Academic Press, United States of America, 2007.
4. Keith J. Laidler, Chemical Kinetics, Pearson Education, India, 1987.
5. Douglas M. Ruthven, Principles of Adsorption and Adsorption Processes, John Wiley & Sons, 1984.
6. Puri B.R., Sharma L.R. and Pathania M.S., Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co. India, 2016.

OUTCOMES

The student will be able to

- calculate entropy, enthalpy and free energy change for different chemical processes
- calculate the rate constant for any chemical and biochemical processes
- differentiate the adsorption processes and calculate the surface area and predict the suitability of catalysts for different chemical processes
- predict the equilibrium conditions for water, alloys, freezing mixtures and draw the thermal curves for phase transition

CHCX07 GREEN TECHNOLOGY

L	T	P	C
2	0	2	3

OBJECTIVES

To make students conversant with the

- basic principles of green chemistry and green technology.
- wastes that causes hazards to human health
- chemicals that harms our environment
- need for green processes in various industries

MODULE I GREEN CHEMISTRY PROTOCOL 7

Need – Significance – 12 Principles with examples – R4 model – Life cycle analysis – sustainable and cleaner production - Green Technology: definition, examples: CFC free refrigerants, green building, energy, 3D printers, nanotechnology – Awards for Green chemistry – organization promoting green chemistry.

MODULE II WASTE & WASTE MINIMISATION 8

Source of wastes: domestic, industrial, medical, nuclear, e-waste; problems; prevention – economy of waste disposal – Waste minimization techniques: general waste treatment and recycling – alternate waste water treatment technologies: hybrid process – Green computing: goals, green cloud, green ICT - Pollution statistics from various industries (Industrial case studies).

MODULE III GREEN SYNTHESIS 7

Introduction - Solvent free reactions - green reagents, green solvents in synthesis - microwave and ultrasound assisted reactions – supercritical fluid extraction – green oxidation and photochemical reactions – catalyst and biocatalysts.

MODULE IV GREEN INDUSTRIAL PROCESSES 8

Polymer industry: biodegradable polymer - textile industry: greener approaches of dyeing, waste disposal – ecofriendly agrochemicals: biofertilizers, biopesticides – Pharmaceutical industry: atom economy, reduction of toxicity, use of biocatalyst, zero waste disposal – Leather industry: greener process in tanning, crusting, surface coating – ecofriendly batteries & fuel cells.

L:30 periods

PRACTICALS

1. Synthesis of an ionic liquids (Ex: imidazolium) and testing the solubility of organic chemicals.
2. Green bromination of stilbene (using pyridine hydrobromide).
3. Green synthesis: Photocatalytic reactions, solvent-free organic reaction – Aldol; green oxidation, green reduction.
4. Microwave assisted chemical reaction. (synthesis of aspirin, pinacol-pinacolone reaction, etc).
5. Comparison of conventional reaction with microwave assisted reactions (atom economy, solvent, etc) [Ex: aldehyde and ketones with hydrazines to give hydrazones].
6. Diels-Alder reaction in eucalyptus oil (green process).

P:30 periods

Total: 60 periods

REFERENCES

1. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi. 2001.
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Ane Books India, New Delhi, 2006.
3. Paul Anastas, John C.Warner, John Warner Joint; Green Chemistry: Theory & Practice New Ed Edition; Oxford University press, USA, 2000.
4. Rashmi Sanghi, M. M. Srivastava, Green chemistry, Narosa publishers, New Delhi, 2003.

OUTCOMES

The students will be able to

- outline the principles and implications of green chemistry.
- comprehend the potential risks of waste generated and analyse the threats to human and environment.
- integrate information into design of molecules to avoid/eliminate toxic solvents & reagents or reduce toxic products.
- identify various alternate greener technologies for various industries.

CHCX08 ORGANIC CHEMISTRY OF BIOMOLECULES

L	T	P	C
2	0	2	3

OBJECTIVES

To make students conversant with the

- basic concepts in organic chemistry
- types and structure of carbohydrates and lipids
- formation of different structures of proteins from amino acid
- structure of nucleic acids

MODULE I BASIC CONCEPTS IN ORGANIC CHEMISTRY 8

Classification and IUPAC nomenclature of organic compounds – stereochemistry – optical, stereo and geometrical isomerism – types of reagents: electrophiles and nucleophiles – types of reactions: addition, substitution, elimination and rearrangement reactions.

MODULE II CARBOHYDRATES, LIPIDS AND VITAMINS 7

Structure and functions of carbohydrates: mono, di, oligo and polysaccharides – lipids: phospholipids, glycolipids, sphingolipids – cholesterol – steroids – Structure, functions and deficiency disorders of fat soluble vitamins: A, D, E & K - Water soluble vitamins B & C: Thiamine, riboflavin, pantothenic acid, niacin, pyridoxine, biotin, cobalamine, folic acid and ascorbic acid.

MODULE III AMINO ACIDS, PEPTIDES AND PROTEINS 7

Aminoacids: classification, properties - peptides – polypeptides – proteins: primary, secondary, tertiary and quaternary structure – glycoproteins – lipoproteins – Enzymes: classification and functions

MODULE IV NUCLEIC ACIDS 8

Nucleic acids – importance - structure of purines and pyrimidines – nucleotides – polynucleotides - RNA – types & structure - DNA – phosphodiester bonds – chemical, helical structure and functions – DNA replication – gene modification.

L: 30 periods

PRACTICALS

1. Qualitative tests to identify carbohydrates.
2. Quantitative estimation of carbohydrates.

3. Separation of sugars – TLC and/or paper chromatography.
4. Quantitative estimation of lipids.
5. Separation of amino acids – TLC and/or paper chromatography.
6. Quantitative estimation of proteins by Lowry's method.

P:30 periods

Total: 60 periods

REFERENCES

1. V. K. Ahluwalia, Organic Reaction Mechanism, Narosa Publishers, New Delhi, 2002.
2. Johnson Arthur T., Biology for Engineers, CRC Press, Finland, 2011.
3. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi. 2001.
4. David L. Nelson, Michael M. Cox, Lehninger Principles of biochemistry, Macmillan press, London, 2010

OUTCOMES

The students will be able to

- classify organic compounds and explain the mechanism of various organic reactions.
- draw the structures and enumerate the functions of carbohydrate, lipids and vitamins.
- correlate the relationship among amino acids, peptides and proteins.
- recognize the role of nucleic acid in the formation of RNA & DNA and differentiate DNA & RNA using their structure and function.

CHCX09	POLYMER SCIENCE AND TECHNOLOGY	L T P C
		2 0 2 3

OBJECTIVES

To make the student conversant with the

- basic concepts of polymers, classification, types of polymerization and molecular weight & its distribution
- preparation, properties and applications of thermoplastics and introduction to biodegradable polymers
- properties and applications of thermosets, elastomers and FRP
- different types of moulding techniques

MODULE I BASIC CONCEPTS OF POLYMERS 8

Definitions**:** monomer, polymer, functionality, degree of polymerization – classification of polymers**:** source, structure, application, thermal processing behavior (thermoplastics and thermosets), composition and structure (addition and condensation), mechanism (chain growth and step-wise growth) – copolymer: types – Definition –nomenclature of polymers – tacticity – types of polymerization : free radical, cationic and anionic polymerization (concepts only) – average molecular weight of polymer**:** number, weight – molecular weight distribution (problems)

MODULE II THERMOPLASTICS AND BIODEGRADABLE POLYMERS 8

Preparation, properties and applications **:** LDPE, HDPE, polypropylene, PVC, PTFE, PET, polyamides (Nylon-6 and Nylon 6,6) and polycarbonates – polymer blends and alloys – basics of biodegradable polymers.

MODULE III THERMOSET RESINS, ELASTOMERS AND FRP 7

Thermoset resins **:** phenolic resins, amino resins (urea and melamine formaldehyde), epoxy resins, unsaturated polyesters – polyurethanes – elastomers **:** vulcanization of natural rubber, diene based elastomers –fibre reinforced plastics**:** glass, aramid and carbon.

MODULE IV MOULDING TECHNIQUES 7

Moulding constituents**:** functions – moulding techniques**:** compression, injection, extrusion (single screw), blow moulding, thermoforming, (mechanical and vacuum forming), lamination.

L: 30 periods

PRACTICALS

1. Determination of molecular weight and degree of polymerization using Oswald's viscometer.
2. Free radical polymerization of styrene.
3. Free radical polymerization of PMMA.
4. Preparation of phenol-formaldehyde.
5. Preparation of urea-formaldehyde.
6. Synthesis of epoxy resin.
7. Synthesis of unsaturated polyester.
8. Preparation of FRP laminates.
9. Demonstration of injection moulding, compression moulding and blow moulding.

P:30 periods

Total: 60 periods

REFERENCES

1. Billmeyer F.N., Text Book of Polymer Science, 3rd Edition, John Wiley and Sons, New York, 1994.
2. George Odian, Principles of Polymerisation, 3rd Edition, McGraw Hill Book Company, New York, 1991.
3. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapman and Hall, New York, 1991.
4. Jacqueline I., Kroschwitz, Concise Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, New York, 1998.
5. Encyclopedia of Polymer Science and Technology, Vol. 1 to XIV, H.F. Mark and N. Gaylord, Interscience, 2nd Ed. 1988.
6. Gowarikar V.R., Viswanathan N.V and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras, 1981.

OUTCOMES

The student will be able to

- classify various polymers, name the polymers and types of polymerization reactions, calculate molecular weight of polymers,
- summarise preparation, properties and applications of thermoplastics and give examples of biodegradable polymers
- elaborate the properties and applications of thermosets, elastomers and FRP
- select the appropriate moulding technique for a given polymer, based on the application

Maths Elective Courses
(to be offered in IV Semester)

MACX 01	DISCRETE MATHEMATICS AND GRAPH THEORY	L	T	P	C
		3	1	0	4

OBJECTIVES:

The aims of this course are to

1. introduce Logical and Mathematical ability to deal with abstraction.
2. familiarize the basic mathematical ideas and terminologies used in computer science.
3. translate real life situations into diagrammatic representations.

MODULE I PROPOSITIONAL CALCULUS 8

Propositions – Logical connectives – Compound propositions – Conditional and biconditional propositions – Truth tables – Tautologies and contradictions – Contrapositive – Logical equivalences and implications – DeMorgan's Laws – Normal forms – Principal conjunctive and disjunctive normal forms – Rules of inference – Arguments – Validity of arguments.

MODULE II PREDICATE CALCULUS 7+3

Predicates – Statement function – Variables – Free and bound variables – Quantifiers – Universe of discourse – Logical equivalences and implications for quantified statements – Theory of inference – The rules of universal specification and generalization – Validity of arguments.

MODULE III FUNCTIONS 7+3

Functions – Classification of functions –– Composition of functions – Inverse functions – Binary and n–ary operations – Characteristic function of a set – Hashing functions – Recursive functions – Permutation functions.

MODULE IV ALGEBRAIC SYSTEMS 8+2

Groups, Cyclic Groups, Subgroups, Cosets, Lagrange's theorem, Normal subgroups – Codes and group codes – Basic notions of error correlation – Error recovery in group codes.

MODULE V GRAPH THEORY 7+3

Graphs – incidence and degree – subgraphs – isomorphism – complement of a graph – operations on graphs

MODULE VI PATH AND CIRCUIT 8+2

Walks, trails and paths – Eulerian graphs – Konigsburg bridge problem - Hamiltonian graphs

L – 45; T – 15; Total Hours –60

TEXT BOOKS:

- Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 30th Reprint 2011.
- Kenneth H.Rosen, "Discrete Mathematics and its Applications:, 7th Edition, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, Special Indian Edition, 2011.

REFERENCES:

- Ralph.P.Grimaldi, "Discrete and Combinatorial Mathematics: An Introduction", 4th Edition, Pearson Education Asia, Delhi, 2007.
- Thomas Koshy, "Discrete Mathematics with Applications", Elsevier Publications, 2006.
- C.L.Liu, D.P.Mohapatra, "Elements of Discrete Mathematics", 4th Edition, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 2012.

OUTCOMES:

At the end of the course, student will be able to

- use the concepts of propositional calculus.
- use the concepts of predicate calculus.
- identify types of functions and their importance.
- decode and encode the messages using group theory concepts.
- apply the basic concepts of graph theory.
- represent some real life situations into diagrammatic representation.

MACX 02 PROBABLITY AND STATISTICS

L	T	P	C
3	1	0	4

OBJECTIVES:

The aims of this course are to impart the

- knowledge of the theory of probability and random variables
- techniques to carry out probability calculations and identifying probability distributions
- application of statistical inference in practical data analysis

MODULE I BASICS OF PROBABILITY AND STATISTICS 8+2

Sample space, events- axioms of probability and interpretation – Addition, multiplication rules – conditional probability, Independent events - Total probability – Baye's theorem - Descriptive Statistics.

MODULE II ONE DIMENSIONAL RANDOM VARIABLE AND PROBABILITY DISTRIBUTION FUNCTIONS 7+3

Discrete random variable –continuous random variable – Expectation - probability distribution - Moment generating function – Binomial, Poisson, Geometric, Uniform (continuous), Exponential and Normal distributions.

MODULE III TWO DIMENSIONAL RANDOM VARIABLES 8+2

Joint, marginal, conditional probability distributions –covariance, correlation - transformation of random variables.

MODULE IV SAMPLING AND ESTIMATION 7+3

Sampling distributions – basic knowledge on Random , simple random , stratified and cluster samplings – Test of Hypotheses - concepts- Point estimation and Interval estimation.

MODULE V THEORY OF INFERENCE 8+2

Large sample tests – test for single and difference on proportions, single mean, difference of means, difference of variances – confidence intervals. Small sample tests – Student's t test, F test and Chi square test on theory of goodness of fit and analyses of independence of attributes.

MODULE VI DESIGN OF EXPERIMENTS 7+3

Analysis of variance – one way classification – two way classification – Completely Randomised Block Designs – Randomised Block Design – Latin square designs - Interpretations - case studies.

L – 45; T – 15; Total Hours –60

TEXT BOOKS:

- T.Veerarajan, “Probability and Statistics”, Tata McGraw-Hill Education, 2008.
- Miller, I., Miller, M.,Freund, J. E., “Mathematical statistics”, 7th Edition, Prentice Hall International, 1999.
- S.P.Gupta, “Applied Statistics”, Sultan Chand & Sons

REFERENCES:

- S.M.Ross, “Introduction to Probability and Statistics for Engineers and Scientists” Fifth Edition, Elesvier.
- S.C.Gupta and V.K.Kapoor, “Fundamentals of Mathematical Statistics” First edition, Sultan Chand and Sons.
- Arora and Arora, “Comphrensive Statistical Methods”, S. Chand, 2007

OUTCOMES:

On completion of the course, students will be able to

1. do basic problems on probability and descriptive statistics.
2. derive the probability mass / density function of a random variable.
3. calculate probabilities and derive the marginal and conditional distributions of bivariate random variables.
4. calculate point and interval estimates.
5. apply some large sample tests and small sample tests.
6. carry out the data collection representation analysis and implications and the importance of inferences.

MACX 03 RANDOM PROCESSES

L	T	P	C
3	1	0	4

OBJECTIVES:

The aims of the course are to

- acquire the knowledge of the theory of probability and random variables
- study discrete and continuous probability distributions.
- demonstrate the techniques of two dimensional random variables and its distributions.
- introduce the random process, stationarity, Markov process and the study of correlation function and spectral analysis.

MODULE I Basics of Probability 7+3

Sample space, events- axioms of probability and interpretation – Addition, multiplication rules – conditional probability, Independent events - Total probability – Baye's theorem - Tchebychev's inequality.

MODULE II One dimensional Random variable and Probability Distribution functions 7+3

Discrete random variable –continuous random variable – Expectation - probability distribution - Moment generating function – Binomial, Poisson, Geometric, Uniform (continuous), Exponential and Normal distributions.

MODULE III TWO DIMENSIONAL RANDOM VARIABLES 7+3

Joint, marginal, conditional probability distributions - covariance, correlation and regression lines - transformation of random variables.

MODULE IV RANDOM PROCESSES 8+2

Classification of Random process - Stationary process - WSS and SSS processes - Poisson process – Markov Chain and transition probabilities.

MODULE V CORRELATION FUNCTIONS 8+2

Autocorrelation function and its properties - Cross Correlation function and its properties - Linear system with random inputs – Ergodicity.

MODULE VI SPECTRAL DENSITY 8+2

Power spectral Density Function - Properties - System in the form of convolution -

Unit Impulse Response of the System – Weiner-Khinchine Theorem - Cross Power Density Spectrum.

L – 45; T – 15; Total Hours –60

TEXT BOOKS:

1 Veerarajan T., “Probability, Statistics and Random Processes”, Tata McGraw Hill,3rd edition, 2008.
2 Papoulis, “Probability, Random Variables and Stochastic Processes”, 4th Edition, Tata McGraw Hill Company, 2002.
3 S.M.Ross, “Introduction to Probability and Statistics for Engineers and Scientists” Fifth Edition, Elesvier

REFERENCES:

1 Scott L. Miller,Donald G. Childers, Probability and Random Processes, Academic Press,2009.
2 Trivedi K S, “ Probability and Statistics with reliability, Queueing and Computer Science Applications”,Prentice Hall of India,New Delhi,2nd revised edition, 2002

OUTCOMES:

On completion of the course, students will be able to

- do basic problems on probability.
- derive the probability mass / density function of a random variable.
- calculate probabilities and derive the marginal and conditional distributions of bivariate random variables.
- identify and study the different random processes.
- compute correlation functions and related identities.
- compute power spectral density functions and apply Weiner-Khinchine formula.

MACX 04	APPLIED NUMERICAL METHODS	L	T	P	C
		3	1	0	4

OBJECTIVES:

The aims of the course are to

- introduce basic computational methods for analyzing problems that arise in engineering and physical sciences.
- acquire knowledge about approximation theory and convergence analysis associated with numerical computation.

MODULE I NUMERICAL SOLUTIONS OF EQUATIONS 7+3

Bisection method - Regula Falsi method – Secant method - Fixed point iteration method - Newton's Raphson method –Gauss Elimination method - Gauss-Jordon method – Gauss Jacobi method - Gauss-Seidel method.

MODULE II INTERPOLATION 8+2

Finite difference operators – Gregory Newton's forward and backward interpolations – Cubic spline interpolation - Lagrange interpolation - Newton's divided difference formula.

MODULE III NUMERICAL DIFFERENTIATION AND INTEGRATION 8+2

Numerical differentiation using Newton's forward and backward formulae – Numerical integration : Trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Gaussian Two Point and Three Point Quadrature formulae – Double integrals using Trapezoidal and Simpson's 1/3 rule.

MODULE IV INITIAL VALUE PROBLEMS FOR FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS 7+3

Numerical solutions by Taylor's Series method, Euler's method, Modified Euler's Method - Runge – Kutta Method of fourth order – Milne's and Adam's Bashforth Predictor and Corrector methods

MODULE V INITIAL AND BOUNDARY VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 8+2

Numerical solutions by Taylor's Series method - Runge – Kutta Method of fourth order of second order ODE. Finite difference methods.

MODULE VI BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS 7+3

Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace equation.

L – 45; T – 15; Total Hours –60

TEXT BOOKS:

1. Grewal, B.S., “Numerical methods in Engineering and Science”, 7th edition, Khanna Publishers, 2007.
2. C.F.Gerald, P.O.Wheatley, “Applied Numerical Analysis” ,Pearson Education, New Delhi, 2002.

REFERENCES:

1. Chapra S.C, Canale R.P. “Numerical Methods for Engineers”, 5th Ed., McGraw Hill, 2006.
2. M.K.Jain, S.R.K.Iyengar, R.K.Jain, “Numerical methods for Scientific and Engineering Computation”, New Age International Publishers, New Delhi, 2003

OUTCOMES:

At the end of this course, students will be able to

1. solve algebraic, transcendental and system of equations.
2. apply interpolation techniques.
3. carry out numerical differentiation and integration using different methods.
4. solve first order ODE using single and multi step methods.
5. solve second order ODE, initial and boundary value problems.
6. solve the boundary value problems in PDE.

Maths Elective Courses
(To be offered in VI Semester)

MACX 05	MATHEMATICAL PROGRAMMING	L	T	P	C
		2	0	0	2

OBJECTIVES:

The aims of the course are to

- acquire knowledge and training in optimization techniques.
- obtain knowledge about optimization in utilization of resources.
- understand and apply operations research techniques to industrial operations.

MODULE I LINEAR PROGRAMMING PROBLEM 10

Linear programming – formulation of the problem - graphical interpretation of optimality - Simplex method – to obtain basic feasible solution – types of linear programming solution – complications and their resolution.

MODULE II ADVANCED LINEAR PROGRAMMING PROBLEMS 8

Artificial variable - Big M method – Two phase method – alternative optimal solution – unbounded solution - Duality – primal dual relationships.

MODULE III TRANSPORTATION PROBLEM 7

Transportation problems – Initial basic feasible solutions, MODI method, Unbalanced transportation problem, Degeneracy in transportation models,.

MODULE IV ASSIGNMENT PROBLEM 5

Assignment problem – Minimization and Maximization type of problems by Hungarian method.

Total Hours –30

TEXT BOOKS:

1. Hamdy A Taha, “Operations Research - An introduction”, 8th edition, Phil Pearson, 2007.
2. Winston.W.L., “Operations Research”, 4th edition, Thompson-Brooks/Cole, 2003.

REFERENCES:

1. Wayne.L. Winston, “Operations Research Applications and Algorithms”, 4th edition, Thomson learning, 2007.
2. Frederick. S. Hiller and Gerald J Lieberman, “Operations Research Concepts and Cases”, 8th edition (SIE), Tata McGraw – Hill Pub. Co. Ltd., New Delhi, 2006.
3. A. Ravindran, D. T. Phillips and J. J. Solberg, "Operations Research: Principles and Practice", 2nd edition, John Wiley & Sons, New York, 1992.
4. Robertazzi. T.G., “Computer networks and systems-Queuing theory and performance evaluation”, 3rd edition, Springer, 2002.

OUTCOMES:

At the end of the course, students will be able to

1. formulate industrial problems as mathematical programming problems.
2. solve linear programming problems by different methods.
3. solve transportation problems by different methods.
4. solve assignment problems by Hungarian method.

MACX 06 STATISTICAL METHODS FOR DATA ANALYSIS

	L	T	P	C
	2	0	0	2

OBJECTIVES:

The aim of the course is to

- introduce statistical quality control tools.

MODULE I TESTS OF HYPOTHESES AND STATISTICAL INFERENCES 8

Small sample tests – Student's ' t ' test for single mean , difference of means, paired t test – F test for difference of variances – Chi square test on theory of goodness of fit and analyses of independence of attributes.

MODULE II DESIGN OF EXPERIMENTS 7

Analysis of variance – one way classification – two way classification – Completely Randomised Block Designs – Randomised Block Design – Latin square designs - Statistical analysis -Interpretations - case studies.

MODULE III STATISTICAL QUALITY CONTROL-I 8

Quality improvement and statistics –Statistical quality control- statistical process control – control charts – design of control charts –analysis of patterns on control charts - X bar chart, R chart and S chart.

MODULE IV STATISTICAL QUALITY CONTROL-II 7

Process and product control – attribute charts – P, np and C charts – control charts performance.

Total Hours –30

TEXT BOOKS:

1. Douglas C.Montgomery, George C. Runger "Applied Statistics and probability for Engineers" V Edition – John Wiley & Sons Inc.
2. Miller, I., Miller, M., Freund, J. E. "Mathematical statistics" 7th Edition. Prentice Hall International, 1999.

REFERENCES:

1. Dekking, F.M., Kraaikamp, C., Lopuhaä, H.P., Meester, L.E. "A Modern Introduction to Probability and Statistics" Springer, 2nd Edition.

2. Chin Long chiang “Statistical Methods of Analysis “World Scientific Books, 2003.
3. S.C.Gupta and V.K. Kapoor, “Mathematical Statistics” , Sultan Chand publications.
4. Veerarajan “Fundamentals of Mathematical Statistics” I Edition, Yes Dee Publishing Pvt. Ltd., 2017.

OUTCOMES:

On completion of the course, students will be able to

1. develop and test hypothesis for different statistical tests
2. design an experiment and case study the experiment with different data.
3. analyze the industrial data using quality control design tools statistically.
4. analyze the industrial data using process and product control tools statistically.

MACX 07	NUMERICAL METHODS FOR INTEGRATION AND DIFFERENTIAL EQUATIONS	L	T	P	C
		2	0	0	2

OBJECTIVES:

1. This course aims to solve numerically integral and differential equations.

MODULE I NUMERICAL INTEGRATION 8

Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Two Point and Three point Gaussian quadrature formulae.

MODULE II NUMERICAL DOUBLE INTEGRATION 6

Double integrals using trapezoidal and Simpson's 1/3 rules

MODULE III NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS 8

Milne's Predictor and Corrector Method – Adam's Predictor-Corrector Method - Finite difference methods for two – point Boundary Value problems for Ordinary Differential Equations.

MODULE IV BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS 8

Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations

Total Hours –30

TEXT BOOKS:

- M.K.Jain, S.R.K.Iyengar, R.K.Jain, "Numerical methods for Scientific and Engineering Computation", New Age International Publishers, New Delhi, 2003.
- Grewal, B.S., "Numerical methods in Engineering and Science" 7^{th} edition, Khanna Publishers, 2007

REFERENCES:

1. C.F.Gerald, P.O.Wheatley, "Applied Numerical Analysis" Pearson Education, New Delhi 2002.
2. P.Dechaumphai, N. Wansophark, "Numerical Methods in Engineering", Narosa Publications, 2012.

OUTCOMES:

At the end of the course students will be able to

- solve the integration by numerical methods.
- solve the double integration by numerical methods
- find numerical solution of ordinary differential equations in engineering problems.
- find numerical solution of partial differential equations in engineering problems.

MACX 08	MATHEMATICAL MODELLING	L	T	P	C
		2	0	0	2

OBJECTIVES:

The aims of the course are to

1. provide basic idea of formation and use of Mathematical models for different purposes.
2. determine the extent to which models are able to replicate real-world phenomena under different conditions

MODULE I PRINCIPLES OF MATHEMATICAL MODELING 7

Mathematics as a modelling language - Classification of models - Building, studying, testing and using models - Black and white box models – Difference equations

MODULE II PHENOMENOLOGICAL MODELS 7

Linear, Multiple linear and nonlinear regression - Neural networks - Fuzzy model - Stability and higher dimensional systems

MODULE III MECHANISTIC MODELS –I 8

Setting up ODE models – Initial and Boundary value problems - Numerical solutions - Fitting ODE to data - Applications

MODULE IV MECHANISTIC MODELS –II 8

Linear and nonlinear equations - Elliptic, parabolic and hyperbolic equations - Closed form solutions - Finite difference and finite element methods

Total Hours –30

TEXT BOOKS:

- G . Ledder , “Calculus, modelling , probability and dynamic systems”, Springer 2013
- Kei Velten, “Mathematical modelling and simulation”, J. Wiley and sons,2009

REFERENCES:

1. Michael D Alder, “An introduction to Mathematical modelling”, Heaven for Books.com

2. Alfio Quarteroni, “Mathematical models in science and engineering”, Notices of AMS
3. J.N. Kapur, “Mathematical models in Biology and Medicine”, Affiliated East-West Press Private Limited, New Delhi, 1992.

OUTCOMES:

On completion of the course, the students will be able to

- identify the relationship between real world and mathematical models
- Classify the data and choose the appropriate model
- Distinguish between linear and nonlinear models
- identify the relationship between empirical and mechanistic models

MACX 09	GRAPH THEORY	L	T	P	C
		2	0	0	2

OBJECTIVES:

The aims of this course are to

- represent the real life situations diagrammatically.
- appraise different methods to find solutions to graph theory problems.

MODULE I INTRODUCTION TO GRAPH THEORY 8

Graphs - finite and infinite graphs - Incident and degree-isolated vertex, pendent vertex and null vertex.

MODULE II PATH AND CIRCUIT 8

Isomorphism – sub graphs-walks, paths and circuits – connected and disconnected graphs- Euler graphs – operation on a graph.

MODULE III TREES AND FUNDAMENTAL CIRCUITS 7

Trees- some properties of trees- pendent vertices in a tree – rooted binary tree- spanning trees-fundamental circuits.

MODULE IV CUT SETS AND CUT VERTICES

Cut sets – some properties of cut sets- fundamental circuits and cut sets-network flows.

Total Hours –30

TEXT BOOKS:

1. NARSINGH DEO, Graph theory with applications to Engineering and Computer Science, Prentice Hall INC, New Delhi,
2. J.A. Pondy and U.S.R. Murthy, North Holland, Oxford, New York Graph theory with applications

REFERENCES:

1. Trembly J.P and Manohar R, “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 30th Reprint 2011
2. Kenneth H.Rosen, “Discrete Mathematics and its Applications”, 7th Edition, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, Special Indian Edition, 2011

3. Md. Saidur Rahman, “Basic graph theory”, Springer, 2017

OUTCOMES:

At the end of the course, students will be able to

- demonstrate the basic concepts of Graph theory.
- explore connected and disconnected graphs.
- identify the real life problems with trees and circuits.
- bring out the cut set properties and network flows properties.

Humanities Elective I
(To be offered in III Semester)

		L	T	P	C
SSCXO1	**FUNDAMENTALS OF ECONOMICS**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

OBJECTIVES:

- To identify and present the basic concepts of demand, supply and equilibrium.
- To explain and discuss the types and concepts of national income and inflation.
- To illustrate the fundamental concepts of money, banking and public finance.
- To apprise the students about Indian economy and the role of engineers in economic development.

MODULE I DEMAND AND SUPPLY ANALYSIS 8

Classification of economy – open and closed economy, Demand - Types of demand - Determinants of demand – Law of Demand - Demand elasticity - Supply - Determinants of Supply – Law of Supply - Supply elasticity - Pricing strategies.

MODULE II NATIONAL INCOME AND INFLATION 7

Concepts of National income and measurement – Importance and difficulties of estimating National Income in India - Aggregate demand and aggregate supply, Macroeconomic equilibrium – meaning of inflation- types - causes and preventive measures

MODULE III MONEY, BANKING AND PUBLIC FINANCE 9

Money – Meaning, types, functions, importance - Commercial Banks - Central Bank - Monetary policy – meaning, objectives, Methods of Credit Control By RBI, Government Budget – Government revenue and Expenditures – Fiscal policy - Its objectives, instruments and limitations - Deficit Financing - The Fiscal Responsibility and Budget Management Act, 2003 (FRBMA) .

MODULE IV INDIAN ECONOMY AND THE ROLE OF ENGINEERS 6

Economic reforms – Liberalization, Privatization and Globalization - challenges and opportunities, Engineers – Engineers' contributions to the economic growth.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

- Dutt and Sundharam (2013), *Indian Economy*, S. Chand & Company Pvt. Ltd, New Delhi.
- Hussain, Moon Moon (2015), *Economics for Engineers*, Himalaya Publishing House, New Delhi.

REFERENCES:

- Cleaver Tony (2004), "*Economics: The Basics*", Routledge, London.
- Mell Andrew and Walker Oliver (2014), "*The Rough Guide to Economics*", Rough Guide Ltd.

OUTCOMES:

On successful completion of this course,

- Students will have had exposure to the basic concepts of demand, supply and various pricing strategies.
- Students will have understood the macroeconomic concepts of national income and inflation.
- Students will be able to apply the knowledge of money, banking and public finance in their real life situations.
- Students will have an overview of the economic reforms introduced in Indian economy.

SSCXO2	**PRINCIPLES OF SOCIOLOGY**.	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

OBJECTIVES:

- To acquaint the students with Concepts and perspectives of Sociology
- To explain the reflection of society in Individuals and vice versa
- To describe the hierarchical arrangement of individuals and groups in society
- To explicate the dimensions, forms and factors of Social change.
- To examine the context, impact and agencies of Globalization

MODULE I THE FOUNDATIONAL CANON 8

Sociology-Definition, scope and importance; Major theoretical perspectives-Functionalism, Conflict Theorising and Interactionism; Elements of social formation-Society, Community, Groups and Association; Associative Social Process- Co-operation, Accommodation and Assimilation; Dissociative Social Process-Competition and Conflict.

MODULE II INDIVIDUAL AND SOCIETY 7

Culture-definition, characteristics, functions, types, cultural lag and civilization, Socialization – definition, process, stages, agencies and anticipatory socialization; Social Control- definition, characteristics, importance, types & agencies.

MODULE III SOCIAL INEQUALITY AND STRATIFICATION 7

Concepts- inequality, hierarchy, differentiation, Social Exclusion, and Social Stratification. Forms of Social Stratification- Caste, Class and Estate. Gender and Social Stratification- sex and gender, patriarchy, factors perpetuating gender stratification; Globalization and gender inequality

MODULE IV SOCIAL CHANGE AND GLOBALIZATION 8

Social Change-definition, nature, direction; Forms- evolution, development, progress and transformation; Factors of social change- demography, economy, technology, polity and culture. Globalization- definition, characteristics, historical and social context and Impact, agencies of globalization- IGOs, INGOs, Nation-State, MNEs and Media

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

- Giddens A. 1989. “Sociology” Cambridge: Polity Press.
- Heald Haralambos, R.M(2014) . ‘‘Sociology Themes and Perspectives”, Oxford, New Delhi-92
- Bhushan Vidya and D.R. Sachdeva (2012). ‘‘Fundamental of Sociology”, Pearson, Delhi.

REFERENCES:

- Das Gupta, Samir and Paulomi Saha (2012), ‘‘An Introduction to Sociology”, Pearson, Delhi
- Bottomore, T.B. 1972. *Sociology- A Guide to Literature and Problems*, New Delhi,

OUTCOMES:

On successful completion of this course,

- Students will have exposure to the fundamentals tenets of Sociology.
- Students will be trained to understand social reality with sociological perspective.
- Students will be oriented to constructively analyze human interactions, social relationship and social issues
- Students will gain exposure to the dynamics of human society with special reference to the contemporary trends of globalization.

SSCXO3	SOCIOLOGY OF INDIAN SOCIETY.	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To present a portrayal of the components of the Indian Social structure
- To describe the nature and contemporary structure of Indian social Institutions.
- To examine the causality and magnitude of social problem facing the contemporary India.
- To elucidate the processes forms and impact of change and development in Indian society

MODULE I INDIAN SOCIAL STRUCTURE 7

Unity and Diversity; Concepts of unity and diversity- racial, religious, ethnic and linguistic composition of India. Types of communities-rural, urban and tribal; Social backwardness- OBC, SC and ST; Indian minorities- religious, ethnic, linguistic and LGBT

MODULE II INDIAN SOCIAL INSTITUTIONS 7

Family- definition, types, characteristics, functions of family; Joint Family- definition features, utility, changes; Marriage- definition, characteristics, marriage as sacrament or contract. Caste- definition, principles, contemporary changes, dominant caste, caste -class interface.

MODULE III SOCIAL PROBLEMS IN INDIA 8

Social Problem-definition, nature, social disorganization; Population explosion-causes, effects, relationship with development; Child Labour- causes, magnitude and consequences; Unemployment-nature , types, causes and effects; Gender issues-social status of women, violence against women and women in work place; Contemporary issues- communalism, terrorism and corruption.

MODULE IV SOCIAL CHANGE AND DEVELOPMENT IN INDIA 8

Socio-cultural Change- Sanskritization, Westernization, Secularization, Modernization;

Processes of Social change- Industrialization, Urbanization, Globalization; Development- definition, elements, role of government, industry and corporate sector. Technology and change- invention and innovation, impact of technology on social institutions, technology and development.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

- Sharma,K.L.2008. *Indian Social Structure and Change*. Jaipur: Rawat Publications,.
- Shah, A.M. 1998. *The Family in India: Critical Essays*. New Delhi: Orient Longman,
- Ahuja Ram. 1999. *Social problems in India*, Rawat Publication: New Delhi.
- Ahuja Ram. 2014. *Society in India,*, Rawat Publication: New Delhi.

REFERENCES:

1. Jayapalan, N.(2001), **“**Indian Society and Social Institutions” Atlantic Publishers & Distri,
2. Atal, yogesh (2006), “Changing Indian Society” Rawat Publications, Jaipur

OUTCOMES:

On successful completion of this course,

1. Students will gain an in-depth understanding of the social structure and social institutions that constitute society in India.
2. Students will be sensitized to the various categories ,Inequalities and their challenges
3. Students will be exposed to the social problems encountered in contemporary India.
4. Students will gain knowledge about the various forms and trends of the social change.
5. Students will become aware about the challenges in the path of progress of Indian society and realize relevance of their role in bringing about development

Humanities Elective II
(To be offered in IV Semester)

SSCXO4	ECONOMICS OF SUSTAINABLE DEVELOPMENT	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To have an increased awareness on the concept and components of sustainable development.
- To develop the ability to demonstrate the need of sustainable development and international responses to environmental challenges.
- To have an insight into global environmental issues and sustainable globalization.
- To establish a clear understanding of the policy instruments of sustainable development.

MODULE I CONCEPT OF SUSTAINABLE DEVELOPMENT 7

Evolution of the Concept – Rio Summit and sustainable development - various definitions of sustainable development - Components of sustainable development: Social, environmental and economic components.

MODULE II NEED FOR SUSTAINABLE DEVELOPMENT 8

Need for sustainability – Global environmental challenges: population growth, resource depletion, pollution, energy use, climate change, pollution, growing water scarcity, other urban problems, loss of biodiversity, hazardous wastes disposal.International responses to environmental challenges - Global policy such as Kyoto Protocol, Montreal Protocol, Basel Convention.

MODULE III GLOBALIZATION AND ENVIRONMENT SUSTAINABILITY 8

Impact of Globalization on sustainable development, Co - existence of globalization and Environment sustainability, Globalization and Global Governance.Green economy - Renewable energy, sustainable transport, sustainable construction, land and water management, waste management.

MODULE IV POLICIES FOR ACHIEVING SUSTAINABLE DEVELOPMENT 7

Principles of environmental policy for achieving sustainable development: precautionary principle and polluter pays principle – Business Charter for Sustainable Development.Policy instruments for sustainable development: direct regulation – market based pollution control instruments such as pollution tax, subsidy, pollution permits.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

1. Anderson, David A (2010), "*Environmental Economics and Natural Resource Management*", Routledge, 3rd edition.
2. Karpagam M (1999), "*Environmental Economics: A Textbook*", Sterling Publishers Pvt. Ltd, New Delhi.

REFERENCES:

1. Karpagam M and Jaikumar Geetha (2010), "*Green Management Theory and Applications*", Ane Books Pvt. Ltd, New Delhi.
2. Sengupta Ramprasad (2004), "*Ecology and Economics: An Approach to Sustainable Development*", Oxford University Press, New Delhi.

OUTCOMES:

On successful completion of this course,

- The students will have understood the concepts and components of sustainable development.
- The students will have a holistic overview on the challenges of sustainable development and International responses to environmental challenges.
- The students will have gained knowledge on the global environment issues and demonstrate responsible globalization through global governance.
- The students will have developed awareness of the ethical, economic, social and political dimensions that influence sustainable development.

SSCXO5	INDUSTRIAL SOCIOLOGY	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To introduce sociological approaches and perspectives to understand the social relationship in manufacturing industries and corporate sector.
- To explain the structure and functions of industrial organizations.
- To elucidate the dynamics of organizational behavior, leadership and communication.
- To inculcate professional ethics and values to equip students to work in organizational settings.

MODULE I INTRODUCTION 8

Industrial Sociology- definition, scope and importance; Theoretical approaches- scientific management, human relations approach, theory of bureaucracy, Fordism and post-fordism; Production system- concept and characteristics of factory system, automation and rationalization; Industrial conflict- strike , lockout and trade unions.

MODULE II INDUSTRIAL ORGANIZATION 7

Formal organization- definition, features, utility; Informal organization- definition, characteristics, types and relevance; Structure of industrial organization- features and functions of line organization, characteristics and roles of staff organization, distinction;

Industrial hierarchy-white collar, blue collar, supervisors and managers.

MODULE III DYNAMICS OF INDUSTRIAL RELATIONS 8

Group dynamics- Definition, Group behaviour model, Group decision making process, group cohesiveness; Leadership- definitions, style and effective supervision; Communication- concepts, types, model barriers; Job satisfaction- nature, employee compensation and job satisfaction.

MODULE IV PROFESSIONAL ETHICS AND VALUES 7

Concepts- values- morals, and ethics, Integrity, work ethics , service learning - Civic Virtue - caring - Sharing - Honesty - Courage - Valuing Time - Co-operation - commitment - empathy - Self-Confidence - Environmental Ethics, Cyber issues - computer ethics, cyber crimes, plagiarism Ethical living-concept of harmony in life.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

1. Narender Singh, Industrial Sociology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.
2. Gisbert Pascal, Fundamentals of Industrial Sociology, Tata Mc. Graw Hill Publishing Co., New Delhi, 1972
3. Schneider Engeno. V, Industrial Sociology 2nd Edition, Mc. Graw Hill Publishing Co., New Delhi, 1979.

REFERENCES:

- Robbins, Stephen, Organizational Behaviour , Prentice Hall of India PVT ltd new Delhi, 1985
- Devis Keith , Human Behaviour at work place, Mc. Graw Hill Publishing Co., New Delhi,1984

OUTCOMES:

On successful completion of this course,

1. Students will have acclimatized with sociological perspectives for dealing with social relationships in production and service organizations.
2. Students will be familiar with structure of authority, roles and responsibility in organizational settings.
3. Students will imbibe leadership, communication and behavioral acumen to govern organization
4. Students will be sensitized to standards of desirable behavior to engage in industrial and corporate sector.

SSCXO6	LAW FOR ENGINEERS	L	T	P	C
		2	0	0	2

OBJECTIVES:

1. To understand the Constitution and Governance of our country.
2. To apprise the students of human rights - local and international and redressal mechanism.
3. To have an insight into the industrial, corporate and labour laws of our country.
4. To establish a clear understanding about the importance of intellectual property related laws.

MODULE I INDIAN CONSTITUTION AND GOVERNANCE 8

Constitution – salient features, Preamble, Citizenship, Fundamental rights, Fundamental duties, Directive principles, Union executive, Legislature – Union – State and union territories – Election Commission – Election for parliament and state legislature, Judiciary- basic functioning of the Supreme Court and High Courts, Right to information Act 2005 – evolution – concept – practice.

MODULE II HUMAN RIGHTS 7

Human rights – meaning and significance, Covenant on civil and political rights, Covenant on Economic, Social and Cultural rights, UN mechanism and agencies, The Protection of Human Rights Act, 1993 – watch on human rights and enforcement.

MODULE III INDUSTRIAL, CORPORATE AND LABOUR LAWS 8

Corporate laws – meaning and scope, Companies Act 1956 – Indian Contract Act 1872 - Principles of Arbitration - Industrial Employment (Standing Orders) Act 1946 - Industrial Disputes Act 1947 - Workmen's Compensation Act 1923 - The Factories Act, 1948.

MODULE IV LAWS RELATED TO IPR 7

IPR – meaning and scope, International organization – WIPO – TRIPS, Major Indian IPR Acts – Copyright laws, Patent and Design Act, Trademarks Act, Trade Secret Act, Geographical Indicator.

L – 30; T – 0; Total Hours –30

TEXT BOOKS:

1. M.P. Jain (2005) *Indian Constitutional Law*, Wadhwa & Co.
2. H. D, Agarwal (2008), *International Law and Human Rights,* Central Law Publications,
3. Rao, Meena (2006), *Fundamental Concepts in Law of Contract*, 3rd edn., Professional offset.
4. Ramappa (2010), *Intellectual Property Rights Law in India*, Asia Law House.
5. Singh, Avtar (2007), *Company Law*, Eastern Book Co.
6. R.F, Rustamji (1967), *Introduction to the Law of Industrial Disputes*, Asia Publishing House.

REFERENCES:

1. Acts: Right to Information Act, Industrial Employees (standing order) Act, Factories Act, Workmen Compensate Act.

OUTCOMES:

On successful completion of this course,

1. Students will `be able to apply the basic concepts of Indian Constitution, Governance and power in their real life situation.
2. Students will have gained knowledge in human rights, cultural, social and political rights.
3. Students will have synthesized knowledge about industrial, corporate and labour laws of our country.
4. Students will have an overview of IPRs and laws related to Intellectual Property Rights.

General Elective Courses
Group I courses
(To be offered in V Semester)

GECX101	**DISASTER MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce the concept of various environmental hazards and its management measures.
- To give exposure on the natural disasters causes and prevention strategies.
- To give exposure on various man-made disasters causes and prevention strategies.
- To make them understand the different segments of disaster management.
- To introduce the concept of different relief measures to be adopted in the time of disaster.
- To give exposure to various environmental policies & programs in India for disaster management

MODULE I ENVIRONMENTAL HAZARDS 7

Environmental hazards, Environmental Disasters and Environmental stress- Meaning and concepts. Vulnerability and disaster preparedness.

MODULE II NATURAL DISASTERS 7

Natural hazards and Disasters - Volcanic Eruption, Earthquakes, Tsunamis, Landslides, Cyclones, Lightning, Hailstorms, Floods, Droughts, Cold waves, Heat waves and Fire.

MODULE III MAN-MADE DISASTERS 7

Man induced hazards & Disasters - Soil Erosion, Chemical hazards, Population Explosion

MODULE IV DISASTER MANAGEMENT 8

Emerging approaches in Disaster Management- Preparing hazard zonation maps, Predictability / forecasting & warning, Preparing disaster preparedness plan, Land use zoning, Communication. Disaster resistant house construction, Population reduction in vulnerable areas, Awareness - Rescue training for search & operation at national & regional level - Immediate relief, Assessment surveys, Political, Administrative, Social, Economic, Environmental Aspects.

MODULE V NATURAL DISASTER REDUCTION & MANAGEMENT 8

Provision of Immediate relief measures to disaster affected people, Prediction of Hazards & Disasters, Measures of adjustment to natural hazards

MODULE VI ENVIRONMENTAL POLICIES & PROGRAMMES IN INDIA 8

Regional survey of Land Subsidence, Coastal Disaster, Cyclonic Disaster & Disaster in Hills with particular reference to India. Ecological planning for sustainability & sustainable development in India, Sustainable rural development: A Remedy to Disasters, Role of Panchayats in Disaster mitigations, Environmental policies & programmes in India- Institutions & National Centers for Natural Disaster reduction, Environmental Legislations in India, Awareness, Conservation Movement, Education & training.

Total Hours –45

REFERENCES:

1. Satender, “Disaster Management in Hills”, Concept Publishing Co., New Delhi, 2003.
2. Singh, R.B. (Ed.), “Environmental Geography”, Heritage Publishers, New Delhi,1990.
3. Savinder Singh, “Environmental Geography”, Prayag Pustak Bhawan,1997.
4. Kates, B.I. and White, G.F., “The Environment as Hazards”, Oxford University Press, New York, 1978.
5. Gupta, H.K., (Ed), “Disaster Management”, University Press, India, 2003.
6. Singh, R.B.,“Space Technology for Disaster Mitigation in India (INCED)”, University of Tokyo, 1994.
7. Bhandani, R.K., “An overview on Natural & Manmade Disaster & their Reduction”, IIPA Publication, CSIR, New Delhi, 1994.
8. Gupta, M.C., “Manuals on Natural Disaster management in India”, National Centre for Disaster Management, IIPA Publication, New Delhi, 2001.

OUTCOMES:

At the end of the course, the students will be able to

- Describe the origin, changes and management of environmental hazards.
- Develop the knowledge on natural disasters.
- Develop the knowledge on man-made disasters.
- Discuss the different segments of disaster management.
- Explain the concept of different disaster relief measures.
- Achieve sufficient knowledge on the National Policy on Disaster Management.

GECX102 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To understand the various principles, practices of TQM to achieve quality.
- To get acquainted with the various statistical tools and approaches for quality control and continuous improvement.
- To get aware of the importance of ISO and Quality Systems.

MODULE I INTRODUCTION 8

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs- Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

MODULE II TQM PRINCIPLES 7

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits.

MODULE III TQM IMPROVEMENT PROCESS 8

Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

MODULE IV STATISTICAL PROCESS CONTROL (SPC) 8

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

MODULE V TQM TOOLS 7

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss

Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

MODULE VI QUALITY SYSTEMS 7

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System– Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 – Concept, Requirements and Benefits

Total Hours –45

TEXT BOOKS:

1. Dale H.Besterfiled, et al., "Total Quality Management", Pearson Education, Inc. 2003.

REFERENCES:

1. James R.Evans & William M.Lidsay, "The Management and Control of Quality", 5th Edition, South-Western (Thomson Learning), 2002.
2. Feigenbaum.A.V., "Total Quality Management", McGraw-Hill, 1991.
3. Oakland.J.S., "Total Quality Management", Butterworth Hcinemann Ltd.,Oxford, 1989.
4. Narayana V. and Sreenivasan. N.S., "Quality Management – Concepts and Tasks", New Age International, 1996.
5. Zeiri, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

OUTCOMES:

The student should be able to

- Apply the various statistical tools and approaches for Quality control.
- Achieve continuous process improvement through TQM.

GECX103 ENERGY STUDIES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn the growing demand, supply of energy on global and national levels and the need for renewable energy promotion.
- To understand the basic need for energy conservation and waste heat recovery.
- To learn the important aspects of energy audit and management.
- To get acquainted with the global environmental issues and carbon credits.

MODULE I GLOBAL AND NATIONAL ENERGY SCENARIO 7

Role of energy in economic development, various energy resources - overall energy demand and availability- Energy consumption in various sectors and its changing pattern - Exponential increase in energy consumption and projected future demands. Need for renewable energy.

MODULE II SOLAR ENERGY 8

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

MODULE III OTHER RENEWABLE ENERGY SOURCES 8

Power from wind – wind turbine working and types, solar thermal power plants – low medium and high power generation, power from wave , tidal, geothermal sources, OTEC system. MHD power plants – working, types, merits and demerits. Energy from biomass.

MODULE IV COGENERATION, WASTE HEAT RECOVERY AND COMBINED CYCLE PLANTS 8

Cogeneration principles- topping and bottoming cycles, role in process industries. Energy from wastes- waste heat recovery- heat recovery from industrial processes. Heat exchange systems – recuperative and regenerative heat exchangers – commercially available waste heat recovery devices. Combined cycle plants – concept, need and advantages, different combinations and practical scope.

MODULE V ENERGY CONSERVATION AND MANAGEMENT 7

Need for energy conservation – use of energy efficient equipment. Energy conservation opportunities - in educational institutions, residential, transport, municipal, industrial and commercial sectors – concept of green building. Energy audit in industries – need, principle and advantages. Case studies.

MODULE VI GLOBAL ENERGY ISSUES AND CARBON CREDITS 7

Energy crisis, fossil consumption and its impact on environmental climate change. Energy treaties – Montreal and Kyoto protocols - Transition from carbon rich and nuclear to carbon free technologies, carbon foot print – credits – clean development mechanism.

L – 45; Total Hours –45

TEXT BOOKS:

1. S.S. Rao and B.B. Parulekar, “Energy Technology”, 3rd Edition, Khanna Publishers, New Delhi, 2011.
2. O. Callaghn. P.W., “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.

REFERENCES:

1. G.D. Rai, “Non Conventional Energy Sources”, Khanna Publishers, New Delhi, 2011.
2. Archie, W Culp. “Principles of Energy Conservation”, McGraw Hill, 1991.
3. D Patrick and S W Fardo, “Energy Management and Conservation”, PHI,1990
4. P. O’Callaghan: “Energy Management”, McGraw - Hill Book Company, 1993.
5. Kenney, W. F., “Energy Conservation in Process Industries”, Academic Press, 1983.

OUTCOMES:

The student should be able to

- Realize the global and national energy status and need to switch over to renewable energy technology.
- Energy audit and suggest methodologies for energy savings.
- Utilize the available resources in an optimal way.
- Concern about the global environmental issues & promote carbon credits.

GECX104	ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn about the robots, various components, of Robots, programming and their applications.

MODULE I **8**

Definition- Need - Application, Types of robots – Classifications – Configuration, work volume, control loops, controls and intelligence- basic parts - functions – specifications. of robot, degrees of freedoms, end effectors – types, selection

MODULE II ROBOT DRIVES AND CONTROL **8**

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

MODULE III ROBOT SENSORS **8**

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

MODULE IV ROBOT PROGRAMMING & AI TECHNIQUES **7**

Types of Programming – Teach pendant programming – Basic concepts in AI techniques – Concept of knowledge representations – Expert system and its components.

MODULE V ROBOTIC WORK CELLS AND APPLICATIONS OF ROBOTS **7**

Robotic cell layouts – Inter locks – Humanoid robots – Micro robots – Application of robots in surgery, Manufacturing industries, space and underwater.

MODULE VI ROBOT KINEMATICS AND DYNAMICS 7

Forward and inverse Kinematic equations, Denvit – Hartenbers representations Fundamental problems with D-H representation, differential motion and velocity of frames - Dynamic equations for sing, double and multiple DOF robots – static force analysis of robots.

L – 45; Total Hours –45

REFERENCES:

1. Yoram Koren," Robotics for Engineers", Mc Graw-Hill, 1987.
2. Kozyrey, Yu, "Industrial Robots", MIR Publishers Moscow, 1985.
3. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
4. Deb, S.R. "Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, "Industrial Robotics Technology, Programming and Applications", Mc Graw- Hill, Int. 1986.
6. Timothy Jordanides et al,"Expert Systems and Robotics", Springer – Verlag, New York, May 1991.

OUTCOMES:

Students would be able to

- Understand about the robots, its various components.
- Design Robots for industrial applications.
- Do programming for robots and apply them in real time applications.

GECX105 TRANSPORT MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the transport fleet and their related activities for minimizing operational cost.
- To understand the need of maintenance and its importance.
- To understand the functions and applications of various types of transport system.

MODULE I INTRODUCTION 7

Personnel management; objectives and functions of personnel management, psychology, sociology and their relevance to organization, personality problems. Selection process: job description, employment tests, interviewing, introduction to training objectives, advantages, methods of training, training procedure, psychological tests.

MODULE II ORGANISATION AND MANAGEMENT 7

Forms of Ownership – principle of Transport Management – Staff administration – Recruitment and Training – welfare – health and safety. Basic principles of supervising. Organizing time and people. Driver and mechanic hiring - Driver checklist - Lists for driver and mechanic - Trip leasing - Vehicle operation and types of operations.

MODULE III TRANSPORT SYSTEMS 9

Introduction to various transport systems. Advantages of motor transport. Principal function of administrative, traffic, secretarial and engineering divisions. chain of responsibility, forms of ownership by state, municipality, public body and private undertakings.

MODULE IV SCHEDULING AND FARE STRUCTURE 8

Principal features of operating costs for transport vehicles with examples of estimating the costs. Fare structure and method of drawing up of a fare table. Various types of fare collecting methods. Basic factors of bus scheduling. Problems on bus scheduling.

MODULE V MOTOR VEHICLE ACT 7

Traffic signs, fitness certificate, registration requirements, permit insurance, constructional regulations, description of vehicle-tankers, tippers, delivery vans, recovery vans, Power wagons and fire fighting vehicles. Spread over, running time, test for competence to drive.

MODULE VI MAINTENANCE 7

Preventive maintenance system in transport industry, tyre maintenance procedures. Causes for uneven tyre wear; remedies, maintenance procedure for better fuel economy, Design of bus depot layout.

L – 45; Total Hours –45

TEXT BOOKS:

1. John Duke, "Fleet Management", McGraw-Hill Co, USA, 1984.
2. Kitchin.L.D., "Bus Operation", III edition, Illiffee and Sons Co., London, 1992

REFERENCES:

1. Government Motor Vehicle Act, Publication on latest act to be used as on date.

OUTCOMES:

Upon completion of the course, students will

- Know about different aspects related to transport system and management.
- Features of scheduling, fixing the fares
- Know about the motor vehicle act and maintenance aspects of transport.

GECX106	CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the system modeling and to derive their transfer function.
- To provide adequate knowledge of time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of Control systems.

MODULE I BASIC CONCEPTS AND SYSTEM REPRESENTATION 8

Control System - Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – Block diagram reduction techniques – Signal flow graphs.

MODULE II TIME RESPONSE ANALYSIS AND DESIGN 8

Time response – Time domain specifications – Types of test input – First and Second order system - Type I and Type II System – Response - Error coefficients – Generalized error series – Steady state error – P, PI, PID modes of feedback control.

MODULE III FREQUENCY RESPONSE ANALYSIS AND DESIGN 7

Performance specifications - correlation to time domain specifications - bode plots and polar plots – gain and phase margin – constant M and N circles and Nichols chart – all pass and non-minimum phase systems.

MODULE IV STABILITY 8

Characteristics equation – Location of roots in s plane for stability – Routh Hurwitz criterion – Root locus construction – Effect of pole, zero addition – Gain margin and phase margin – Nyquist stability criterion.

MODULE V COMPENSATOR DESIGN 8

Performance criteria – Lag, lead and lag-lead networks – Compensator design using bode plots and root locus technique.

MODULE VI CONTROL SYSTEM COMPONENTS AND APPLICATION OF CONTROL SYSTEMS 6

Synchros – AC servomotors - DC Servo motors - Stepper motors - AC Tacho generator - DC Tacho generator - Typical applications of control system in industry.

L – 45; Total Hours –45

REFERENCES:

1. K. Ogata, "Modern Control Engineering", 4th Edition, Pearson Education, New Delhi, 2003.
2. I.J. Nagrath & M. Gopal, "Control Systems Engineering", New Age International Publishers, 2003.
3. C.J.Chesmond, "Basic Control System Technology", Viva student edition, 1998.
4. I.J.Nagarath and M.Gopal, "Control System Engineering", Wiley Eastern Ltd., Reprint, 1995.
5. R.C.Dorf and R.H.Bishop, "Modern Control Systems", Addison-Wesley (MATLAB Reference), 1995.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Proper understanding of basics of Control Systems.
- Ability and skill to carry-out time domain and frequency domain analysis.
- Capable of determining stability of the system using Routh Hurwitz criterion, Root locus and Nyquist criterion.
- Ability to design lag, lead and lag lead compensator networks.

GECX107	INTRODUCTION TO VLSI DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Basic concepts of HDL.
- Verilog language and its syntax constructs.
- Programmable Logic Devices and FPGAs
- MOS devices theory
- CMOS based combinational and sequential circuits

PREREQUISITES:

Fundamentals of Electronics
Basics knowledge in Digital Electronics.

MODULE I REVIEW OF BASIC DIGITAL SYSTEMS 7

Boolean algebra, Building blocks of combinational logic design-Adders, multiplexer, encoder, decoder, comparator, Latches & flip-flops, counters, shift registers.

MODULE II LOGIC DESIGN USING VERILOG HDL 8

Overview of Digital Design with Verilog HDL, Levels of Design Description, Concurrency, Hierarchical Modeling Concepts, Modules and Ports, Component instantiation Data flow and RTL, structural, gate level, switch level modeling and Behavioral Modeling.

MODULE III LANGUAGE CONSTRUCTS OF VERILOG HDL 7

Identifiers- gate primitives, gate delays, operators, timing controls, procedural assignments, conditional statements Variable types, arrays and tables, Tasks and functions, Test bench.

MODULE IV BUILDING BLOCKS OF DIGITAL VLSI SYSTEMS 8

HDL Design -Data Path Operations-Addition/Subtraction, Parity Generators, Comparators, Zero/One Detectors, Binary Counters, ALUs, Multiplication, Shifters, Memory Elements. Programmable logic elements and AND-OR arrays, FPGAs programming methods.

MODULE V TRANSISTOR THEORY 7

Introduction to MOS Transistors-NMOS & PMOS Characteristics, Current Equations, Complementary CMOS Inverter-DC Characteristics, Static Load MOS Inverters.

MODULE VI BASICS OF DIGITAL CMOS DESIGN 8

NMOS & PMOS Logic Gate, CMOS Logic Gate, Basic layout design of simple gate-stick diagram, CMOS Logic Structures-full adder, multiplexers.

Total Hours –45

TEXT BOOKS:

1. M.Morris Mano "Digital Design", 3rd Edition, Prentice Hall of India Pvt. Ltd New Delhi, 2003

REFERENCES:

1. Michael D. Ciletti“Advanced Digital Design with the Verilog HDL" (2nd Edition) Hardcover – January 31, 2010
2. J.Bhasker: Verilog HDL primer, BS publication, 2001.
3. J. P. Uyemura, "Introduction to VLSI Circuits and System", Wiley, 2002
4. Neil Weste and K. Eshragian, “Principles of CMOS VLSI Design: A System Perspective,” 2nd edition, Pearson Education (Asia) Pvt.Ltd., 2000
5. Douglas A Pucknell& Kamran Eshragian , “Basic VLSI Design” PHI 3rd Edition (original edition – 1994)

OUTCOMES:

At the end of the course the students will be able to

- Create basic Register Transfer Level (RTL) models for combinational circuits & Sequential circuits using Verilog HDL.
- Create basic behavioral models for combinational circuits & Sequential circuits using Verilog HDL.
- Describe the usage of Programmable Logic Devices and FPGAs.
- Describe MOS devices theory and inverter circuit DC characteristics
- Design the basic digital building blocks using MOS circuit.
- • Apply VLSI design concepts based on the requirements to conduct experiments or projects

GECX 108 PLANT ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide in depth knowledge on Plant Engineering
- To introduce detail engineering and P&ID
- To learn about the support to Instrumentation from other disciplines
- To study about the Installation and commissioning

MODULE I INTRODUCTION OF PLANTS 7

General Project Cycle – Feed – Sales - Plant Description, Component / Areas of Plant, Plant Layout, Plant Interfaces, Plant Location

MODULE II ELEMENTS OF PLANT 8

Main Elements of a Plant, Process Flow Scheme (PFD – Process Flow Diagram) P&ID's, Plant Legend Finalization.

MODULE III DETAIL ENGINEERING 10

P& ID Development with PFD's, Major Discipline Involvement & Inter discipline Interaction, Major Instrumentation & Control Systems - Development Phase – Instrument List , I/O Count, Specification Sheets, Instrument Installation (Hook ups) , Control Philosophy – Detail Engineering.

MODULE IV SUPPORT FROM OTHER DISCIPLINE 8

Other Discipline Supports to Instrumentation – Plot Plan, Piping / Equipment Plan, Electrical Area Classification, Fire Hazardous Classification Telecommunication Systems - Control Network architecture.

MODULE V INSTALLATION AND COMMISSIONING 7

Plant Construction - Key Drawings for Construction Support Construction Activities, System Testing, Startup / Commissioning, Production.

MODULE VI CASE STUDIES 5

Case studies of Water Treatment Plant - Paper Industry – Power Plant etc

L – 45; Total Hours –45

REFERENCES:

1. Duncan C Richardson, Plant Equipment and Maintenance Engineering Handbook, McGraw-Hill Education: New York, Chicago, San Francisco, Athens, London, Madrid, Mexico City, Milan, New Delhi, Singapore, Sydney, Toronto,2014 McGraw-Hill Education
2. Gabriel Salvendy, Handbook of Industrial Engineering – Technology and operations Management, John Wiley & Sons, 2001.
3. Robert C Rosaler , Standard Handbook of Plant Engineering, Mc Graw Hill third Edition, 2004
4. R. Keith Mobley, Plant Engineer's Handbook, Technology and Engineering, 2001.

OUTCOMES:

At the end of the course, the student will be able to

- Review and correct P&IDs
- Do installation and commissioning of new plants
- Apply plant engineering in design and maintenance of water treatment plant / power plant etc

GECX109 **NETWORK SECURITY**

L	T	P	C
3	0	0	3

OBJECTIVES:

The students should be able to

- Discuss the basic concepts of computer security, model and attacks
- Examine the major types of threats and the associated attacks
- Identify the encryption techniques in real time applications
- Understand the special requirements for wireless security and how authentication is implemented in wireless systems
- Understand the functions of Network Security Device Firewall and its types
- Interpret the various network intrusion such as computer viruses, network worms etc

MODULE I INTRODUCTION 6

Computer Security Concepts - The OSI Security Architecture - Security Attacks - Security Services - Security Mechanisms - A Model for Network Security - Standards – classical encryption techniques.

MODULE II SYMMETRIC ENCRYPTION AND MESSAGE CONFIDENTIALITY 7

Symmetric Encryption Principles - Symmetric Block Encryption Algorithms - Random and Pseudorandom Numbers - Stream Ciphers and RC4 - Cipher Block Modes of Operation

MODULE III PUBLIC KEY CRYPTOGRAPHY AND MESSAGE AUTHENTICATION 8

Approaches to Message Authentication - Secure Hash Functions - Message Authentication Codes - Public-Key Cryptography Principles - Public-Key Cryptography Algorithms - Digital Signatures

MODULE IV KEY DISTRIBUTION ,USER AUTHENTICATION AND TRANSPORT-LEVEL SECURITY 8

Symmetric Key Distribution Using Symmetric Encryption - Kerberos - Key Distribution Using Asymmetric Encryption - X.509 Certificates - Public-Key

Infrastructure -Federated Identity Management - Web Security Considerations - Secure Socket Layer and Transport Layer Security - Transport Layer Security

MODULE V WIRELESS NETWORK SECURITY, ELECTRONIC MAIL SECURITY AND IP SECURITY 8

IEEE 802.11 Wireless LAN Overview -IEEE 802.11i Wireless LAN Security - Wireless Application Protocol Overview - Wireless Transport Layer Security - WAP End-to-End Security - Pretty Good Privacy - S/MIME – Domain Keys Identified Mail- IP Security Overview -IP Security Policy - Encapsulating Security Payload - Combining Security Associations - Internet Key Exchange - Cryptographic Suites

MODULE VI SYSTEM SECURITY 8

Intruders -Intrusion Detection -Password Management - Types of Malicious Software - Viruses Virus Countermeasures – Worms - Distributed Denial of Service Attacks- The Need for Firewalls - Firewall Characteristics - Types of Firewalls - Firewall Basing - Firewall Location and Configurations

L – 45; Total Hours –45

REFERENCES:

1. William Stallings,"Network security Essentials:Applications and standards“, Prentice Hall, Fifth Edition , ISBN-13: 978-0134527338, 2013
2. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson, ISBN-13:978-0-273-79335-9,2013
3. Behrouz Forouzan, Debdeep Mukhopadhyay,Cryptography and network security (sie) 2nd edition, ISBN-13: 978-0070702080, 2016
4. Wikipedia, "Network Security and Management" , https://en.wikipedia.org/wiki/Book:Network Security and Management, 2014.
5. Nitesh Dhanjani, Justin Clarke, "Network Security Tools", O'Reilly Media, ISBN-13: 9780596007942, 2005.

OUTCOMES:

Students who complete this course will be able to

- Recognize the computer security concepts, architecture attacks and model
- Distinguish the symmetric and asymmetric encryption techniques
- Apply the cryptographic algorithms in different applications
- Express the network security designs using available secure solutions such as PGP,SSL, IPSec, etc.
- Describe the firewalls principles and different types of firewalls applied in organization
- Identify abnormalities within the network caused by worms, viruses and Network related security treats**.**

GECX110 KNOWLEDGE MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

The course

- Focuses on positioning knowledge as a valuable commodity, embedded in products and in the tacit knowledge of highly mobile individual employees.
- Presents KM as a deliberate and systematic approach to cultivating and sharing an organization's knowledge base.
- Brings out the paradigm in terms of information technology and intellectual capital.

MODULE I KNOWLEDGE MANAGEMENT 6

KM Myths – KM Life Cycle – Understanding Knowledge – Knowledge, intelligence – Experience – Common Sense – Cognition and KM – Types of Knowledge – History of Knowledge Management - From Physical assets to Knowledge Assets – Expert knowledge – Human Thinking and Learning.

MODULE II KNOWLEDGE MANAGEMENT SYSTEMS AND MODELS 9

Challenges in Building KM Systems – Conventional Vs KM System Life Cycle (KMSLS) – Knowledge Creation and Knowledge Architecture – KM cycle - Different variants of KM cycle - KM models - Implications and practical implementations.

MODULE III CAPTURING KNOWLEDGE AND SHARING 9

Tacit knowledge capture - Explicit knowledge codification – Knowledge taxonomies - Knowledge sharing - Communities - Obstacles to knowledge capture and sharing.

MODULE IV KNOWLEDGE MANAGEMENT TOOLS 9

KM System tools – Neural Network – Association Rules – Classification Trees – Data Mining and Business Intelligence – Knowledge capture and creation tools - Content creation tools - Data mining and knowledge discovery – Content management tools - Knowledge sharing and dissemination tools – Group ware and Collaboration tools - Intelligent filtering tools.

MODULE V KNOWLEDGE APPLICATION 6

KM at individual level - Knowledge workers - Task analysis and modeling - Knowledge application at group and organizational levels – Knowledge repositories - Knowledge reuse -Case study: e-learning.

MODULE VI VALUE OF KNOWLEDGE MANAGEMENT 6

KM return on investment and metrics - Benchmarking method – Balanced scorecard method - House of quality method - Results based assessment method - Measuring success - Future challenges for KM.

L – 45; Total Hours –45

TEXT BOOKS:

1. Elias M. Awad, Hassan M. Ghaziri, “Knowledge Management”, Prentice Hall, 2nd Edition, 2010.
2. Jay Liebowitz, “Handbooks on Knowledge Management”, 2nd Edition, 2012.
3. Irma Becerra-Fernandez, Rajiv Sabherwal, ”Knowledge Management: Systems and Processes”, 2010.

OUTCOMES:

Students who complete this course will be able to

- Describe the fundamental concepts in the study of knowledge and its creation, acquisition, representation, dissemination, use and re-use, and management.
- Explains the core concepts, methods, techniques, and tools for computer support of knowledge management.
- Critically evaluate current trends in knowledge management and apply it for e-learning

GECX111 CYBER SECURITY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the basics of Cyber Security Standards and Policies.
- To know the legal, ethical and professional issues in Cybersecurity.
- TounderstandCyberFraudsandAbuseanditsSecurityMeasures.
- To know the technological aspects of CyberSecurity.

MODULE I FUNDAMENTALS OF CYBER SECURITY 7

Securityproblemincomputing–CryptographyBasics–HistoryofEncryption– Modern Methods – Legitimate versus Fraudulent Encryption methods– EncryptionusedinInternet.

MODULE II CYBERCRIME AND CYBEROFFENSES 8

Cybercrime and Information Security – Cybercriminals – Classifications of Cybercrimes – Email Spoofing – Spamming – Cyber defamation – Internet Time Theft – Forgery – Web jacking – Hacking – Online Frauds – Software Piracy – Mail Bombs – Password Sniffing – Cyberoffenses – Categories – Planning the attacks – Cyberstalking – Cybercafe and Cybercrimes – Botnets.

MODULE III CYBERCRIME: MOBILE AND WIRELESS DEVICES 8

Proliferation of Mobile and Wireless Devices – Trends in Mobility – Credit card frauds in Mobile and Wireless Computing – Security Challenges – Authentication Service Security – Attacks on Mobile Phones.

MODULE IV TOOLS AND METHODS USED IN CYBERCRIME 8

Proxy Servers and Anonymizers – Phishing – Password Cracking – Keyloggers and Spywares – Virus and Worms – Trojan Horses and Backdoors – Steganography – DoS and DDoS Attacks.

MODULE V SECURITY POLICIES 7

Introduction - Defining User Policies – Passwords – Internet Use – Email Usage – Installing/ Uninstalling Software – Instant Messaging – Defining System Administrative Policies – Defining Access Control Developmental Policies Standards, Guidelines and Procedures – Basics of assessing a system

MODULE VI COMPUTER FORENSICS 7

General Guidelines – Finding Evidence on the PC - Finding Evidence in System Logs – Windows Logs – Linux Logs – Getting Back Deleted Files – Operating System Utilities – The Windows Registry.

L – 45; Total Hours –45

TEXT BOOKS:

1. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley, 2011.
2. Chuck Easttom, "Computer Security Fundamentals", 2nd Edition, Pearson Education,2012.

REFERENCES:

1. Charles B. Pfleeger, Shari Lawrence Pfleeger, "Security in Computing",3rdEdition, Pearson Education,2003.
2. WilliamStallings,"CryptographyandNetworkSecurity–Principlesand Practices", 3rd Edition, Pearson Education,2003.
3. AtulKahate,"CryptographyandNetworkSecurity",TataMcGrawHill,2000.

OUTCOMES:

Uponcompletionofthiscourse, students will be able to

- Explain the general security issues.
- Discuss various cybercrimes and offenses.
- Outline the occurrence of Cybercrime in mobile and wireless environment.
- Use relevant tools and methods in cybercrime
- Apply security policies in cyber forensics.
- Outline the strategies adopted in computer forensics.

GECX112	GENETIC ENGINEERING	L	T	P	C
		4	0	0	4

OBJECTIVES:

- The course aims to provide an advanced understanding of the core principles and topics of Cell and Organism reproduction and the Principles of heredity and their experimental basis, and to enable students to be able to apply these principles in assessment of pedigrees to identify genotypes and predict the mating outcomes.

MODULE I GENETICS AND ORGANISM 10

Genetics and human affairs, Genetics and Biology, Genes and Environment, Techniques of genetic analysis, The chromosome theory of heredity, Sex chromosomes, Sex linkage, The parallel behaviour of autosomal genes and chromosomes.

MODULE II MENDELISM AND LINKAGE 12

Mendel's laws of inheritance, Interaction of genes, Variations on dominance, Multiple alleles, Lethal alleles, Several genes affecting the same character, Penetrance and expressivity, Linkage- Basic eukaryotic chromosome mapping, The discovery of linkage, Recombination linkage symbolism, Linkage of genes on X chromosomes, Linkage maps, Examples of linkage maps.

MODULE III FINE STRUCTURE OF GENES 10

The concept of promoter, Coding sequence, Terminator, Induction of gene for expression. The concept of extranuclear genome in higher plants and animals, Overview of mitochondrial genome, Chloroplast genome.

MODULE IV RECOMBINATION IN BACTERIA AND VIRUSES 10

Conjugation recombination and mapping the E.coli chromosomes, Transformation, Transduction, Chromosome mapping. Population genetics: Darwin's revolution, Variation and its modulation, The effect of sexual reproduction on variation, The sources of variation, Selection quantitative genetics

MODULE V PRINCIPLES OF PLANT BREEDING 9

Objectives, Selfing and crossing techniques, Male sterility,Incompatability, Hybrid vigour.

MODULE VI HUMAN GENOME PROJECT 9

Genetic diseases in humans, Genetics and society

L – 45; T – 15; Total Hours –60

REFERENCES:

1. In Introduction to genetic analysis, Griffiths, Miller, Suzuki, Lewontin and Gelbart, Freeman and Company.
2. Genetics, A.V.S.S. Sambamurty, Narosa Publishing House.
3. Concepts of Genetics, Klug & Cummings, Prientice Hall.
4. Molecular Cloning, Moniatisetal, Cold Spring Harbor Laboratory.

OUTCOMES:

At the end of the course students will be able to

- Describe the structure, function and replication of DNA as the genetic materialDescribe gene structure, expression and regulation
- Describe the chromosomal basis of inheritance and how alterations in chromosome number or structure may arise during mitosis and meiosis

GECX113	FUNDAMENTALS OF PROJECT MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

The students would gain knowledge on

- Technicalities attached to Project Management and Significance of Quality Consideration
- Project management methodologies – tools and techniques, supplemented with examples from case studies
- The importance of Efficient HR team and role of Communication in executing Projects.
- Managing Risks in Project Management

MODULE I INTRODUCTION TO PROJECT MANAGEMENT 9

Introduction to Project and Project Management-Project Management as a Career-Project Management Skill Sets-Project Scope Management: Project Charter, Scope Creep, Scope Validation, Scope Change Control-Type of Organization: Organization Structure-Influence of Organization Structure on Project, Project Stakeholders and Organizational Productivity.

MODULE II PROJECT MANAGEMENT PROCESS, TOOLS AND TECHNIQUES 8

Project life cycle-Initiation, Planning, Execution, Monitoring and Closing Phase; - Link between project management process, process groups and knowledge areas; Project management tools and techniques- Project Stakeholders description and mapping - Stakeholder Management Process

MODULE III PROJECT QUALITY, COST AND SCHEDULE MANAGEMENT 10

Triple constraints of project-quality, cost and schedule-Quality Planning, Quality Assurance and Quality Control, Process Control, Cost of Quality, Seven Tools of Quality Control- Cost Management: Cost Estimating Methods, Estimating Completion Cost, Earned Value Management, Budgeting, Life-Cycle Cost analysis- Project Time Management: Duration Estimation Method, FS/FF/SS/ SF Relations, Lead/Lag, Arrow Diagram Method and Precedence Diagram Method for Scheduling-Resource Allocation

MODULE IV PROJECT HR MANAGEMENT 5

Organizational Goals- (MBO/MBE/MBP)-Responsibility Assignment Matrix (RAM)-Types of Powers- Manage or Lead-Conflict management Techniques-Performance Evaluation Process-Motivation Theories and its Application for execution of Projects-Leadership Styles-Project Team Building-Project Staffing Constraints/Policies

MODULE V COMMUNICATION MANAGEMENT 5

Communication Management: Understanding Body languages of Project Personnel-Effective Communications- Interpersonal Skills for project Managers-PMIS-Communicating with the Customer-Communicating with Management-Formal vs. Informal Communications-Written, Verbal and Non-Verbal Communications.

MODULE VI PROJECT PROCUREMENT & RISK MANAGEMENT 8

Introduction to Project Procure Management: Soliciting RFQ/RFP-Contract Proposals-Contract Negotiation-Contract Closure-Risk Management: Defining risks-Risk management process-Risk identification-Qualitative and Quantitative Risk-Probability and Decision trees-Risk Response strategies / methods-Expected monetary value-Risk vs. life cycle phases

L – 45; Total Hours –45

REFERENCES:

1. Jack. R. Meredith, Samuel. J. Mantel & Scott. M. Shafer, Project Management in Practice, Fifth Edition, Bangalore: Wiley, 2015
2. Bob Hughes, Mike Cotterrel “Software Project Management”, Tata McGraw-Hill, 2009

OUTCOMES:

- Learners will be able to identify the Key Knowledge Areas and apply PM process in hypothetical project assignments given as continuous assessment.
- They would be able to suitably recognize tools and techniques required for various phases included in a project.
- They would also be able to manage scope, time, cost and other major components that would help them to execute the project efficiently.

GECX114	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire knowledge and training in optimization techniques.
- To get knowledge about optimization in utilization of resources.
- To understand and apply operations research techniques to industrial operations

MODULE I LINEAR PROGRAMMING PROBLEM 8

Linear programming – formulation of the problem - graphical interpretation of optimality - Simplex method – to obtain basic feasible solution – types of linear programming solution – complications and their resolution.

MODULE II ARTIFICIAL VARIABLE AND TWO PHASE METHOD, DUALITY 6

Artificial variable - Big M method – Two phase method – alternative optimal solution – unbounded solution - Duality – primal dual relationships - rules of constructing the dual from primal.

MODULE III TRANSPORTATION PROBLEM & ASSIGNMENT PROBLE 8

Transportation problems – Initial basic feasible solutions, MODI method, Unbalance in transportation, Degeneracy in transportation models, Assignment problem – Minimization and Maximization type of problems by Hungarian method.

MODULE IV NETWORK AND SEQUENCING PROBLEMS 8

PERT and CPM – Network diagram – Fulkerson's rule - CPM Probability of achieving completion date – Crash time – Cost analysis. Sequencing N jobs through 2 machines and 3 machines.

MODULE V QUEUING THEORY & SIMULATION 7

Poisson arrivals and exponential service times – characteristics of Queuing models – single channel – Introduction to multi channel models – Random number generation – Monte Carlo Simulation.

MODULE VI INVENTORY CONTROL, REPLACEMENT MODELS AND GAME THEORY 8

Types of inventory- Inventory cost - EOQ - Deterministic inventory problems – Introduction to probabilistic models & system level inventory control - Replacement models – Replacement of items that deteriorate with time – value of money changing with time – not changing with time – Individual and group replacement policy - Game theory – simple games.

L – 45; Total Hours –45

TEXT BOOKS:

1. Hamdy ATaha, “Operations Research an introduction”, 8th edition, Phil Pearson, 2007.
2. Winston.W.L., “Operations Research”, 4th edition, Thompson-Brooks/Cole, 2003.

REFERENCES:

1. Wayne.L. Winston, “Operations Research applications and algorithms”, 4th edition, Thomson learning, 2007.
2. Frederick. S. Hiller and Gerald.J.Lieberman, “Operations Research concepts and cases”, 8th edition (SIE), Tata McGraw – Hill Pub. Co. Ltd., New Delhi, 2006.

A. Ravindran, D. T. Phillips and J. J. Solberg, "Operations Research:Principles and Practice", 2nd edition, John Wiley & Sons, New York, 1992.

3. Robertazzi. T.G., “Computer networks and systems-Queuing theory and performance evaluation”, 3rd edition, Springer, 2002.

OUTCOMES:

At the end of the course students will be able to

- solve linear programming problems
- solve transportation and assignment problems.
- solve network and sequencing problems.
- apply the operations research techniques to solve industrial problems.

GECX115 **NANO TECHNOLOGY**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce the basic concepts of Nanoscience relevant to the field of engineering.
- To provide an exposure about the importance of various synthesis method.
- To enrich the knowledge of students in various characterisation techniques.

MODULE I INTRODUCTION & CLASSIFICATION OF NANOMATERIALS 9

Definition - Origin of nanotechnology - Difference between bulk and nanomaterials-Top-down and bottom-up processes - Size dependent properties (magnetic, electronic,transport and optical), Classification based on dimensional property - 0D, 1D, 2D and 3D nanostructures – Kubo gap.

MODULE II TYPES OF NANOMATERIALS 9

Metal oxides and metal nano particles - Ceramic nano particles - Semi conducting quantum dots - Core-shell quantum dots - Nanocomposites - Micellar nanoparticles.

MODULE III PRODUCTION OF NANOPARTICLES 7

Sol-gel, hydrothermal, solvothermal, Plasma Arcing, Electro deposition, RF sputtering, Pulsed laser deposition, Chemical vapour, deposition.

MODULE IV CARBON BASED NANOMATERIALS 6

Carbon nanotubes: Single wall nanotubes (SWNT), Multiwall nanotubes (MWNT) - structures-carbon nanofibre, Fullerenes-Application of carbon nanotubes and Fullerenes.

MODULE V NANOPHOTONICS 7

Light and nanotechnology, Interaction of light and nanotechnology, Nanoholes and photons, nanoparticles and nanostructures; Nanostructured polymers, Photonic Crystals, Solar cells.

MODULE VI CHARACTERISATION TECHNIQUES 7

Basic principles of scanning Electron Microscopy (SEM), Atomic force microscopy (AFM), Scanning tunneling microscopy (STM), Scanning probe microscopy (SPM) and Transmission electron microscopy (TEM), Particle size analyzer, Luminescence techniques.

L – 45; Total Hours –45

TEXT BOOKS:

1. Hari Singh Nalwa, "Handbook of Nanostructured Materials and Nanotechnology", Academic Press, 2000.
2. Guozhong Cao, "Nanostructures and Nano materials-Synthesis, Properties and Applications", Imperial College Press (2011).
3. Zhong Lin Wang, "Handbook of Nanophase and Nanomaterials (Vol 1 and II)", Springer, 2002.
4. Mick Wilson, Kamali Kannangara, Geoff smith, "Nanotechnology: Basic Science and Emerging Technologies", Overseas press, 2005.

REFERENCES:

1. A. Nabok, "Organic and Inorganic Nanostructures", Artech House, 2005.
2. C.Dupas, P.Houdy, M.Lahmani, Nanoscience: "Nanotechnologies and Nanophysics", Springer-Verlag Berlin Heidelberg, 2007.
3. Mick Wilson, Kamali Kannangara, Michells Simmons and Burkhard Raguse, "Nano Technology – Basic Science and Emerging Technologies", 1st Edition, Overseas Press, New Delhi,2005.
4. M.S. Ramachandra Rao, Shubra SinghH, "Nanoscience and Nanotechnology: Fundamentals to Frontiers", Wiley, 2013.

OUTCOMES:

At the end of this course, the students will be able to:

- Apply the knowledge of different types of nanomaterials for various engineering applications.
- Acquire the knowledge of various methods of production of nanomaterials.
- Familiarize with various characterization techniques.

GECX116	VEHICLE MAINTENANCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know about the various methods of maintaining procedure, vehicle insurance and basic problems in a vehicle.
- The student able to impart knowledge in maintaining of engine components and subsystems.
- The student able to impart knowledge in maintaining of transmission, driveline, steering, suspension, braking and wheels.
- The student able to impart carefully maintaining their vehicle and can increase driving safety.

MODULE I MAINTENANCE, WORKSHOP PRACTICES, SAFETY AND TOOLS 7

Maintenance – Need, importance, primary and secondary functions, policies - classification of maintenance work - vehicle insurance - basic problem diagnosis. Automotive service procedures – workshop operations – workshop manual - vehicle identification. Safety – Personnel, machines and equipment, vehicles, fire safety - First aid. Basic tools – special service tools – measuring instruments – condition checking of seals, gaskets and sealants. Scheduled maintenance services – service intervals - Towing and recovering.

MODULE II ENGINE AND ENGINE SUBSYSTEM MAINTENANCE 8

General Engine service- Dismantling of Engine components- Engine repair- working on the underside, front, top, ancillaries- Service of basic engine parts, cooling and lubricating system, fuel system, Intake and Exhaust system, electrical system - Electronic fuel injection and engine management service - fault diagnosis- servicing emission controls.

MODULE III TRANSMISSION AND DRIVELINE MAINTENANCE 8

Clutch- general checks, adjustment and service- Dismantling, identifying, checking and reassembling transmission, transaxle- road testing- Removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joints- Rear axle service points- removing axle shaft and bearings- servicing differential assemblies- fault diagnosis.

MODULE IV STEERING AND SUSPENSION MAINTENANCE 7

Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. Dismantling and assembly procedures. Inspection, Maintenance and Service of steering linkage, steering column, Rack and pinion steering, Recirculating ball steering service- Worm type steering, and power steering system.

MODULE V BRAKE AND WHEEL MAINTENANCE 7

Inspection, Maintenance and Service of Hydraulic brake, Drum brake, Disc brake, parking brake. Bleeding of brakes. Wheel alignment and balance, removing and fitting of tyres, tyre wear and tyre rotation.

MODULE VI AUTO ELECTRICAL AND AIR CONDITIOING MAINTENANCE 8

Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Replacement of hoses- Leak detection-AC Charging- Fault diagnosis Vehicle body repair like panel beating, tinkering, soldering, polishing, painting.

L – 45; Total Hours –45

TEXT BOOKS:

1. Ed May, "Automotive Mechanics Volume One" , Mc Graw Hill Publications, 2003
2. Ed May, "Automotive Mechanics Volume Two" , Mc Graw Hill Publications, 2003
3. Vehicle Service Manuals of reputed manufacturers
4. Vehicle maintenance and garage practice by Jigar A.Doshi Dhru U.Panchal,Jayesh P.Maniar. 2014
5. A Practical Approach to Motor Vehicle Engineering and Maintenance 3rd Edition by Allan Bonnick.

REFERENCES:

1. Bosch Automotive Handbook, Sixth Edition, 2004.
2. Advanced Automotive Fault Diagnosis by Tom Denton 2011.
3. Nissan Patrol Automotive Repair Manual: 1998-2014 by Haynes Manuals Inc.
4. Automobile electrical manual a comprehensive guide by Haynes manual car repair.

OUTCOMES:

On completion of the course student should be able to

- Prepare maintenance schedules and procedures with appropriate tools.
- Demonstrate the procedure and methods to repair and calibrate the engine.
- Analyze the causes and remedies for fault in transmission and drive line systems.
- Analyze the causes and remedies of steering and suspension systems.
- Analyze the causes and remedies of brake system.
- Demonstrate the procedure for wheel alignment and wheel balanced.

GECX117 FUNDAMENTALS OF DIGITAL IMAGE PROCESSING

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- Describe and explain basic principles of digital image processing
- Design and implement algorithms that perform basic image processing
- Design and implement algorithms for advanced image analysis
- Assess the performance of image processing algorithms and systems

PRE-REQUISITES:

- Basic knowledge of transforms in Mathematics

MODULE I DIGITAL IMAGE FUNDAMENTALS 8

Elements of Image Processing System, Fundamentals steps in Digital Image Processing, Image Sampling & Quantization, Spatial and Gray Level Resolution.

MODULE II COLOR IMAGE PROCESSING 8

Fundamental of color image processing, color models- RGB, CMY, HIS, Pseudo color image processing

MODULE III IMAGE ENHANCEMENT 7

Basic gray level Transformations, Histogram Processing, Spatial Filtering

MODULE IV IMAGE TRANSFORMS 7

2D-DFT, DCT, Haar Transform,Fundamentals of 2D-wavelet transform, sub-band coding

MODULE V IMAGE SEGMENTATION AND RESTORATION 8

Point, line and edge detection methods ,Image Segmentation and its types, Restoration: Noise model, Inverse filter and Wiener filter.

MODULE VI IMAGE COMPRESSION 7

Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, JPEG and MPEG Compression standards.

TOTAL HOURS : 45

TEXT BOOKS

1. Gonzalez and Woods, "Digital Image Processing", 3rd Edition, Pearson Education, 2016.
2. Anil. K. Jain, "Fundamentals of Digital Image Processing"; 4th Edition, PHI, 2007

REFERENCES

1. Pratt William, "Digital Image Processing", John Wiley & Sons, 2007.
2. Arthur Weeks Jr., "Fundamentals of Digital Image Processing", PHI, 2006.

OUTCOMES:

On completion of the course, students will be able to

- Explain the fundamental concepts of digital image processing.
- Discuss about color image processing
- Recognize & apply various image enhancement techniques.
- Apply various transforms for image processing.
- Apply various techniques for image segmentation and restoration.
- Identify and use appropriate image compression techniques

Group II courses
(To be offered in VII Semester)

		L	T	P	C
GECX201	**GREEN DESIGN AND SUSTAINABILITY**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To impart knowledge on the concepts of sustainable development and fundamentals of socio economic systems.
- To understand the basics of green building and frame work for the attainment of sustainability.
- To enhance the student's interest in the design of green building and energy efficient measures in a buildings.

MODULE I CONCEPTS OF SUSTAINABLE DEVELOPMENT 7

Objectives of Sustainable Development - Need for sustainable development- Environment and development linkages - Globalisation and environment- Population, poverty and pollution- global, regional and local environment issues- Green house gases and climate change.

MODULE II SUSTAINABLE DEVELOPMENT OF SOCIO ECONOMIC SYSTEMS 8

Demographic dynamics of sustainability- Policies for socio economic development- Sustainable Development through trade- Economic growth-Action Plan for implementing sustainable development- Sustainable Energy and Agriculture.

MODULE III FRAME WORK FOR ACHIEVING SUSTAINBAILITY 7

Sustainability indicators- Hurdles to sustainability- Business and Industry – Science and Technology for Sustainable Development- Performance indicators of sustainability and assessment mechanism- Constraints and barriers of Sustainable Development.

MODULE IV GREEN BUILDINGS 8

Introduction to Green Building- Energy- Water- Materials and Resources - Sustainable Sites and Land Use - Indoor Environmental Quality- Life Cycle Assessment- Energy, water and materials efficiency.

MODULE V ENERGY CONSERVATION AND EFFICIENCY 7

Energy savings- Energy Audit- Requirements- Benefits of Energy conservation- Energy conservation measures for buildings- Energy wastage- impact to the environment.

MODULE VI GREEN BUILDINGS DESIGN 8

Elements of Green Buildings Design- Foundation, Electrical, Plumbing, flooring, Decking, roofing, insulation, wall coverings, windows, siding, doors and finishing, LEED certification for Green Buildings, Green Buildings for sustainability.

Total Hours –45

TEXT BOOKS:

1. Kirby, J., Okeefe, P., and Timber lake, “Sustainable Development”, Earthscan Publication, London, 1995.

REFERENCES:

1. Charles Kibert, J., “Sustainable Construction: Green Building Design and Delivery”, 2nd Edition, John Wiley and sons, 2007.

OUTCOMES:

At the end of the course, the students will be able to

- explain the objective, need for the sustainability and also the link between the globalization and environment.
- Address the economic, environmental, and social concerns in the sustainable development.
- Acquire knowledge on the performance indicators, constraints and barrier for sustainability.
- Explain the relationship between sustainability and emergence of green building practices.
- Recommend relevant energy conservation measures in a building
- describe the elements in green building design and suggest ideas for attainting sustainability in building.

GECX202 APPROPRIATE TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the concepts of appropriate technology and expose the students to the basics of financial analysis and energy fundamentals.
- To create awareness on the appropriate technology with relevant to building design, water, sanitation and waste management.
- To enhance student's interest in energy efficient techniques and impart knowledge on relevant policies.

MODULE I BASICS CONCEPTS 7

Back ground, Tools, Choices and Implications, Appropriate Technology Movement (an overview) - Basic design process, basic financial analysis-discounted cash flow, and energy fundamentals.

MODULE II APPROPRIATE TECHNOLOGY WITH REFERENCE TO BUILDING DESIGN 7

Appropriate Building Materials, Appropriate Energy Saving Techniques, Water Conservation (Indoor), Rain Water Harvesting.

MODULE III WATER, HEALTH AND SANITATION MANAGEMENT 7

Water Storage: Designing Dams and Pipelines, Appropriate Selection for Sanitation Technique, Sewerage, Communal Health and Waste Water Recycling.

MODULE IV WASTE MANAGEMENT 8

Types of Waste - Sources - Collections and On-Site Processing -Transferring Stations - Disposal Systems - Recycling.

MODULE V ENERGY EFFICIENT TECHNIQUES 8

Green building concepts-renewable energy sources- Solar – Steam and wind-Biofuels - Biogas – Electricity.

MODULE VI TECHNOLOGY POLICY 8

Government Policies- Energy Policy-Appropriate technology Development Centre-its function and responsibilities-Building policies-Case Studies.

Total Hours –45

TEXT BOOKS:

1. Barrett Hazeltine and Christopher Bull, "Appropriate Technology: Tools Choices and Implications", Academic Press, Orlando, USA, 1998.
2. Ken Darrow and Mike Saxenian, "Appropriate Technology Source Book : A Guide to Practical Books for Village and Small Community Technology", Stanford, 1986.

REFERENCES:

1. Richard Heeks, "Technology and Developing Countries: Practical Applications Theoretical Issues", 1995.
2. John Pickford, "The Worth of Water : Technical Briefs on Health, Water and Sanitation", Intermediate Technology Publications, 1998.

OUTCOMES:

At the end of the course the students will be able to

- describe about the tools, choices of appropriate technology along with concepts of energy fundamentals
- conceptualize the techniques to be adopted in building design for saving energy and water.
- acquire knowledge about the techniques for water, health and sanitation management
- explain the classification, collection dispose and recycling systems adopted in waste management.
- elucidate the concepts of green building and renewable energy sources.
- express the polices relevant to technology and recommend an appropriate technology for an sustainable development.

GECX203	ENGINEERING SYSTEM MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the concepts, techniques, tools for modeling and simulation systems and environments through the use of computers.
- To study the various aspects of discrete dynamic, stochastic systems modeling and conducting experiments with those models on a computer.

MODULE I INTRODUCTION 6

Systems – Modelling – types – systems components – Steps in model building- Simulation Algorithms and Heuristics; Simulation Languages.

MODULE II RANDOM NUMBERS / VARIATES 7

Random numbers – methods of generation – random variates for standard distributions like uniform, exponential, Poisson, binomial, normal etc. – Testing of Random variates – Monte Carlo Simulation.

MODULE III MODELLING PROCESS 7

Primitive Models : Establishing relationships via physical laws; Establishing relationships via curve fitting; Parameters estimation problems; Elementary state transition models.

MODULE IV DESIGN OF SIMULATION EXPERIMENTS 9

Steps on Design of Simulation Experiments – Development of models using of Highlevel language for systems like Queuing, Inventory, Replacement, Production etc., – Model validation and verification, Output analysis.

MODULE V SIMULATION LANGUAGES 10

Need for simulation Languages – Comparisons & Selection of Languages – GPSSARENA- EXTEND – Study of any one of the languages.

MODULE VI CASE STUDIES USING SIMULATION LANGUAGES 6

Case Study using simulation languages

L – 45; Total Hours –45

REFERENCES:

1. Law, A.M., & W.D. Kelton, "Simulation Modelling and Analysis", McGraw Hill, Singapore, 2000.
2. Harrel, C.R., et. al., "System Improvement Using Simulation", 3rd Edition, JMI Consulting Group and ProModel Corporation, 1995.
3. Harrel, C.R. & T. Kerim, "Simulation Made Easy, A Manager's Guide", IIE Press, 1995.
4. Geoffrey Gordon, "Systems Simulation", Prentice Hall, 2002.
5. David Kelton, Rondall P Sadowski, David T Sturrock, "Simulation with Arena", Mc Graw Hill, 2004.

OUTCOMES:

The student should be able to

- Model and simulate systems and environments through the use of computers.
- Conduct experiments with discrete dynamic, stochastic system models on a computer.

GECX204	VALUE ANALYSIS AND ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To get acquainted with value analysis and engineering tool for productivity improvement.
- To understand and analyze the theory and methodology of Value Engineering.

MODULE I VALUE ENGINEERING BASICS 8

Origin of Value Engineering, Meaning of value, Definition of Value Engineering and Value analysis, Difference between Value analysis and Value Engineering, Types of Value, function - Basic and Secondary functions, concept of cost and worth, creativity In Value Engineering.

MODULE II VALUE ENGINEERING JOB PLAN AND PROCESS 6

Seven phases of job plan, FAST Diagram as Value Engineering Tool, Behavioural and organizational aspects of Value Engineering, Ten principles of Value analysis, Benefits of Value Engineering.

MODULE III ORIENTATION AND INFORMATION PHASES 8

Launching Value Engineering project work - Objectives and Targets - VE Project work: a time-bound programme - Projects and Teams - Time Schedule - Co-ordination - Consultant. Technical data - Marketing related information - Competition profile - Cost data - Materials Management related information - Quality related information - Manufacturing data.

MODULE IV FUNCTION ANALYSIS AND CREATIVE PHASES 9

Objectives - Function definition - Classification of functions - Higher level functions – Function – Cost – Function – Worth - Value Gap - Value index - How to carry out Function Analysis? – Fast Diagraming - Cost Modelling.

Creativity - How to improve creativity of an individual? – How to promote creativity in the organisation? - Obstacles to Creativity - Mental road blocks - Creativity killer phrases. Positive thinking - Ideas stimulators - Creativity techniques - Brainstorming.

MODULE V EVALUATION, INVESTIGATION AND RECOMMENDATION 6

Paired comparison and Evaluation Matrix techniques - Criteria for selection of VE solutions. Design – Materials – Quality – Marketing – Manufacturing - Preview session. The report - presentation.

MODULE VI IMPLEMENTATION PHASE AND CASE STUDIES 8

Design department - Materials department - Production Planning & Control - Quality Control – Manufacturing – Marketing - Need for co-ordinated teams - The Action Plan. Value Engineering case studies.

L – 45; Total Hours –45

TEXT BOOKS:

1. Mudge, Arthur E. "Value Engineering- A systematic approach", McGraw Hill, New York, 2000.
2. Kumar S, Singh R K and Jha J K (Ed), "Value Engineering", Narosa Publishing House, 2005.

REFERENCES:

1. Park RJ, "Value Engineering: A Plan for Invention", St.Lucie Press, New York, 1999.
2. Lawrence, D.M., "Techniques of Value Analysis and Engineering", McGraw Hill 1988.
3. George, E.D., "Engineering Design: a Material and Processing Approach", McGraw Hill, 1991.
4. Heller, D.E., "Value Management, Value Engineering and Cost Reduction", Addison Wesley, 1988.

OUTCOMES:

- The student will be able to realize the value of products, processes and implement value analysis to achieve productivity improvement.

GECX205	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the various safety measures to be taken in different industrial environments.

MODULE I SAFETY MANAGEMENT 7

Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety. safety education and training.

MODULE II SAFETY IN MANUFACTURING 7

Safety in metal working-Machine guarding -Safety in welding and gas cutting -Safety in cold forming and hot working of metals -Safety in finishing, inspection and testing -Regulation.

MODULE III SAFETY IN CONSTRUCTION 8

General safety consideration in Excavation, foundation and utilities – Cordoning – Demolition – Dismantling –Clearing debris – Types of foundations – Open footings.

Safety in Erection and closing operation - Safety in typical civil structures – Dams-bridges-water Tanks-Retaining walls-Critical factors for failure-Regular Inspection and monitoring.

MODULE IV ELECTRICAL SAFETY 8

Electrical Hazards – Energy leakage – Clearance and insulation – Excess energy – Current surges – Electrical causes of fire and explosion – National electrical Safety code.

Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance.

MODULE V SAFETY IN MATERIAL HANDLING 8

General safety consideration in material handling devices - Ropes, Chains, Sling, Hoops, Clamps, Arresting gears – Prime movers.

Ergonomic consideration in material handling, design, installation, operation and maintenance of Conveying equipments, hoisting, traveling and slewing mechanisms.
Storage and Retrieval of common goods of shapes and sizes in a general store of a big industry.

MODULE VI SAFETY EDUCATION AND TRAINING 7

Importance of training-identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

L – 45; Total Hours –45

REFERENCES:

1. Krishnan N.V, “Safety Management in Industry”, Jaico Publishing House, Bombay, 1997.
2. Blake R.B., “Industrial Safety”, Prentice Hall, Inc., New Jersey, 1973.
3. Fulman J.B., “Construction Safety, Security, and Loss Prevention”, John Wiley and Sons, 1979.
4. Fordham Cooper W., “Electrical Safety Engineering”, Butterworths, London, 1986.
5. Alexandrov M.P., “Material Handling Equipment”, Mir Publishers, Moscow, 1981.

OUTCOMES:

Students would be able to

- Acquire knowledge on various safety Hazards.
- Carry out safety measures for different industrial environments.

GECX206	ADVANCED OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the various advanced optimization tools.
- To provide an understanding to deal with ill identified and fuzzy problems.

MODULE I INTRODUCTION 7

Review of conventional optimization techniques - limitations - limitation of exhaustive search - need for artificial intelligence - bio mimicking methods

MODULE II HEURISTICS METHODS 8

Introduction – Advanced methods of algorithm design: Greedy method, Backtracking method, Divide and Conquer method – Dynamic programming – Heuristics exploration algorithms – Greedy search - Local search – Hill climbing – Tabu search – Gradient search – Beam search – Simulated Annealing.

MODULE III GENETIC ALGORITHM 7

Introduction - Basics of GA – Population – Reproduction – Cross over – Mutation -genetic algorithms in search, optimization and machine learning-practical genetic algorithms.

MODULE IV ANT COLONY OPTIMIZATION 8

Introduction: Ant Colony Optimization – Meta-heuristic Optimization – History – The ACO Meta-heuristic – ACO Algorithms: Main ACO – Ant system – Ant colony system – Max-Min Ant system – Applications: Routing in telecommunication networks – Travelling salesmen – Graph Coloring – Advantages & Disadvantages

MODULE V FUZZY LOGIC AND ANN 8

Fuzzy logic, knowledge representation and inference mechanism – Fuzzy and expert control – standard Takagi-Sugeno mathematical characterizations

– Design example – Biological foundations to intelligent systems: Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks.

MODULE VI IMPLEMENTATIONS & APPLICATIONS 7

Reduction of size of an optimization problem – multilevel optimization – parallel processing – multi objective optimization – Job shop scheduling – Vehicle scheduling – Line balancing – Sensor integration.

L – 45; Total Hours –45

REFERENCES:

1. Singiresu S. Rao, “Engineering optimization – Theory and practices”, John Wiley and Sons, 1996.
2. Ravindran – Phillips –Solberg, “Operations Research – Principles and Practice, John Wiley and Sons, 1987.
3. Fredrick S.Hillier and G.J.Liberman, “Introduction to Operations Research”, McGraw Hill Inc. 1995.
4. Kalymanoy Deb, “Optimization for Engineering Design”, PHI, 2003
5. Christos H. Papadimitriou, Kenneth Steiglitz, Combinatorial Optimization, PHI 2006

OUTCOMES:

At the end of the course student will be able to

- Formulate a real life situation as an optimization the problem.
- Identify the appropriate solution methodology and provide a solution

GECX 207	MATLAB SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Teach students how to mathematically model engineering systems
- Teach students how to use computer tools to solve the resulting mathematical models. The computer tool used is MATLAB and the focus will be on developing and solving models of problems encountered in engineering fields

MODULE I INTRODUCTION MATLAB DATA PRESENTATION 7

Vectors, Matrices -Vector/Matrix Operations & Manipulation- Functions vs scripts- Making clear and compelling plots-Solving systems of linear equations numerically and symbolically- Least squares regression -Curve fitting.

MODULE II MATLAB PLOT FUNCTION 7

Introduction- Plot Function – Animation- 3D Plots-Customizing Plots – Plot Applications- Saving &Painting Plots.

MODULE III ROOT FINDING AND COMPUTER REPRESENTATION OF NUMBERS 7

Linearization and solving non-linear systems of equations- The Newton-Rapson method- Integers and rational numbers in different bases- Floating point numbers- Round off and errors in basic arithmetic-Significant digits when reporting results

MODULE IV ORDINARY DIFFERENTIAL EQUATIONS 8

Numerical integration and solving 1st order, ordinary differential equations (Euler’s method and Runge-Kutta)- Use of ODE function in MATLAB

MODULE V NON-LINEAR DIFFERENTIAL EQUATIONS 8

Converting 2nd order and higher ODEs to systems of 1st order ODEs- Solving systems of ODEs via Euler’s method and Runge-Kutta)- Solving single and systems of non-linear differential equations by linearization-Use of the function ODE in MATLAB to solve differential equations

MODULE VI INTRODUCTION OF SIMULINK 8

Simulink & its relations to MATLAB – Modeling a Electrical Circuit- Modeling a fourth order differential equations- Modeling the solution of three equations with three unknowns- Representing a model as a subsystem-Simulink demos.

L – 45; Total Hours –45

REFERENCES:

1. Griffiths D V and Smith I M, Numerical Methods for Engineers, Blackwell, 1991.
2. Laurene Fausett, Applied Numerical Analysis Using MATLAB, Pearson 2008.
3. Moin P, Fundamentals of Engineering Numerical Analysis, Cambridge University Press, 2001.
4. Wilson HB, Turcotte LH, Advanced mathematics and mechanics applications using MATLAB. CRC Press, 1997
5. Ke Chen, Peter Giblin and Alan Irving , Mathematical Exploration with MATLAB, Cambridge University Press, 1999.

OUTCOMES:

At the end of this unit students will be able to:

- Use Matlab as a convenient tool for solving a broad range of practical problems in engineering from simple models to real examples.
- Write programs using first principles without automatic use of built-in ones.
- Write programs for solving linear and nonlinear systems, including those arising from boundary value problems and integral equations, and for root-finding and interpolation, including piecewise approximations.
- Be fluent in exploring Matlab’s capabilities, such as using matrices as the fundamental data-storage unit, array manipulation, control flow, script and function m-files, function handles, graphical output.
- Make use of Maltab visual capabilities for all engineering applications.
- An ability to identify, formulate, and solve engineering problems. This will be accomplished by using MATLAB to simulate the solution to various problems in engineering fields

GECX208	EMBEDDED SYSTEMS AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide a detailed overview of embedded system.
- To equip students with the software development skills necessary for practitioners in the embedded systems field.
- To understand entire software development lifecycle and examine the various issues involved in developing software for embedded systems.

MODULE I EMBEDDED SYSTEMS OVERVIEW 8

Introduction –Embedded Systems vs. General computing systems- Fundamental Components of embedded systems- Characteristics- Challenges-Examples-Embedded System design process.

MODULE II EMBEDDED COMPUTING PLATFORM 8

Overview of Processors and hardware units in an embedded system-CPU buses – Memory devices –Memory types- I/O devices – Designing with computing platforms-Consumer electronics architecture-Design example: Alarm clock.

MODULE III REAL TIME EMBEDDED SYSTEMS 8

Programming embedded systems in assembly and C – Real time systems – Hard and Soft real time systems- Need for RTOS in Embedded Systems- Multiple tasks and processes –Context switching-Scheduling policies- Interprocess communication and synchronization.

MODULE IV EMBEDDED SOFTWARE DEVELOPMENT PROCESS and TOOLS 8

Development process of an embedded system-software modules and tools for implementation of an embedded system- Integrated development environment- Host and target machines-cross compiler-cross assembler-Choosing right platform.

MODULE V PROGRAM MODELING IN EMBEDDED SYSTEMS 8

Program Models – Data Flow Graph model-control DFG model-Synchronous DFG model- Finite state machines- UML modeling – UML Diagrams.

MODULE VI EMBEDDED SYSTEMS APPLICATION 5

Application specific embedded system – case study: digital camera hardware and software architecture, embedded systems in automobile, embedded system for a smart card.

Total Hours –45

TEXT BOOKS:

1. Marilyn Wolf , "Computers as components", Elsevier 2012.
2. Shibu. K.V, “Introduction to Embedded Systems”, Tata Mcgraw Hill,2009.
3. Rajkamal, "Embedded Systems Architecture, Programming and Design",1st Reprint,Tata McGraw-Hill, 2003
4. Frank Vahid and Tony Gwargie, "Embedded System Design", John Wiley & sons,2002.

REFERENCES:

1. Sriram V Iyer and PankajGupta ,”Embedded Realtime Systems Programming ”TataMcGraw-Hill,2008
2. Qing Li and Carolyn Yao," Real-Time Concepts for Embedded Systems",CMPBooks, 2003
3. David E.Simon, "An Embedded Software Primer", Pearson Education, 2003

OUTCOMES:

On completion of this course, the students will be able to

- Identify the suitable processor and peripherals in embedded applications
- Develop embedded programs in assembly and c
- Choose the right platform for designing an embedded system
- Explore different scheduling mechanism in rtos
- Design the program model for embedded applications.
- Analyze different domain specific applications in embedded systems.

GECX209	USABILITY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The objective of this course is

- To understand the emerging concept of usability, requirements gathering and analysis.
- To learn about human computer interaction with the help of interfaces that has high usability.

MODULE I INTRODUCTION 6

Cost Savings – Usability Now – Usability Slogans – Discount Usability Engineering – Usability – Definition – Example – Trade-offs – Categories – Interaction Design – Understanding & Conceptualizing Interaction – Cognitive Aspects.

MODULE II USER INTERFACES 8

Generation of User Interfaces – Batch Systems, Line Oriented Interfaces, Full Screen Interfaces, Graphical User Interfaces, Next Generation Interfaces, Long Term Trends – Usability Engineering Life Cycle – Interfaces – Data Gathering – Data Analysis Interpretation and Presentation.

MODULE III INTERACTION DESIGN 8

Process of Interaction Design - Establishing Requirements – Design,Prototyping and Construction - Evaluation and Framework.

MODULE IV USABILITY TESTING 8

Usability Heuristics – Simple and Natural Dialogue, Users' Language, Memory Load, Consistency, Feedback, Clearly Marked Exits, Shortcuts, Error Messages, Prevent Errors, Documentation, Heuristic Evaluation – Usability Testing - Test Goals and Test Plans, Getting Test Users, Choosing Experimenters, Ethical Aspects, Test Tasks, Stages of a Test, Performance Measurement, Thinking Aloud, Usability Laboratories.

MODULE V USABILITY ASSESSMENT METHODS 8

Observation, Questionnaires and Interviews, Focus Groups, Logging Actual Use, User Feedback, Usability Methods – Interface Standards - National, International and Vendor Standards, Producing Usable In-House Standards.

MODULE VI USER INTERFACES 7

International Graphical Interfaces, International Usability Engineering, Guidelines for Internationalization, Resource Separation, Multilocale Interfaces – Future Developments – Case Study.

L – 45; Total Hours –45

TEXT BOOKS:

1. Yvonne Rogers, Helen Sharp, Jenny Preece, "Interaction Design: Beyond Human - Computer Interaction", John Wiley & Sons, 3rd Edition, 2011 (Module I, II, III).
2. Jakob Nielsen, "Usability Engineering", Morgan Kaufmann Academic Press, 1994. (Module I – VI).

REFERENCES:

1. Ben Shneiderman, Plaisant, Cohen, Jacobs, "Designing the User Interface: Strategies for Effective Human Interaction", Pearson Education, 5th Edition, 2010.
2. Laura M. Leventhal, Julie A. Barnes, "Usability Engineering: Process, Products, and Examples", Pearson/Prentice Hall, 2008

OUTCOMES:

Students who complete this course will be able to

- build effective, flexible and robust user interfaces.
- translate system requirements into appropriate human/computer interaction sequences.
- choose mode, media and device for the application requirements.

GECX210	SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the various decision phases in a supply chain
- To be aware of the Supply Chain and its drivers
- To design Supply Chain Network
- To build a aggregate plan in supply chain
- To understand Sourcing Decisions in Supply Chain
- To comprehend the influence of Information technology in Supply Chain

MODULE I INTRODUCTION TO SUPPLY CHAIN 7

Understanding Supply Chain - Decision phases - Supply chain performance - Competitive and supply chain strategies - Achieving strategic fit - Expanding strategic scope

MODULE II SUPPLY CHAIN DRIVERS AND DESIGN 7

Drivers of supply chain performance – Designing distribution network - Network Design in the Supply Chain - Network design in Uncertain Environment

MODULE III AGGREGATE PLANNING AND MANAGING SUPPLY, DEMAND AND INVENTORY 8

Aggregate Planning in a Supply chain: role - Managing Supply - Managing Demand in Supply Chain – Cycle and Safety inventory in supply chain – Level of product availability.

MODULE IV MANAGING INVENTORY IN SUPPLY CHAIN 8

Managing Economies of Scale in a Supply Chain : Cycle Inventory- Managing uncertainty in a Supply Chain Safety Inventory- Determining optimal level of Product Availability

MODULE V SOURCING AND TRANSPORTATION 8

Sourcing decision in supply chain - Third and Fourth – Party Logistics providers - Supplier scoring and assessment - Transportation in a Supply Chain – Risk and Trade-offs in transportation design.

MODULE VI INFORMATION TECHNOLOGY IN A SUPPLY CHAIN 7

Information technology in a supply chain – CRM, ISCM, SRM in supply chain - Over view of recent trends in Supply Chain: e-SRM, e-LRM, e-SCM.

L – 45; Total Hours –45

REFERENCES:

1. Sunil Chopra and Peter Meindl, "Supply Chain Management-Strategy Planning and Operation", Pearson Education, 5th Indian Reprint, 2013.
2. Jananth Shah "Supply Chain Management – Text and Cases" Pearson Education, 2008.
3. Altekar Rahul V, "Supply Chain Management-Concept and Cases", Prentice Hall India, 2005.
4. Monczka et al., "Purchasing and Supply Chain Management", Thomson Learning, 2nd Edition, 2nd Reprint, 2002.

OUTCOMES:

- After taking up the course the student will be able to brighten his prospects of taking up a career on supply chain management.
- The student decision making capability specific to supply chain issues in an industry is improved.
- The student can plan a well defined execution of supply chain strategy in companies.
- The student will be able to design a optimal distribution network as per the demands of the industry.
- The student can also determine the most favorable transportation plan for a company.
- The student will also be able to bring in company from paper environment to paperless environment.

GECX211	SYSTEMS ANALYSIS AND DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To describe the phases of the systems development life cycle
- To teach the automated tools for system development
- To develop and evaluate system requirements.
- To explain the organizational issues in system implementation
- To teach the usability testing and electronic data interchange
- To elucidate the importance of System analysis and design in electronic commerce.

MODULE I FUNDAMENTALS OF SYSTEM DEVELOPMENT 8

System Concept – Characteristics – Elements of System – Types of System – Modern Approach to System Analysis and Design – System Development Life Cycle – Approaches to Improving Development – Tools for System Development – Succeeding as a System Analyst – Skills – Managing the Project.

MODULE II AUTOMATED TOOLS FOR SYSTEMS DEVELOPMENT 7

What is requirements determination? Fact finding techniques, Tools for documenting procedure and decision-CASE Tools-Need for CASE tools-Reverse engineering and reengineering- phases of the software life cycle-Ranking projects-Value Chain Analysis- Corporate Strategic Planning vs. Information Systems Planning.

MODULE III SYSTEM ANALYSIS 8

Determining System Requirements – Traditional Methods - Modern Methods – Radical Methods – Structuring System Requirements – Process Modeling – Data Flow Diagramming – Logic Modeling – Conceptual Data Modeling – E-R Modeling.

MODULE IV SYSTEM DESIGN 8

System Implementation – Software Application Testing – Installation – Documentation – Training and Support – Organizational Issues in Systems Implementation – Maintaining Information System – Conducting System

Maintenance.

MODULE V USABILITY AND MEASURING USER SATISFACTION 7

Usability Testing-User satisfaction test- A tool for analyzing user satisfaction – Unified Modeling Language(UML)- Case study: System Design: Application in Human Resource-Financial Applications

MODULE VI SAD IN E-COMMERCE 7

Systems analysis and design in the era of electronic commerce: B2B, B2C and C2C e-commerce -advantages and disadvantages of e-commerce. E-commerce system architecture – physical networks, logical network, World Wide Web, web-services - HTML, XML - case studies-El electronic data interchange: EDI standards - virtual private networks - XML and EDI

L – 45; Total Hours –45

REFERENCES:

1. Jeffrey A. Hoffer, Joey F. George, Joseph S. Valacich, “Modern Systems Analysis and Design”,Fifth Edition, Prentice Hall,March 2007.
2. Ned Kock, “Systems Analysis & Design Fundamentals” Sage South Asia, May 2008.
3. Joseph S. Valacich, Jeffrey A. Hoffer, Joey F. George, “Essentials Of System Analysis And Design” Prentice Hall , August 2005.
4. Rumbaugh et al, “Succeeding with Booch and Rambaugh Methods”, Addisson Wesley, second Edition, 1998.
5. Larman, C.,” Applying UML and Patterns. An introduction to Object-Oriented Analysis and Design”. Prentice-Hall PTR, 2002.

OUTCOMES:

- List the characteristics of the system and specify the approaches in the development of the system.
- Summarize the phases of the software life cycle
- Differentiate Corporate Strategic Planning and Information Systems Planning.
- Illustrate the system requirements through various modeling diagrams.
- Use tools and techniques for process and data modeling.
- Solve realistic systems analysis problems and perform user satisfaction test.

GECX212	ADVANCED MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student conversant with

- Dielectric materials
- Magnetic materials
- Energy materials
- Nano materials
- Semi conductors
- Smart materials

MODULE I **8**

Dielectric Materials- Polarization and Mechanism-Internal or local field-Clausius-Mossotti relation- Dielectric loss- Temperature and Frequency effect-Measurement of Dielectric constant and loss using Scherring bridge- electric break down- ferro, piezo, pyroelectric materials and its application.

MODULE II **8**

Magnetic Materials- Terminology and classification of magnetic materials (Dia, Para, Ferro & Ferri) – Magnetic moments due to electrospin – Domain theory of Hysteresis – Heisenberg theory of Exchange Interaction (without derivation)-Structure and properties of Ferrites- Properties of Soft and Hard Magnetic Materials- Application: floppy disk, CD ROM, Magneto optical recording.

MODULE III **8**

Energy Materials (Nuclear) - Introduction to nuclear materials- Materials for nuclear fuel in fission and fusion reactors, Fissile and fertile materials- Control & Construction Materials for Nuclear reactors, Moderators, Heat Exchangers-Radiation proof materials- Brief discussion of safety and radioactive waste disposal.

MODULE IV **7**

Nano Materials- The nanosize range- classification of nanomaterials-processing of nanomaterials-properties of nanomaterials- mechanical, electrical, magnetic properties- other properties- carbon based nanomaterials- other nanomaterials and its application.

MODULE V **7**

Semiconductors- The energy gap in solids-Extrinsic Semiconductors- Intrinsic Semiconductors- Hall Effect in semiconductors- Application of Hall Effect- Basic ideas of compound semiconductors -Semiconductor materials- Fabrication of Integrated Circuits- Some semiconductor Devices

MODULE VI **7**

Smart materials- aerospace materials Ni and Co based super alloys, Special steels, Titanium alloys, Intermetallics, ceramics and their composites, New High strength material, Properties of Materials, Materials in Medical Applications, Stainless steel alloys,Cobalt based alloys, titanium based alloys, polymers

L – 45; Total Hours –45

REFERENCES:

1. Materials science and Engineering: A first course by V. RAGHAVAN, 6th ed., Eastern Economy edition,Prentice Hall of India,2015
2. Materials science and Engineering: An Introduction by William D. Callister Jr., 7th ed. John Wiley & Sons Inc. 2007
3. Material science by Dr.M.Arumugam, Anurasha agencies ,third revised edition ,2002

OUTCOMES:

Students will be able to know

- significance of dielectric materials
- types and applications of magnetic materials
- applications of nuclear materials for energy harvesting
- applications of nano materials
- significance of semi conductor devices
- applications of smart materials

GECX213 NATIONAL SERVICE SCHEME

L	T	P	C
2	0	0	2

OBJECTIVES:

Primary Objective: Personality development through community service.
To achieve the above objective, the following should be adhered:

- To provide an understanding about the aims, structure and programmes and activities of National Service scheme in terms of Nation Building
- To develop certain basic skills for personality development through community development.
- Understand the community in which they work and their relation
- Identify the needs and problems of the community and involve them in problem-solving and
- Practice national integration and social harmony.

MODULE I INTRODUCTION TO NSS 8

Orientation and structure of NSS,-Aims and Objectives of National Service Scheme- The history of NSS- Symbol and meaning- NSS hierarchy from national to college level – Role and responsibilities of various NSS functionaries

MODULE II PERSONALITY AND COMMUNITY DEVELOPMENT SKILLS 8

Importance of youth Leadership, Traits of Good Leadership and Personality Development. Role of youth in creating awareness through NSS Programmes on Health & Hygiene; Environmental Conservation and Enrichment for Sustainable Development; Sanitation and Swachh Bharat.

MODULE III UNDERSTANDING YOUTH 7

Definition and Profiles of youth categories, Youth Issues, Challenges and Opportunities for Youth, Youth as agent of social change & Community Mobilization Role of Youth in Nation Building. National Youth Policy.

MODULE IV SOCIAL HARMONY AND NATIONAL INTEGRATION 7

National Integration, Various obstacles in the way of National Integration; such as caste, religion, language and provisional problems etc. Role of youth in Peace building and conflict resolution-Globalization and its Economic Social Political and

Cultural impacts.

L – 30; Total Hours –30

TEXT BOOKS:

- National Service Scheme – A Youth Volunteers Programme for Under Graduate students as per UGC guidelines J.D.S.Panwar et al. Astral International. New Delhi.
- National Service Scheme Revised Manual, 2006.Govt. of India. Ministry of Youth Affairs & Sports. New Delhi.
- Social Problems in India, *Ram Ahuja.*

REFERENCES:

1. National Youth Policy-2014. Ministry of Youth Affairs & Sports. .Govt. of India

OUTCOMES:

On successful completion of this course-

- Students will have exposure to the the aims, structure and programmes and activities of National Service scheme in terms of Nation Building
- Students will be trained to skills for personality development through community development.
- Students will gain knowledge about national integration and social harmony.
- Students will be exposed to the role of youths in Nation building Students will gain

GECX214	AUTOMOTIVE POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To have a fair knowledge in automotive pollution control.
- To understand the concept of formation and control techniques of pollutants like UBHC, CO, NOx, particulate matter and smoke for both SI and CI engine will be taught to the students.
- To know about the instruments for measurement of pollutants
- To get introduced about emission standards

MODULE I EMISSION FROM AUTOMOBILES 8

Sources of Air Pollution. Various emissions from Automobiles — Formation — Effects of ollutants on environment and human beings. Emission control techniques – Modification of fuel, after treatment devices. Emission standards. Automotive waste management, old vehicle disposal, recycling, tyre recycling

MODULE II SI ENGINE EMISSIONS AND CONTROL 9

Emission formation in SI Engines- Carbon monoxide & Carbon di oxide - Unburned hydrocarbon, NOx, Smoke —Effects of design and operating variables on emission formation – controlling of pollutants - Catalytic converters, Charcoal Canister, Positive Crank case ventilation system, Secondary air injection, thermal reactor

MODULE III CI ENGINE EMISSION AND CONTROL 8

Formation of White, Blue, and Black Smokes, NOx, soot, Effect of Operating variables on Emission formation — Fumigation, Split injection, Catalytic Coating, EGR, Particulate Traps, SCR, Fuel additives — Cetane number Effect.

MODULE IV NOISE POLLUTION FROM AUTOMOBILES 8

Sources of Noise — Engine Noise, Transmission Noise, vehicle structural Noise, aerodynamics noise, Exhaust Noise. Noise reduction in Automobiles — Encapsulation technique for noise reduction —Silencer Design.

MODULE V TEST PROCEDURES 6

Constant Volume Sampling I and 3 (CVSI &CVS3) Systems- Sampling Procedures — Chassis dynamometers - Seven mode and thirteen mode cycles for Emission Sampling.

MODULE VI EMISSION MEASUREMENTS 6

Emission analysers —NDIR, FID, Chemiluminesecent, Smoke meters, Dilution Tunnel, SHED Test, Sound level meters.

L – 45; Total Hours –45

TEXT BOOKS:

1. V.Ganesan, 'Internal combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2005.
2. Crouse and Anglin, 'Automotive Emission Control', McGraw Hill company., Newyork 1993.

REFERENCES:

1. G.P.Springer ad D.J.Patterson, Engine Emissions, Pollutant formation, Plenum Press, New York. 1986.
2. D.J.Patterson and N.A.Henin, 'Emission from Combustion Engine and their control', Anna Arbor Science Publication,1985.
3. L.Lberanek, 'Noise Reduction', Mcgrawhill Company., Newyork1993.
4. C.Duerson, 'Noise Abatment', Butterworths ltd., London1990.
5. A.Alexander, J.P.Barde, C.lomure and F.J. Langdan, 'Road traffic noise',
6. Applied science publisher ltd., London,1987.

OUTCOMES:

On completion of the course student should be able to

- Identify the sources of emission from vehicles.
- Analyse the causes and effects of emissions.
- Analyse causes and effects of noise pollution
- Bring out solutions for control of emissions.
- Demonstrate the test procedures and emission norms.
- Select suitable instruments for measurement of emissions.

GECX215	**MOTOR VEHICLE ACT, INSURANCE AND POLICY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To learn about basic act and regulation followed for road vehicle
- To learn about systematic steps involved to get licence and registration of motor vehicle
- To learn arbour various types of motor vehicle polices and insurances

MODULE I BASIC RULES FOR ROAD VEHICLE 8

Display and Use of Number Plates- Attachment of number plates- Number plates in horizontal position- Removal of number plates on transfer- Hours prescribed for lighted lamps- Mounting of lamps and reflectors- Multiple beam headlamps- Daytime running lamps- Auxiliary driving lamps- Parking lamps- Brakes- Stopping distances- Emergency or parking brakes- Horn- Muffler- Mirrors- Inspection of motor vehicles- Standards of safety and repair

MODULE II LICENSING OF DRIVERS OF MOTOR VEHICLES 8

Necessity of driving licence- Age limit in connection with driving of motor vehicle-Responsibility of owners of motor vehicles-Restriction on the holding of driving licence-Grant of learner's licence-Grant of driving licence-Addition to driving licence- Renewal of driving licence-Revocation of driving licence on grounds of disease or disability-Driving licence to drive motor vehicle belonging to the central government- power of court to disqualify- suspension of driving licence in certain cases- suspension or cancellation of driving licence on convection- Endorsement.

MODULE III REGISTRATION OF MOTOR VEHICLE 7

Necessity for registration – Registration Where and how to be made- Special provision for registration of motor vehicle of diplomatic officers-Temporary registration- Production of vehicle at the time of registration- Refusal of registration- renewal of certificate of registration- effectiveness in India of registration- Change of residence or place of business-transfer of ownership- Suspension of registration – cancellation of registration suspended under section 53- certificate of fitness of transport vehicle-cancellation of registration.

MODULE IV INSURANCE OF MOTOR VEHICLE 8

Necessity for insurance against third party – Requirements of policies and limits of liability- - Duty of insurers to satisfy judgements and awards against person insured in respect of third party risks-Duty to give information as to insurance-Settlement between insurers and insured persons- transfer of certificate of insurance-production of certain certificates, licences and permit in certain cases-Special provisions as to compensation in case of hit and run motor accident – Types of motor polices

MODULE V CONTROL OF TRANSPORT VEHICLES 7

Power to State Government to control road transport- Transport authorities-General provision as to applications for permits- Application for stage carriage permit- Procedure of Regional Transport Authority in considering application for stage carriage permit- Scheme for renting of motor cabs- Application for private service vehicle permit- Procedure in applying for and granting permits- Duration and renewal of permits- Transfer of permit- Replacement of vehicles-Temporary permits

MODULE VI OFFENCES AND PUNISHMENT 7

Driving without holding an effective driving licence- Driving by an under-aged person (Minor driving vehicle)- Holding of a driving licence permitting it to be used by other person.- Driving a vehicle at an excessive speed- Driving or permitting to drive a vehicle carrying excess load- Driving dangerously / its Abetment Driving an uninsured vehicle

Rider and pillion rider failing to wear protective head gear (Helmet) -Violation of Mandatory Signs -.e-challan and spot challan

L – 45; Total Hours –45

TEXT BOOKS:

1. The motor vehicle act 1988, Universal law publishing co.cpvt ltd. Newdelhi 2011
2. A Commentary On The Motor Vehicles Act, 1988 by SUKHDEV AGGARWAL The Bright Law House, New Delhi

REFERENCES:

1. The Motor Vehicles Act, 1988 Along with Latest Case Law, Notifications & Table of Offences and Punishments Asia Law House; 15th edition (2014)
2. Assessment of Compensation in Accidents under Motor Vehicles Act by Karkara Delhi Law House (2013)

OUTCOMES:

On completion of the course students should be able to

- Explain the analysis of rules and regulations for road vehicles
- Analyze the procedure for getting driving license for vehicles at national and international level
- Analyze the procedure for registration of vehicles.
- Analyze the procedure for Insurance of vehicles and claims.
- Analyze the procedure for obtaining Government Permits and renewal
- Analyze the consequences of not following the rules and regulations

GECX216	PRINCIPLES OF COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the analog and digital modulation techniques.
- To elaborate the working of communication receivers in the presence of noise.
- To give an overview of various communication systems.

MODULE I LINEAR MODULATION 8

Baseband signals, Amplitude Modulation – Modulation Index, Power Transmitted, Double Side Band and Single Side Band AM, AM Modulators and AM Receivers, AM Radio systems, Frequency Division Multiplexing.

MODULE II ANGLE MODULATION 8

Frequency Modulation and Phase Modulation, Frequency deviation and modulation index, Bandwidth of FM, FM Modulators and FM receivers, FM Radio and FM Stereo Systems

MODULE III SAMPLING AND PULSE MODULATION 7

Sampling, Nyquist's Sampling Theorem, Pulse Modulations - PAM, PPM and PWM, Time Division Multiplexing, Bandwidth of TDM systems.

MODULE IV DIGITAL COMMUNICATION 7

Digital baseband data,Digital Modulations – ASK, FSK, PSK and QPSK. Digital Communication Transmitters and Receivers.

MODULE V NOISE 8

Sources of Noise, Thermal Noise, shot noise, White noise, Narrow band Noise, Effect of noise in communication, SNR, Receiver Noise Temperature and Noise Equivalent Bandwidth.

MODULE VI COMMUNICATION SYSTEMS & NETWORK 7

FM Radio Systems, Cellular Mobile network, Satellite Communications, Optical Fiber Communication.

L – 45; T – 0; Total Hours – 45

TEXT BOOKS:

1. A.Bruce Carlson, Paul B. Crilly, “Communication Systems”, 5th Edition, McGraw Hill Int., 2011.
2. B.P. Lathi, Zhi Ding, Hari M. Gupta, “Modern Digital and Analog Communication Systems”, 4th Edition, Oxford University Press, 2017.

REFERENCES:

1. Herbert Taub, Donald L. Schilling, Goutam Saha, “Principles of Communication Systems” 4th Edition, McGraw Hill Int. 2013.
2. Simon Haykin, “An Introduction To Analog And Digital Communications”, 1st Edition, Wiley India, 2010.
3. Simon Haykin , “Communications Systems” 4th Edition, Wiley India, 2006.
4. Hwei P. Hsu, “Analog and Digital Communications” 3rd Edition,

OUTCOMES:

On completion of the course students will be able to

- Identify various communication systems and the corresponding modulation schemes.
- Predict the characteristics of various analog and digital modulation schemes.
- Interpret the effect of noise and bandwidth in a communication systems
- Apply the Nyquist criteria for a given baseband signals.
- Evaluate the performance of communication receivers.
- Demonstrate the applications of common communication systems.

GECX 217	LEAN MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

The objective of the Course to make the student know about

- The basics of leanproduction management,
- How Lean principles are applied to the Construction industry to improve the operation management and product development.

MODULE I **7**

Lean production – Introduction, background, and lean thinking. Importance of philosophy, strategy, culture, alignment, focus and systems view. Discussion of Toyota Production System.

MODULE II **8**

Manufacturing systems – an overview of manufacturing strategies. Job shops, batch flow, and flexible manufacturing systems Flow production and lean production systems

MODULE III **7**

Value stream mapping in process design and product development Waste reduction - lead time reduction

Process cycle time and value-added vs. non-value added activities Optimum lot sizing

MODULE IV **8**

Lean production processes, approaches and techniques.—Importance of focusing upon flow. Tools -. Workplace organization – 5S. - Stability. - Just-In-Time – One piece flow – Pull. - . Cellular systems. - . Quick change and set-up reduction methods. f. Total productive maintenance. -. Poka-Yoke – mistake proofing, quality improvement. Standards. - . Leveling. - . Visual management. Just-in-time techniques – SMED and Takt Times - Standard work processes and line balancing Poka-yoke and pull systems material handling reduction and facilities planning

MODULE V **8**

Managing change in the lean organization Human resource management and the lean enterprise Employee involvement – Teams – Training – Supporting and encouraging involvement – Involving people in the change process -- communication -- Importance of culture. Startup of lean processes and examples of applications. Sustaining improvement and change, auditing, follow-up actions.

MODULE VI **7**

The lean enterprise and supply chain management Costs and risks of lean initiatives - Measuring lean initiatives

Total Hours –45

TEXT BOOKS:

1. The Toyota Way Field book, Jeffrey Liker and David Meier, McGraw-Hill, 2006. Lean Production Simplified, Pascal Dennis, Productivity Press, 2007.
2. Womack, James P., and Daniel T. Jones. Lean Thinking. New York, NY: Simon and Schuster, 2003. ISBN: 0743249275.
3. Murman, Earll. Lean Enterprise Value. New York, NY: Palgrave Macmillan, 2002. ISBN: 0333976975.

REFERENCES:

1. Readings athttp://www.leanconstruction.org/readings.htm
2. Hopp,W.J.,andSpearman,M.L.(2011).FactoryPhysics,ThirdEdition, WavelandPress,LongGrove,Il. 720pp.

OUTCOMES:

The student will be able to

- Describe the manufacturing approaches employed and the background and philosophy of lean production.
- Illustrate the concept of waste reduction
- Apply evaluation techniques that can be used in preparation for and use in learn production activities.
- Select the tools that can be used implementing lean production in production operations.
- Discuss the importance of workplace organization, pull production, cellular arrangement and employee involvement, need for employee creativity
- Describe about the Methods for promoting success in implementing lean transformations

GECX218	**SPATIAL DATA MODELING AND ANALYSIS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To impart knowledge on the fundamental representation and analysis of geospatial phenomena and provides the various methods and algorithms used in GIS analysis.
- To focus in terrain modeling, geomorphometry, watershed analysis and introductory GIS-based modeling of landscape processes (water, sediment). The course includes analysis from lidar data, coastal change assessment and 3D visualization.

MODULE I INTRODUCTION TO GEOSPATIAL DATA 7

Mapping natural phenomena –Concept of continuous fields and discrete sampling – Units, projections, coordinate transformation – Georeferencing, geospatial formats, conversions, geospatial data abstraction library – Raster and vector representation, raster and vector conversions and resampling.

MODULE II DATA DISPLAY AND VISUALIZATION 7

Display of continuous and discrete data, use of color, shading, symbols, to extract the spatial pattern and relationships – 3D visualization: multiple surfaces and volumes, 3D vector objects – visualization for data analysis (lighting, scaling, transparency, cutting planes, animations) – view/create maps/post your data on-line (Google Earth/Maps, GPS visualizer)

MODULE III GEOSPATIAL ANALYSIS 7

Foundations for analysis of continuous and discrete phenomena – neighborhood operations and buffers – analysis and modeling with map algebra – cost surfaces and least cost path – spatial interpolation and approximation (gridding)

MODULE IV TERRAIN MODELING AND ANALYSIS 9

terrain and bathymetry mapping – mathematical and digital representations (point clouds, contour, raster, TIN) – DEM and DSM, working with multiple return lidar data – spatial interpolation of elevation data and topographic analysis, line of sight, view shed analysis – solar irradiation, photovoltaic energy potential, time series of elevation data, analysis of coastal change.

MODULE V FLOW TRACING, WATERSHED ANALYSIS AND LANDFORMS 8

Methods for flow routing and flow accumulation – Extraction of stream networks – Extraction of watershed boundaries and building watershed hierarchies – feature extraction, types of landforms.

MODULE VI MODELING OF GEOSPATIAL PROCESSES 7

Model formulation, input data processing – introduction to GIS-based hydrologic, erosion and environmental modeling – Geocomputational methods, including agent-based modeling, artificial neural networks and evolutionary computing.

Total Hours –45

TEXT BOOKS:

1. Hassan A, Karimi (2017), Geospatial Data Science Techniques and Applications, CRS Press & Co.
2. Sudipto Banerjee, Bradley P, Carlin, Alan E. Gelfand (2014), Hierarchical Modeling and Analysis for Spatial Data, CRS Press & Co.

REFERENCES:

1. Maguire, D., M. Batty, and M. Goodchild. 2015. GIS, Spatial analysis, and modeling. ESRI Press (G70.212 .G584 2005)
2. Zeiler, M. 2010. Modeling Our World: The ESRI Guide to Geodatabase Design. Second Ed. ESRI Press, Redlands, California

OUTCOMES:

On successful completion of this course, students will be able to

- apply the basic concepts of Conceptualize models as representations of real life systems with inputs, outputs, and processes.
- employ the spatial tools to make simulations and predictions of real life phenomena.
- integrate and develop models with geospatial data through GIS.
- evaluate models in terms of accuracy, sensitivity, and uncertainty.
- perform a system-based approach for problem solving, with an emphasis on sustainability.
- execute the hydrological, erosion and environmental modeling through GIS.

GECX 219	ADVANCED ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop an entrepreneurial mindset.
- To learn the tools and methods for achieving sustainable growth.
- To explore various funds for a business and to get know about importance of a good team.
- To select public image branding and examine all channel types.
- To identify technology needs and establish key metrics to measure progress the business.
- To know about legal issues, regulations of starting and operating a venture and capstone presentation on practice venture.

Course Pre-requisites Completion of Social Entrepreneurship CourseAccess to Learnwise Platform

MODULE I ENTREPRENEURSHIP BASICS & REFINING BUSINESS MODEL 8

EntrepreneurshipBasics - Recap of Key Concepts, Introduction to First Venture, Recap of idea selection and Lean Canvas, Revisit product/service, Business model, Team formation**. Refining Business Model –**Pivoting, Types of Business Model, Refining Business Models, Evaluate business model, Identify additional customer segments, Analyze Business Model of Competitors, Importance of Product Management.

MODULE II BUSINESS PLANNING & REVENUE 8

Business Planning – Introduction to Business Plan, Make a Sales Plan, Hiring Sales Team, Make a People Plan for Venture, Financial Planning and Forecasting Template, Revisit Business Model, Create a Procurement Plan, Negotiation. **Revenue** –Exploring ways to Increase Revenue, Understanding Primary Revenue Source, Customer Lifecycle for Growing Customers, Exploring Secondary Sources of Revenue.

MODULE III FUNDING GROWTH & BUILDING A-TEAM 7

Funding Growth – Funding Options for an Entrepreneur, Explore the Right Funding Options, Exploring crowd funding platforms, Create Your Funding Plan, Pitch Practice. **Building A-Team** – Intro to Building an A-Team, Defining roles and responsibilities, Pitching to Attract Talent, Setting Your Team Up for Success, Defining Role of a New Hire

.

MODULE IV BRANDING AND CHANNEL STRATEGY 7

Branding and Channel Strategy– Intro to Branding, Draw your Venture's Golden Circle, Define Your Values, Positioning Statements, Selecting Brand Name, Social Media Handle, Logo and Mobile app names forYour Venture, Creating online public profiles, Bulls Eye Framework and other traditional channel types, Identify your Right Channel using Bulls Eye Framework.

MODULE V LEVERAGING TECHNOLOGIES AND AVAILABLE PLATFORMS & MEASURING PROGRESS 8

Leveraging Technologies and Available Platforms – Leaping Ahead with Technology, Digital Marketing for Your Startup, Plan a Social Media Campaign, Digital Collaboration, Store Your Documents Online, Other Platforms, Make Your Tech Plan and Platform Wish List. Measuring Progress – Metrics for Customer Retention and Satisfaction, Find your CAC, CLV, and ARPU, Key Financial Metrics, How to Communicate Your Metrics, Find New Revenue Streams based on Your Key Financial Metrics, Re-forecast your Financial Plan to Increase Margin.

MODULE VI LEGAL MATTERS & SEEKING SUPPORT & FINAL PROJECT 7

Legal Matters – Identify the Professional Help and Legal and Compliance Requirements for Your Venture, Conduct a Trademark Search for Your Company/Brand Name. **Seeking Support** – How Mentors Help to Create Successful Startups, Identify Mentors and Advisors, Scout for Board of Directors.**Final Project –** Capstone Project Presentation.

Total Periods- 45

TEXT BOOKS

1. Learn wise platform - Wadhwani Foundation, 2018.
2. All Lessons are delivered as Online videos accessible using Wadhwani Foundation's Learnwise Platform - https://lms.learnwise.wfglobal.org

OUTCOMES:

On completion of the course, students will be able to

- Achieve sustainable growth by pivoting, refining business models, expand customer segments, and business planning for developing early customer traction into a repeatable business.
- Develop strategies to grow revenues and markets.
- Develop an A-Team, brand strategy and create digital presence.
- Develop brand and channel strategy for customer outreach
- Leverage social media to reach new customers cost effectively.
- Explore licensing and franchising for business expansion.

GECX220	ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concept of Electric Vehicles.
- To familiarize the basic energy transfer processes that govern existing and proposed methods of power generation for Electric Vehicles.
- To familiarize with the traditional and non-traditional sources for Electric Vehicles in terms of energy content, accessibility, required processing steps and projected remaining reserves

MODULE I INTRODUCTION 8

A Brief History - Types of Electric Vehicle in Use Today : Battery electric vehicles - The IC engine/electric hybrid vehicle - Fuelled electric vehicles - Electric vehicles using supply lines - Solar powered vehicles - Electric vehicles which use flywheels or super capacitors - Ultra Capacitor – Ultra high Speed Flywheels.

MODULE II BATTERIES 7

Battery Parameters - Lead Acid Batteries - Nickel-based Batteries - Sodium-based Batteries - Lithium Batteries - Metal Air Batteries - Battery Charging - Choice of Battery - Use of Batteries in Hybrid Vehicles - Battery Modeling.

MODULE III FUEL CELLS 8

Hydrogen Fuel Cells - Fuel Cell Thermodynamics - Connecting Cells in Series - Water Management in the PEM Fuel Cell - Thermal Management of the PEM Fuel Cell - A Complete Fuel Cell System - Hydrogen Supply - Fuel Reforming - Hydrogen Storage.

MODULE IV ELECTRIC VEHICLE MODELLING AND DESIGN CONSIDERATIONS 7

Tractive Effort - Modeling Vehicle Acceleration - Modelling Electric Vehicle Range - Aerodynamic Considerations - Transmission Efficiency - Electric Vehicle Chassis and Body Design - General Issues in Design.

MODULE V DESIGN OF ANCILLARY SYSTEMS 7

Heating and Cooling Systems - Design of the Controls - Power Steering - Choice of Tyres - Wing Mirrors, Aerials and Luggage Racks - Electric Vehicle Recharging and Refueling Systems.

MODULE VI ENVIRONMENTAL IMPACT AND ENERGY STORAGE 8

Vehicle Pollution - The Effects - A Quantitative Analysis - Vehicle Pollution in Context - Alternative and Sustainable Energy Used via the Grid Hybridization of Energy Storages - Energy Consumption in Braking - Brake System of EVs and HEVs - Antilock Brake System.

Total Hours – 45

REFERENCES:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained",John Wiley & Sons Ltd, 2nd edition, 2015.
2. M. Ehsani, Y. Gao, Stefano Lango, K.M.Ebrahimi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 3rd Edition,2018.
3. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition, CRC Press, 2016.
4. Tom Denton, "Electric and Hybrid Vehicles" Routledge Publishers, 1st edition, March 2016.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Identify and quantify the important energy transfer for Batteries and fuel cell schemes.
- Identify the opportunities and challenges of advances in Electric Vehicles.
- Choose a suitable drive scheme for developing an electric hybrid vehicle depending on Resources
- Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
- Choose proper energy storage systems for vehicles
- Identify the current industry activities by car makers, electricity utilities, parts, suppliers (motors and batteries), including joint ventures, product announcements and pilot projects.

GECX 221	ARTIFICIAL INTELLIGENCE AND EVOLUTIONARY COMPUTING USING MATLAB	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To expose the students to the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback neural networks.
- To teach about the concept of fuzziness involved in various systems.
- To provide adequate knowledge about fuzzy set theory.
- To provide comprehensive knowledge of fuzzy logic control and its application to real time systems.
- To expose the ideas of GA and EP in optimization and control.

MODULE I FUNDAMENTALS OF ARTIFICIAL NEURAL NETWORKS 9

Objectives,history, biologicalinspiration, neuron model, McCulloch-Pitts neuron model, single-input neuron, multi-input neuron, network architectures, perceptron architecture, single-neuron perceptron, multi-neuron perceptron, perceptron learning rule, constructing learning rules, training multiple-neuron perceptron

MODULE II ASSOCIATIVE NETWORKS 9

Simple associative networks, auto-associative and hetero-associative nets, learning in neural nets, supervised and unsupervised learning, unsupervised Hebb rule, Kohonen rule, ADALINE and MADALINE network, back propagation neural networks,Hopfield networks, adaptive networks, applications using Neural Network toolbox in Matlab.

MODULE III FUZZY SET THEORY 6

Fuzzy versus crisp, crisp sets, fuzzy sets, operations and properties, membership function, crisp relations, fuzzyrelations.

MODULE IV FUZZY SYSTEMS 6

Crisp logic – fuzzy logic – fuzzy rule-based system- defuzzification methods – applications – Greg Viot's fuzzy cruise controller - fuzzy logic control using FIS in Matlab

MODULE V FUNDAMENTALS OF GENETIC ALGORITHMS 7

Genetic algorithms, history, basic concepts, working principle, encoding, fitness function, reproduction

MODULE VI GENETIC MODELING AND APPLICATIONS 8

Genetic operators, cross over types, mutation operator, coding steps of GA, convergence characteristics, applications of AI techniques in various domains using GATOOL in matlab

Total Hours –45

REFERENCES:

1. Laurance Fausett, Englewood cliffs, N.J., ‘Fundamentals of Neural Networks’,Pearson Education, 1992.
2. Timothy J. Ross, ‘Fuzzy Logic with Engineering Applications’, Tata McGraw Hill,1997.
3. David Goldberg, “Genetic Algorithms and Machine learning”, PHI
4. Wassermann, P. D. "Neural Computing" Van Reinhold, 1988.
5. Zimmermann, H. J., 'Fuzzy Set Theory and Its Applications', 2nd Edition,Kluwer Academic Publishers.
6. Martin T. Hogan, Howard B.Demuth. M,’Neural network design’4th edition
7. Zureda, J.M.,’Introduction to Artificial Neural Systems’, Jaico publishing house Bombay, 1994.
8. Bose N.K, Liang P. 'Neural Network Fundamentals with graphs, Algorithms and applications', TMH Pub. Co. Ltd, 2001.
9. S.Rajasekaran, G.A.Vijayalaksmi Pai , Neural Networks, Fuzzy logic and Genetic algorithms Synthesis and Applications , PHI private learning Ltd.,.New Delhi, 2011.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge andachieve skills on the following:

- Enumerate the theoretical basis of soft computing.
- Discuss the neural networks and supervised and unsupervised learning networks
- Design suitable neural networks, fuzzy systems, genetic representations with appropriate fitness functions for simple problems
- Apply the most appropriate soft computing algorithm for a given situation
- Know the key issues in using these techniques for search of difficult search-spaces
- Be aware of the different approaches and different applications in the field.