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

B.Tech.

POLYMER ENGINEERING

VISION AND MISSION OF THE INSTITUTION

VISION

B.S. Abdur Rahman Institute of Science and Technology aspires to be a leader in Education, Training and Research in Engineering, Science, Technology and Management and to play a vital role in the Socio-Economic progress of the Country.

MISSION

- To blossom into an internationally renowned University
- To empower the youth through quality education and to provide professional leadership
- To achieve excellence in all its endeavours 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 a 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 product development through effective integration of design engineering and material technology
- To undertake research in multidisciplinary 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 a 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

- 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 the 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 be able to;

- 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 modelling 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.
- Design and analyze moulds and plastics products to meet the needs of the industries.
- Process plastics, rubbers and composites materials to various components and products.

REGULATIONS - 2017
B.TECH. DEGREE PROGRAMMES

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 a theory or practical subject that is normally studied in a semester, like Mathematics, Physics, Engineering Graphics, Computer Practice, 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 the 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 streams.

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. Manufacturing Engineering
10. Mechanical Engineering
11. Polymer Engineering
12. Biotechnology
13. Cancer Biotechnology
14. Food Biotechnology

4.0 STRUCTURE OF THE PROGRAMME

4.1 Every Programme will have 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 a 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.

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

4.4 For the award of the degree, a student has to earn minimum total credits specified in the curriculum of the relevant branch of study. The minimum credits to be earned will be between 174 and 180, depending on the program.

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 will 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 will be nominated by the HOD as Class Advisor for the class throughout the period of study except the 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) will be nominated by the first year coordinator.

6.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counselling, the Head of the Department of the students will 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 will be constituted branch-wise and semester-wise

8.1 The composition of class committees for first and second semester will be 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 will be 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 four times during the semester. The first meeting will 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 will be decided for the first and second assessment. The second meeting will be held within a week after the date of the first assessment report, to review the students' performance and for follow up action. The third meeting will be held within a week after the second assessment report, to review the students' performance and for follow up action.

8.4 During these three meetings the student members representing the entire class shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process.

8.5 The fourth 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 ENROLMENT

9.1 Except for the first semester, every student shall register for the ensuing semester during a specified week before the semester end examination of the ongoing semester. Every student shall submit a completed registration form indicating the list of courses intended to be enrolled during the ensuing semester. Late registration with the approval of the Dean (Academic Affairs) along with a late fee will be permitted up to the last working day of the current semester.

9.2 From the second year onwards, all students shall pay the prescribed fees for the year on a specific day at the beginning of the semester confirming the registered courses. Late enrolment along with a late fee will be permitted up to two weeks from the date of commencement of classes. If a student does not enroll, his/her name will be removed from rolls.

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

9.4 A student should have registered for all preceding semesters before registering for a particular 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 assessment 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 the first assessment 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 will not be considered as a break of study. A student who has availed break of study has to rejoin in the same semester only.

12.0 CREDIT LIMIT FOR ENROLMENT & MOVEMENT TO HIGHER SEMESTER

12.1 A student can enrol 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 5^{th} semester
- Not less than 60 credits, (40 for lateral entry) to move to the 7^{th} 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:

Assessment No.	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 Exam	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 will have 60% weightage for continuous assessments and 40% for the semester end examination. However, a student should have secured a minimum of 50% marks in the semester end practical examination.

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 the 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 will be evaluated along with an oral examination by a committee of faculty members, constituted by the Head of the Department. A progress report from the industry will also be taken into account for evaluation. The weightage for 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(s), an oral examination (viva-voce) will be conducted as the semester end examination, for which one external examiner, approved by the Controller of Examinations, will be included. The weightage for periodic review will be 50%. Of the remaining 50%, 20% will be for the project report and 30% for the Viva Voce examination.

13.8 Assessment of seminars and comprehension will 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 the first appearance will 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 has missed, for genuine reasons, a maximum of one of the two continuous assessments of a course may be permitted to write a substitute examination paying the prescribed substitute examination fees. 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 Dean of School for that purpose. However there is no Substitute Examination for Semester End examination.

14.2 A student who misses any continuous assessment test in a course 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 missed assessment test. However the Substitute Examination will be conducted after the last working day of the semester and before 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 Institution 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 will consolidate and furnish the list of students who have earned less than 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 the 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 re-do 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 will 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 will 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 will not be 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 will 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 will be made on an 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 the 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 Schools 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 will contain the following details. The list of courses enrolled during the semester including redo courses, if any, and the grade scored, the Grade Point Average (GPA) for the semester and the Cumulative Grade Point Average (CGPA) of all courses enrolled from the 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 shall be calculated in a similar manner, considering all the courses enrolled from the first semester.

"I" and "W" grades will be excluded for calculating GPA .

"U", "I", "AB" and **"W"** grades will be excluded for calculating CGPA.

The formula for the conversion of CGPA to the 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 will be awarded the following classifications based on CGPA.

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in the first appearance and completing the programme within the Prescribed period of 8 semesters for normal entry and 6 semesters for lateral entry
First Class	6.50 and above and completing the programme within a maximum of 10 semesters 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 the study. For this purpose, the authorized break of study will not be counted. The students who do not satisfy the above two conditions will be classified as second class. For the purpose of classification, the CGPA will be rounded to two decimal places. For the purpose of comparison of the 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/self-study courses not exceeding a total of six credits 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. In case of credits earned through online mode ratified by the respective Board of Studies, the credits may be transferred following the due approval procedures. The students shall undergo self-study courses on their own with the mentoring of a member of the faculty. The online/self-study courses can be considered in lieu of elective courses.

19.0 SUPPLEMENTARY EXAMINATION

Final Year students can apply for supplementary examination for a maximum of two courses thus providing an opportunity to complete their degree programme. Like wise students with less credits can also apply for supplementary examination for a maximum of two 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.

20.0 PERSONALITY AND CHARACTER DEVELOPMENT

20.1 All students shall enrol, on admission, in any of the personality and character development programmes, NCC / NSS / NSO / YRC / Rotaract and undergo practical training.

- **National Cadet Corps (NCC)** will have to undergo a specified number of parades.
- **National Service Scheme (NSS)** will have social service activities in and around Chennai.
- **National Sports Organization (NSO)** will have sports, games, drills and physical exercises.
- **Youth Red Cross (YRC)** will have social service activities in and around Chennai.
- **Rotaract** will have social service activities in and around Chennai.

21.0 DISCIPLINE

21.1 Every student is required to observe disciplined and decorous behaviour both inside and outside the campus and not to indulge in any activity which will tend to affect the prestige of the Institution.

21.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the HOD / Dean will be referred to a Discipline and Welfare Committee nominated by the Vice-Chancellor, 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 semesters (12 semesters for lateral entry) from the date of admission, including a break of study

ii) no dues to the Institution, Library, Hostels

iii) no disciplinary action pending against him/her.

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

23.0 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.

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 1181	Physics	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 Lab	0	0	2	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 Lab	0	0	2	1	
9.	ESF	EEC 2182	Electrical and Electronics Lab	0	0	2	1	
10.	EC	PEC 2105	Machining Practice Lab	0	0	2	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 Lab	0	0	2	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 & 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 Lab	0	0	2	1	
11.	EC	PEC 3105	Rubber Processing Lab	0	0	2	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 & 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	2	1	
11.	EC	PEC 3215	Polymer Testing Lab	0	0	2	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 lab	0	0	2	1	
10.	EC		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 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	Biomedical 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 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	1	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	PECX030	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 026	Computer Aided Modelling	2	0	0	2
2.	PE	PECX 027	Computer Aided Manufacturing	2	0	0	2
3.	PE	PECX 028	Design of Composite Structures	2	0	0	2
4.	PE	PECX 029	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	Paint Technology	1	0	0	1
6.	PE	PECX 038	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	Course Title	L	T	P	C
1.	CHCX01	Analytical Instrumentation	2	0	2	3
2.	CHCX02	Corrosion and its Control	2	0	2	3
3.	CHCX03	Electrical Materials and Batteries	2	0	2	3
4.	CHCX04	Engineering Materials	2	0	2	3
5.	CHCX05	Fuels and Combustion	2	0	2	3
6.	CHCX06	Fundamentals of Physical Chemistry	2	0	2	3
7.	CHCX07	Green Technology	2	0	2	3

8.	CHCX08	Organic Chemistry of Biomolecules	2	0	2	3
9.	CHCX09	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.	SSCX01	Fundamentals of Economics	2	0	0	2
2.	SSCX02	Principles of Sociology	2	0	0	2
3.	SSCX03	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.	SSCX04	Economics of Sustainable Development	2	0	0	2
2.	SSCX05	Industrial Sociology	2	0	0	2
3.	SSCX06	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.	GECX101	Disaster Management	Civil
2.	GECX102	Total Quality Management	Mechanical
3.	GECX103	Energy Studies	Mechanical
4.	GECX104	Robotics	Mechanical
5.	GECX105	Transport Management	Automobile
6.	GECX106	Control Systems	EEE
7.	GECX107	Introduction to VLSI Design	ECE
8.	GECX108	Plant Engineering	EIE
9.	GECX109	Network Security	CSE
10.	GECX110	Knowledge management	CSE
11.	GECX111	Cybersecurity	IT
12.	GECX112	Genetic Engineering	LS
13.	GECX113	Fundamentals of Project Management	CBS
14.	GECX114	Operations Research	Mathematics
15.	GECX115	Nano Technology	Physics / Chemistry
16.	GECX116	Vehicle Maintenance	Automobile
17.	GECX117	Fundamentals of Digital Image Processing	ECE

Group II Courses

(To be offered in VII semester)

Sl. No.	Course Code	Course Title	Offering Department
1.	GECX201	Green Design and Sustainability	Civil
2.	GECX202	Appropriate Technology	Civil / Mechanical
3.	GECX203	Engineering System Modelling and Simulation	Mechanical
4.	GECX204	Value Analysis and Engineering	Mechanical
5.	GECX205	Industrial Safety	Mechanical
6.	GECX206	Advanced Optimization Techniques	Mechanical
7.	GECX207	Mat Lab Simulation	EEE
8.	GECX208	Embedded Systems and its Applications	ECE
9.	GECX209	Usability Engineering	CSE
10.	GECX210	Supply Chain Management	CBS
11.	GECX211	System Analysis and Design	CA
12.	GECX212	Advanced Materials	Physics & Chemistry
13.	GECX213	National Service Scheme	School of Humanities
14.	GECX214	Automotive Pollution and Control	Automobile
15.	GECX215	Motor Vehicle Act, Insurance and Policy	Automobile
16.	GECX216	Principles of Communication Systems	ECE
17.	GECX217	Lean Management	Civil
18.	GECX218	Spatial Data Modeling & Analysis	Civil

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 eigenvalues 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 - the 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" (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. 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, the student will be able to

- Understand the matrix techniques and compute eigenvalues 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 the 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 the narration of incidents.
S: Narrating an experience
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 Storytelling 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 Abridged by Mukul Chowdhri). Hyderabad University 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 the 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 classroom.
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

The 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, machinery and equipment.

Computer, internet browsing.

Banking,

Exercises.

TOTAL HOURS: 45

TEXTBOOKS:

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 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

TEXTBOOKS:

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 the 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 give 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 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 the 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. Exercise book 1of Nihongo 1, and other supplementary material
3. Nippon, the Land and its People & Encyclopedia of Contemporary Japanese
4. Japan: 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 1181	PHYSICS	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
- the phenomenon of wave optics and its applications
- the 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 on 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, CO2 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 RENEWABLE ENERGY SOURCES 7

Present Energy sources and sustainability - Solar energy - Solar photovoltaics - Solar cells – Bioenergy - Biomass – production of liquid fuels from biomass – Wind energy – Wind turbines – energy and power from wind turbines - Geothermal energy - Ocean energy: Wave energy – Wave energy conversion devices – Tidal energy – Tidal power basics – power generation –Tidal energy potential – Environmental benefits and impacts of renewable energy sources

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 fibre 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.

L – 45; P – 30; TOTAL HOURS – 75

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 the application.

CHC1181 CHEMISTRY

L	T	P	C
3	0	2	4

OBJECTIVES:

The students should be conversant with

- The basic problems like hardness, alkalinity, dissolved oxygen associated with the water used for domestic and industrial purpose and treatment process involved.
- The synthesis, properties and applications of nanomaterials.
- The importance of renewable energy sources like solar, wind, biogas, biomass, geothermal, ocean and their limitations.
- The basic analytical techniques like UV-Visible, FT-IR, NMR, AAS, AES, Circular Dichroism and XRD etc.
- Photochemistry concepts related to physical processes and chemical reactions induced by photon absorption and their applications.
- Basic principles of electrochemistry, cell construction and evaluation and to understand general methodologies for construction & design of the electrochemical cell

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 method: – lime soda and 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, disinfection }– desalination: electrodialysis, reverse osmosis.

MODULE II NANOCHEMISTRY 6

Introduction – distinction between molecules, bulk materials and nanoparticles – classification based on dimension with examples –

synthesis (top-down and bottom-up approach} : sol-gel, thermolysis (hydrothermal and solvothermal), electrodeposition, chemical vapour deposition, laser ablation – properties and applications (electronic, magnetic and catalytic) – risk factors and future perspectives.

MODULE III ENERGY SOURCES 8

Energy: past, today, and future – a brief history of energy consumption – present energy scenario of conventional and renewable energy sources – renewable energy : needs of renewable energy, advantages and limitations of renewable energy – solar energy: basics, solar energy in the past , photovoltaic, advantages and disadvantages – bioenergy: conversion, biodegradation, biogas generation, biomass gasifier, factors affecting biogas generation, advantages and disadvantages – geothermal energy: geothermal resources (hot dry rock and magma resources, natural and artificial), advantages and disadvantages – wind energy: wind resources, wind turbines, advantages and disadvantages – ocean energy: wave energy, wave energy conversion devices, ocean thermal energy, advantages and disadvantages.

MODULE IV PHOTOCHEMISTRY 7

Introduction: absorption and emission, chromophores, auxochromes – laws of photochemistry: Grotthus-Draper law, Stark-Einstein law – quantum yield (problems) –photophysical processes: fluorescence and phosphorescence - Jablonski diagram (electronic states and transitions) – quenching, annihilation – photosensitization: principle and applications – chemiluminescence, bioluminescence.

MODULE V ANALYTICAL TECHNIQUES 7

Spectroscopy: electromagnetic radiation and spectrum – types of transitions – types of spectra (atomic and molecular with their chemical usefulness) – Beer-Lamberts law (problems) – principles, instrumentation and applications of: Colourimetry – UV-Vis spectrophotometer – atomic absorption spectroscopy – atomic emission spectroscopy – principles and applications of: IR, NMR, mass and X-ray diffraction analysis.

MODULE VI ELECTROCHEMISTRY 8

Electrochemistry - types of electrodes (principle and working) : gas (SHE), metal/metal ion electrode, metal-metal insoluble salt (calomel electrode), ion-selective (glass electrode and fluoride ion selective electrode) – Electrolytic and galvanic cells, construction of cell, EMF measurement and applications (problems), standard cell (Weston-cadmium), reversible and irreversible cell, concentration cell. Determination of fluoride ion using fluoride ion selective electrode – Chemically modified electrodes (CMEs): concept, approaches and applications.

PRACTICALS

1. Estimation of hardness in a given water sample.
2. Estimation of the alkalinity of the given water sample.
3. Estimation of a strong acid by conductometry.
4. Estimation of Fe^{2+} present in the given sample by potentiometry.
5. Verification of Beer-Lamberts law and estimation of Cu^{2+} present in the unknown sample.
6. Estimation of sodium and potassium present in the given sample by flame photometry.
7. Determination of molecular weight and degree of polymerisation of a polymer by viscosity method.
8. Synthesis of thermosetting polymer.

L – 45; P – 30; TOTAL HOURS – 75

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.
- classify nanomaterials and apply the nanochemistry approach to synthesize the nanomaterials.
- explain the principle and enumerate the advantages and disadvantages of various renewable energy sources.
- state the principle and illustrate the instrumentation of various analytical techniques.
- apply the concepts of photochemistry to elaborate on various photo-physical and photochemical reactions.
- construct an electrochemical cell and describe the various types of electrodes and determine the fluoride content.

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 freehand 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. Freehand sketching of orthographic views of simple machine parts as per first angle projection. Orthographic projection of points in all quadrants. Some commands and demonstrationn 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

TEXTBOOKS:

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 Benchmarking 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 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 practical exposure to basic engineering practices like carpentry, fitting, plumbing, welding and making of simple electrical and electronic circuits
- To have an understanding of 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 a lathe
3. Mould 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 the 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 an 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 integrations.
- 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

TEXTBOOKS:

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, the 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 linearity 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 to inertial properties of surfaces and solids
- To provide an understanding of 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:

The student will be 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 groundwater, 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 freshwater ecosystems (pond, lake, river) (c) Aquatic saltwater 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 the current situation

TOTAL HOURS – 30

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 a suitable method to alleviate the pollutants and natural disasters.
- assess the impact of human population and the health-related issues and the ethics to be followed for sustainable life.

GEC 1213 COMPUTER PROGRAMMING II

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 an 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, the 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 mould manufacturing – process, materials and design. Hobbing for mould 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 electrodeposition in damaged moulding surfaces, surface texturing of moulds – process description, types of moulds, types of patterns and mould shapes, metals that can be etched, mould 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

TEXTBOOKS:

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.

3. P.N. Rao, “Manufacturing Technology”, Tata McGraw-Hill Publishing Limited, II Edition, 2009.

4. HMT – “Production Technology”, Tata McGraw-Hill, 2001.

REFERENCES:

1. Geoffrey 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 mould manufacturing.
- Compare the milling and hobbing processes for core and cavity manufacturing.
- Describe various polishing techniques involved in mould manufacturing. Identify the basic measuring instruments used in the 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 teach the fundamentals, applications of drying with related examples.
- To equip students to understand the various terminologies of humidification.
- To develop the ability in identifying different type of crushers and grinders.
- To impart knowledge of separation processes practised in 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 Crossflow. 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, Equipment 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 equipment, 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

TEXTBOOKS:

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 the 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 Thermodynamics, 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 students will be able to

- Analyze the problems associated with fluid mechanics
- Compute the flow of fluid using various devices
- Evaluate the performance of pumps involved in various systems
- Assess the various parameters in different equipment associated with heat transfer
- Operate ball mill and jaw crushers
- Demonstrate knowledge on size reduction ad separation processes

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 a 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 the 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

TEXTBOOKS:

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, the 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 the wave equation and the heat flow equation.
- Solve ordinary differential equations using Laplace transform.
- Solve the 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 the 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 workplace 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 the 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 of 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 of polymers and polymerization reactions.
- Ability to demonstrate the knowledge on the mechanism and kinetics 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 an understanding of polymer chain conformation on its morphological behaviour.
- To provide an understanding of polymer chain configuration on its morphological behaviour.
- 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, cross-linked, and network polymers - homochain and heteroatomic 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 the modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness – crazing in glassy polymers – ductilebrittle 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

TEXTBOOKS:

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 editions 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 editions, 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, Academic 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

- Identify the conformation and configuration of polymers.
- Demonstrate the knowledge of thermodynamic transition in polymers.
- Correlate the structure and properties of various polymers.
- Predict the properties of newly synthesized polymers.
- Analyse the electrical, optical and chemical 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

TEXTBOOKS:

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 encyclopaedia", John Wiley & Sons, 2003.

OUTCOMES:

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

- Demonstrate the knowledge of various polymerization techniques
- Describe the manufacturing process of various thermoplastics
- Modify the characteristics of plastics by various techniques
- Select appropriate method for the synthesis of specialty plastics
- Correlate the properties of different thermoplastic materials with the structure
- Apply the knowledge in identifying plastics for specific 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 of the power system and various methods of power generation through renewable energy sources.
- The concepts of the quantum theory of solids and semiconductor materials.
- The 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 – Photodiode – 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

TEXTBOOKS:

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 the 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 the power system and the 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

		L	T	P	C
PEC 2104	**POLYMER SYNTHESIS LAB**	**0**	**0**	**2**	**1**

OBJECTIVES:

- To impart practical skills in synthesizing various polymers using different polymerization techniques.
- To impart knowledge in identifying suitable method for polymerization of the monomer.
- To develop an understanding of 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 the mechanism of polymerisation.
- 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 Geoffrey 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.

COURSE 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**	**2**	**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

TEXTBOOKS:

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	2	1

OBJECTIVES:

- To demonstrate the knowledge of machining principles and safe working practices.
- To equip how to set the machining parameters in accordance with machining requirement.
- To impart practical skills in metal cutting processes.
- To provide an 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 the 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 callipers, 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.
- Geoffrey 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 the 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

TEXTBOOKS:

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.

COURSE 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 behaviour of polymeric materials.
- To provide understanding of mechanical models based on its properties.
- To impart knowledge in rheological behaviour of polymer melts.
- To provide an understanding of 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 the mechanical behaviour of polymeric materials – creep – stress relaxation – Boltzmann principle – time-temperature superposition principle – WLF equation.

MODULE: II MECHANICAL MODELS-VISCOELASTIC BEHAVIOUR 9

Mechanical models – stress-strain response of spring and dashpot – viscoelastic models – Maxwell element – Voight kelvin element – response to creep and stress relaxation – four-parameter model – dynamic mechanical properties – the behaviour 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, fibre 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 dependent 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 viscometer – 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

TEXTBOOKS:

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, Cincinnati, 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. I

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 to

- Explain knowledge on mechanical behaviour of polymeric materials.
- Construct models for viscoelastic behavior of polymer melts
- Analyze and measure the different parameters which influences polymer rheology
- Evaluate the flow properties of polymer melts.
- Explain the functions of various instruments role in measuring rheological properties
- Apply theoretical knowledge of rheology in 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 of the properties and application of various rubbers.
- To have fundamental knowledge on the mechanism of vulcanizing rubbers.
- To enhance their skill in developing formulations 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 moulding 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 applications– BR: polymerization, properties and applications – IR: Manufacture, properties and applications – poly alkenamers, polynorbornenes.

MODULE: VI HIGH PERFORMANCE AND THERMOPLASTIC ELASTOMERS 9

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

L – 45; T – 0; Total Hours – 45

TEXTBOOKS:

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.

COURSE 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 machinery and develop a high-quality rubber compound.
- Select proper vulcanization mechanism for a particular rubber compound to meet desired product performance.
- Select suitable grades of general purpose rubbers for the 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.

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

OBJECTIVES:

- To develop an understanding of 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 the compounding of various thermoplastics to attain the desired performance.
- To impart skill in the 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 – colourants – 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 machinery for rubbers – two roll mill – internal batch mixers – continuous mixers – Banbury mixer - operations and maintenance of mixing equipment.

L – 45; T – 0; Total Hours – 45

TEXTBOOKS:

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 Publication, 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 Compound 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.

COURSE 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 the compounding of various thermoplastics to enhance proper dispersion and attain desired performance.
- Apply knowledge in the 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 advanced applications.

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

OBJECTIVES:

- To impart the skill in identifying various polymers and validating their quality.
- To provide an understanding of 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 of the 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 PROCESSABILITY 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

TEXTBOOKS:

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.

COURSE OUTCOMES:

After completion of this course, students will be able to

- Analyse the various plastics and rubbers by simple physical & chemical methods.
- Analyze morphological characteristics 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.

		L	T	P	C
PEC 2215	**POLYMER CHARACTERIZATION LAB**	**0**	**0**	**2**	**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 the melt flow index of thermoplastic materials.
7. Determination of filler content in plastics/rubbers.
8. Determination of total solids, 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.

COURSE 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 structure and its properties of various polymers.
- Determine the cure characteristics of the thermosetting resins.
- Characterize the quality of latex.

SEMESTER – V

MSC 3182	SOCIAL ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To be able to understand the field of social entrepreneurship and Social problems
- To be able to describe and understand the traits of social entrepreneurs
- To recognize the social business opportunities
- To synthesize the resource mobilization ways for social entrepreneurship
- To understand the social entrepreneurship models
- To recognize the impact of social entrepreneurship on societies

MODULE I INTRODUCTION TO SOCIAL ENTREPRENEURSHIP 07

Introduction - Emergence and Development of Social Entrepreneurship. Social Problems in India: An Overview. Social Development: The Indian Scenario. Emergence of Social Entrepreneurs and Sustainable Solutions to Social Problem. Characteristics and Context of Social Entrepreneurship .The Role of Social Entrepreneurship in Societies & Economies.

MODULE II SOCIAL ENTREPRENEURSHIP: DRIVERS AND CHALLENGES 07

The Drivers of Social Entrepreneurship. Elements of the Social Entrepreneurial Personality. Challenges of financial constraints. Challenge to attract and cultivate talented workers. Challenge of evaluation of social entrepreneur impact. Challenge of scaling and its impact. Cases

MODULE III SOCIAL ENTREPRENEURSHIP: OPPORTUNITY RECOGNITION 07

Opportunity Recognition and Planning Process. Opportunities for Social Entrepreneurs. The Nature of Social Entrepreneurial Opportunities. Social Problems into Opportunities. Idea development and conceptualization of social problem. Cases

MODULE IV RESOURCE MOBILIZATION FOR SOCIAL VENTURE 08

Resources at Initial Stage. Social Network as a role of Social Capital. Team and Collective Efforts. Need and Determination of Important Resources. Resource of Knowledge, Skills and Abilities. overview of venture capital and angel investment. Cases

MODULE V BUSINESS MODELS AND BUSINESS PLAN FOR SOCIAL ENTERPRISES 08

Design Principles of Social Entrepreneurship Business Models , Evaluation of the Root Cause of a Societal Problem. Developing business plan for social ventures. Developing an investor presentation. Feasibility study and report. How to start a business - Procedures for registration of small scale industry

MODULE VI THE IMPACT OF SOCIAL ENTREPRENEURSHIP ON SOCIETY 08

Static Impact of Social Entrepreneurship. Impact of Charitable NGOs vs. Social Entrepreneurship, Impact of For-Profit Companies vs. Social Entrepreneurship. Social entrepreneurship report preparation by students.
Case Study of Social Entrepreneurs

L – 45; Total Hours – 45

REFERENCES:

1. “Social Entrepreneurship : New models of sustainable social change” . Alex Nicholls, Oxford University Press 2006
2. The Process of social value creation : A multiple case study on Social Entrepreneurship in India , Archana Singh Springer 2016
3. “Social Entrepreneurship and social business” Christine K Volkmann, Springer Gabler 2012
4. “Social Entrepreneurship” Manuel London ,Routlege, 2010

OUTCOMES:

The students can able to

- Conceptualize social entrepreneurship in terms of a theoretical framework between changing social values and institutions
- Think and communicate about social values
- Learn about practical models of social change to launch, lead,

manage, and evaluate a social venture

- Analyze funding needs and sources for the social venture
- Experience the ideas can be critically and collaboratively examined prior to commitment.

ENC 3181	COMMUNICATION AND SOFT SKILLS - I	L	T	P	C
	CONFIDENCE BUILDING	0	0	2	1

OBJECTIVES:

- To develop professional skills like work ethics, analytical skills, presentation skills etc.
- To train them in problem solving skills and leadership skills pertaining to industries.
- To train them in team building skills.
- To train in setting up career goals

MODULE I **6**

Brief about Multinational companies- Analysing work ethics of multinational companies and small industries- discussing as pairs-Knowledge about etiquette (different types)

MODULE II **6**

Visit to an Industry and prepare reports --Critically reading of industry specific journal articles and write ups-- preparing reports.

MODULE III **4**

Analysing problem solving situations in industries (relating to application of core subject to specific jobs) and discussing about them- working on a sample case

MODULE IV **6**

Developing Leadership in team projects-- debating about various aspects of leadership: for example, responsibility and reliability-time management

MODULE V **8**

Team building skills-- group discussions pertaining to industries-- presenting career goals. -- preparing for interviews- interpersonal skills

Total Hours – 30

REFERENCES:

1. Covey,S.R. (2004). The 7Habits of Highly Effective People: Powerful Lessons in Personal Change. Free Press.UK
2. Fine, P.M.& Alice Olins. (2016).Step up: Confidence, Success and Your Stellar Career in 10 Minutes a Day. Vermilion.UK
3. Pai, A. (1993).How to Develop Self-Confidence. Amazon.com
4. Wentz,F.H.(2012). Soft skills training: A Workbook to Develop Skills for Employment. Amazon.com

OUTCOMES:

After completing the course students would be able to

- Exhibit critical reading skills through review of industry specific articles.
- Provide solutions to problem based situations.
- Exhibit leadership qualities by debating over industry specific issues.
- Participate in group discussions confidently.
- Present their career goals.

		L	T	P	C
PEC 3101	**PLASTICS PROCESS ENGINEERING**	**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 OTHER 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.

		L	P	T	C
PEC 3102	**STRENGTH OF MATERIALS**	**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.

COURSE 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 calibration methods of plastics.
- Perform various tests for evaluating the mechanical and electrical properties of plastic materials.
- Perform various tests for evaluating the optical 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.

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

OBJECTIVES:

- To develop the knowledge of various parameters influence the injection moulding process
- To impart skill in setting up and optimizing injection moulding process.
- To operate the compression moulding press for manufacturing thermoset plastic products
- To equip with the fundamental knowledge of operating an extruder.
- To introduce to the nanofibers 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 moulding process by hand-operated injection moulding machine.
2. Determination of the influence of pressure in injection and clamping of semi-automatic injection moulding process.
3. Setting up of injection moulding process in automatic injection moulding machine
4. Moulding of thermoset resin by compression moulding process.
5. Understanding the principle of blow moulding by hand operated blow moulding machine.
6. Determination of various parameters influences 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 the level of addition of regrind materials into 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.

		L	T	P	C
PEC3105	**RUBBER PROCESSING LAB**	**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 moulding press to manufacture rubber product
- To equip with compound preparation of latex
- To introduce latex products manufacturing techniques
- To develop an understanding of 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 of rubber of an ODR curve.
- Operate the hydraulic press for manufacturing rubber products.
- Perform latex compounding.
- Produce latex products from dipping and other processes.
- Formulate compounding recipe for rubbers.

SEMESTER VI

MSB 3181	LEADERSHIP & CEO TRAINING	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 the 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 the 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 - Multifactor leadership questionnaire and personal reflections

MODULE II LEADERSHIP STYLE AND COMMUNICATION 08

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 08

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 09

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 08

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.

L – 45; 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 through continuous efforts
- Manage their own emotions as well as other resulting in successful relationship building with all stakeholders

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 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 a 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.The 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.

PEC 3211	**PLASTIC AND RUBBER PRODUCT DESIGN**	**L**	**P**	**T**	**C**
		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.

TOTAL **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), 3e

REFERENCES:

- Kuang-Hua Chang "Product Design Modeling using CAD/CAE", 1st Edition, Elsevier, 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 carry out error analysis and find the probable error in a measurement system
- To teach 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), variable area 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 PROCESSING SYSTEMS 8

Introduction to polymer processes (injection moulding, blow moulding, melt spinning, batch polymerization), Control of continuous and batch polymerization processes. Advanced Process Control Systems: Introduction to Advanced process control systems, Feedforward, 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

TEXTBOOKS:

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 the 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 the physical system also to analyse physical systems using block diagram algebra and SFG (Signal Flow Graph)
- Understand the role of process control in polymer machinery

PEC 3213 **POLYMER REACTION ENGINEERING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To teach the basic concepts of reaction engineering.
- To teach the students about the fundamentals, applications of reaction. engineering with related examples.
- To develop design principles in reaction engineering.
- To develop the ability in analysing the processes and contribute to new designs.
- To design 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 a 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, "Fundamentals 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.

COURSE OUTCOMES:

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

- Evaluate the kinetics and rate of chemical reactions
- Interpret batch reactor systems used for polymerization
- Select reactors, determine its size, conversion for a given application
- Identify and compare the different type of reactors used for polymerisation
- Demonstrate knowledge on the heterogeneous catalyst systems.
- Apply the theoretical knowledge of polymerization in different type of reactors

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 the 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. Product for Agriculture Application.
2. Product for Automobile Application.
3. Product for Medical Application.
4. Product for Household Application.
5. Product for Electronic Application
6. Design of Plastic Gear
7. Design of Plastic Bearing

Total Hours : 45

REFERENCES:

1. Malloy.R, " Plastic Part Design for Injection moulding", 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, Elsevie,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

PEC 2215	POLYMER TESTING LAB	L	T	P	C
		0	3	0	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.

TEXTBOOKS:

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.

COURSE 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.
- Analyse 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 mould 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, hot runner and cold runner mould, Classification of injection moulds – number of cavities – selection of injection moulding 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, diaphragm gate, ring gate, pin gate, submarine gate, design rules – use of mould flow for gate design.

MODULE II — DESIGN OF INJECTION MOLD — 10

Ejection systems – constructional features of ejector grid, ejector grid layout, 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 moulds, mould 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 mould design.

MODULE IV **COMPRESSION & TRANSFER MOLD DESIGN** **10**

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

MODULE V **BLOW MOLD DESIGN** **10**

Blow mould design – material selection, mould cooling, mould venting, pinch-off, parison diameter calculation, wall thickness, blow ratio. Moulds for blow moulding, moulds for injection stretch blow moulding, moulds for thermoforming and rotational moulding. Design and constructional features of the different type of parison die. Design of Hot and Cold runner mould.

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, fishtail 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 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 mould 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 of the 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 the 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 the 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.

COURSE OUTCOMES:

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

- Gain fundamental knowledge of 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 the 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 the 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 nanocomposites.

MODULE VI APPLICATIONS OF POLYMER NANOCOMPOSITES 7

Applications of polymer nanocomposites: automobiles – aerospace – injection moulded 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 Parameswaran Pillai, 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 a novel polymer to achieve synergistic properties.
- Analyze and characterize polymer nanocomposites.
- Select appropriate techniques for processing of polymer nanocomposites.
- Suggest suitable techniques for the dispersion of nanomaterials in polymers.
- Gain knowledge of 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 mould 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 mould flow software for mould 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 thermoset 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 modelling 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 the laboratory course, the students will be able to

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

PROGRAMME ELECTIVES
GROUP I (Materials)

PECX001	THERMOPLASTICS POLYESTERS	L	T	P	C
		1	0	0	1

OBJECTIVES:

- To provide fundamental knowledge in the synthesis of thermoplastic polyesters.
- To impart knowledge in polyester fibre 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 and 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

TEXTBOOKS:

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 developing 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

TEXTBOOKS:

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.

COURSE OUTCOMES:

On completion of this course, students should be able

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

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

Objectives:

- To impart the knowledge of electrical conduction mechanism in electro-active polymers.
- To develop an 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.

COURSE OUTCOMES:

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

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

PECX 004 HEAT RESISTANT POLYMERS

L	P	T	C
1	0	0	1

Objectives:

- To develop an understanding of the properties and applications of high-temperature resistant speciality polymers.
- To provide an insight into 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.

COURSE OUTCOMES:

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

- Select suitable polymers 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 an understanding on the 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 the 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

TEXTBOOKS:

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 be able to

- Demonstrate the knowledge of biodegradable plastics and mechanism of biodegradation of plastics
- Synthesize biodegradable plastics
- Understand the evaluation of biodegradability of plastics
- Evaluate the biodegradability of polymers.

PECX 005	BIOPLASTICS TECHNOLOGY	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To impart knowledge on the synthesis and properties of bioplastic materials.
- To develop an understanding on polymeric biomaterials.
- To impart knowledge on advanced bioplastics.
- To provide an understanding of applications of bioplastics.

MODULE: I 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: II POLYMERIC BIOMATERIALS 7

Surgical sutures. Adhesives. Polymer cements. Dental restorations and implants. Hydrogels. Contact lenses. Artificial skin. Polymers in pharmaceutical tablets. Controlled release of drugs.

MODULE: III ADVANCED BIOPLASTICS 8

New biocomposites based bioplastics. Flexible and low migration bioplastics. Hybrid bioplastics. Sustainable bioplastics based coatings: paint and plastic coatings.

MODULE: IV APPLICATIONS OF BIOPLASTICS 8

Packaging - packaging materials - fibres and nets. Foams - biodegradable hot melt adhesive compositions. Food applications chewing gum medical applications - drug delivery – electrospinning - drug release from electrospun fibres - 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.

L – 30; T – 0; Total Hours –30

TEXTBOOKS:

- Michael Niaounakis, 'Biopolymers: Reuse, Recycling, and Disposal' Elsevier, 2013.
- David Plackett, 'Biopolymers: New Materials for Sustainable Films and Coatings'Wiely, 2013.
- Susheel Kalia, Luc Avérous, 'Biopolymers: Biomedical and Environmental Applications', John Wiley & Sons, 2011.

REFERENCES

- Srikanth Pilla, Handbook of Bioplastics and Biocomposites Engineering Applications, Wiley 2011.
- Stoyko Fakirov, **'**Handbook of Engineering Biopolymers: Homopolymers, Blends and Composites'Hanser, 2015.
- 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 to

- Synthesise and analyse properties of bio-based plastic materials.
- Synthesize polymeric biomaterials for specific applications.
- Demonstrate the knowledge of advance bioplastics.
- Analyse bio-plastic 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 the synthesis and processing of biomedical polymers.
- To equip with knowledge of biomaterials used in dental, orthopaedics, 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

TEXTBOOKS:

3. A.K. Bajpai, Jaya Bajpai, "Smart biomaterial devices - Polymers in Biomedical Sciences", CRC Press, 2017.
4. Vinod B. Damodaran, Divya Bhatnagar, N. Sanjeeva Murthy "Biomedical Polymers Synthesis and Processing", SpringerBriefs in Applied Sciences and Technology, 2016.
5. Munmaya K. Mishra, "Encyclopedia of Biomedical Polymers and Polymeric Biomaterials, 11 Volume Set", CRC Press, 2015.
6. C. M. Agrawal, "Introduction to biomaterials basic theory with engineering applications", Cambridge University Press, 2014.
7. 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 to

- Define biomaterials and their compatibility with the human body system.
- Describe the design, manufacture and requirements of various biomaterial implants.
- Select suitable methods for synthesis and process polymers for biomedical applications.
- Choose polymeric materials for dental applications.
- Distinguish biomaterials used for contact lenses and drug delivery systems.

		L	P	T	C
PECX 008	**IONIC POLYMERS**	**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 polystyrene, 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, photoresist 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

TEXTBOOKS:

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.

COURSE OUTCOMES:

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

- Identify the specific method to synthesize ionic polymers for electrical and electronic applications.
- Develop polyelectrolyte membranes for advanced applications.
- Analyze electrical properties of conducting polymers.
- Interpret data based on electroanalytic techniques.
- Identify the 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 nanomaterials
- To enrich the knowledge of students in various characterisation techniques and application in nanodevices and sensors fabrication
- To provide knowledge on applications of polymer based nano materials in biotechnology.

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 nanocomposites 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

TEXTBOOKS:

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 Niemeyer C.M, Mirkin C.A (Eds) 2005. Nanobiotechnology.

2 H.S. Nalwa (Ed) Handbook of Nanostructured Biomaterials and their applications in nanobiotechnology, American Scientific Publishers.2005.

COURSE 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 nanoparticles with appropriate methods applicable to individual materials.
- Acquire the knowledge of various methods of characterization of nanomaterials.
- Fabricate advanced semiconductors and electro-optic devices and sensors with nanomaterials by the knowledge acquired on different methods.
- Acquire knowledge on various nanomaterials and their functional properties from the performance of the devices.
- Apply the knowledge on properties of various polymer based nanomaterials in biotechnology.

PEC X010	**NANOMATERIALS TECHNOLOGY**	**L**	**P**	**T**	**C**
		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 of critical characterization techniques of nanomaterials
- To introduce the diversity of applications of the nanoparticles 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 the process. Handling of nano particles - Health hazards – Precautions.

MODULE: III PREPARATION METHOD - CHEMICAL 8

Chemical Methods of Preparation: Sol-gel method –Gel combustion - Co-precipitation 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 - Quantum Dot (QD) Sensitized Solar Cells (QD-SSC) - Smart Coatings (Self Cleaning) - Superhydrophobic 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

TEXTBOOKS:

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 Biomaterials and their applications in nanobiotechnology, American Scientific Publishers.2005.

COURSE OUTCOMES:

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

- Acquire the knowledge of the 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 nanomaterials.

- Apply the knowledge of various critical and advanced techniques to characterize nanoparticles..
- Apply the knowledge gained in different types of nanomaterials for various engineering applications.
- Synthesize and apply the knowledge of the various nano carbons and polymer nanofibres in advanced material technologies and bioengineering.
- Characterize various nanomaterials using advance characterization techniques.

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 waveguides, piezo sensors and pyro sensors.

MODULE: I **INTRODUCTION** **7**

Introduction of Polymer Classification: Insulators, Ionically conducting polymers - Electronically conducting polymers – Conductivity Ranges. Mechanism of electrical behaviour: 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: Polyimides-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

TEXTBOOKS:

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 Wiley & 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.

COURSE 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 optoelectronic industry.
- Select, modify, design materials and apply acquired knowledge in processing technology to deliver the relevant item for electronic Industries.

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 a 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

TEXTBOOKS:

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.

COURSE 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 – Miscellaneous Products – Crystalline PVC- Chlorinated PVC – Graft polymers based on PVC –Vinyl chloride – propylene copolymers –Vinyl chloride- N- cyclohexyl maleimide copolymers.

L – 15; T – 0; Total Hours – 15

TEXTBOOKS:

1 J.A Brydson, “Plastics Materials”, Fifth edition, Elsevier, 2013

2 M.V. Titow, “PVC Technology”, Springer Science & Business Media, 2012

REFERENCES:

1 Nicholas P. Chermisinof, “Hand Book of Engineering Polymeric Materials”, Marcel Dekker Inc. N.Y. 1997.

OUTCOMES:

At the end of the course, the students will be able 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 FIBRE 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, the importance of moisture, the 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

TEXTBOOKS:

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 Nicholas P. Chermisinof, “Hand Book of Engineering Polymeric Materials”, Marcel Dekker Inc. N.Y. 1997

COURSE 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..
- Compare the properties of various types of nylons.

PECX 015	LATEX TECHNOLOGY	L	T	P	C
		1	0	0	1

OBJECTIVES:

- To provide fundamental knowledge of NR latex in terms of collection, storage and conversion into useful form.
- 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 coagulum, 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

TEXTBOOKS:

a. Rani Joseph, “Practical Guide to Latex Technology”, Smithers Rapra Technology Ltd, 2013.
b. 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 into a useful form.
- Suggest process to manufacture latex rubber products

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

TEXTBOOKS:

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.

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OUTCOMES:

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

- Apply the knowledge of thermoformed part design.
- Classify thermoforming machineries.

		L	P	T	C
PECX 017	**INJECTION MOULDING TECHNOLOGY**	**2**	**0**	**0**	**2**

Objectives:

- To impart knowledge of the injection moulding process and the parameters affect the process.
- To introduce computer-aided engineering and their use in the injection moulding process.
- To develop knowledge of auxiliary equipment and their role in the injection moulding process.
- To equip with knowledge of cost involved in the injection moulding 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-mould shrinkage, minimizing moulded-in stress.

MODULE: II CAE IN INJECTION MOLDING 9

CAE and its types, simulation and polymer processing - injection moulding - physics of injection moulding - material complexity, geometric complexity, process stability, value of simulation - current technology for injection- moulding simulation - filling and packing analysis, cooling analysis, fibre orientation analysis, predicting fibre 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 moulding cost - Material Costs, Labor Costs, Machine Costs, Tooling Costs - Secondary Operations cost.

L – 30; T – 0; Total Hours – 30

TEXTBOOKS:

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 moulding: theory and practice", Carl Hanser Verlag, Munich, 2010.

COURSE OUTCOMES:

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

- Demonstrate the injection moulding process and the parameters affect the process.
- Apply the knowledge of computer aided engineering and their use in the injection moulding process.
- Identify and select auxiliary equipment for the injection moulding process.
- Estimate the cost involved in the injection moulding process.

PECX 018 EXTRUSION TECHNOLOGY

L	T	P	C
2	0	0	2

OBJECTIVES:

- To impart knowledge of extrusion moulding 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 - multi-screw extruder - twin screw extruder, multi-screw 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

TEXTBOOKS:

- 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.

COURSE OUTCOMES:

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

- Demonstrate the extrusion moulding 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 the necessary instrumentation and control system in an extruder.

		L	P	T	C
PECX 019	**BLOW MOULDING TECHNOLOGY**	**2**	**0**	**0**	**2**

Objectives:

- To impart fundamental knowledge of blow moulding process.
- To equip with knowledge of extrusion blow moulding process.
- To develop knowledge of injection stretch blow moulding process.
- To illustrate the various troubleshooting process of blow moulding.

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, mould closed, stretch rod engages, pre blow 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 - pre blow pressure control - changing preform temperatures - output control - troubleshooting of specific problems - internal folding in the neck area, candlestick, off-center gate, haze in bottle walls, stress whitening, deformed necks, under blown 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

TEXTBOOKS:

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 moulding, CRC Press, 2007.

REFERENCES:

i. Norman C. Lee, "Practical Guide to Blow Moulding", Rapra Technology Limited, 2006.

COURSE OUTCOMES:

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

- Demonstrate the different types of the blow moulding process.
- Describe the parison wall thickness control and parison programming process.
- Demonstrate the various steps involved in stretch blow moulding process and compare the EBM and SBM techniques.
- Identify and use relevant troubleshooting procedure to solve the moulding defects.

		L	P	T	C
PECX 020	**POST PROCESSING OPERATIONS**	**2**	**0**	**0**	**1**

Objectives:

- To provide understanding of post processing operations.
- To impart knowledge on the 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.
3. Akira Kobayashi, **“**Machining of Plastics”, McGraw-Hill, 1990.

REFERENCES:

1. Modern Plastic World Encyclopedia – 2000, Modern Plastics International.

8. Walter Michaeli, “Plastic Processing, an Introduction”, Hanser publications – Munich, 2005.

COURSE 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.

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PECX021	RUBBER PRODUCT MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop fundamental knowledge of rubber mixing machinery.
- 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 sports 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, moulding - compression moulding, transfer moulding, injection moulding, injection moulding of types.

MODULE II LATEX PRODUCT MANUFACTURING 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 FOOTWEAR & SPORTS GOODS MANUFACTURING 6

Types of footwear – plimsolls – build up shoes – all rubber shoes – DVP shoes – dip shoes – plastic footwear manufacturing by slush moulding – injection moulded PVC shoes - injection moulding of sole and heel units – expanded microcellular soling – methods of manufacturing microcellular soling – troubleshooting.

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 examples - 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

TEXT BOOKS:

- Richard F. Grossman, "The Mixing of Rubber", Chapman & Hall, 1997.
- Rani Joseph, "Practical Guide to Latex Technology", Smithers Rapra Technology Ltd, 2013.
- Saikat Dasgupta, " Reverse Engineering of Rubber Products, Concepts, Tools, And Techniques", Taylor & Francis Group, 2014
- A.K. Bhowmick, M.M. Hall and H.A. Benaney, “Rubber Products Manufacturing Technology”, Marcel Dekker Inc, New York, 1994.

REFERENCES:

- Blow. C.M. and Hepburn C, “Rubber Technology and Manufacture”, Butterworths, 1982.
- 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 sports 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 machinery.
- To impart knowledge of mixing procedure for different compounds.
- To provide knowledge of calendaring and extrusion process.
- To illustrate the moulding 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 – piggyback extruders - Twin screw extruder – Criteria for machine selection.

MODULE IV MOULDING OPERATIONS 6

Injection moulding of rubbers - machine construction, screw design, mould construction, moulding defects and rectification.

Compression, transfer moulding - 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, pipelining, 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

TEXTBOOKS:

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 machinery.
- Identify and suggest suitable mixing procedure for different compounds.
- Demonstrate the calendaring and extrusion process.
- Explain injection, transfer and compression moulding of rubbers.
- Describe different vulcanisation methods used in rubber processing.
- Suggest processing methods for various rubber products.

PECX023	TYRE MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart interest and sense of appreciation of all about the pneumatic tyre.
- To educate the students in respect of tyre components and construction of a pneumatic tyre.
- To provide insight into 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 behaviour.

MODULE IV TYRE CORD REINFORCEMENTS 8

Tyre cords – Physical Properties of tyre-cords- Rayon, Nylon, Polyester, Fibreglass, 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

TEXTBOOKS:

- 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.

PECX 025	PLASTIC WASTE MANAGEMENT	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 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, rubber 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

- 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, thermoset and elastomeric wastes.

GROUP III (Product & Mould Design)

		L	P	T	C
PECX026	**COMPUTER AIDED MODELING**	**2**	**0**	**0**	**2**

Objectives:

- To make a list of computer hardware requirement for executing computer-aided modelling.
- To impart knowledge on various computer graphics techniques used for computer-aided designing.
- To prepare and explain different types of geometric modelling techniques used for computer-aided modelling.
- To demonstrate the various techniques of drafting in computer-aided modelling.

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 modelling, transformation of geometry, 3D transformations, mathematics of projections, clipping, hidden surface removal

Module: III GEOMETRIC MODELLING 10

Geometric modelling: Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modelling facilities desired

Module: IV DRAFTING 8

Drafting and Modelling systems: Basic geometric commands, layers, display control commands, editing, dimensioning, solid modelling, constraint-based modelling.

Total 30 hrs.

COURSE OUTCOMES:

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

- Prepare a list of computer hardware requirement for executing computer-aided modelling.
- Demonstrate the knowledge of various computer graphics techniques used for computer-aided designing.
- Explain different types of geometric modelling techniques used for computer-aided modelling.
- Demonstrate the various techniques of drafting in computer-aided modelling.

TEXTBOOKS:

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.

		L	P	T	C
PECX027	**COMPUTER AIDED MANUFACTURING**	**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 centre, turning centre, 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, Retrieval type and generative type. Material requirement planning, manufacturing resources planning.runner mould.

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.

COURSE 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 production planning for the material requirement and manufacturing resources.
- To predict the benefits of computer integrated manufacturing in industrial applications.

TEXTBOOKS:

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.

		L	T	P	C
PECX 028	**DESIGN OF COMPOSITE STRUCTURES**	**2**	**0**	**0**	**2**

OBJECTIVES:

- To introduce the various materials for the 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.

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

TEXTBOOKS:

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 Decker,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.

PECX029	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 mechanism 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 mechanism and circuits in troubleshoot problems in injection moulding process.
- Appreciate the fundamentals of pneumatic systems.

PECX030	**RAPID PROTOTYPING**	**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

Stereolithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photopolymerization, 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

TEXTBOOKS:

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 toolbox 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.

COURSE OUTCOMES:

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

- Explain the various terminology used in rapid prototyping
- Apply Fused Deposit Model in rapid prototyping
- Design prototype models using powder-based prototyping systems
- Use the rapid prototyping technique in the various field of Engineering

		L	P	T	C
PECX031	**FAILURE ANALYSIS OF POLYMERS**	**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 thermal – 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.

COURSE 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 thermal – oxidation issues.
- To evaluate the failure of plastic materials due to chemical attack.

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.

		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 mould 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 mould making. Electroforming for mould manufacturing - discussion of the process, materials for electroforming, machining for electroformed blanks

Module: III — HOBBING PROCESS OF MOULD MANUFACTURING — 6

Hobbing for mould 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.

TEXTBOOKS:

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

2 P.Radhakrishnan and S.Subramanian, "CAD/CAM/CIM", 3rd edition. New Age International, 2009.

COURSE 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 advanced 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)

		L	T	P	C
PECX 033	**BIOCOMPOSITE TECHNOLOGY**	**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 of application of bioplastics.

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. The 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 (CO2 & CH4) Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fibre reinforcement (short and long fibres, fibres 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 Biomaterials 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

TEXTBOOKS:

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.

COURSE OUTCOMES

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

- Identify genetically modified bioplastics.
- Identify relevant surface preparation method and application techniques based on biodegradation.
- Identify various methods to assess the quality of biodegradability.
- Select suitable type of biomaterials for specific applications.

		L	T	P	C
PECX 034	**MECHANICS OF COMPOSITES**	**2**	**0**	**0**	**2**

OBJECTIVES:

- To introduce the basics of macro and micromechanical behaviour of a lamina.
- To impart knowledge about the 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 MICROMECHANICAL 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, antisymmetric 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

TEXTBOOKS:

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 Decker,1988.

REFERENCES:

1. M.Mukhopadhyay, “Mechanics of Composite Materials and Structures”, Universities Press, 2005.

COURSE OUTCOMES:

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

- Analyze the stress-strain relationships of macro and micromechanical behaviour 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 the 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 Decker,1988

COURSE 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.

		L	T	P	C
PECX 036	**POLYMER BLENDS AND ALLOYS**	**2**	**0**	**0**	**2**

OBJECTIVES:

- To provide an understanding on the miscibility of polymers and phase morphology of blends
- To provide an understanding of 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 Compatibilisation 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, methods of formation of IPNs, properties and uses, the 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, the 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.

COURSE OUTCOMES:

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

- Select the appropriate combination of polymers to have required synergistic property in the polymer blend.
- Predict the suitable compatibilizer for enhancing the miscibility of immiscible blends.
- Understand phase morphology of miscible and immiscible blends.
- Demostrate the knowledge of selecting the right choice of equipment for blending of polymers.
- To analyse and characterize the morphological behaviour of polymer blends

		L	T	P	C
PECX 037	**BASICS OF PAINT TECHNOLOGY**	**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 colour mixing, subtractive colour mixing, gloss, specular gloss, bloom gloss, surface uniformity, chromaticity diagrams for colour measurement.

L – 15; T – 0; Total Hours –15

TEXTBOOKS:

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.

		L	T	P	C
PECX 038	**BASICS OF ADHESIVES TECHNOLOGY**	**1**	**0**	**0**	**1**

OBJECTIVES:

- To impart knowledge of various types of adhesives and 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. Speciality 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

TEXTBOOKS:

1. Gerald L. Schonberger, “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, “Handbook of adhesives”, Butterworth’s, 1984.

COURSE 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.

		L	T	P	C
PECX 039	**SURFACE COATING TECHNOLOGY**	**2**	**0**	**0**	**2**

OBJECTIVES:
- To develop an understanding of properties 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, fluoropolymers, 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 - colour, gloss, hiding power, ageing properties -factors affecting viscosity of paints - effect of rheological behaviour 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

TEXTBOOKS:

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, "Handbook of adhesives", Butterworth's, 1984.

REFERENCES:

4. Arthur A. Tracton, Coating Technology Handbook, Third Edition, Taylor and Francis, 2005.

5. George Mathews, "Polymer Mixing Technology", Applied Science Publishers. London, 1982.

COURSE OUTCOMES:

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

- Analyse 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.

		L	P	T	C
PECX040	**PLASTIC PACKAGING TECHNOLOGY**	**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 of 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 Shrinkwrap, 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:

- Mark J.Kirwar, “Paper And Paperboard Packaging Technology”, Blackwell Publishing, 2005
- “Handbook Of Package Design Research”, Water Stem Wiley Interscience, 1981.
- Paine, “Packaging Development”, PIRA International, 1990.
- Arthur Hirsch, “Flexible Food Packaging”, Van Nostor And Reinhold, New York, 1991.
- Susan E.M.Salke & Et Al, Plastics Packaging, Hansar, 2nd Edition 2004.
- 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.

COURSE 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 the suitable polymer material and technology for manufacturing of a specific type of packaging.
- Analyse the quality of 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 help students to acquire the properties and applications of conducting and semiconducting materials.
- To familiarize students with basic ideas about the properties of dielectric and magnetic materials and their applications.
- To familiarize students with basic knowledge of nanomaterials and its electrical, electronic, mechanical and magnetic properties.
- 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 concentration, 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 Ferroelectric Random Access Memory (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, graphene - nanocomposites – applications of nanomaterials.

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 the RC circuit.
5. Determination of paramagnetic susceptibility of a given liquid.
6. Determination of hysteresis loss in a transformer using the BH curve.
7. Analysis of size effect on the absorption spectrum of nanomaterials.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. William D. Callister, “Material Science and Engineering”, Wiley Publications, 2006.
2. Raghavan, V., “Materials Science and Engineering”, 5th edition, Prentice 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

- apply the concepts of conducting and semiconducting materials for solid state devices.
- comprehend the significance of properties of dielectric magnetic materials and derive these properties from synthesized materials.
- differentiate between the properties of the nanomaterials compared to bulk materials.
- 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 to 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 of 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 and available energy – temperature-entropy diagram for Carnot's cycle - Third Law of thermodynamics (qualitative).

PRACTICALS

1. Determination of mechanical equivalent of heat by Joule's calorimeter.
2. Relation between the 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 good conductor-Forbe's method
5. Determination of thermal conductivity of a bad conductor-Lee's disc method

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Mathur. D.S, "Heat & Thermodynamics", S.Chand & Co., 2009.
2. Brijlal & Subramaniam, "Heat and Thermodynamics", S.Chand & Co, Delhi, 2010.
3. Gupta. A.B and Roy. H, "Thermal Physics", Books and Allied Ltd., 2002.
4. 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.
- apply the knowledge 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 synthesis and 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, grapheme - 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

Photolithography - electron beam lithography - X-ray and Ion beam lithography - nanoimprint lithography - soft lithography -

nanoelectromechanical systems (NEMS) - nanoindentation principles.

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.

L – 30; P – 30; TOTAL HOURS – 60

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. Gadd and. W., Brenner. D., Legerski. 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 fibre optics as channel.

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.

L – 30; P – 30; TOTAL HOURS – 60

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 the 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 basic understanding of properties and applications of dielectric materials.
- To impart knowledge of 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 10

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 6

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 7

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 - Photodetectors : 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 given semiconductor material.
4. Determination of 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; P – 30; TOTAL HOURS – 60

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 the fundamentals of conducting and semiconducting materials.
- Understand the concepts and applications of Dielectric and 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 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.

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.

L – 30; P – 30; TOTAL HOURS – 60

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 the acoustic of the 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.

MODULE 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 photoelasticity - Photo elastic coatings.

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 photoelastic 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 acoustically good auditorium and identifying the sound absorbing materials in the auditorium.

L – 30; P – 30; TOTAL HOURS – 60

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 the viscosity of liquid and measurement.
- demonstrate the acoustical aspects of building and its importance in construction.
- apply the fundamental concept of photoelasticity 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 the 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.

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.
   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 the flywheel.

L – 30; P – 30; TOTAL HOURS – 60

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 concept of elasticity of materials.
- comprehend the basic concepts of motion of rigid bodies and their applications.
- demonstrate the various NDT techniques and their importance.
- know 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 the 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 Electrooptic Modulators: Kerr and Pockel modulators –- Magneto-optic effect - Magneto-optic Modulators – Acousto Optic modulators.

MODULE IV OPTICAL DETECTORS 8

Photodetectors - 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.

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 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.

L – 30; P – 30; TOTAL HOURS – 60

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-meter – 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

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 colourimetric 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.

L – 30; P – 30; TOTAL HOURS – 60

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:

The students should be conversant with the

- 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 an inorganic coating

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 embrittlement, decarburization and hydrogen attack – corrosion of silver and copper by sulphur compounds – liquid metal corrosion (embrittlement 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.

PRACTICALS

1. Determination and comparison of the rate of corrosion of metals in the presence of acid, base and neutral medium by weight loss method.
2. Determination of the 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. Electroless plating of base metal with copper
7. Chemical conversion coatings such as chromate and phosphate coatings.
8. Demonstration on the study of the rate of corrosion by using cyclic voltammetry.

L – 30; P – 30; TOTAL HOURS – 60

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:

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 on 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:

The students should be 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).

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
7. using UTM
8. Demonstration of electrical properties of insulating materials
9. Construction of batteries using natural resources
10. Measurement of EMF for different batteries.

L – 30; P – 30; TOTAL HOURS – 60

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 on the different types of fuel cells.

CHCX04	**ENGINEERING MATERIALS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES:

The students should be conversant with

- properties and uses of different types of refractories and abrasives
- adhesives, cement and lime, the setting of cement and their chemical behaviours.
- 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 7

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 – waterproof 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 8

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.

PRACTICALS

1. Preparation of refractory bricks
2. Preparation of abrasive papers/cloth
3. Preparation of simple adhesives
4. Estimation of alkalinity in cement
5. Determination of cloud point and pour point
6. Determination of flash point and fire point
7. Preparation of fibre-reinforced composite

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).
2. B.Sivasnakar, “Engineering Chemistry”, Tata McGraw-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.

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 the internal combustion engine – Demonstration

L – 30; P – 30; TOTAL HOURS – 60

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, volatile matter, ash content, calorific value etc
- calculate the 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:

The students will be 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 - 1st law of thermodynamics: internal energy, enthalpy, heat capacity, isothermal and adiabatic expansion, Joule-Thomson effect - Zeroth law of thermodynamics: absolute temperature - 2nd law of thermodynamics: - spontaneous and cyclic process, Entropy in isothermal, isobaric and isochoric processes, work and free energy function, Maxwell's relation - 3rd 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 examples - adsorption of gases on solids and surface area measurement by BET method - Terms in catalysis - homogeneous and heterogeneous and enzyme catalysis with examples.

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.

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 first and second-order reactions.*
4. Phase rule experiments with organic compounds: (i) naphthalene and p-dichlorobenzene (ii) naphthalene and diphenyl (iii) m-dinitrobenzene and p-nitrotoluene.

L – 30; P – 30; TOTAL HOURS – 60

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 cause hazards to human health
- chemicals that harm 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 wastewater 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 – eco-friendly batteries & fuel cells.

PRACTICALS

1. Synthesis of 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).

L – 30; P – 30; TOTAL HOURS – 60

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 the 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 OF 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.

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.

L – 30; P – 30; TOTAL HOURS – 60

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.

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.

L – 30; P – 30; TOTAL HOURS – 60

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)

		L	T	P	C
MACX 01	**DISCRETE MATHEMATICS AND GRAPH THEORY**	**3**	**1**	**0**	**4**

OBJECTIVES:

The aims of this course are to

- introduce Logical and Mathematical ability to deal with abstraction.
- familiarize the basic mathematical ideas and terminologies used in computer science.
- 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 the 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

TEXTBOOKS:

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.

REFERENCES:

1 Ralph.P.Grimaldi, "Discrete and Combinatorial Mathematics: An Introduction", 4th Edition, Pearson Education Asia, Delhi, 2007.
2 Thomas Koshy, "Discrete Mathematics with Applications", Elsevier Publications, 2006.
3 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, the 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

TEXTBOOKS:

1. T.Veerarajan, “Probability and Statistics”, Tata McGraw-Hill Education, 2008.
2. Miller, I., Miller, M., Freund, J. E., “Mathematical statistics”, 7th Edition, Prentice Hall International, 1999.
3. S.P.Gupta, “Applied Statistics”, Sultan Chand & Sons

REFERENCES:

1. S.M.Ross, “Introduction to Probability and Statistics for Engineers and Scientists” Fifth Edition, Elsevier.
2. S.C.Gupta and V.K.Kapoor, “Fundamentals of Mathematical Statistics” First edition, Sultan Chand and Sons.
3. Arora and Arora, “Comprehensive Statistical Methods”, S. Chand, 2007

OUTCOMES:

On completion of the course, students will be able to

- Solve basic problems on probability and descriptive statistics.
- Derive the probability mass/density function of a random variable.
- calculate probabilities and derive the marginal and conditional distributions of bivariate random variables.
- Calculate point and interval estimates.
- Apply some large sample tests and small sample tests.
- 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 their distributions.
- introduce the random process, stationarity, Markov process and the study of the 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

TEXTBOOKS:

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, Elsevier

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 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

TEXTBOOKS:

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

- solve algebraic, transcendental and system of equations.
- apply interpolation techniques.
- carry out numerical differentiation and integration using different methods.
- solve first order ODE using single and multi-step methods.
- solve second order ODE, initial and boundary value problems.
- 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

TEXTBOOKS:

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

- Formulate industrial problems as mathematical programming problems.
- Solve linear programming problems with different methods.
- Solve transportation problems through different methods.
- Solve 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

- develop and test the hypothesis for different statistical tests
- design an experiment and case study the experiment with different data.
- analyze the industrial data using quality control design tools statistically.
- 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:

- 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

TEXTBOOKS:

1. M.K.Jain, S.R.K.Iyengar, R.K.Jain, "Numerical methods for Scientific and Engineering Computation", New Age International Publishers, New Delhi, 2003.
2. Grewal, B.S., "Numerical methods in Engineering and Science" 7th 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 the numerical solution of ordinary differential equations in engineering problems.
- find the numerical solution of partial differential equations in engineering problems.

MACX 08	**MATHEMATICAL MODELLING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

The aims of the course are to

- provide basic idea of formation and use of Mathematical models for different purposes.
- 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

L	**T**	**P**	**C**
2	**0**	**0**	**2**

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

TEXTBOOKS:

1. G . Ledder, “Calculus, modelling, probability and dynamic systems”, Springer 2013
2. 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 the 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
		3	0	0	3

OBJECTIVES:

The aims of this course are to

- represent 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

TEXTBOOKS:

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)

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 the 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 economic growth.

L – 30; T – 0; Total Hours –30

TEXTBOOKS:

1. Dutt and Sundharam (2013), *Indian Economy*, S. Chand & Company Pvt. Ltd, New Delhi.
2. Hussain, Moon Moon (2015), *Economics for Engineers*, Himalaya Publishing House, New Delhi.

REFERENCES:

1. Cleaver Tony (2004), "*Economics: The Basics*", Routledge, London.
2. 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 the 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

TEXTBOOKS:

1. Giddens A. 1989. “Sociology” Cambridge: Polity Press.
2. Heald Haralambos, R.M(2014). ‘‘Sociology Themes and Perspectives”, Oxford, New Delhi-92
3. Bhushan Vidya and D.R. Sachdeva (2012). ‘‘Fundamental of Sociology”, Pearson, Delhi.

REFERENCES:

1. Das Gupta, Samir and Paulomi Saha (2012), ‘‘An Introduction to Sociology”, Pearson, Delhi
2. 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 a 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 the social problem facing 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 workplace; 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:

1. Sharma,K.L.2008. *Indian Social Structure and Change*. Jaipur: Rawat Publications,.
2. Shah, A.M. 1998. *The Family in India: Critical Essays*. New Delhi: Orient Longman,
3. Ahuja Ram. 1999. *Social problems in India*, Rawat Publication: New Delhi.
4. 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,

- Students will gain an in-depth understanding of the social structure and social institutions that constitute a society in India.
- Students will be sensitized to the various categories, Inequalities and their challenges
- Students will be exposed to the social problems encountered in contemporary India.
- Students will gain knowledge about the various forms and trends of social change.
- Students will become aware of the challenges in the path of progress of Indian society and realize the relevance of their role in bringing about the 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 increased awareness of the concept and components of sustainable development.
- To develop the ability to demonstrate the need for 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, Coexistence 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

TEXTBOOKS:

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 of the challenges of sustainable development and International responses to environmental challenges.
- The students will have gained knowledge of the global environmental 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 the corporate sector.
- To explain the structure and functions of industrial organizations.
- To elucidate the dynamics of organizational behaviour, 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

TEXTBOOKS:

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:

1. Robbins, Stephen, Organizational Behaviour, Prentice Hall of India PVT Ltd new Delhi, 1985
2. Devis Keith, Human Behaviour at workplace, Mc. Graw Hill Publishing Co., New Delhi,1984

OUTCOMES:

On successful completion of this course,

- Students will have acclimatized with sociological perspectives for dealing with social relationships in production and service organizations.
- Students will be familiar with the structure of authority, roles and responsibility in organizational settings.
- Students will imbibe leadership, communication and behavioural acumen to govern the organization
- Students will be sensitized to standards of desirable behaviour to engage in the industrial and corporate sector.

SSCXO6	**LAW FOR ENGINEERS**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

OBJECTIVES:

- To understand the Constitution and Governance of our country.
- To apprise the students of human rights - local and international and redressal mechanism.
- To have an insight into the industrial, corporate and labour laws of our country.
- To establish a clear understanding of 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

TEXTBOOKS:

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,

- Students will `be able to apply the basic concepts of Indian Constitution, Governance and power in their real-life situation.
- Students will have gained knowledge in human rights, cultural, social and political rights.
- Students will have synthesized knowledge about industrial, corporate and labour laws of our country.
- Students will have an overview of IPRs and laws related to Intellectual Property Rights.