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

Regulations 2021
Curriculum and Syllabi
(Updated upto September 2024, as per 22nd Academic Council)

B.Tech.
(Polymer Engineering)

REGULATIONS 2021

CURRICULUM AND SYLLABI

(Updated upto September 2024, as per 22nd Academic Council)

B.TECH. POLYMER ENGINEERING

VISION AND MISSION OF THE INSTITUTION

VISION

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

MISSION

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

DEPARTMENT OF POLYMER ENGINEERING

VISION AND MISSION

VISION

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

MISSION

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

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

B.TECH. (POLYMER ENGINEERING)

PROGRAMME EDUCATIONAL OBJECTIVES

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

PROGRAMME OUTCOMES

On successful completion of the programme, the graduates will

- apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- identify, formulate, research literature, and analyses complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- use research –based knowledge and research methods including design of experiments, analysis and interpretation of

data and synthesis of the information to provide valid conclusions.

- create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
- synthesis polymers by using various techniques and characterize their physical properties.
- select polymers, formulate them for specific applications and characterize the performance properties.
- process plastics, rubbers and composites materials to various components and products.
- design and analyze moulds and plastic products to meet the needs of the industries.

REGULATIONS - 2021
B.TECH. DEGREE PROGRAMMES

(Under Choice Based Credit System)

(Amendments Approved by the 19th Academic Council – September 2022)

1.0 PRELIMINARY DEFINITIONS & NOMENCLATURE

In these Regulations, unless the context otherwise requires:

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

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

iii) **"Course"** means theory / practical / laboratory integrated theory / seminar / internship / project and any other subject that is normally studied in a semester like English, Mathematics, Environmental Science, Engineering Graphics, Electronic Devices etc.,

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

v) **"Academic Council"** means the Academic Council, which is the apex body on all academic matters of this Institute.

vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of the Institution who is responsible for the implementation of relevant rules and regulations for all the academic activities.

vii) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of the Institution who is responsible for activities related to student welfare and discipline in the campus.

viii) **"Controller of Examinations"** means the Controller of Examinations of the Institution who is responsible for the conduct of examinations and declaration of results.

ix) **"Dean of the School"** means the Dean of the School of the department concerned.

x) **"Head of the Department"** means the Head of the Department concerned.

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) The student shall have studied at least any three of the following courses: Physics, Mathematics, Chemistry, Computer Science, Electronics, Information Technology, Biology, Informatics Practices, Biotechnology, Technical Vocational Subjects, Agriculture, Engineering Graphics, Business Studies, Entrepreneurship at 10+2 level. In case if the student has not studied any or all the courses viz., mathematics, physics and chemistry, he / she shall undergo bridge course(s) in the concerned course(s) at 10+2 level knowledge.

2.2 Notwithstanding the qualifying examination, the candidate might have passed at 10+2, 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 the courses considered eligible for admission on the standards prescribed for 10+2 academic stream.

2.3 Candidates for admission to the third semester of the eight semester B.Tech. programme under lateral entry category shall be required to have passed minimum Three years / Two years (Lateral Entry) Diploma examination in any branch of Engineering / Technology or passed B.Sc. Degree from a recognized University as defined by UGC and passed 10+2 examination with Mathematics as a subject or Passed three year Diploma of Vocation Stream (D.Voc) in the same or allied sector or any other examination of any other authority accepted by the Institution as equivalent thereto.

2.4 The Institution shall offer suitable bridge courses in Mathematics, Physics, Engineering drawing, etc., for the students of diverse backgrounds.

2.5 The eligibility criteria such as marks, number of attempts and physical fitness shall be as prescribed by the Institution in adherence to the guidelines of regulatory authorities 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.

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

4.0 STRUCTURE OF THE PROGRAMME

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

i) Basic Science Courses - BSC
ii) Humanities and Social Sciences including Management Courses - HSC
iii) Engineering Science Courses - ESC
iv) Professional Core Courses - PCC
v) Professional Elective Courses - PEC
vi) Open Elective Courses - OEC
vii) Laboratory Courses – LC
viii) Laboratory Integrated Theory Courses – LITC
ix) Mandatory Courses- MC
x) Project - PROJ (Project work, seminar and internship in industry or at appropriate workplace)

4.1.1 Mandatory Induction Programme for First year Students

The first year students upon admission shall undergo a mandatory three week induction programme consisting of physical activity, creative arts, universal human values, literary, proficiency modules, lectures by eminent people, visits to local areas, familiarization with departments / schools and centres, etc.,

4.1.2 Personality and Character Development

All students shall enroll, on admission, in any of the following personality and character development programmes:

- National Cadet Corps (NCC)
- National Service Scheme (NSS)
- National Sports Organization (NSO)
- Youth Red Cross (YRC)
- Rotaract
- Crescent Indian Society Training Development (ISTD–C)
- Crescent Creative Strokes
- Crescent Technocrats club

The training activities / events / camp shall normally be organized during the weekends / vacation period.

4.1.3 Online Courses for Credit Transfer

Students are permitted to undergo department approved online courses under SWAYAM up to 40% of credits of courses in a semester excluding project semester with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean (Academic Affairs) during his / her period of study. The credits earned through online courses ratified by the respective Board of Studies shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

4.1.4 Value Added Courses

The students are permitted to pursue department approved online courses (excluding courses registered for credit transfer) or courses offered / approved by the department as value added courses.

The details of the value added course viz., syllabus, schedule of classes and the course faculty shall be sent to the Dean (Academic Affairs) for approval. The students may also undergo the valued added courses offered by other departments with the consent of the Head of the Department offering the course.

These value added courses shall be specified in the consolidated mark sheet as additional courses pursued by the student over and above the curriculum during the period of study.

4.1.5 Industry Internship

The students shall undergo training for a period as specified in the curriculum during the summer vacation in any industry relevant to the field study.

The students are also permitted to undergo internship at research organizations / eminent academic institutions for the period prescribed in the curriculum during the summer vacation, in lieu of Industrial training.

In any case, the student shall obtain necessary approval from the Head of the Department / Dean of School and the training has to be taken up at a stretch.

4.1.6 Industrial Visit

The student shall undergo at least one industrial visit every year from the second year of the programme. The Heads of Departments / Deans of Schools shall ensure the same.

4.2 Each course is normally assigned certain number of credits:

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

4.3 Each semester curriculum shall normally have a blend of lecture courses, laboratory courses, laboratory integrated theory courses, etc.

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 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 students).

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

5.3 The maximum duration for completion of the programme as mentioned in clause 5.1 shall also include period of break of study vide clause 7.1 so that the student may be eligible for the award of the degree.

6.0 REGISTRATION AND ENROLLMENT

6.1 The students of first semester shall register and enroll for courses at the time of admission by paying the prescribed fees. For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

6.2 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.

6.3 Withdrawal from a Course

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

7.0 BREAK OF STUDY FROM PROGRAMME

7.1 A student may be allowed / enforced to take a break of study for two semesters from the programme with the approval of Dean (Academic Affairs) for the following reasons:

7.1.1 Medical or other valid grounds

7.1.2 Award of ‘I’ grade in all the courses in a semester due to lack of attendance

7.1.3 Debarred due to any act of indiscipline

7.2 The total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 5.1).

7.3 A student who has availed a break of study in the current semester (odd/even) can rejoin only in the subsequent corresponding (odd/even) semester in the next academic year on approval from the Dean (Academic affairs).

7.4 During the break of study, the student shall not be allowed to attend any regular classes or participate in any activities of the Institution. However, he / she shall be permitted to enroll for the 'I' grade courses and appear for the arrear examinations.

8.0 CLASS ADVISOR AND FACULTY ADVISOR

8.1 Class Advisor

A faculty member shall be nominated by the Head of the Department as class advisor for the class throughout the period of study except first year.

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

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

8.2 Faculty Advisor

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

9.0 COURSE COMMITTEE

9.1 Each common theory course offered to more than one group of students shall have a "Course Committee" comprising all the course faculty teaching the common course with one of them nominated as a course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending on whether all the course faculty teaching the common course belong to a single department or from several departments. The course committee shall ensure preparation of a common question paper and scheme of evaluation for the tests and semester end examination.

10.0 CLASS COMMITTEE

A class committee is constituted branch wise and semester wise by the Head of the Department / Dean of the School shall normally comprise of faculty members handling the classes, student representatives and a senior faculty member not handling the courses as chairman.

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

i) The first year coordinator shall be the chairman of the class committee

ii) Faculty members of all individual courses of first / second semester

iii) Six student representatives (male and female) of each class nominated by the first year coordinator

iv) The class advisor and faculty advisors of the class

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

i) One senior faculty member preferably not handling courses for the concerned semester appointed as chairman by the Head of the Department

ii) All the faculty members handling 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

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

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

10.5 The third meeting of the class committee, excluding the student members, shall meet after the semester end examinations to analyse 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 course faculty concerned.

11.0 CREDIT LIMIT FOR ENROLLMENT & MOVEMENT TO HIGHER SEMESTER

11.1 A student can enroll for a maximum of 32 credits during a semester including Redo / Predo courses.

11.2 The minimum credits earned by the student to move to 7th semester shall not be less than 60 credits (40 credits for lateral entry students).

12.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

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

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

12.2 Theory Course

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

12.3 Laboratory Course

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

12.4 Laboratory Integrated Theory Courses

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 components shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical components shall be through continuous assessment.

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

12.6 Industry Internship

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

12.7 Project Work

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

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

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

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 components.

13.0 SUBSTITUTE EXAMINATIONS

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

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

14.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

14.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% 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.

14.2 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 the concerned course to the class advisor. The class advisor shall 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 the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end examination in each course.

14.3 If a student secures attendance between 65% and less than 75% in any course in a semester, due to medical reasons (hospitalization / accident / specific illness) or due to participation in the institution approved events, the student shall be given exemption from the prescribed attendance requirement and the student shall be permitted to appear for the semester end examination of that course. In all such cases, the students shall submit the required documents immediately after joining the classes to the class advisor, which shall be approved by the Head of the Department / Dean of the School. The Vice Chancellor, based on the recommendation of the Dean (Academic Affairs) may approve the condonation of attendance.

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

14.5 The student awarded "I" grade, shall enroll and repeat the course when it is offered next. In case of "I" 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 the Head of the Department / Dean of the School.

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

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

15.0 REDO COURSES

15.1 A student can register for a maximum of three redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the concerned department, based on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

15.2 The number of contact hours and the assessment procedure for any redo course shall be the same as regular courses, except there is no provision for any substitute examination and withdrawal from a redo course.

16.0 PASSING AND DECLARATION OF RESULTS AND GRADE SHEET

16.1 All assessments of a course shall be made on absolute marks basis. The class committee without the student members shall meet to analyse the performance of students in all assessments of a course and award letter grades following the relative grading system. 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	-
I	-

"W" - denotes withdrawal from the course
“I” - denotes inadequate attendance in the course and prevention from appearance of semester end examination
“U” - denotes unsuccessful performance in the course.

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

16.3 Upon awarding grades, the results shall be endorsed by the chairman of the class committee and Head of the Department / Dean of the School. The Controller of Examinations shall further approve and declare the results.

16.4 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 the Controller of Examinations. Subsequently, the Head of the Department / Dean of the 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 faculty member having expertise in that course as members. 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.

16.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from 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 C_i, is the number of credits assigned for the i^{th} course and GP_i is the Grade Point in the i[th] course,

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

Where n = number of courses

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

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

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

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

Percentage equivalent of marks = CGPA X 10

16.6 After successful completion of the programme, the degree shall be awarded to the students with the following classifications based on CGPA.

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

16.6.1 Eligibility for First Class with Distinction

- A student should not have obtained 'U' or 'I' grade in any course during his/her study
- A student should have completed the UG programme within the minimum prescribed period of study (except clause 7.1.1)

16.6.2 Eligibility for First Class

- A student should have passed the examination in all the courses not more than two semesters beyond the minimum prescribed period of study (except clause 7.1.1)

16.6.3 The students who do not satisfy clause 16.6.1 and clause 16.6.2 shall be classified as second class.

16.6.4 The CGPA shall be rounded to two decimal places for the purpose of classification. The CGPA shall be considered up to three decimal places for the purpose of comparison of performance of students and ranking.

17.0 SUPPLEMENTARY EXAMINATION

Final year students and passed out students can apply for supplementary examination for a maximum of three courses thus providing an opportunity to complete their degree programme. Likewise, students with less credits in VI semester can also apply for supplementary examination for a maximum of three courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in the even semester.

18.0 DISCIPLINE

18.1 Every student is expected to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

18.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the Head of the Department / Dean of the School concerned shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action. This committee shall also address the grievances related to the conduct of online classes.

19.0 ELIGIBILITY FOR THE AWARD OF DEGREE

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

i) Successfully earned the required number of total credits as specified in the curriculum of the programme of study within a maximum period of 14 semesters (12 semesters for lateral entry) from the date of admission, including break of study.

ii) Successfully completed the requirements of the enrolled professional development activity.

iii) No dues to the Institution, Library, Hostel, etc.

iv) No disciplinary action pending against him/her.

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

20.0 MINOR DEGREE PROGRAMMES OFFERED FOR STUDENTS

20.1 The students admitted in the following B.Tech. programmes can graduate with a minor degree, which is optional, along with a major degree:

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

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

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

		Aeronautical Engineering Polymer Engineering Automobile Engineering Civil Engineering Biotechnology Electrical and Electronics Engineering
8.	Robotics	Artificial Intelligence and Data Science Computer Science and Engineering (Cyber Security) Computer Science and Engineering (IoT) Computer Science and Engineering Information and Technology Civil Engineering Biotechnology Electrical and Electronics Engineering Electronics and Instrumentation Engineering
9.	3D Printing	Artificial Intelligence and Data Science Computer Science and Engineering (Cyber Security) Computer Science and Engineering (IoT) Computer Science and Engineering Information and Technology Biotechnology Electrical and Electronics Engineering Electronics and Instrumentation Engineering Electronics and Communication Engineering
10.	Electric Vehicles	Artificial Intelligence and Data Science Computer Science and Engineering (Cyber Security) Computer Science and Engineering (IoT) Computer Science and Engineering Information and Technology Civil Engineering Biotechnology Electronics and Communication Engineering
11.	Industrial Automation	Artificial Intelligence and Data Science Computer Science and Engineering(Cyber Security) Computer Science and Engineering (IoT)

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

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

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

21.0 POWER TO MODIFY

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

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B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE ANDTECHNOLOGY
B.TECH. POLYMER ENGINEERING

CURRICULUM FRAMEWORK, REGULATIONS 2021

(Choice Based Credit System)

SEMESTER I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BSC	PHD 1181	Applied Physics *	3	0	2	4
2.	BSC	CHD 1181	Engineering Materials and Applications *	3	0	2	4
3.	BSC	MAD 1181	Algebra and Differential Calculus	3	1	0	4
4.	ESC	GED 1101	Engineering Graphics	2	0	2	3
5.	ESC	GED 1102	Engineering Design	2	0	0	2
6.	ESC	GED 1103	Manufacturing Practices Laboratory**	0	0	2	1
7.	ESC	GED 1104	Programming for Problem Solving **	1	0	2	2
			Credits				**20#**

SEMESTER II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	HSC	END 1281	English for Engineers	3	0	0	3
2.	BSC		Physics Elective	2	0	0	2
3.	ESC	MAD 1283	Partial Differential Equations and Transforms *	3	1	0	4
4.	ESC	GED 1202	Basic Electrical and Electronics Engineering *	3	0	2	4
5.	ESC	GED 1201	Engineering Mechanics	3	1	0	4
6.	PCC	PED 1211	Basics of Machining*	2	0	2	3
7.	PCC	PED1212	Principles of Chemical Engineering*	2	0	2	3
8.	MC	GED 1206	Environmental Sciences	2	0	0	2
			Credits				**25**

SEMESTER III

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	HSC		Humanities Elective I	3	0	0	3
2.	BSC		Mathematics Elective	3	1	0	4
3.	PCC	PED 2101	Polymer Chemistry	3	0	0	3
4.	PCC	PED 2102	Polymer Physics	3	0	0	3
5.	PCC	PED 2103	Thermoset Materials Technology	3	0	0	3
6.	PCC	PED 2104	Science and Technology of Rubbers	3	0	0	3
7.	PCC	PED 2105	Biodegradable Polymers	3	0	0	3
8.	PCC	PED 2106	Polymeric Materials Analysis Laboratory**	0	0	2	1
9.	PCC	PED 2107	Polymer Synthesis Laboratory**	0	0	2	1
10.	HSC	GED 2101	Essential Skills and Aptitude for Engineers**	0	0	2	1
			Credits				**25**

SEMESTER IV

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	PED 2201	Thermoplastics	3	0	0	3
2.	PCC	PED 2202	Polymer Compounding Technology	3	0	0	3
3.	PCC	PED 2203	Rubber Processing Technology	3	0	0	3
4.	PCC	PED 2204	Analysis and Characterisation of Polymers	3	0	0	3
5.	PCC	PED 2205	Polymer Rheology	3	1	0	4
6.	PCC	PED 2206	Plastic Processing Technology	3	0	0	3
7.	PCC	PED 2207	Plastic Processing Laboratory**	0	0	2	1
8.	PCC	PED 2208	Polymer Characterization Laboratory**	0	0	2	1
9.	PEC		Professional Elective Course	3	0	0	3
10.	HSC	GED 2201	Workplace Skills and Aptitude for Engineers**	0	0	2	1
11.	MC	GED 2202	Indian Constitution and Human Rights	2	0	0	0
			Credits				**25**

SEMESTER V

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	HSC	MSD 3181	Fundamnetals of Entrepreneurship	3	0	0	3
2.	PCC	PED3101	Polymer Composites Engineering	3	0	0	3
3.	PCC	PED 3102	Polymer Blends and Nanocomposites	3	0	0	3
4.	PCC	PED 3103	Plastic and Rubber Testing Technology	3	0	0	3
5.	PCC	PED 3104	Polymer Reaction Engineering	3	0	0	3
6.	PCC	PED 3105	Rubber Processing Laboratory**	0	0	2	1
7.	PEC		Professional Elective Courses				6
8.	HSC	GED 3101	Communication Skills For Career Success**	0	0	2	1
9.	PROJ	PED 3106	InternshipI ##	0	0	0	1
			Credits				**24**

SEMESTER VI

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	HSC		Humanities Elective II	2	0	0	2
2.	OEC		Open Elective I	3	0	0	3
3.	BSC		Chemistry Elective	2	0	0	2
4.	PCC	PED 3201	Plastic and Rubber Product Design	3	0	0	3
5.	PCC	PED 3202	Polymer Testing Laboratory**	0	0	2	1
6.	PCC	PED 3203	Plastic Product Design Laboratory**	0	0	2	1
7.	PCC		Professional Elective Courses				6
8.	HSC	GED 3201	Reasoning and Aptitude for Engineers**	0	0	2	1
			Credits				**19**

SEMESTER VII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	OEC		Open Elective II				3
2.	OEC		Open Elective III				3
3.	PCC	PED 4101	Mould and Die Design	3	0	0	3
4.	PCC	PED 4102	Mould Design and Flow Simulation Laboratory**	0	0	2	1
5.	PEC		Professional Elective Courses				12
6.	PROJ	PED 4103	Internship II###				1
7.	HSC	GED 4101	Employability Skills $	0	0	2	1
			Credits				**24**

SEMESTER VIII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PROJ	PED 4201	Project Work	0	0	18	9
			Credits				**9**

Overall Total Credits – 171

* Laboratory Integrated Theory course

** Laboratory Course

Three Week Orientation Programme – Mandatory Non-Credit Course

15 days of Industrial training during the summer vacation of second year. The credit will be awarded in the 5th Semester.

15 days of Industrial training during the summer vacation of third year. The credit will be awarded in the 7th Semester.

$ Not a Mandatory Course - The student will take up this course during the Summer Holidays of III year as a comprehension of Soft Skills courses offered from semester III to VI. Upon successful completion, the course will be mentioned in grade sheet of VII semester.

LIST OF PROFESSIONAL ELECTIVE COURSES

SPECIALIZATION I: MATERIALS

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PEC	PEDX 01	Biopolymer and Hydrogel	3	0	0	3
2.	PEC	PEDX 02	Biomedical Polymers for Health care	3	0	0	3
3.	PEC	PEDX 03	Polymers for Advanced Technologies	3	0	0	3
4.	PEC	PEDX 04	Nanoscience and Technology	3	0	0	3
5.	PEC	PEDX 05	Polymers for Battery Technology	3	0	0	3
6.	PEC	PEDX 06	Speciality Elastomers	3	0	0	3
7.	PEC	PEDX 07	Polymers for Electric Vehicles	3	0	0	3
8.	PEC	PEDX 08	Thermodynamics for Polymer Engineers	3	0	0	3

SPECIALIZATION II: PROCESS ENGINEERING

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1	PEC	PEDX 11	Fiber Technology	3	0	0	3
2	PEC	PEDX 12	Polymer Post Processing Operations	3	0	0	3
3	PEC	PEDX 13	Rubber Product Manufacturing Technology	3	0	0	3
4	PEC	PEDX 14	Advanced Processing Technology	3	0	0	3
5	PEC	PEDX 15	Tyre Manufacturing Technology	3	0	0	3
6	PEC	PEDX 16	Polymer Waste Management and Recycling	3	0	0	3

7	PEC	PEDX 17	Plastic Packaging Technology	3	0	0	3
8	PEC	PEDX 18	Additive Manufacturing Technology	3	0	0	3

SPECIALIZATION III: PRODUCT AND MOULD DESIGN

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1	PEC	PEDX 31	Mould Manufacturing Techniques	3	0	0	3
2	PEC	PEDX 32	Computer Aided Modelling	3	0	0	3
3	PEC	PEDX 33	Computer Aided Manufacturing	3	0	0	3
4	PEC	PEDX 34	Failure Analysis of Polymers	3	0	0	3
5	PEC	PEDX 35	Automation in Polymer Industries 4.0	3	0	0	3

SPECIALIZATION IV: COMPOSITES, ADHESIVES AND COATINGS

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1	PEC	PEDX 41	Mechanics of Composites	3	0	0	3
2	PEC	PEDX 42	Adhesives and Surface Coating Technology	3	0	0	3

PHYSICS ELECTIVES – II Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	PHDX 01	Non Destructive Testing of Materials	2	0	0	2
2	PHDX 02	Materials Science for Engineering	2	0	0	2
3	PHDX 03	Biomaterials	2	0	0	2
4	PHDX 04	Optical Fibre Communication	2	0	0	2
5	PHDX 05	Semiconductor Physics for	2	0	0	2

		Information Technology				
6	PHDX 06	Sensors and Actuators	2	0	0	2
7	PHDX 07	Fundamentals of Nanotechnology and its Applications	2	0	0	2

MATHEMATICS ELECTIVES – III Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	MADX 01	Transforms and Partial Differential Equations	3	1	0	4
2	MADX 02	Discrete Mathematics	3	1	0	4
3	MADX 03	Probablity and Statistics	3	1	0	4
4	MADX 04	Random Processes	3	1	0	4
5	MADX 05	Numerical Methods	3	1	0	4

HUMANITIES ELECTIVES – III Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	SSDX 01	Engineering Economics and Management	3	0	0	3
2	SSDX 02	Sociology of Science and Technology	3	0	0	3
3	SSDX 03	Industrial Economics and Management	3	0	0	3
4	SSDX 04	Dynamics of Indian Social Structure	3	0	0	3

HUMANITIES ELECTIVES – VI Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	SSDX 11	Economics of Sustainable Development	2	0	0	2
2	SSDX 12	Sociology of Industrial Relations.	2	0	0	2
3	SSDX 13	Professional Ethics and Human	2	0	0	2

		Values				
4	SSDX 14	Gender, Technology and Development	2	0	0	2

CHEMISTRY ELECTIVES – VI Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	CHDX 01	Chemistry of Construction Materials	2	0	0	2
2	CHDX 02	Chemistry of Materials and Electrochemical Devices	2	0	0	2
3	CHDX 03	Chemistry and Instrumentation for Electrical and Electronic Applications	2	0	0	2
4	CHDX 04	Functional Materials and Applications	2	0	0	2
5	CHDX 05	Chemistry of Fuels, Combustion and Lubricants	2	0	0	2
6	CHDX 06	Instrumental Methods of Polymer Analysis	2	0	0	2
7	CHDX 07	Medicinal Chemistry	2	0	0	2

OPEN ELECTIVE COURSES FOR
B.TECH. PROGRAMMES R 2021 - VI SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	C	Offering Department
1.	GEDX 201	Application of Fluid Mechanics in Everyday Life	3	0	0	3	Aero
2.	GEDX 202	Basics of Management and Organizational Behaviour	3	0	0	3	CSB
3.	GEDX 203	Big Data Analytics	3	0	0	3	CA
4.	GEDX 204	Biology for Engineers	3	0	0	3	SLS
5.	GEDX 205	Consumer Electronics	3	0	0	3	ECE
6.	GEDX 206	Creative Writing	2	1	0	3	English
7.	GEDX 207	Cyber Forensics	3	0	0	3	CSE
8.	GEDX 208	Cyber Security	3	0	0	3	IT
9.	GEDX 209	Disaster Management	3	0	0	3	Civil
10.	GEDX 210	English for Competitive Examination	2	1	0	3	English
11.	GEDX 211	Enterprise Risk Management	3	0	0	3	CSB
12.	GEDX 212	Fundamentals of Project Management	3	0	0	3	CSB
13.	GEDX 213	Industrial Robotics	2	0	2	3	Mech.
14.	GEDX 214	Internet of Things and its Applications	3	0	0	3	ECE
15.	GEDX 215	Introduction to Health Care Analytics	3	0	0	3	CA
16.	GEDX 216	IPR and Patent Laws	3	0	0	3	CSB
17.	GEDX 217	Logistics and Supply Chain Management	3	0	0	3	CSB
18.	GEDX 218	Nano Materials and Technology	2	0	2	3	Physics
19.	GEDX 220	Optimization Techniques	3	0	0	3	Maths
20.	GEDX 221	Polymers for Different Transportation	3	0	0	3	Polymer
21.	GEDX 222	Programming Language Principles	3	0	0	3	CSE
22.	GEDX 223	Public Speaking and Rhetoric	2	1	0	3	English
23.	GEDX 224	Python Programming	2	0	2	3	IT
24.	GEDX 226	Smart Sensors for Healthcare Applications	3	0	0	3	EIE
25.	GEDX 227	Total Quality Management	3	0	0	3	Mech.
26.	GEDX 228	Value Education	3	0	0	3	Commerce
27.	GEDX 229	Waste Water Management	3	0	0	3	Civil
28.	GEDX 231	Electronics for Mechanical Systems	3	0	0	3	ECE
29.	GEDX 232	Renewable Energy Engineering					EEE
30.	GEDX 233	Nuclear Hazard and Disarmament	3	0	0	3	Physics

OPEN ELECTIVE COURSES FOR

B.TECH. PROGRAMMES R 2021 - VII SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	C	Offering Department
1.	GEDX 101	Advanced Entrepreneurship	3	0	0	3	CSB
2.	GEDX 102	Artificial Intelligence and Machine Learning Applications	3	0	0	3	CSE
3.	GEDX 103	Automotive Technology	3	0	0	3	Automobile
4.	GEDX 105	Building Repair Solutions	3	0	0	3	Civil
5.	GEDX 106	Cloud Services and Management	3	0	0	3	CA
6.	GEDX 108	Cyber Law and Ethics	3	0	0	3	CSL
7.	GEDX 110	Deep Learning Essentials /	3	0	0	3	CSE
8.	GEDX 111	Drone Technologies	2	0	2	3	Aero
9.	GEDX 112	Electric Vehicle	3	0	0	3	EEE
10.	GEDX 113	Emerging Technologies in Mobile Networks	3	0	0	3	ECE
11.	GEDX 114	Fundamentals of Data Science and Machine Learning	3	0	0	3	IT
12.	GEDX 115	Genetic Engineering	3	0	0	3	SLS
13.	GEDX 116	Green Design and Sustainability	3	0	0	3	Civil
14.	GEDX 117	Image Processing and its Applications	3	0	0	3	ECE
15.	GEDX 118	Industrial Automation and Control	3	0	0	3	EIE
16.	GEDX 119	Industrial Safety	3	0	0	3	Mech.
17.	GEDX 120	Industry 4.0	3	0	0	3	Mech.
18.	GEDX 121	Introduction to Artificial Intelligence	3	0	0	3	IT
19.	GEDX 122	Introduction to Artificial Intelligence and Evolutionary Computing	3	0	0	3	CSE
20.	GEDX 123	Motor Vehicle Act and Loss Assessment	3	0	0	3	Automobile
21.	GEDX 126	Personal Finance and Investment	3	0	0	3	Commerce
22.	GEDX 127	Soft Computing Techniques	3	0	0	3	CSE
23.	GEDX 128	Value Analysis and Engineering	3	0	0	3	Mech.
24.	GEDX 129	Vehicle Maintenance	3	0	0	3	Automobile
25.	GEDX 130	Graphical Programming Based System Design	3	0	0	3	ECE

SEMESTER I

PHD 1181	APPLIED PHYSICS	L	T	P	C
		3	0	2	4

SDG: 4

COURSE OBJECTIVES:

COB1: To make the students in understanding the importance of mechanics and properties of matter.

COB2: To classify the different types of crystal structures and study their defects.

COB3: To correlate the quantum mechanics principles and its impact in its application.

COB4: To introduce the basics of oscillations, optics and lasers.

COB5: To analyze the acoustics of buildings and applications of ultrasonics

MODULE I MECHANICS AND PROPERTIES OF MATTER 9

Moment of inertia (M.I.) - Radius of gyration - Theorems of M .I - M.I of circular disc, solid cylinder , hollow cylinder , solid sphere and hollow sphere - Elasticity – Stress-strain diagram – Factors affecting elasticity – Poisson's ratio - Twisting couple on a wire – Shaft – Torsion pendulum – Bending moment - Depression on a cantilever – Young's modulus by cantilever – Uniform and non-uniform bending.

MODULE II CRYSTAL PHYSICS 9

Miller Indices-Interplanar distance- Hexogonally closely packed crystal structures – Reciprocal Lattice -Defects in crystals: voids – Line defects - Edge and screw dislocations - Surface Defects - Crystal Growth Techniques - Bridgman method – Czochralski method (qualitative)-Polymorphism and allotropy in crystals.

MODULE III QUANTUM MECHANICS 9

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 wavelength - Physical significance of wave function – Schrodinger wave equation – Time independent and time dependent wave equation – Particle in one dimensional box – Quantum computing.

MODULE IV OPTICS AND LASERS 9

Interference -Anti-reflection coating -Air Wedge – Michelson's Interferometer – Determination of wavelength of light and thickness of thin transparent sheet-Characteristics of Laser – Spontaneous and Stimulated Emissions – Einstein's

Coefficients - Population inversion – Pumping Mechanism – Laser Action – Types of Laser: Nd:YAG laser –CO_2 laser and semiconductor laser - Applications : Laser Materials Processing - Holography.

MODULE V ACOUSTICS & ULTRASONICS 9

Basic requirement for the acoustically good halls - Factors affecting the architectural acoustics and their remedy-Sound absorbing materials - 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.

PRACTICALS

List of Experiments

1. Determination of rigidity modulus of the given wire using Torsional pendulum.
2. Determination of young's modulus of the beam by uniform / non-uniform bending method.
3. Determination of young's modulus of the beam by cantilever method.
4. Determination of coefficient of viscosity of low viscous liquid by Poiseuille's flow.
5. Determination of coefficient of viscosity of high viscous liquid by Stoke's method.
6. To determine the frequency of an electrically maintained tuning fork using a vibration generator. (Melde's experiment)
7. Determination of thickness of a thin wire / sheet using Air Wedge method.
8. Determination of wavelength of laser light using semiconductor laser diffraction.
9. Determination of angle of divergence of a laser beam using semiconductor diode laser and He-Ne laser.
10. Determination of particle size of lycopodium powder using semiconductor laser.
11. Determination of velocity of sound in solids using Kundt's tube method.
12. Determination of velocity of ultrasonic waves in the liquid using ultrasonic interferometer.

L – 45; P – 15 ; TOTAL HOURS –60

TEXT BOOKS:

1. P K. Palanisamy, Engineering Physics Vol I and II Scitech Publications (India) Pvt Ltd, 2018.

2. Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2013.

REFERENCES:

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education, 2017.
2. Brij Lal and N. Subramanyam, Properties of Matter, S.Chand& Co, 2003.
3. P K. Palanisamy, Engineering Physics Vol I and II Scitech Publications (India) Pvt Ltd, 2018.
4. Serway R.A. and Jewett, J.W., Physics for Scientists and Engineers with Modern Physics, Brooks/cole Publishing Co., 2010.
5. Tipler P.A. and Mosca, G.P., Physics for Scientists and Engineers with Modern Physics, W.H. Freeman, 2007.
6. Markert J.T., Ohanian. H. and Ohanian, M., Physics for Engineers and Scientists, W.W. Norton & Co., 2007.

COURSE OUTCOMES:

CO1:grasp the importance of mechanics and the principles of elastic behaviour of materials & apply them to analyze the various substances based on elasticity.

CO2: get acquainted with the topics concerning types, defects in crystal structures, methods of preparation and apply the same to categorize different crystal systems in real time.

CO3: comprehend the importance &principles of quantum mechanics and utilize ideas to understand working of modern devices and its variants.

CO4: know the basics of oscillations, optics and lasers and their applications.

CO5: assimilate the ideas of acoustical requirements of buildings, understand principles of ultrasonics and add values to their usefulness in acoustical design of halls and their applications.

Board of Studies (BoS) :

13th BoS of Physics held on 14.09.2023

Academic Council:

21st AC held on 20.12.2023

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M

CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

CHD1181	**ENGINEERING MATERIALS AND APPLICATIONS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**2**	**4**

COURSE OBJECTIVES:

To make the students conversant with

COB1:preparation, properties and applications of various polymers and composites

COB2: synthesis, properties and applications of nanomaterials

COB3: the basic concepts and different types of catalysts involved in catalytic processes.

COB4: basic principles and its applications of certain spectroscopic techniques towards characterization of chemical compounds and concepts of photochemical processes involved in photochemical reactions.

COB5: different types of sensors and its applications.

MODULE I POLYMER AND COMPOSITES 9

Introduction – classification: source, heat, composition and structure- glass transition temperature – synthesis, properties and applications of polycarbonate, polyurethane, teflon, ABS, kevlar, bakelite, epoxy resin, acrylic polymers (PAN) - biopolymers : importance and applications of biodegradable polymers (PLA, PHBV). Composites- Introduction - properties and applications: fibre-reinforced plastics (glass, carbon and aramid), ceramic matrix composites (CMC) –- bio-composites - Society of the Plastics Industry (SPI)' Code.

MODULE II NANOCHEMISTRY 9

Introduction – classification based on dimension with examples – properties of nanomaterials (surface to volume ratio and size quantisation effect) - synthesis of nanomaterials (Top-down and Bottom-up)– role of capping & reducing agents - CVD (CNT), laser ablation (Ag, Ag_2O), electrodeposition (semiconductor materials), precipitation (Ag, Au), thermolysis: solvothermal (CuO, CeO_2) and hydrothermal (TiO_2, ZnO, carbon dots), microwave method (metal oxide), bio-nanomaterials - biogenic method (synthesis of Ag, Au by plants extracts, bacteria, fungi)

MODULE III CATALYSIS 9

Types of catalysis – Criteria for catalysts - catalysis by transition metal ions and their complexes- solid catalyst - metal oxides and zeolites - shape selective catalysts- mechanism of catalytic action- CO oxidation, NOx and SOx reduction – Enzyme catalysis-Mechanism of enzyme action-electrocatalysis -green catalyst.

MODULE IV PHOTOCHEMISTRY AND SPECTROSCOPY 9

Laws of photochemistry – Quantum yield -– Jablonski diagram - photophysical processes - photosensitisation – Quenching– chemiluminescence – bioluminescence

Atomic and molecular spectrum – absorption and emission spectrum - Beer Lambert's law – problems and applications – principles and applications: colorimetry, UV -vis spectroscopy (Chromophore- auxochrome, red and blue shift), atomic absorption spectroscopy, IR spectroscopy (finger print region, functional group interpretation)

MODULE V SENSORS 9

Sensors – types: bio and toxic chemicals sensors- principle, working and applications of Electrochemical sensors: MEMS and NEMS, - Biosensors-construction, working and classification, Advantages - Biochips - touch sensor (oxi and gluco meter) - Advanced sensors: Smoke and gas sensors, humidity sensors, temperature sensor and alcohol sensor.

PRACTICALS

List of Experiments

1. Preparation of polymers – phenol-HCHO, urea-HCHO, polylactic acid, epoxy resin
2. Determination of molecular weight and degree of polymerization using Oswald'sviscometer.
3. Synthesis of nano-ZnO and CuO by precipitation
4. Demonstration of Laser ablation techniques for nanomaterials.
5. Electrochemical synthesis of graphene oxide
6. One-pot synthesis using green catalyst.
7. Green synthesis: Photocatalytic reactions, solvent - free organic reaction - Aldol; green oxidation, green reduction.
8. Diels - Alder reaction in eucalyptus oil (green process).
9. Spectrophotometer iron estimation.(Beer Lambert's law) determination of Fe^{3+}
10. FT-IR spectral characterisation (functional group interpretation)

L – 45; P – 30; TOTAL HOURS – 75

TEXT BOOKS:

1. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi. 2016.
2. G.A. Ozin and A.C. Arsenault, "Nanochemistry: A Chemical Approach to Nanomaterials", RSC Publishing, Thomas Graham House, Cambridge,2012.
3. B. Viswanathan, S. Sivasanker and A.V. Ramaswamy (Editors), Catalysis: Principles and Applications, Narosa Publishing House, 2002.
4. Gadi Rothenberg, Catalysis: Concepts and Green Applications, WILEY-VCH
5. Nicholas J. Turro, V.Ramamurthy and Juan C. Scaiano, Principles of molecular photochemistry: An introduction, University Science Books, Sausalito, CA, 2009.
6. John Vetelino, AravindReghu , Introduction to Sensors By · 2017.

REFERENCES:

1. Jhon S. Wilson, Sensor Technology Handbook, Elsevier 2005.

COURSE OUTCOMES:

The students will be able to

CO1: enumerate and compare the preparation, properties and applications of various types of polymers and composites.

CO2: synthesize different type of nanomaterials on a commercial scale based on its size and applications.

CO3: apply the concepts of spectroscopic techniques towards spectral interpretation for identification of compounds and explain various photochemical processes in photochemical reactions.

CO4: Impart types, characteristics and applications of different types of catalyst.

CO5: categorize the sensors and its applications to real time situation.

Board of Studies (BoS) :	**Academic Council:**
13^{th} BoS of Chemistry held on 08.09.2023	21^{st} AC held on 20.12.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	-	-	-	M	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	M	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	M	-	-	-	-	-	-	-	-
CO4	-	-	-	M	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	M	-	-	-	-	-	-	-	-	-	-	-

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9: To support scientific & technology development and innovation of materials and electronic devices

Introduction of basics on various materials and electronic devices towards innovation on new technology.

		L	T	P	C
MAD 1181	**ALGEBRA AND DIFFERENTIAL CALCULUS**	**L**	**T**	**P**	**C**
SDG: 4		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

COB1: To introduce matrix algebra techniques for engineers to apply in practical problems

COB2: To find the roots of polynomial equations using different techniques

COB3: To demonstrate the concepts of limits, continuity and application of differential calculus.

COB4: To familiarize the students with the functions of several variables

COB5: To develop the use of differential equations necessary for engineering applications

MODULE I MATRICES 9+3

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 THEORY OF EQUATIONS 9+3

Introduction - Surds and irrational roots – simple problems – Equations whose roots are in A.P,G.P and in H.P – Relations between the roots and coefficients – symmetric functions – Formation of equations – Decreasing and Increasing the roots – transformation of equation – Reciprocal equations

MODULE III DIFFERENTIAL CALCULUS 9+3

Limits of functions - one sided limits – Continuity - Curvature – Cartesian and polar coordinates – center and radius of curvature – Circle of curvature – Involutes and evolutes – Envelopes

MODULE IV DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES 9+3

Laws of limits –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 9+3

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

L – 45; T – 15; TOTAL HOURS – 60

TEXT BOOKS:

1. Ramana, B.V, "Higher Engineering Mathematics" Tata McGraw Hill Publishing Co. New Delhi, 2010.
2. Grewal B.S., "Higher Engineering Mathematics" 44th edition, Khanna Publishers, New Delhi, 2017.
3. Kreyszig, E., "Advanced Engineering Mathematics", 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2011

REFERENCES:

1. Veerarajan.T., "Engineering Mathematics" (5th edition) Tata Mc Graw Hill Publishing Co. New Delhi, 2012
2. Jain, R.K. & Iyengar, S. R. K., "Advanced Engineering Mathematics", Narosa Publishers, 5th edition, 2016.
3. Peter V. O'Neil, "Advanced Engineering Mathematics", 7th edition, Cengage Learning, 2011.
4. Venkataraman, M.K., "Engineering Mathematics", Volume I, 2nd edition, National Publishing Co., Chennai, 2003.
5. James Stewart ," Calculus" 7th edition, Brooks/Cole Cengagelearning, UK

COURSE OUTCOMES:

At the end of the course students will be able to

CO1:use the matrix algebra methods for finding eigenvalues, eigenvectors and diagonalization

CO2: solve equations using the relations between roots and coefficients

CO3: apply differential calculus in various engineering problems

CO4:use differential calculus on several variable functions

CO5:solve various types of differential equations that arise in many applications

Board of Studies (BoS) :	**Academic Council:**
12th BOS of Mathematics & AS held on 23.06.2021	17th AC held on 15.07.2021

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	M	L	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4 : Ensure inclusive and equitable quality education and promote lifelong opportunities for all

Learning of various mathematical techniques like matrices and calculus will lead to knowledge of applications in Engineering problems

GED 1101	**ENGINEERING GRAPHICS**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To introduce the basic concepts of engineering drawing, and familiarize with conic sections, special curves and orthographic projection of points and straight lines

COB2: To get practical exposure on projection of planes and solids

COB3: To be familiar with sectioning of solids, and development of surfaces

COB4: To conversant with 3D isometric projection, and perspective projection of simple solids

COB5: To introduce computerized drafting using CADD for drawing the orthographic views of simple solids

MODULE I — BASICS, ENGINEERING CURVES AND ORTHOGRAPHIC PROJECTION OF POINTS AND STRAIGHT LINES — L: 7 P: 7

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

Conic sections: ellipse, parabola, hyperbola. Special curves: cycloid, epicycloid, hypocycloid and involutes.

Orthographic projection – first angle, second angle, third angle and fourth angle projections. Orthographic projection of points in all quadrants. Projection of straight lines in first quadrant – true length and true inclinations – traces of straight line.

MODULE II — PROJECTION OF PLANES AND SOLIDS — L: 7 P: 7

Projection of plane lamina in first quadrant and its traces

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

MODULE III — SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES — L:5 P:5

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

Development of surface of truncated solids: prism, pyramid, cone and cylinder

– frustum of cone, pyramid and simple sheet metal parts.

MODULE IV THREE DIMENSIONAL PROJECTIONS L:4 P: 4

Isometric projection: Isometric scale – isometric axes- Isometric projection and view of prism, pyramid, cylinder, cone and frustums.
Perspective projection: station point – vanishing point – Perspective projection and views of prism, pyramid by Visual ray method.

MODULE V ORTHOGRAPHIC PROJECTION USING CADD L:7 P:7

Introduction to CADD - Basic commands for sketching - Editing sketches - creating texts and tables - Basic dimensioning and editing dimensions - Sketching orthographic views of simple solids and machine parts as per first angle projection - Plotting drawings.

L – 30; P – 30; TOTAL HOURS – 60

TEXT BOOKS:

1. N.D. Bhatt, “Engineering Drawing”,Charotar Publishing house, 53rdEdtion, 2014.
2. Venugopal. K, and V. Prabhu Raja, “Engineering Graphics”, New Age International (P) Ltd., Publication, Chennai, Edition 15, 2017.

REFERENCES:

1. K.V. Natarajan, “A text book of Engineering Graphics”, Dhanalakshmi publishers, Chennai, 31st Edition, 2018.
2. Agrawal B. & Agrawal C. M., “Engineering Graphics”, TMH Publication, 2012.
3. Jeyapoovan, T., “Engineering Graphics using AutoCAD”, Vikas Publishing House Pvt. Ltd., New Delhi, 2015.
4. AutoCAD Software Theory and User Manuals
5. Engineering graphics You tube Lecture videos link: https://www.youtube.com/user/BSAUNIV/videos

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: identify the specifications and standards of technical drawing and draw conic sections, special curves and orthographic projection of points and straight lines

CO2: apply the concept of orthographic projection to draw the orthographic views of plane figures and simple solids

CO3:draw the sections of solids and development of solid surfaces

CO4:apply the concept of isometric and perspective projection to draw the 3-D views of simple solids
CO5: draw the orthographic views of simple objects using drafting software

Board of Studies (BoS):
18th BoS of MECH held on 21.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	M	L	L	-	-	-	-	-	-	L	-	-	-	-
CO2	M	L	L	-	-	-	-	-	-	L	-	-	-	-
CO3	M	L	L	-	-	-	-	-	-	L	-	-	-	-
CO4	M	L	L	-	-	-	-	-	-	L	-	-	-	-
CO5	M	L	L	-	M	-	-	-	-	L	-	-	-	-

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.
The various industrial standards of technical drawing and the application of orthographic projections to draw simple solids helps to innovate a new design for sustainable industrialization

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

SDG:9

COURSE OBJECTIVES:

COB1: To learn the basic concepts of design in engineering

COB2: To study the basic design thinking principles in problem solving

COB3: To encourage the students to develop a prototype using design concepts

COB4: To introduce the role of innovation in engineering

MODULE I INTRODUCTION TO DESIGN 08

Introduction to Engineering design – Design thinking – Problem identification - Design of Product, Process, System and Software – Case studies on Product, Process, Systems and Software design.

MODULE II DESIGN THINKING PROCESS 08

Empathy – Ideate - Need analysis - Voice of customers - product specification - concept generation - Bench marking - Quality function deployment - Concept evaluation - Case studies

MODULE III PROTOTYPE DESIGN 07

Product form and function – High level design – Design detailing - Sketch models – Prototypes - 3D printing - Case studies.

MODULE IV INNOVATION 07

Creativity and innovation – Role of innovation in Engineering – incremental changes and systemic changes; scientific approach to driving innovation – Intellectual property rights - case studies on innovative products.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Clive L. Dym, Patrick Little, and Elizabeth J. Orwin, “Engineering Design: A Project Based Introduction”, 4th Edition, Wiley, 2014.
2. Eppinger, S. and Ulrich, K., “Product design and development”, McGraw-Hill Higher Education, 2015.

REFERENCES:

1. Nigel Cross, “Design Thinking”, Berg Publishers, 2011.
2. Tom Kelley, “The Art of Innovation”, Profile Books Ltd, London, 2016.
3. Tim Brown, “Change by Design”, HarperCollins e-books, 2009.
4. Cliff Matthews, “Case Studies in Engineering Design”, John Wiley & Sons Pvt. Ltd, New York, 1998.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: explain the basic concepts of design in engineering products / process / Service

CO2:analyse the problems and perform design thinking process

CO3: correlate the basic principles of design thinking to solve engineering problems and develop prototypes

CO4: apply innovative approaches to engineering problems and provide design solutions

Board of Studies (BoS):

18th BoS of MECH held on 21.06.2021

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CO3	H	-	H	-	M	-	-	-	-	L	-	L	-	-
CO4	-	-	M	-	-	-	-	-	-	L	-	L	-	-

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The holistic understanding of basic knowledge in Engineering design and its process in the development of prototypes results in satisfying industrial challenges.

GED 1103	**MANUFACTURING PRACTICES LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

SDG: 9

COURSE OBJECTIVES:

COB1: To learn the basics of pipe connections used in household and industrial systems

COB2: To educate the usage of welding equipment's and machining methods

COB3: To impart knowledge onsand mould preparation for simple components

COB4: To explorevarious tools, instruments and methods used in electrical wiring

COB5: To impart knowledge onDesign, assembly and testing of electronic circuits

PRACTICALS

List of Experiments:

CIVIL ENGINEERING PRACTICE:

1. Study of plumbing in general household and industrial systems: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
2. Making a small window frame with Lap and Mortise & Tenon Joints by sawing planing and cutting.
3. Introduction to power tools

MECHANICAL ENGINEERING PRACTICE

1. Fabrication of a small Table frame with Butt, Lap and Fillet Joints using Arc Welding - Gas cutting (Demo)
2. achining of a component using simple turning and drilling practices.
3. Foundry operations such as sand mold preparation for simple component.
4. Plastic Component Manufacturing (Demo on Injection / Blow moulding)

ELECTRICAL ENGINEERING PRACTICE:

1. Comparison of incandescent, fluorescent, CFL and LED lamps.
2. Domestic, staircase and go down wiring.

3. Measurement of earth resistance.
4. Study of protection devices (small relay, fuse, MCB, HRC, MCCB, ECCB).
5. Familiarization of household electrical gadgets (Iron Box, Wet Grinder).
6. Study of inverter fed UPS/Emergency lamp

ELECTRONICS ENGINEERING PRACTICE:

1. Identifications and symbolic representation of active and passive electronic components
2. Soldering and tracing of electronic circuits and checking its continuity
3. Design and testing of electronic circuits using active and passive electronic components

P –30; TOTAL HOURS –30

TEXT BOOK:

1. S.Gowri and T.Jeyapoovan, "Engineering Practices Lab Manual – Civil, Mechanical, Electrical, Electronics included", Vikas Publishing, 5th Edition, 2019.

REFERENCES:

1. SubhransuSekhar Dash &K.Vijayakumar, "Electrical Engineering Practice Lab Manual", Vijay Nicole Imprints Private Ltd., First Edition, 2013.
2. Raghbir Singh Khandpur, "Printed Circuit Boards: Design, Fabrication, and Assembly", Tata McGraw-Hill Education, 2005.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: demonstrate Plumbing requirements of domestic buildings.

CO2: use welding equipment's to join the structures and to carry out machining operations

CO3: perform the task of making sand mould for simple components

CO4: execute simple electrical wiring and comprehend the construction and working of household appliances.

CO5: assemble and test simple electronic circuits used in day-to-day life

Board of Studies (BoS):	**Academic Council:**
18th BoS of MECH held on 21.06.2021	17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	M	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	M	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	L	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The holistic understanding of welding, moulding, machining, wiring and electronic circuit increases the access of small-scale industrial and other enterprises in developing countries.

GED 1104	**PROGRAMMING FOR PROBLEM SOLVING**	**L**	**T**	**P**	**C**
SDG: 8		**1**	**0**	**2**	**2**

COURSE OBJECTIVES:

COB1: To explore the hardware and software components of thecomputer

COB2: To learn the structured and procedural programming concepts usingC.

COB3: To study the constructs of decision making in branching and iteration statements

COB4: To learn Functions for effective reusability and readability of the code.

COB5: To understand pointer and file operation concepts.

MODULE I INTRODUCTION TO C PROGRAMMING 05

Introduction to components of a computer system: disks, primary and secondary memory, processor, operating system, system software, compilers, creating, compiling and executing a program, Introduction to Algorithms: steps to solve logical and numerical problems. Representation of Algorithm, Flowchart/Pseudo code with examples, Program design and structured programming - Structure of C - C Tokens – Data Types – Declaration of Variables and Storage class – Operators – Expressions - Type Conversion.

MODULE II DECISION MAKING AND ARRAY 05

Decision Making and Branching: Simple if Statements, The if..else statements, Nesting of if..else statements, else…if Ladder, switch Statements, goto Statements, Looping: while, do…while, for Statements, Array: One-Dimensional, Two-Dimensional and Multi-Dimensional operations.

MODULE III USER-DEFINED FUNCTIONS AND FILE OPERATIONS 05

Definition of Functions - Function Types – Nesting of Functions – Recursion – Structures and Unions – Pointers - File handing operations.

PRACTICALS

LIST OF PROGRAMS IN C:

1. Computer organization –Hardware in a typical computer Identification – Booting error messages and what it means
2. Structure of a basic program - Hello world program
3. Data types and Type conversions
4. Input / Output: Formatted functions – Unformatted functions – Library functions

5. Properties of operators – Priority of operators – Arithmetic relational logical and bitwise operators
6. Conditional Statements: If – if else- nested if else- goto- switch case – nested switch case
7. Iteration Statements: for loops – nested for loops – while loop – do-while loop – break and continue statement
8. I/O operations of one- and two-dimensional arrays
9. Bubble Sort and Linear Search using arrays.
10. Functions and its types, Recursion Function
11. Pointers File Operations

L – 15; P – 30 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Richard L. Stegman, "Focus on Fundamentals of Programming with C", Ninth Edition, ISBN -170077395X, 9781700773951, 2019.
2. E.Balagurusamy, "Programming in ANSI C", McGraw Hill Education, Eighth Edition, ISBN-13: 978-93-5316-513-0, ISBN-10: 93-5316-513-X, 2019.

REFERENCES:

1. Brian W. Kernighan and Dennis M. Ritchie, " The C Programming Language", Prentice Hall, ISBN 0-13-110362-8, 2015.
2. Ashok N Kamthane, "Computer Programming", Pearson Education, 2nd Edition, ISBN 13: 9788131704370, 2012.
3. Paul J. Deitel, Deitel & Associates, "C How to Program", Pearson Education, 7th Edition, ISBN-13: 978-0132990448, 2012.

COURSE OUTCOMES:

Students who complete this course will be able to

CO1: identify the hardware components and describe the software components of computer.

CO2: bring out the importance of structural and procedural programming

CO3: write C coding using conditional and iteration statements

CO4: develop programs using Functions, Pointers and Files

CO5: implement program to build a real time application.

Board of Studies (BoS) :

18th BoS of CSE held on 26.07.2021

Academic Council:

17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	-	M	L	H	-	L	-	-	M	-	-	-	-	-
CO2	H	M	M	-	-	H	M	-	M	-	-	-	-	-
CO3	H	M	H	-	-	H	-	-	H	-	-	-	-	-
CO4	H	H	H	H	M	H	-	-	H	-	-	-	-	-
CO5	H	H	H	H	H	H	H	H	H	L	H	H	-	-

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Statement: The students can have productive employment and decent work by learning this computer fundamentals and programming course.

SEMESTER II

END 1281	**ENGLISH FOR ENGINEERS**	**L**	**T**	**P**	**C**
SDG: 4		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To train students to use appropriate vocabulary in academic and technical contexts

COB2: To facilitate students to speak effectively while exchanging ideas and making presentations

COB3: To develop students' listening skill for comprehending and analysing information

COB4: To develop their reading skill through sub skills like skimming, scanning and critical reading of a text

COB5: To sharpen their academic writing skills

COB6: To expose them to the correct usage of language and help them to apply that knowledge appropriately

MODULE I HUMAN RESOURCES 10

L: Listening to short texts – short formal & informal conversations.

S: Introducing one self – exchanging personal info.

R: Process of reading purposes, Reading comprehension, improving comprehension skills, Reading activities – short comprehension passages, practice in skimming & scanning.

W: Scientific & Technical Writing, Editing skills, Activities – completing sentences, developing hints - Paragraph Writing

Voc. development: Prefixes, Suffixes

Lang. development: Articles, Countable and Uncountable nouns, Present tense, Wh– Questions, Yes or No questions.

MODULE II TRANSPORT 10

L: Listening to long scientific talks

S: Sharing personal information – greeting, leave taking.

R: Comprehension passages with multiple choice questions / Wh– questions/ openended questions - Reading longer technical texts & completing exercises based on them.

W: Use of reference words & discourse markers on a text, jumbled sentences, describing a process – flow chart, use of sequence words.

Voc. development: Guessing meanings of words in context, vocabulary used in formal letters, e-mails & reports.

Lang. development: Preposition of Time, Place & Date, Past tense, Conjunctions, Impersonal passive voice, Question tags, Numerical Adjectives.

MODULE III ENERGY 9

L:Listening to talk on the topic & completing tasks.

S: Asking about routine actions & expressing opinions.

R: Locating Specific Information

W: Letter seeking permission for Industrial Visit / symposium – Letter of invitation

Voc. development: Sequence words, misspelt words.

Lang. development: Adverbs, Degrees of comparison, Future tense, Homophones

MODULE IV OUR LIVING ENVIRONMENT 8

L: Listening to scientific texts & making notes – Effective ways of making notes.

S: Speaking about one's friend.

R: Reading texts & magazines for detailed comprehension. (Students can be asked to read any book of their choice to encourage reading habit)

W: Argumentative writing.

Voc. Development: Synonyms, antonyms, phrasal verbs.

Lang. development: If clauses, Subject - Verb Agreement

MODULE V TECHNOLOGY 8

L: Listening to talks (General & Scientific).

S: Short group conversations.

R: Reading and understanding technical articles, Short narratives & articles from Newspaper including conversations.

W: Short essays, Dialogue writing.

Voc. Development: Idioms & Phrases.

Lang. development: Modal verbs.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Board of Editors. Using English A Coursebook for Undergraduate Engineers and Technologists. Orient BlackSwan Limited, Hyderabad:2015
2. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

REFERENCES:

1) Perry, Carol Rosenblum(2011). The Fine Art of Technical Writing, Create Space Independent Publishing Platform, New Delhi.
2) Dutt, P.K. Rajeevan G. andPrakash, C.L.N. (2007). A course in Communication Skills, Cambridge Univesity Press, India.
3) Sen, Leena(2004). Communication Skills, Prentice Hall, New Delhi.
4) Matt Firth, Chris Sowton et.al (2012). Academic English An Integrated Skills Course for EAP, Cambridge University Press, Cambridge.
5) Bailey,Stephen2011. Academic Writing: A practical guide for students, New York, Rutledge.
6) Redston, Chris&Gillies (2005). Cunningham Face2Face (Pre-intermediate Student's Book&Workbook) Cambridge University Press, New Delhi.
7) Dutt P. Kiranmai and RajeevanGeeta (2013). Basic Communication Skills, Foundation Books.

COURSE OUTCOMES:

CO1: Read articles of a general kind in magazines and newspapers

CO2:Participate effectively in conversations, introduce themselves and their friends and express opinions in English

CO3: Comprehend conversations and short talks delivered in English

CO4: Write short essays of a general kind and letters and emails in English

CO5: Express through speaking and writing using appropriate vocabulary and grammar

Board of Studies (BoS) :
13th BoS of Department of English held on 17.6.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	-	-	M	-	-
CO2	-	-	-	-	-	-	-	-	-	H	-	-
CO3	-	-	-	-	-	-	-	-	-	M	-	-
CO4	-	-	-	-	-	-	-	-	-	H	-	-
CO5	-	-	-	-	-	-	-	-	-	M	-	-

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG No. 4 : Give Quality Education to all the Engineers

Statement: In future, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

MAD 1283	**PARTIAL DIFFERENTIAL**	**L**	**T**	**P**	**C**
SDG: 4	**EQUATIONS AND TRANSFORMS**	**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

COB1: To formulate and solve partial differential equation of first, second and higher orders

COB2: To introduce basics and engineering applications of Fourier series

COB3: To develop Fourier transform techniques

COB4: To introduce techniques and engineering applications of Laplace Transforms

COB5: To acquaint with Z -Transform techniques for discrete time systems

MODULE I PARTIAL DIFFERENTIAL EQUATIONS 9+3

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 9+3

Fourier Series and Dirichlet's conditions - General Fourier series – Even and Odd functions - Half range Fourier series - Parseval's identity - Harmonic Analysis

MODULE III FOURIER TRANSFORMS 9+3

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

MODULE IV LAPLACE TRANSFORM 9+3

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 V Z – TRANSFORM 9+3

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 –45 ; T – 15; TOTAL HOURS – 60

TEXT BOOKS:

1. Kreyszig .E., "Advanced Engineering Mathematics", 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2011.
2. Grewal B.S., "Higher Engineering Mathematics", 44th edition, Khanna Publishers, New Delhi, 2017.
3. Ramana, B.V, "Higher Engineering Mathematics" Tata Mc Graw Hill Publishing Co. New Delhi, 2010.

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.

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: form and solve the partial differential equations

CO2: derive a Fourier series of a given periodic function by evaluating Fourier coefficients

CO3: apply integral expressions for the forward and inverse Fourier transform to a range of non-periodic waveforms

CO4: solve ordinary differential equations using Laplace transforms

CO5: solve difference equations using Z-transform

Board of Studies (BoS) :

12th BOS of Mathematics & AS held on 23.06.2021

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	H	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	H	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	H	L	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4 : Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

Learning of various mathematical techniques like Partial differential equations and transform techniques will help to solve complicated engineering problems

GED 1201	**ENGINEERING MECHANICS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

COB1: To impart knowledge about the basic laws of mechanics, resolution of forces, equilibrium of particles in 2D and 3D force systems.

COB2: To learn about supports, reactions and equilibrium of rigid bodies

COB3: To educate surface properties such as centroid and moment of inertia

COB4: To impart knowledge on friction and its applications

COB5: To study the laws of motion, impulse, momentum and elastic bodies

MODULE I VECTOR APPROACH AND EQUILIBRIUM OF PARTICLE **L: 11 T: 3**

Introduction - Vectors – Vectorial representation of forces and moments – Vector Algebra and its Physical relevance in Mechanics – Laws of Mechanics – Parallelogram and triangular Law of forces- Coplanar Forces Principle of transmissibility, Resolution and Composition of forces- Forces in plane and space - Lame's theorem - Equilibrium of a particle in 2D plane - Equilibrium of a particle in 3D space - Equivalent systems of forces – Single equivalent force

MODULE II EQUILIBRIUM OF RIGID BODY **L: 7 T: 3**

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 III PROPERTIES OF SURFACES **L:10 T:3**

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 using standard formula – second and product moments of plane area – Physical relevance - Standard sections: Rectangle, triangle, circle- composite sections, Hollow section using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia

MODULE IV FRICTION **L:9**
T:3

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

MODULE V LAWS OF MOTION **L:8**
T:3

Review of laws of motion – Newton's second law – D'Alembert's principle and its applications in plane motion; Work Energy Equation of particles– Impulse and Momentum – Impact of elastic bodies.

L – 45; T – 15; TOTAL HOURS – 60

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R, "Vector Mechanics for Engineers", McGraw Hill Education, 10th Edition, 2017.
2. R.K. Bansal., "A Text Book of Engineering Mechanics", Laxmi Publications, 6th Edition, 2015.

REFERENCES:

1. Russell C Hibbeler, "Engineering Mechanics: Statics & Dynamics", 14th Edition, Pearson, 2015.
2. Irving H. Shames, "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education India, 2005.
3. R.S. Khurmi., "A Text Book of Engineering Mechanics", S. Chand Publishing, 22nd Edition, 2018.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: resolve composite forces, apply concept of equilibrium to particles and solve problems

CO2: apply the concept of equilibrium to rigid bodies and solve problems

CO3: determine the properties of surfaces

CO4: analyse and evaluate the frictional forces between the bodies

CO5: apply the laws of motion in solving dynamics problems

Board of Studies (BoS):
18th BOS held on 21.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CO3	-	-	L	-	-	-	-	-	-	-	-	-	-	-
CO4	-	M	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	L	-	-	-	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The understanding of force systems and its components leads to construction of robust engineeringsystems.

GED 1202	**BASIC ELECTRICAL AND**	**L**	**T**	**P**	**C**
SDG: 3, 5, 8, 12	**ELECTRONICS ENGINEERING**	**3**	**0**	**2**	**4**

COURSE OBJECTIVES:

COB1: To make the students understand the basic calculations and measurements in DC circuits.

COB2: To provide the basic knowledge on AC circuit calculations and measurements.

COB3: To familiarize with working and characteristics of different DC and AC machines.

COB4: To impart knowledge onbasic semiconductor devices and their applications.

COB5: To introduce the students to fundamentals of digital electronics.

MODULE I DC CIRCUITS & MEASUREMENTS 12

The concept of voltage and current-Electric circuit elements: R, L, C – Independent and dependent sources - Ohm’s law- Kirchhoff’s law- series and parallel resistive circuits – Voltage and current division – Star-delta transformation - Mesh and nodal analysis of resistive circuits – simple problems - Measurement ofvoltage, current and power in DC circuits.

MODULE II AC CIRCUITS & MEASUREMENTS 17

Sinusoidal voltage - RMS, average, peak value, peak factor and form factor - single phase RL, RC and RLC circuits –phasor representation - complex power – power factor - simple problems - Resonance in RLC circuits – 3 phase balanced circuit calculations– star and delta connections - Principles of measurement of AC voltage, current, power and energy - Measurement of three phase power.

MODULE III ELECTRICAL MACHINES 18

Construction, principle of operation, basic equations, characteristics and applications of DC generators, DC motors, single phase transformers and three phase induction motors. Working principle of BLDC Motor and its applications in home appliances.
(Qualitative treatment only).

MODULE IV SEMICONDUCTOR DEVICES AND APPLICATIONS 14

Introduction to semiconductors - Characteristics of PN Junction Diode – Zener Diode and its characteristics – SCR and its characteristics — Bipolar Junction Transistorand its characteristics – JFET & MOSFET – their characteristics.
Applications: Half wave and full wave rectifiers - Voltage Regulation – Regulator ICs.

MODULE V INTRODUCTION TO DIGITAL CIRCUITS 14

Logic gates- Boolean algebra theorems– K Map-Introduction to combinational circuits– Flip-Flops – Registers– A/D and D/AConversion – Data acquisition systems

PRACTICALS

List of Experiments

1. Verification of KCL and KVL (ii) Measurement of voltage, current and power in DC circuits.
2. (i) Resonance of RLC series circuit
   (ii) Measurement of voltage, current, power and power factor in single phase & three phase AC circuits.
3. (i) Magnetization characteristics of DC generator
   (ii) Characteristics of DC shunt motor, single phase transformer and three phase induction motor.
4. Fabrication of a low voltage regulated power supply.
5. Implementation of half and full adders.

L – 45 ; P – 30 ; TOTAL HOURS – 75

REFERENCES:

1. Edward Hughes, “Electrical and Electronics Technology”, Pearson India, 12th Edition, 2016.
2. D P Kothari and I J Nagrath, “Basic Electrical Engineering”, McGraw Hill Education, First Edition, 2017.
3. Cotton H, “Electrical Technology”, CBS Publishers, 7th Edition, 2007.
4. Del Toro, “Electrical Engineering Fundamentals”, Pearson Education, New Delhi, 2015.
5. Jacob Millman & Christos C. Halkias, Satyaprataba Jit “Electronic Devices and Circuits” McGraw Hill Education, 4th Edition, 2021.
6. Floyd, “Electronic Devices: Conventional Current Version” Pearson Education India, 7th Edition, 2008.
7. S. Salivahanan, N. Sureshkumar and A. Vallavaraj, “Electronic

Devices and Circuits", McGraw Hill Education (India) Pvt. Ltd., 2018.
8. Thomas L. Floyd, "Digital Fundamentals", 10th Edition Pearson Education Inc., New Delhi, 2008.

COURSE OUTCOMES:

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

CO1 :perform the basic calculations in DC circuits and measure the various quantities associated with DC circuits.

CO2: measure and compute the rms current and voltage, power, power factor and energy in AC circuits.

CO3: choose appropriate motor for specific applications based on the motor characteristics.

CO4: fabricate a regulated power supply for low voltage applications and build static switches using BJT and SCR.

CO5: build simple digital circuits like half adder and full adder.

Board of Studies (BoS) :
15th meeting of BoS of EEE held on 25.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	-	H	L	M	-	M	-	L	L	M	L	-	-	-
CO2	H	-	H	L	M	-	M	-	L	L	M	L	-	-	-
CO3	H	-	H	L	-	-	M	-	L	L	M	L	-	-	-
CO4	H	-	H	L	-	-	M	-	L	L	M	L	-	-	-
CO5	H	-	H	L	-	-	M	-	L	L	M	L	-	-	-

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 3: Good health and well being.

Statement: Understanding of the fundamentals of electrical and electronics systems can help in designing systems to promote good health and well being.

SDG 5: Gender equality

Statement: Acquiring the interdisciplinary knowledge help overcome the gender barriers in work place.

SDG 8: Descent work and economic

Statement: The learners of this course can get descent work and earn financial benefits and they can work in interdisciplinary areas.

SDG 12: Responsible consumption and production.
Statement: Use of right and energy efficient electric and electronic components and devices results is reasonable consumption and production.

		L	T	P	C
PED 1211	**BASICS OF MACHINING**	**L**	**T**	**P**	**C**
SDG: 4		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To impart knowledge and train the students to draw the machines for machining operations and to identify the major parts.

COB2: To provide an understanding on shaping, thread cutting, grinding and drilling operations.

COB3: To introduce the planner, electroforming and hobbing processes in mould manufacturing processes.

COB4: To enhance the understanding on EDM process, tool wear mechanisms and to understand the economics of machining processes

COB5: To demonstrate the various measurement tools during machining operations

MODULE I MACHINE TOOLS 8

Introduction to machining operations and machine tools, Classification, construction and specifications of lathe, Drilling machine, Milling – horizontal / Vertical milling.

MODULE II MACHINING PROCESSES 7

Introduction, Types of motions in machining, turning and Boring, Shaping, Grinding. Electrical discharge machining– characteristics, design consideration and typical applications.

MODULE III PLANNER,ELECTROFORMING AND HOBBING 9

Machining processes on Plannner and Slotting, Electroforming for mold manufacturing – process, materials and design. Hobbing for mold making – process & its advantages**.**

MODULE IV CUTTING TOOL MATERIALS AND TOOL WEAR 6

Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications. Introduction - tool wear mechanism, tool wear equations, effect of process parameters on tool life for the single point and multi point tools used in drilling, milling, turning and shaping operations.

MODULE V METROLOGY 9

Basic measuring instruments: vernier, micrometer, surface roughness measurement, tool makers microscope.

PRACTICALS:

1.Exercise on plain Milling

2.Exercise on vertical milling

3. Exercise on surface grinding

4. Exercise on shaping machine making square rod from round rod.

5. Exercise on drillings

6. Study of micrometer, vernier callipers and slip gauges

L – 30 ; P – 30; TOTAL HOURS – 60

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Workshop Technology", Vol. I and II, Media Promoters Pvt Ltd., Mumbai, 2007.
2. P.C. Sharma, "A Text Book of Production Technology", S. Chand and Company, X Edition, 2008.
3. P.N. Rao, "Manufacturing Technology – Metal Cutting and Machine Tools", Volume II, McGraw-Hill Education, 4e, 2018.
4. Zainul Huda, "Machining Processes and Machines – Fundamentals, Analysis and Calculations", CRC Press, 1st edition, 2020
5. HMT – "Production Technology", Tata McGraw-Hill, 2001.

REFERENCES:

1.Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 2006

2. Richerd R. Kibbe, John E. Neely, Roland O. Merges and Warren J. White, "Machine Tool Practices", Prentice Hall of India, 2003.

COURSE OUTCOMES:

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

CO1: Classify the lathe machines and able to draw the drilling, milling, grinding, turning indicating the major parts and able to operate the machines independently.

CO2: Explain and operate the shaper machine and the drilling machine.

CO3: Draw and explain the planner, electroforming and hobbing operations.

CO4: Role of EDM process in mould manufacturing and able to explain characteristics of cutting tool materials.

CO5: Measure the dimensions of work piece using vernier, micrometer, slip gauges and indentify straightness using collimeter

Board of Studies (BOS):
16th BoS of Polymer Engineering held on 17.08.2023

Academic Council:
21st^{h} AC held on 20.12.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M														H	
CO2									L							
CO3											L				L	
CO4											M					
CO5															H	

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4: Ensures inclusive and equitable quality education and promote life long opportunities for all.

Statement: Learning of various mechanical operation techniques will help the students while designing and manufacturing for proeducing plastic parts.

PED 1212 SDG: 4	PRINCIPLES OF CHEMICAL ENGINEERING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES :

COB 1: To provide knowledge in different heat transfer equipment and impart skill to students in measuring the area, heat transfer coefficients for different heat transfer systems.

COB2: To provide skills for separating mixtures of liquids by using different distillation techniques.

COB3: To develop the ability in identifying different types of crushers and grinders and perform the different size reduction methods.

COB4: To impart knowledge of separation processes practiced in various industries and find the efficiencies of separation using screening systems.

COB5: To familiarize students with the knowledge in operation of various unit operations.

MODULE I HEAT TRANSFER 12

Unit conversion systems. Heat Transfer - Modes of heat transfer - conduction, convection and radiation, steady state conduction across composite walls, cylinder and hollow sphere. Logarithmic mean temperature difference (LMTD), Individual and overall heat transfer coefficients, Heat exchanger – principle - types - parallel, counter, and cross flow. Heat exchanger (equipment description and solution to simple problems).

MODULE II MASS TRANSFER 8

Mass Transfer – principles - theory of diffusion, Distillation - Industrial equipment for distillation, problems based on distillation – McCabe Thiele method, Adsorption – principle, kinetics and equipment for adsorption.

MODULE III DRYING AND HUMDITY MEASUREMENT 9

Drying - principles, Derivation - time of drying - simple problems to find time for drying, Equipment for drying - classification - dryers for solids and pastes, dryers for solution and slurries. Humidity, dry bulb, wet bulb and dew point temperatures, specific volume and enthalpy - simple problems using psychrometric chart, equipment - water - cooling towers.

MODULE IV SIZE REDUCTION 8

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

MODULE V SEPARATION PROCESSES 8

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

PRACTICALS

- Determination of thermal conductivity of solids
- Heat transfer in lagged pipe
- Parallel / Counter flow heat exchanger
- Determination of emissivity of given surface
- Simple distillation process
- Adsorption kinetics evaluation
- Determination of moisture content of different materials
- Performance test on air conditioning systems
- Determine the efficiency of size reduction using ball mill and jaw crusher
- Measurement of screening efficiency using sieve shaker

L - 30; P-30; TOTAL HOURS -60

TEXT BOOKS :

1. Mc Cabe W. L , Smith J.C and Peter Harriot Emeritus, "Unit Operations of Chemical Engineering", - 7th edition McGraw Hill Chemical Engineering Series, New York (2004).
2. Puspavanam S, "Introduction to Chemical Engineering" , 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 and Vol. 2, Asian Books Private 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).

COURSE OUTCOMES :

CO1 : Outline the different types of heat exchangers and assess the various parameters in different equipment associated with heat transfer.

CO2 : Explain the different systems of mass transfer and operate simple mass transfer units.

CO3 : Demonstrate knowledge on drying and humidification processes.

CO4 : Identify the appropriate size reduction equipment, separation process and measure the efficiency of the equipment.

CO5 : Analyze the processes and contribute to new designs in polymer engineering

Board of Studies (BoS) :
13th BoS of Polymer Engineering held on 26.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M														H	
CO2									M							
CO3											L				H	
CO4											L					
CO5															M	

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4: All the topics in each module in this courses has been dsigned to ensure incluse quality education and promote life long learning opportunities for the students.

Statement: Students by learning thise course will be familiarized with the knowledge in various unit operations of chemical engineering. This basics helps the student to design polymerisation reactors to get a particular poduct.

		L	T	P	C
GED 1206	**ENVIRONMENTAL SCIENCES**	**L**	**T**	**P**	**C**
SDG: All		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

To make the student conversant with the

COB1: various natural resources, availability, utilisation and its current scenario.

COB2: diverse ecosystems and its function, importance of biodiversity, its values, threats and conservation.

COB3: types of pollutants and its impacts on the environment and the effects of natural disasters.

COB4: impacts of human population, human health, diseases and immunisation for a sustainable lifestyle.

MODULE I NATURAL RESOURCES 8

Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems - (a) Land resources: Land degradation soil erosion and desertification - (b) Forest resources: Use and over-exploitation, deforestation (c) Water resources: Use and over-utilisation of surface and ground water, conflicts over water, dams: benefits and problems, effects on forest and tribal people - (d) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, mining (e) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture (f) Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources.

MODULE II ECOSYSTEMS AND BIODIVERSITY 8

Concept of an ecosystem - Food chains, food webs, Energy flow in the ecosystem - ecological pyramids - Ecological succession - Characteristic features, structure and function of (a) Terrestrial Ecosystems: Forest ecosystem, Grassland ecosystem, Desert ecosystem (b) Aquatic fresh water ecosystems: Ponds and lakes, rivers and streams (c) Aquatic salt water ecosystems: oceans and estuaries

Biodiversity and its conservation - Types: genetic, species and ecosystem diversity - Values of biodiversity - India as a mega-diversity nation - Invasive, endangered, endemic and extinct species - Hot sports of biodiversity and Red Data book - Threats to biodiversity - Conservation of biodiversity: In-situ and

Ex-situ conservation of biodiversity.

MODULE III ENVIRONMENTAL POLLUTION AND DISASTER MANAGEMENT 8

Sources, 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 pollution (h) ill-effects of fireworks and upkeep of clean environment, types of fire and fire extinguishers- Solid waste Management: types, collection, processing and disposal of urban waste, industrial waste, e-waste and biomedical wastes - Disaster management: flood, drought, cyclone, landslide, avalanche, volcanic eruptions, earthquake and tsunami.

MODULE IV HUMAN POPULATION, HEALTH AND SOCIAL ISSUES 6

Human Population - Population growth, Population explosion, population pyramid among nations - Family Welfare Programme - Human Rights - Value Education - Environment and human health: air-borne, water borne, infectious diseases, contagious diseases and immunisation (all types of vaccines from birth), risks due to chemicals in food and water, endocrine disrupting chemicals, cancer and environment - Sustainable development - Resettlement and rehabilitation of people - Environment Legislative laws- Women and Child Welfare, Public awareness.

Case studies related to current situation.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

- 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.
- Benny Joseph, "Environmental Studies", Tata McGraw-Hill Education, India, 2009.
- Ravikrishnan A, "Environmental Science and Engineering", Sri Krishna Publications, Tamil Nadu, India, 2018.
- Raman Sivakumar, "Introduction to Environmental Science and Engineering", McGraw Hill Education, India, 2009.
- Venugopala Rao P, "Principles of Environmental Science and Engineering", Prentice Hall India Learning Private Limited; India, 2006.
- Anubha Kaushik and Kaushik C.P., "Environmental Science and Engineering", New Age International Pvt. Ltd., New Delhi, India, 2009.

REFERENCES:

- Masters G.M., “Introduction to Environmental Engineering and Science”, Prentice Hall, New Delhi, 1997.
- Henry J.G. and Heike G.W., “Environmental Science and Engineering”, Prentice Hall International Inc., New Jersy, 1996.
- Miller T.G. Jr., “Environmental Science”, Wadsworth Publishing Co. Boston, USA, 2016.
- “Waste to Resources: A Waste Management Handbook”, The Energy and Resources Institute, 2014.
- https://www.teriin.org/article/e-waste-management-india-challenges-and-opportunities.
- https://green.harvard.edu/tools-resources/how/6-ways-minimize-your-e-waste.
- https://www.aiims.edu/en/departments-and-centers/central-facilities/265-biomedical/7346-bio-medical-waste-management.html.
- https://tspcb.cgg.gov.in/Shared%20Documents/Guidelines%20for%20Management%20of%20Healthcare%20Waste%20Waste%20Management%20Rules,%202016%20by%20Health%20Care%20Facilities.pdf.

COURSE OUTCOMES:

The student will be able to

CO1: analyse the current scenario of various natural resources and their depletion and suggest remedies to curb the exploitation.

CO2: identify food chains and web and its function in the environment, assess the impacts on the biodiversity and propose solutions to conserve it.

CO3: analyse the types and impacts of pollutants in the environment and propose suitable methods to alleviate the pollutants and the natural disasters.

CO4: assess on the impact of human population and the health related issues and immunisation practices and sustainable developments for a healthy life

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Board of Studies (BoS) :
11th BoS of Chem held on 17.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	L	M	-	-	L	M	-	-	-	-	-	-	-	-
CO2	-	-	-	M	H	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	M	M	-	-	L	-	M	-	-

CO4	-	-	-	-	-	M	M	M	-	-	-	L	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SDG All: No Poverty, Zero Hunger, Good Health and Well-Being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable & Clean Energy, Decent Work and Economic Growth, Industry, Innovation & Infrastructure, Reduced Inequalities, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace, Justice and Strong Institutions, Partnerships for the Goals.

Statement: This course discuss about the environment, all the natural resources available, sharing of resources, effective utilisation, effects of over utilisation, health and environmental issues pertained to that, global warming and related issues, climates, disasters, impact assessments, population, human rights, societal welfare, laws to conserve the environment and sustainability.

SEMESTER – III

PED 2101	**POLYMER CHEMISTRY**	**L**	**T**	**P**	**C**
SDG: 9, 12		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

To make the student conversant with

COB1: the basic concepts of polymers, classification of polymers, copolymer types and tacticity.

COB2: the kinetics & mechanism of different types of addition polymerisation and free radical copolymerization

COB3: the kinetics & mechanism of two types of condensation polymerisation and ring-opening polymerization

COB4: the various types of polymerisation techniques

COB5: the molecular weight and its distribution and different methods of molecular weight determination.

MODULE I BASIC CONCEPTS OF POLYMERS 9

Basic concepts of polymers – degree of polymerization – significance of functionality – classification of polymers based on **:** source, structure, thermal processing behaviour, composition and structure, mechanism, intermolecular forces – nomenclature of polymers – tacticity – copolymers and its types **:** alternate, random, block and graft copolymers.

MODULE II ADDITION POLYMERISATION 10

Kinetics and mechanism of free radical polymerization **:** chain transfer, inhibition and retardation – Kinetics and mechanism of cationic polymerisation and anionic polymerisation – living polymers – Ziegler-Natta catalysts – co-ordination polymerisation – kinetics of free radical copolymerisation – copolymer equation – monomer reactivity ratio and its significance.

MODULE III CONDENSATION POLYMERISATION 9

Kinetics of polycondensation reactions (acid catalysed and self-catalysed) – ring-opening polymerization – multichain polymerization : branching, cross-linking – step-wise copolymerization – methods of synthesizing copolymers **:** statistical, alternate and block copolymers.

MODULE IV POLYMERISATION TECHNIQUES 8

Classification of polymerisationtechniques: homogenous and heterogeneous polymerisation – bulk or mass polymerisation – Trommsdroff effect – solution polymerisation – suspension polymerisation – emulsion polymerisation – interfacial polymerisation – melt polycondensation.

MODULE V MOLECULAR WEIGHT AND ITS DISTRIBUTION 9

Molecular weight of polymer – number, weight and viscosity average molecular weights – molecular weight distribution (problems) – molecular weight determination: end-group analysis, colligative properties, osmometry, light scattering, gel permeation chromatography and viscometry.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Fred W. Bill Meyer 'Textbook of Polymer Science' John Wiley & Sons, 2008.
2. George Odian, Principles of Polymerisation, 3rd Edition, McGraw Hill Book Company, New York, 1991.
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. Andrew J. Peacock and Allison Calhoun, Polymer Chemistry: Properties and Application, Carl Hanser Verlag GmbH & Company, 2012.
8. Robert J. Young, Peter A. Lovell, Introduction to Polymers, Third Edition CRC Press, 2011.

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.

COURSE OUTCOMES:

The student will be able to

CO1: classify polymers based on various criteria and also name the polymers using proper nomenclature.

CO2: derive the rate equations and explain the mechanism of addition polymerisation reactions.

CO3: derive the rate equations and explain the mechanism of condensation polymerisation reactions.

CO4: describe the various polymerisation techniques.

CO5: elaborate on methods of molecular weight determination and calculate molecular weight of polymers.

Board of Studies (BoS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H															
CO2					H		M						H	M	L	
CO3					H		M						H	M	L	
CO4					H									M	L	
CO5	M				M											

Note: L- Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : Industry, Innovation & Infrastructure.
SDG 12 : Responsible Consumption & Production.

SDG 9 : The holistic understanding of synthesizing techniques, mechanism and molecular weight determination leads to improvement in technological capabilities and sustainable industrialization.

SDG 12 : The holistic understanding of synthesizing techniques, mechanism and molecular weight determination leads to appropriate polymer materials. This also leads to responsible production chains and supply chain.

PED 2102	**POLYMER PHYSICS**	**L**	**T**	**P**	**C**
SDG: 9, 12		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

To make the student conversant with

COB1: theknowledge on chain conformations in polymers.

COB2: an understanding on the thermodynamic behavior of polymers.

COB3: theknowledge on thermal transitions and crystalline behavior of polymers.

COB4: the various types of polymerisation techniques

COB5: the molecular weight and its distribution and different methods of molecular weight determination.

MODULE I CHAIN CONFORMATIONS IN POLYMERS 9

Conformational energy of molecules- staggered and eclipsed statesexperimental determination of dimensions of chain molecules:random coils and average end to end distance- freely jointed and freely rotating chain models -random flight analysis.

MODULE II THERMODYNAMICS OF POLYMERS 9

Thermodynamics – First and second law of thermodynamics-carnot cycle, entropy and enthalpy- Energy driven and entropy driven elasticity - thermoelasticity: energetic and entropic elastic force in rubbers- statistical mechanical theory of rubber elasticity.

MODULE III THERMAL TRANSITIONS AND CRYSTALLINITY OF POLYMERS 9

Amorphous state-transition temperatures-glasstransition temperature-free volume, kinetic and thermodynamic views of glass transition- factors influencing glasstransition temperature.

Crystalline State-Crystal systems, unit cells, primitive cell- Bravais lattices-polymorphism-polymer single crystals, lamellae spherulites- supermolecular structures- fringed micelle model, degree of crystallinity- factors affecting crystallinity.

MODULE IV CHAIN ORIENTATION OF POLYMERS 9

Chain orientation: Orientation in amorphous and crystalline polymers - Uniaxial and biaxial orientation - Orientation processes: fibre spinning- blown film extrusion- solid state extrusion-profile extrusion- Properties of oriented polymers-Birefringence.

MODULE V POLYMER SOLUTIONS 9

Polymer solutions : types of solutions- Hilderbrand approach -Florry Huggins Theory - Concentration regimes of polymer solution - theta conditions - Solubility Parameter - thermodynamic view of miscibility, upper critical solution temperature (UCST), lower critical solution temperature (LCST) .

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Fred W. Bill Meyer 'Textbook of Polymer Science' John Wiley & Sons, 2008.
2. George Odian, Principles of Polymerisation, 3rd Edition, McGraw Hill Book Company, New York, 1991.
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. Andrew J. Peacock and Allison Calhoun, Polymer Chemistry: Properties and Application, Carl Hanser Verlag GmbH & Company, 2012.
8. Robert J. Young, Peter A. Lovell, Introduction to Polymers, Third Edition CRC Press, 2011.

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.

COURSE OUTCOMES:

The student will be able to

CO1: classify polymers based on conformations.

CO2: implement thermodynamics of polymers in various applications.

CO3: suggest and characterize thermal transition and crystallinity of various polymers.

CO4: identify various chain orientation process and select suitable applications based on properties.

CO5: predict the properties of newly synthesized polymers.

Board of Studies (BoS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H															
CO2					H		M						H	M	L	
CO3					H		M						H	M	L	
CO4					H									M	L	
CO5	M				M											

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : To support scientific, technology development and innovation in the field of polymer technology.
SDG 12 : Responsible Consumption & Production.

Statement :
SDG 9: The holistic understanding of amorphous and crystalline states of polymers leads to improvement in technological capabilities and sustainable industrialization.

SDG 12 : The holistic understanding of thermodynamics, thermal transitions and chain orientation of polymers leads to responsible production chains and supply chain.

PED 2103	**THERMOSET MATERIALS TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 9,12		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To acquire knowledge on basic concepts and recycling of thermosets.

COB2: To impart knowledge on the chemistry and mechanism of thermoset resins.

COB3: To develop an understanding on the manufacturingtechnology and curing characteristics of various thermoset resins.

COB4: To provide skills on selecting suitable thermoset resins for specific applications.

COB5: To develop an understanding on testing of foams.

MODULE I INTRODUCTION OF THERMOSETS 9

Basic concepts of thermosets: Definition, cross-linking, curing, influence of time, temperature and mass, shelf life, pot life, cross link density – recycling of polymer thermosets : regrind processes, SMC scrap, pyrolysis and energy recovery.

MODULE II GENERAL PURPOSE THERMOSETS 9

Industrial manufacturing process, properties, curing characteristics and applications of : unsaturated polyesters – vinyl ester – phenol formaldehyde resin – urea formaldehyde resin – melamine formaldehyde resin.

MODULE III SPECIAL PURPOSE THERMOSETS 9

Industrial manufacturing process, properties, curing characteristics and applications of : epoxies – diglycidylether of bisphenol-A resins, epoxy novalacs – cycloaliphatic epoxies – thermoset polyimides – silicone resin – polybenzoxazine.

MODULE IV POLYURETHANES 9

Industrial manufacturing process, properties, curing characteristics and applications of : thermoset polyurethanes – cast polyurethane rubber – malleable gums – flexible foams – rigid foams – skin integral foam – coatings.

MODULE V TESTING OF FOAMS 9

Rigid foam: density, cell size, open cell content, compressive properties, dimensional stability, water absorption, thermal conductivity, flammability, dielectric constant and dissipation factor – flexible foam: steam autoclave test, constant deflection compression set test, indentation force deflection test, air flow test, compression force deflection test, dry heat test, fatigue test, tear resistance test, resilience test.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. J.A.Brydson, "Plastics materials", Butterworth- Heinemann – Oxford, 6th Edition, 1995.
2. Feldman.D and Barbalata.A, "Synthetic Polymers", Chapman & Hall, 1996.
3. Dr. GumterOertal (ed.), "Polyurethane Hand Book", Hanser Publication Munich,1985
4. George woods, "The ICI Polyurethane book" published journals by ICI, John Wiley and sons NY,1990.

REFERENCES:

1. Hanna Dodiuk and Sidney H.Goodman, "Handbook of Thermoset Plastics", 3rd Edition, 2014.
2. Manas Chanda and Salil K. Roy, "Plastics Technology Handbook", Marcel Dekker, New York, 4th Edition, 2006.
3. Irvin. I. Rubin, "Hand Book of Plastic Materials and Technology", Wiley Interscience, NY, 1990.

COURSE OUTCOMES:

CO1: Apply knowledge in recycling of thermoset matrices.

CO2: Demonstrate the synthesis methodology of thermoset resins.

CO3: Examine the curing characteristics of thermosets.

CO4: Select the suitable thermoset resins for specific applications.

CO5: Suggest the specific test for foams.

Board of Studies (BOS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1			H													M
CO2		L											H			
CO3					M								H			
CO4					M									H		
CO5		M												H		

SDG 9 : Industry, Innovation & Infrastructure

SDG No. 12: Responsible consumption and production

- The holistic understanding of thermoset materials leads to development of resilient and sustainable infrastructure and industrial diversification.

- The holistic understanding of thermoset materials reduce waste and use the resource efficiently.

PED 2104	**SCIENCE AND TECHNOLOGY OF**	**L**	**T**	**P**	**C**
SDG: 9	**RUBBERS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To impart fundamental knowledge ofelastomers.

COB2: To develop knowledge of various compounding ingredients and mixing process.

COB3: To provide knowledge in synthesis, properties and applications of general-purpose elastomer.

COB4: To impart knowledge in synthesis, properties and applications of speciality elastomers.

COB5: To impart knowledge in synthesis, properties and applications of thermoplastic elastomers.

MODULE I FUNDAMENTALS OF ELASTOMERS 6

Rubber elasticity – thermodynamics of rubber – classification of rubbers – effect of structure on:Tgperformance properties, and processing properties of elastomers.

MODULE II COMPOUNDING AND MIXING 9

Principles of rubber compounding – compounding ingredients and their role carbon blacks, non-black fillers, crosslinking agents chemistry of vulcanisation (sulphur and non-sulphur) – plasticizers, accelerators, activators, cross-linking agents – special purpose additives– rubber mixing mechanism– mixing machinery – two-roll mill, Internal mixer, extruder.

MODULE III GENERAL PURPOSE RUBBERS 9

Natural rubber: tapping of latex, conversion to dry rubber, properties, grading and specifications, chemicalmodification – SBR: manufacture, types, properties and applications– BR: polymerization, properties and applications – IR: Manufacture, properties and applications – EPDM: Manufacture, properties and applications poly alkenamers, polynorbornenes.

MODULE IV SPECIAL PURPOSE RUBBERS 12

Manufacture, properties and application: butyl rubbers –nitrile rubbers and blends – polychloroprene – ACM– EVA – CSM– CM– silicone elastomers– fluorocarbon rubbers – polyurethane rubbers – epichlorohydrin rubbers – polysulphide rubbers.

MODULE V THERMOPLASTIC ELASTOMERS 9

Definition – categories of TPEs- methods of preparation –Styrenic block copolymers – thermoplastic elastomeric olefins– thermoplastic polyurethanes - copolyesters – polyamides- thermoplastic vulcanizates

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Brendan Rodgers, "Rubber Compounding, Chemistry and Applications", CRC Press, 2016.
2. John S. Dick, "Rubber Technology: Compounding and Testing for Performance", Second Edition, Carl Hanser Verlag GmbH & Company KG, 2014.
3. Maurice Morton, "Rubber Technology", Third edition, Springer Science & Business Media, 2012.

REFERENCES:

1. Anil K. Bhowmick, Howard Stephens, "Handbook of Elastomers", Second Edition, CRC Press, 2001.
2. James E. Mark, BurakErman, Frederick R. Eirich, "Science and Technology of Rubber", Second Edition, Academic Press, 2014.

COURSE OUTCOMES:

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

CO1:explain the fundamental properties of elastomers.

CO2:demonstrate the skills in rubber compounding and mixing.

CO3:suggest suitable elastomers for commodity applications.

CO4:select elastomers for high performance applications.

CO5: recommend thermoplastic elastomer for suitable applications.

Board of Studies (BOS) :

14th BoS of PE held on 15.12.2021

Academic Council:

18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	L											L	L		L	
CO2				M		L		L				L		H	L	
CO3												L	L	M		
CO4												L	L	M		
CO5												L	L	M		

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Understand the fundamental aspects of rubbers to enable industrialization and foster innovation.

Statement: The holistic understanding the science of different rubbers and their applications to industrialization and innovative rubber materials and products.

PED 2105	BIODEGRADABLE POLYMERS	L	T	P	C
SDG: 12,15		3	0	0	3

COURSE OBJECTIVES:

COB1: To impart knowledge of biodegradable polymers and the mechanism of biodegradation.

COB2: To provide knowledge of biodegradable polymers based on starch

COB3: To equip with fundamental knowledge on biodegradable polyesters

COB4: To impart knowledge of aliphatic and aromatic polyesters

COB5: To introduce the various test procedures for evaluating biodegradable polymers

MODULE I BIODEGRADABLE POLYMERS 9

Biodegradable polymers - definition of biodegradability – classification - mechanisms of polymer degradation: non-biological degradation of polymers, biological degradation of polymers - abiotic degradation - biotic degradation - common biodegradable polymers in market - factors affecting biodegradability.

MODULE II STARCH-BASED TECHNOLOGY 6

Starch polymer - Starch-filled Plastics -Thermoplastic Starch:Manufacture, properties and applications-Starch-Based Materials on the Market.

MODULE III BIODEGRADABLE POLYESTERS 9

Poly (Lactic Acid) (PLA): homopolymer and co-polymer synthesis–Manufacture, structure, properties, degradation, and applications of PLA.Poly(e-caprolactone) – synthesis - properties and degradation of poly(e-caprolactone) – applications.

MODULE IV ALIPHATIC AND AROMATIC POLYESTERS 12

Poly(hydroxyalkanoate) Synthesis – Properties and applications of PHA. Poly (alkylene dicarboxylate) synthesis - properties, and applications – degradation of polyesters, degradation mechanism – biocorrosion, in-vivo degradation, biodegradation in the environment, composting conditions, soil, aqueous environment, aneorabic conditions – degradation of aromatic sequence.

MODULE V EVALUATION OF BIODEGRADABILITY 9

Degradation of Biodegradable Polymers - Polymer Biodegradation Mechanisms - Assessment of Biodegradable Polymers Degradability – International and National Norms onBiodegradability and Certification Procedures -ASTM, BS, BIS series, Aquatic, Aerobic Biodegradation Tests, Compost Biodegradation Tests.

L – 45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Ray Smith, 'Biodegradable polymers for industrial applications' CRC Press, 2005.
2. Jie Ren, 'Biodegradable Poly (Lactic Acid)', Springer, 2010.
3. Joseph P. Greene, Sustainable Plastics, Wiley, 2014.
4. StoykoFakirov, Biodegradable Polyesters, Wiley VCH Verlag GmbH & Co, 2015.
5. Xiang Cheng Zhang, 'Science and Principles of Biodegradable and Bioresorbable Medical Polymers' Elsevier Ltd., 2017.

REFERENCES:

1. Catia Bastioli, 'Handbook of Biodegradable Polymers' Walter de Gruyter GmbH, Berlin, 2020.
2. SinaEbnesajjad 'Handbook of Biopolymers and Biodegradable Plastics' Elsevier, 2013.

COURSE OUTCOMES:

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

CO1: define biodegradation and its mechanism

CO2: describe the biodegradable polymers based on starch

CO3: explain the various routes to synthesis biodegradable polyesters

CO4: suggest relevant methods to prepare aliphatic and aromatic polyesters

CO5:conduct necessary functional and characterization to assess the biodegradability of polymers

Board of Studies (BOS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L									M		
CO2	L				L									H		
CO3								M						H		
CO4					M									H		

Note: L - Low Correlation M -Medium Correlation H - High Correlation

SDG:12,15: Prepare a polymer which can undergo biodegradation either in water or landfillthere by consuming the waste and restoring the biodiversity.

To effective usage of polymer products and enable them to degrade after their consumption naturally or through inoculum.

PED 2106	**POLYMERIC MATERIALS**	**L**	**T**	**P**	**C**
SDG: 9	**ANALYSIS LABORATORY**	**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To provide skills in identification of plastics and rubbers by simple physical and chemical methods**.**

COB2: To impart fundamental knowledge in analyzing the basic physical and chemical properties of the polymers.

PRACTICALS

List of Experiments:

Part I

1. Identification of Plastics:
   PE, PP, PS, PVC, PVA, PA6, PA66, PET, PBT, ABS, PF, UF and MF
2. Identification of Rubbers:
   NR, BR, SBR, IR, IIR, CR, NBR and Silicone rubber.

Part II

1. Determination of molecular weight of polymers by viscosity method.
2. Determination of viscosity by Brookfield Viscometer.
3. Determination of hydroxyl value of polyol.
4. Determination of K – value of PVC resin.

P – 30 ; TOTAL HOURS – 30

TEXT BOOKS:

- Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah, “Polymer Processing and Characterization: 1 (Advances in Materials Science)”,Apple Academic Press; 1 edition ,January 31, 2013.
- V.A. Bershtein , G.C. Berry, et al, “Polymer Analysis and Characterization (Advances in Polymer Science)”,2013.
- T.R. Crompton, “Practical Polymer Analysis”, 2012.
- Joseph D. Menczel , R. Bruce Prime, “Thermal Analysis of Polymers”, Fundamentals and Applications”, Wiley; 1 edition , April 20, 2009.
- Characterization and Analysis of Polymers, by Wiley, 2008.

COURSE OUTCOMES:

CO1: Predict the fundamental properties governing the polymersby physical and chemical methods.

CO2: Segregate different plastics based on density variations.

Board of Studies (BOS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M												H			
CO2		L												M		

SDG No. 9: Industry, Innovation & Infrastructure

- The holistic understanding of identification of polymeric materials leads to develop sustainable industrial diversification and environmentally sound technologies.

		L	T	P	C
PED 2107	**POLYMER SYNTHESIS LABORATORY**	**L**	**T**	**P**	**C**
SDG: 9		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To develop an understanding on various methods of polymerisation and its structure property relationship.

COB2: To equip with the fundamental knowledge of mechanism of polymerization and various process parameters affecting the polymerisation technique.

PRACTICALS

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

P – 30 ; TOTAL HOURS – 30

TEXT BOOKS:

- Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah, “Polymer Processing and Characterization: 1 (Advances in Materials Science)”,Apple Academic Press; 1 edition ,January 31, 2013.
- V.A. Bershtein , G.C. Berry, et al, “Polymer Analysis and Characterization (Advances in Polymer Science)”,2013.
- T.R. Crompton, “Practical Polymer Analysis”, 2012.
- Joseph D. Menczel , R. Bruce Prime, “Thermal Analysis of Polymers”, Fundamentals and Applications”, Wiley; 1 edition , April 20, 2009.
- Characterization and Analysis of Polymers, by Wiley, 2008.

COURSE OUTCOMES:

CO1: Develop new polymers and chemically modify the existing polymers based on specific property requirements.

CO2: Select a suitable technique for synthesizing polymers for advance applications.

Board of Studies (BOS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M												H			
CO2		L												M		

SDG No. 9: Industry, Innovation & Infrastructure.

- The holistic understanding of various polymerization techniques identification of polymeric materials leads to develop sustainable industrial diversification and environmentally sound technologies.

		L	T	P	C
GED 2101	**ESSENTIAL SKILLS AND APTITUDE FOR ENGINEERS**	**L**	**T**	**P**	**C**
SDG: 17		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1:To enable them to make effective business presentations

COB2:To train them to participate in group discussions

COB3: To enhance the problem-solving skills

COB4: To train students in solving analytical problems

MODULE I ORAL DISCOURSE 07

Importance of oral communication-verbal and non-verbal communication, Presentation Strategies- one minute presentation (using Audacity/vocaro) - Effective listening skills, listening for specific information

MODULE II VERBAL COMMUNICATION 08

Understanding negotiation, persuasion & marketing skills - Listening to short conversations & monologues - Group Discussion techniques - Role plays - Interview techniques

MODULE III BASIC NUMERACY 08

Simplification and Approximation – Competitive Examination Shortcut Techniques - Number Systems - Simple and Compound Interest-Progression

MODULE IV ANALYTICAL COMPETENCY 07

Blood Relations – Clocks and Calendars – Coding and Decoding – Analytical Reasoning(Linear Arrangement, Circular Arrangement, Cross Variable Relationship and Linear Relationship)– Directions .

L – 30; TOTAL HOURS - 30

REFERENCES:

1. Whitby, Norman (2014). Business Benchmark: Pre-Intermediate to Intermediate. Cambridge University Press, UK
2. Swan, Michael (2005). Practical English Usage, Oxford University Press
3. Bhattacharya. Indrajit (2008). An Approach to Communication Skills, DhanpatRai& Co., (Pvt.) Ltd. New Delhi.
4. Tyra .M, Magical Book On Quicker Maths, BSC Publishing Company Pvt. Limited, 2009
5. R. S. Aggarwal , Quantitative Aptitude for Competitive Examinations,

S. Chand Limited, 2017
6. R. S. Aggarwal , A Modern Approach to Verbal & Non-Verbal Reasoning , S. Chand Limited, 2010
7. Khattar Dinesh , The Pearson Guide to Quantitative Aptitude for Competitive Examinations, 3e, Pearson India , 2016
8. Rajesh Verma , Fast Track Objective Arithmetic Paperback , Arihant Publications (India) Limited , 2018
9. Arun Sharma Teach Yourself Quantitative Aptitude Useful for All Competitive Examinations, McGraw Hill Education (India) Pvt. Limited, 2019.

COURSE OUTCOMES:

CO1: Make effective business presentations

CO2: Speak English intelligibly, fluently and accurately in group discussions

CO3: To apply the various problem-solving techniques

CO4: Understand and solve aptitude problem

Board of Studies (BoS) :
13th BoS of the Department of English held on 17.6.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1										H					
CO 2									M	H					
CO 3					L	L									
CO 4		M		L											
CO 5															

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Statement: This course ensures capacity building and skills development requisite for implementing global partnership.

SEMESTER IV

PED 2201	**THERMOPLASTICS**	**L**	**T**	**P**	**C**
SDG: 9, 12		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To provide fundamental knowledge in the synthesis of monomers for different plastics.

COB2: To impart skills to understand the different polymerization methods involved in the manufacturing of various vinyl polymers.

COB3: To demonstrate the skill to differentiate engineering plastics based on structure property relationship.

COB4: To provide knowledge on manufacture, properties and applications of miscellaneous polymers.

COB5: To impart knowledge on various industrial and high-performance plastics, their properties and applications.

MODULE I POLYOLEFINS AND STRYENIC 9

Industrial manufacturing processes, properties, applications: Polyethylene (LDPE - HDPE – LLDPE- HMWHDPE-UHMWHDPE) crosslinked polyethylene (XLPE) - polypropylene(PP) - polyisobtylene-polystyrene (PS) - high impact polystyrene (HIPS) -expanded polystyrene (EPS), acrylonitrile butadiene styrene (ABS).

MODULE II VINYLPOLYMERS 9

Industrial manufacturing processes, properties, applications:

Poly (viny chloride) (PVC)- chlorinated poly (vinyl chloride) (CPVC) -plastisols - organosols - poly(vinylidene chloride) (PVDC)- poly (vinyl acetate) (PVA_c) - poly (vinyl-2-pyrrolidone) -polyacrylonitrile (PAN) - poly (methyl methacrylate) (PMMA).

MODULE III ENGINEERING POLYMERS -FLUOROPOLYMERS 8

Industrial manufacturing processes, properties, applications: Poly (tetrafluoro ethylene) (PTFE) -poly(chlorofluoroethylene)-fluorinated (ethylene-propylene) (FEP) - poly(vinylidene fluoride) (PVDF)poly(vinylidene-co-hexafluoropropylene) (PVdF-HFP)

MODULE IV ENGINEERING POLYMERS – MISCELLANEOUS 10

Industrial manufacturing processes, properties, applications:Poly (ethylene terephthalate) (PET)- Poly(butylene terephthalate),Polycarbonate (PC), polyoxymethylene (POM) -polyethylene (oxide), nylon 6- nylon 6, 6, nylon 6,12.

MODULE V SPECIALITY POLYMERS 9

Industrial manufacturing processes, properties Poly (ether ether ketone)-polyimides-poly (amide-imides)- poly(aryl ether ketone)- poly (p-phenylene oxide) (PPO)-polysulfones-poly (ether sulfones)(PES), poly(phenylene sulfide) (PPS).

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Olagoke Olabisi, “Hand Book of Thermoplastics”, Marcel Decker, inc., 1997.
2. K.J. Saunders, “Organic Polymer chemistry”, Chapman & Hall, NY, 1988.
3. Irvin.I.Rubin, “Hand Book of Plastic Materials and Technology”, Wiley Interscience, NY, 1990.

REFERENCES:

1. J.A.Brydson, “Plastics Materials”, Butterworth- Heinemann – Oxford Press, 2005.
2. Olagoke Olabisi, “Hand Book of Thermoplastics”, Marcel Decker, inc., 1997.1. Lloyd M.Robeson, “Polymer Blends”, Hansergardner publications, U.S.A, 2007.
3. S.W. Mayo, “Manufacture of Plastics”, Reinhold Publishing Corporation, Chapman & Hall, Ltd. London, 1964.
4. S.L. Rosen, “Fundamentals Principles of Polymeric Materials”, John Wiley Publisher, 2nd edition, 1993.

COURSE OUTCOMES:

CO1: To demonstrate the synthesis of monomers for different plastics.

CO2: To select different polymerization methods involved in manufacturing of various plastic materials.

CO3: To exhibit knowledge in different polymers, their structure property relationship and applications.

CO4: To identify plastics based on the application requirements.

CO5: Understanding of phase morphology of miscible and immiscible blends.

Board of Studies (BOS) :	**Academic Council:**
14th BoS of PE held on 15.12.2021	18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1			H													M
CO2		L											H			
CO3					M								H			
CO4					M									H		
CO5		M												H		

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG No. 9: Industry, Innovation & Infrastructure
SDG No. 12: Responsible consumption and production

- The holistic understanding of thermoplastic materials leads to development of resilient and sustainable infrastructure and industrial diversification.
- The holistic understanding of thermoplastic materials reduce waste and use the resource efficiently.

PED 2202	**POLYMER COMPOUNDING**	**L**	**T**	**P**	**C**
SDG: 12	**TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To provide fundamental knowledge on the plastics compounding.

COB2: To impart the knowledge of additives in polymer formulation for suitable applications.

COB3: To impart knowledge of compounding different polymers in compliance with REACH standard.

COB4: To impart skills in different methods of mixing additives with polymers.

COB5: To provide knowledge on polymer formulation for specific applications.

MODULE I INTRODUCTION TO COMPOUNDING 9

Fundamentals of plastics compounding –essentials of compounding: ingredients, formulation, morphology, polymer melt, processing requirementsandtemperature – melt compounding – masterbatch – devolatilization – optimisation - regrind usage in compounding.

MODULE II ADDITIVES FOR POLYMERS 12

Additives – classification – ageing and degradation: stabilisers, antioxidants, light stabilisers, flame retardants, smoke suppressants – physical properties modification: plasticisers, lubricants, nucleating agents, processing aids, mould release agents, slip additives, antistatic agents, antifogging agents, coupling agents, antimicrobial agents – Foaming agents – colourants. Indian and international regulations for the use of chemicals: BIS, REACH – compliance procedure, list of restricted substances subject to authorisation.

MODULE III REINFORCEMENT AND FILLERS 9

Fillers – physical properties of fillers: particle morphology, shape, size, and distribution, surface area, chemistry, wetting, and coupling, loading and density, rheology and processability, mixing and dispersion, mechanical properties, thermal properties, optical properties, permeability –surface modifications - filler classifications –particulate fillers, mineral based particulate fillers, synthetic particulate fillers, organic particulate fillers, speciality particulate fillers, nanofillers.

MODULE IV EQUIPMENT FOR COMPOUNDING 9

Mixing: laminar mixing, dispersive mixing, distributive mixing – batch mixers: internal high-speed mixer, kneaders – continuous mixers: single-screw extruder, twin-screw extruder, reactive extrusion – colour compounding – filler compounding –

compounding with reinforcing fibres.

MODULE V BASIC POLYMER FORMULATIONS 6

Polyolefins – polyvinylchloride – nylon – ABS – phenolic and melamine moulding powders – epoxy resin and unsaturated polyester resins – rubber hose – latex gloves – bicycle tube – rubber gasket.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Natamai Subramanian Murali Srinivasan, "Introduction to Polymer Compounding: Raw Materials", Volume 1, Smithers Rapra Technology Ltd, Volume 1, 2014.
2. Natamai Subramanian Murali Srinivasan, "Introduction to Polymer Compounding: Machinery and Technology", Volume 1, Smithers Rapra Technology Ltd, Volume 2, 2014.
3. Roger Rothon, "Fillers for PolymerApplications", Springer International Publishing Switzerland, 2017.
4. Johannes Karl Fink, "A Concise Introductionto Additives for thermoplastic polymers", Scrivener Publishing, LLC, 2010.
5. Reachin brief, Environment Directorate General, European Commission, October 2007.

REFERENCES:

1. Stuart Patrick, PVC Compounds andProcessing, Rapra Technology Limited, Volume 15, Number 3, 2004.
2. George Wypych, "Functional FillersChemical composition, morphology, performance, applications", ChemTec Publishing, 2018.

COURSE OUTCOMES:

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

CO1: demonstrate the knowledge on the plastics compounding.

CO2: suggest suitable compounding ingredients based on the requirements.

CO3: apply knowledge in the compounding of plastic materials in compliance with Indian and international standards.

CO4: select suitable equipment for mixing additives with various polymers.

CO5: formulate polymers for suitable applications

Board of Studies (BOS):	**Academic Council:**
16th BoS of Polymer Engineering held on	21st[h] AC held on 20.12.2023

17.08.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L									M		
CO2	L				L									H		
CO3								M						H		
CO4					M									H		
CO5														H		

Note: L- Low Correlation M - Medium Correlation H - High Correlation

SDG:12 Development of plastic material goods by understanding the compounding requirements and able to adopt to the sustainable consumption.

Statement:The understanding the plastic compounding requirements and prepare plastic materials for sustainable consumption.

PED 2203	RUBBER PROCESSING TECHNOLOGY	L	T	P	C
SDG:8		3	0	0	3

COURSE OBJECTIVES:

COB1: To develop fundamental knowledge of rubber mixing machineries.

COB2: To impart knowledge of mixing procedure for different compounds.

COB3: To illustrate the molding process used in processing rubbers.

COB4: To introduce processing methods for various rubber products.

COB5: To develop knowledge of different vulcanisation methods used in rubber processing.

MODULE I COMPOUNDING AND MIXING OPERATIONS 9

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 9

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.

MODULE III FORMING OPERATIONS 9

Calendering - Calender configurations and operations - roll deflection and methods of correction - feeding; sheet cooling, and batch-off equipment.

Extrusion; Ram type – Screw type – L/D ratio and its influence – Hot & cold feed extruders – Pin barrel extruder – piggy back extruders - Twin screw extruder – Criteria for machine selection.

MODULE IV MOULDING OPERATIONS 9

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

Compression, transfer moulding - Blanks & pre-heating technique and manufacturing techniques.

MODULE V VULCANISATION TECHNIQUES 9

Autoclaves, Hot air chambers, curing of built-up articles, continuous vulcanization, L.C.M. (Liquid Curing Media), Fluidized Bed, microwave curing. Hand building and forming equipment for tank, pipe lining, roller covering.

P– 45;TOTAL HOURS – 45

TEXT BOOKS:

1. Richard F. Grossman, "The Mixing of Rubber", Chapman & Hall, 1997.
2. A.K. Bhowmick, M.M. Hall and H.A. Benaney, “Rubber Products Manufacturing Technology”, Marcel Dekker Inc, New York, 1994.
3. Bernie Stritzke, "Custom Molding of Thermoset Elastomers", Hanser Publications, 2009
4. John G. Sommer, Engineered Rubber Products, Introduction to Design, Manufacture and Testing, Hanser Publishers, 2008.
5. B.G. Crowther, "Rubber Extrusion Theory andDevelopment", 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.

COURSE OUTCOMES:

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

CO1:describe rubber mixing process

CO2:identify and suggest suitable mixing procedure for different compounds

CO3:demonstrate calendaring and extrusion process

CO4:explain injection, transfer and compression molding of rubbers

CO5:describe different vulcanisation methods used in rubber processing

Board of Studies (BOS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L											L			H	M
CO2	L											L			H	M
CO3	L											L			H	M
CO4	L											L			H	M
CO5	L											L			H	M

Note: L- Low Correlation M - Medium Correlation H - High Correlation

SDG 8: Promote the knowledge of rubber processing methods which leads to a productive employment and trigger entrepreneurship.

The aggregate understanding of various rubber processing methods to process rubber products there by improving the employability skills and promotes entrepreneurship mindset.

PED 2204 SDG: 9, 12	ANALYSIS AND CHARACTERISATION OF POLYMERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: identification of various thermoplastics and validating their quality.

COB2: identification of thermosets and rubbers and validating their quality.

COB3: principle and instrumentation of spectroscopic techniques, analysis and interpretation of polymers using these techniques.

COB4: principle and instrumentation of thermal techniques, analysis and interpretation of polymers and additives using these techniques.

COB5: principle, instrumentation of morphological techniquess analysis and interpretation of polymers, blends and composites using these techniques.

MODULE I ANALYSIS OF THERMOPLASTICS 8

Preliminary Identification of thermoplastics: Appearance, colour, odour, pyrolysis test, melting point, solubility test density, copper wire test, apparent density, specific gravity test – moisture content – particle size: sieve analysis test – viscosity, melt flow index, K-value.

MODULE II ANALYSIS OF THERMOSETS AND RUBBERS 8

Preliminary and chemical identification of thermosets: flow test (cup, spiral, disc), gel time and peak exothermic temperature, acid value, hydroxyl value, isocyanate index, epoxy equivalent – analysis of latex: Brookfield viscosity, TSC, DRC, alkalinity, KOH number, mechanical stability.

MODULE III SPECTROSCOPIC CHARACTERISATION 10

Principle, instrumentation, analysis and interpretation: UV-Visible spectroscopy – Fourier-Transform Infrared spectroscopy (FTIR) –Raman spectroscopy – NMR spectroscopy – Mass spectrometry.

MODULE IV THERMAL CHARACTERISATION 10

Principle, instrumentation, analysis and interpretation: Thermogravimetric analysis (TGA) – Differential thermal analysis (DTA) – Differential scanning calorimetry (DSC) – Dynamic mechanical analysis (DMA) – Thermomechanical analysis (TMA) – Dielectric thermal analysis (DETA).

MODULE V MORPHOLOGICAL CHARACTERISATION 9

Principle, instrumentation, analysis and interpretation: X-RAY Diffraction (WAXD and SAXS) – Birefringence – Optical microscopy – scanning electron microscopy – Transmission electron microscopy – atomic force microscopy.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

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

REFERENCES:

1. Dan Campbell, Richard A. Pethrick, Jim R. White, “Polymer Characterization: Physical Techniques”, Second Edition, CRC Press, 2000.
2. LuigiaSabbatini, “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:

The student will be able to

CO1: identify the thermoplastics by simple physical and chemical analytical methods.

CO2: identify the thermosets and rubbers by simple physical and chemical analytical methods.

CO3: analyze and interpret the spectral data of polymers.

CO4: determine the thermal stability and thermal transitions of polymers, polymer blends and composite materials using various thermal techniques.

CO5: characterise the morphology of polymers, polymer blends and composite materials.

Board of Studies (BOS):
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1		H		H			L				M		H			
CO2		H		H			L				M		H			
CO3		H		H			M	M		H	H			H		
CO4		H		H			M			H	H			H		
CO5		H		H			M			H	H			H		

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : Industry, Innovation & Infrastructure
SDG 12 : Responsible Consumption & Production

SDG 9 : The holistic understanding of analysis and characterization of polymeric materials leads to improvement in efficiency in resource use andsustainable industrialization.

SDG 12 : The holistic understanding of analysis and characterization of polymeric materials leads to appropriate procurement of polymer materials and resource efficiency. This also leads to responsible production chains and supply chain.

PED2205	**POLYMER RHEOLOGY**	**L**	**T**	**P**	**C**
SDG:9		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

COB1: To provide an understanding about the mechanical behaviour of polymeric materials.

COB2: To provide knowledge about mechanical models based on viscoelastic characteristics.

COB3: To impart knowledge on the rheological behavior of polymer melts.

COB4: To equip knowledge about the function of variousrheometers function

COB5: To apply polymer rheology foundations in a variety of industrial applications.

MODULE I MECHANICAL BEHAVIOUR OF POLYMERIC MATERIALS 10

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 (Problems) – Boltzmann principle – Time – Temperature superposition principle (Problems)– William–Landel–Ferry equation (Problems).

MODULE II MECHANICAL MODELS - VISCOELASTIC BEHAVIOUR 15

Mechanical models – Stress strain response of spring and dashpot – Viscoelastic models – Maxwell element – *Kelvin–Voigt*element – Response to creep and stress relaxation – Four Parameter model – Dynamic mechanical properties – Behavior of Maxwell element and relaxation spectra (Problems based on all the topics).

MODULE III FLOW PROPERTIES OF POLYMER MELT 15

Fluid flow – Types of fluid flow - Newtonian and non-Newtonian fluids – Laminar flow of Newtonian fluids - Viscosity of polymer melts – Shear thinning and shear thickening(Problems)– Zeroshear rate viscosity – Laminar flow of Newtonian fluids(Problems)– Power law – General treatment of isothermal viscous flow in tubes – Entrance and exit effects – Elastic effects in polymer melt flow (Problems)– Dieswell and melt fracture – Weissenberg effect (Problems)– Normal stress difference – elongational viscosity.

MODULE IV MEASUREMENT OF RHEOLOGICAL PROPERTIES 10

Measurements of rheological properties – Capillary rheometers – Melt flow index (Problems) – Cone and plate viscometer (Problems) - Torque rheometers - Mooney viscometer - MDR (Problems).

MODULE V APPLICATION OF POLYMER RHEOLOGY TO PROCESSING 10

Rheological behavior of thermoplastics PC, PE, PP, PS, PVC, and Nylon. Applications of rheology to polymer processing (injection, extrusion and blow moulding).

L –60; TOTAL HOURS – 60

TEXT BOOKS:

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

REFERENCES:

1. Herman F. Mark, “Encyclopedia of Polymer Science and Technology”,Wiley; 4th Edition, 2014
2. Alexander Ya. Malkin, Avraam I. Isayev Rheology, “Concepts, Methods, and Applications”, ChemTech Publishing, 2ndEdition, 2012
3. Christopher W. Macosko, “Rheology : Principles, Measurements, and Applications”, Wiley VCH, 1996.

COURSE OUTCOMES :

CO1: Analyze the mechanical behaviour of polymeric materials.

CO2: Construct a model for various viscoelastic polymer combinations.

CO3: Demonstrate the rheological properties of different polymer melts.

CO4: Explain how various rheological instruments work and how to optimize their parameters.

CO5: Apply the theory of rheology in the applications of polymer processing.

Board of Studies (BOS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M				H											M
CO2	L			M	L									L	L	L
CO3		L		H	M									M	L	L
CO4		M		M										L	H	
CO5		M		M							M			H	M	H

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9: To support scientific, technology development and innovation in the area of polymer rheology.

The topics mentioned in this course are designed towards understanding the different viscoelastic models, flow properties of various type of polymeric materials,measurement of rheological properties and applications. This course foster innovationand technological capabilities in processing of polymeric materials which will satisfy the current industrial challenges.

PED 2206	**PLASTIC**	**L**	**T**	**P**	**C**
SDG: 8	**PROCESSING TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To provide fundamental knowledge of injection moulding process.

COB2: To impart knowledge of extrusion molding process and its applications.

COB3: To illustrate various blow moulding processes.

COB4: To develop knowledge of thermoforming and rotational moulding processes.

COB5: To develop knowledge of processing thermoset materials by compression and transfer molding processes.

MODULE I INJECTION MOULDING PROCESS 9

Working principle, process sequence, moulding cycle – injection moulding machines, types, machine specifications, selection criteria – clamp systems – process control – process optimization – troubleshooting– machine startup and shut down procedure.

MODULE II EXTRUSION MOULDING PROCESS 9

Basic operation of single screw and twin-screw extruders – screw design– construction and operation.

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 and its effects.

MODULE III BLOW MOULDING PROCESS 9

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 blow moulding process – stretch blow molding process – troubleshooting.

MODULE IV THERMOFORMING AND ROTATIONAL MOULDING PROCESSES 9

Rotational molding process – polymers used – raw material characteristics – rheology of powder flow – part removal – liquid rotational molding –types of machines – troubleshooting.

Principles of thermoforming – forming characteristics – thermoforming methods – thermoforming machines – advantages and disadvantages of thermoforming.

MODULE V COMPRESSION ANDTRANSFER MOULDING PROCESSES 9

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

Principle of transfer moulding process – moulding cycle – types of transfer molding – molding defects – process parameters and their effect on product quality – advantages and limitations – comparison between compression and transfer moulding process.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Donald G. Baird, Dimitris I. Collias, “Polymer Processing: Principles and Design, 2nd Edition, John Wiley & Sons, 2014.
2. Musa R. Kamal, “Injection Moulding - Technology and Fundamentals", Hanser Publications, Inc., Cincinnati, 2009.
3. Suhas Kulkarni. "Robust process development and scientific molding: theory and practice", Hanser Publications, 2010
4. Chris Rauwendaal, "Polymer Extrusion" V edition, Hanser Publications, 2013.
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. Dominick V. Rosato, Donald V. Rosato, MarleneG.Rosato, “Injection molding handbook” 3rd ed., Kluwer Academic Publishers, 2000
2. Richard G. Griskey, “Polymer Process Engineering”, Chapman & Hall, 2001

COURSE OUTCOMES:

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

CO1: describe the injection moulding process

CO2: demonstrate the working of single and twin-screw extruders and extrusion molding process

CO3: compare various blow moulding process

CO4: demonstrate thermoforming and rotational moulding processes

CO5:explain the processing of thermoset materials by compression and transfer molding processes

Board of Studies (BOS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L							L	L	L	H	L
CO2	L				L							L	L	L	H	L
CO3	L				L							L	L	L	H	L
CO4	L				L							L	L	L	H	L
CO5	L				L							L	L	L	H	L

Note: L- Low Correlation M - Medium Correlation H - High Correlation

SDG 8:Develop the knowledge of plastics processing technologies that promotes a productive employment and potential entrepreneurship.

The holistic understanding of different plastics processing methods that involved in manufacturing of plastic products there by enabling an employability and promotes an entrepreneurial mindset.

PED 2207	**PLASTICS PROCESSING**	**L**	**T**	**P**	**C**
SDG: 8	**LABORATORY**	**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To impart skills to operate various injection molding machines, blow moulding machines, and extruders.

COB2: To inculcate competency in setting various process parameters and conduct necessary trails to define the quality of the product and expose to process defects

COB3: To provide knowledge in the troubleshooting various moulding process.

COB4: To equip with the skill to operate an extruder

COB5: To develop the skill in grinding and estimation of runner ratio to add with raw materials.

PRACTICALS

List of Experiments:

1. Preparation of plastic raw materials for different moulding process (processing parameters, drying temperature and time)
2. Study of impact of pressure in injection and clamping of semi-automatic injection moulding process.
3. Evaluation of process setting parameters of injection moulding process in an automatic injection moulding machine.
4. Study of hold on time in injection phase by scientific approach in an injection moulding process.
5. Determination of process window of injection moulding process by shot short method.
6. Appreciate the theory of blow moulding principle by hand blow moulding process.
7. Determination of various process parameters that influence the automatic blow moulding process.
8. Setting up of process parameters for single screw extrusion process.
9. Study the effect of screw speed in extrusion of strands and pellets by single screw extrusion and calculation of output.
10. Understanding the principle of compression moulding process by moulding thermoset resin.
11. Compounding of thermoplastic resin in a hot roll mill and compression moulding of thermoplastic resins

12. Effective utilization of moulded scraps by scrap grinding process

P – 30 ; TOTAL HOURS – 30

TEXT BOOKS:

- Suhas Kulkarni, "Robust ProcessDevelopment andScientific Moulding", Carl Hanser Verlag, München, Germany, 2010. (ISBN 978-3-446-42275-9)
- D. V. Rosato, "Extruding Plastics - A practical processing handbook", Springer-Science+Business Media, B.V., 1998 (SBN 978-1-4615-5793-7 DOI 10.1007/978-1-4615-5793-7)
- Samuel L.Belcher, "Practical extrusion blow moulding process", Marcel Dekker Inc., USA., 1997.

REFERENCES:

1. VannessaGoodship, "Practical Guideto InjectionMoulding", Rapra Technology Limited, 2004. (ISBN: 1-85957-444-0)

COURSE OUTCOMES:

CO1: Set the process parameters and run an injection molding machine

CO2: Calculate the process output and cycle time for different process

CO3: Demonstrate the extrusion molding process

CO4: Identify defects in the manufactured plastic products and suggest necessary corrective actions

CO5: Grind the runners and determine the quantity of ground materials to be added in the raw material

Board of Studies (BOS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1															H	
CO2				L											H	
CO3								M							H	
CO4															H	
CO5															H	

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 8: Inculcate the plastics processing skills that leads to a productive employment and likely to develop entrepreneurship.

The hands-on experience in manufacturing of different plastics products thus providing ample employment opportunities and promotes an entrepreneurial mindset.

PED 2208	**POLYMER CHARACTERIZATION LABORATORY**	**L**	**T**	**P**	**C**
SDG: 9		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To impart skills in characterizing various physical properties of plastics and rubbers.

COB2: To equip with skill in analyzing the quality of natural rubber latex.

PRACTICALS

List of Experiments:

1. Determination of gel time and peak exothermic temperature for thermosetting resins.
2. Determination of melt flow index for thermoplastics.
3. Determination of moisture and volatile content in plastics / rubbers.
4. Determination of water absorption in plastics.
5. Determination of apparent density and bulk density of polymers.
6. Determination of epoxy equivalent.
7. Determination of acid value of polyester resin.
8. Determination of filler content in plastics / rubber.
9. Determination of total solid and dry rubber content of NR latex.
10. Determination of total alkalinity of NR latex.

P – 30 ; TOTAL HOURS – 30

TEXT BOOKS:

- Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah, "Polymer Processing and Characterization: 1 (Advances in Materials Science)",Apple Academic Press; 1 edition ,January 31, 2013.
- V.A. Bershtein , G.C. Berry, et al, "Polymer Analysis and Characterization (Advances in Polymer Science)",2013.
- T.R. Crompton, "Practical Polymer Analysis", 2012.
- Joseph D. Menczel , R. Bruce Prime, "Thermal Analysis of Polymers", Fundamentals and Applications", Wiley; 1 edition , April 20, 2009.
- Characterization and Analysis of Polymers, by Wiley, 2008.

COURSE OUTCOMES:

CO1: Analyze and determine the various physical properties of plastics and rubbers.

CO2: Characterize the quality of latex and plastic raw materials.

Board of Studies (BOS) :
14th BoS of PE held on 15.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M												H			
CO2		L												M		

SDG No. 9: To support scientific, technology development and innovation in the field of polymer technology.

The holistic understanding of analyzing of polymeric materials leads to develop sustainable infrastructure and environmentally sound and clean technologies.

GED 2201	**WORKPLACE SKILLS AND APTITUDE FOR ENGINEERS**	**L**	**T**	**P**	**C**
SDG: 8		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To expose them to reading for specific purposes, especially in professional contexts

COB2: To expose them to the process of different kinds of formal writing

COB3: To prepare the students to be successful in their career

COB4: To familiarize various problem-solving techniques in aptitude and puzzles.

MODULE I EXTENSIVE READING & WRITING 07

Reading for comprehension - inferring and note-making – Process of writing- paragraph development - elements of business writing: Email, memos.

MODULE II INTENSIVE READING & WRITING 08

Intensive reading and reviewing - Interpretation of charts, graphs - Résumé - Letter of enquiry, thanksgiving letters.

MODULE III QUANTITATIVE APTITUDE 08

Percentage - Ratio and Proportion - Profit and Loss – Averages, Allegations and Mixtures.

MODULE IV LOGICAL COMPETENCY 07

Syllogism – Blood Relations- Number, Alpha and Alpha numeric series - Puzzles – Cubes and Dice - Odd One Out-Coding and Decoding

L – 30; TOTAL HOURS - 30

REFERENCES:

1. Sharma, R.C. and Mohan, Krishna (2010). Business Correspondence and Report Writing. 4th edition. Tata McGraw Hill Education Private Limited, New Delhi
2. Whitby, Norman (2014). Business Benchmark: Pre-Intermediate to Intermediate. Cambridge University Press, UK
3. Tyra .M, Magical Book On Quicker Maths, BSC Publishing Company Pvt. Limited, 2009
4. R. S. Aggarwal , Quantitative Aptitude for Competitive Examinations, S. Chand Limited, 2017

5. R. S. Aggarwal , A Modern Approach to Verbal & Non-Verbal Reasoning , S. Chand Limited, 2010
6. Khattar Dinesh , The Pearson Guide to Quantitative Aptitude for Competitive Examinations, 3e, Pearson India , 2016
7. Rajesh Verma , Fast Track Objective Arithmetic Paperback , Arihant Publications (India) Limited , 2018
8. Arun Sharma Teach Yourself Quantitative Aptitude Useful for All Competitive Examinations, McGraw Hill Education (India) Pvt. Limited, 2019.

COURSE OUTCOMES:

CO1: Demonstrate reading skills with reference to business related texts
CO2: Draft professional documents by using the three stages of writing
CO3: Apply various short cut techniques for solving complicated aptitude problems
CO4: To understand various problems and patterns of different ways to solve it

Board of Studies (BoS) :
13th BoS of the Department of English held on 17.6.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		L		H						H		
CO2			L							H		
CO3			L				M					
CO4		H		M								
CO5												

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement:Demonstrating, Drafting and applying various techniques for sustainable growth to employment.

GED 2202	**INDIAN CONSTITUTION AND HUMAN RIGHTS**	**L**	**T**	**P**	**C**
SDG: 16		**2**	**0**	**0**	**0**

COURSE OBJECTIVES:

COB1: To explicate the emergence and evolution of Indian Constitution.

COB2: To have an insight into the philosophy of fundamental rights and duties, and Directive Principles.

COB3: To differentiate the structure of executive, legislature and judiciary.

COB4: To understand human rights and its implication - local and international and redressal mechanism.

MODULE I INTRODUCTION AND BASIC INFORMATION ABOUT INDIAN CONSTITUTION 8

Meaning of the constitution law and constitutionalism - Historical Background of the Constituent Assembly - Government of India Act of 1935 and Indian Independence Act of 1947 - The Constituent Assembly of India - Enforcement of the Constitution - Indian Constitution and its Salient Features - The Preamble of the Constitution. Citizenship.

MODULE II FUNDAMENTAL RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES 7

Fundamental Rights and its Restriction and limitations in different complex situations - Directive Principles of State Policy (DPSP) & its present relevance in our society with examples- Fundamental Duties and its Scope and significance in nation building - Right to Information Act 2005.

MODULE III GOVERNANCE IN INDIA 8

The Union Executive – the President and the Vice-President – The Council of Ministers and the Prime Minister – Powers and functions. The Union legislature – The Parliament – The Lok Sabha and the Rajya Sabha, Composition, powers and functions – Government of the State - The Governor – the Council of Ministers and the Chief Minister – Powers and Functions-Elections-Electoral Process and Election Commission of India - Indian judicial system.

MODULE IV HUMAN RIGHTS AND INDIAN CONSTITUTION 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 - Roles of National Human Rights Commission of India - Special Constitutional Provisions for SC & ST, OBC - Special Provision for Women, Children & Backward Classes.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. B.K. Sharma, Introduction to the Constitution of India, 6th ed., PHI Learning Private Limited, New Delhi 2011
2. Durga Das Basu "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19th / 20th Edn. 2008
3. M.P. Jain, Indian Constitutional Law, 7th ed., LexisNexis, Gurgaon. 2014.

REFERENCES:

1. Fadia B.L "Indian Government and Politics", Sahitya Bhavan Publications. 2010
2. Kashyap Subhash C "Our Constitution: An Introduction to India's Constitution and constitutional Law, NBT. 2017
3. M.V.Pylee "An Introduction to Constitution of India", Vikas Publishing. 2002
4. Sharma Brij Kishore "Introduction to the Indian Constitution", 8th Edition, PHI Learning Pvt. Ltd. 2015
5. Latest Publications of NHRC - Indian Institute of Human Rights, New Delhi.

COURSE OUTCOMES: At the end of the course, the students will be able to

CO1: describe the emergence and evolution of Indian Constitution.

CO2: realize the status and importance of fundamental rights, fundamental duties and directive principles of state policy and relation among them by understanding the articulation of its basic values under the Constitution of India.

CO3: compare the various structure of Indian government.

CO4: recognize the human rights, cultural, social and political rights and its relationship with Indian constitution. .

Board of Studies (BoS) :	**Academic Council:**
4th BoS of SSSH held on 28.06.2021	17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1			M			H	M	L	M		M	
CO2			H			M	H	M			H	
CO3			M			H	M	L			L	
CO4			H			H	H	M	M			H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Application of human, legal and political rights leading to empowerment in real-life situations for protection of fundamental freedoms and freedom from violence, abuse, trafficking and exploitation are at the core of human rights.

SEMESTER – V

		L	T	P	C
MSD 3181	**FUNDAMENTALS OF ENTREPRENEURSHIP**				
SDG: All 1-17.		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To understand the fit between individual and their entrepreneurial ambitions.

COB2: To identify the customers and find a problem worth solving.

COB3: To create a business model for solving the problems of customer, forming solution and present the Business Model Canvas

COB4: To develop a solution for customers' problem and analyze the problem solution fit & product market fit.

COB5: To build and demonstrate a Minimum Viable Product (MVP) for startup

MODULE I PROBLEM IDENTIFICATION AND OPPORTUNITY DISCOVERY 9

Entrepreneurial Thinking, Business Opportunities, Problem Identification, Design Thinking, Potential solutions, Presentation of the problem- Case Study

MODULE II CUSTOMER, SOLUTION AND BUSINESS MODEL 10

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

MODULE III VALIDATION AND FINANCIALS 10

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

MODULE IV GO TO MARKET 8

Positioning and Branding, Golden Circle model: Sinek's theory value proposition, Branding Elements, Market Penetration Strategy, Collaboration Tools and Techniques, Channels – Case Study

MODULE V MANAGING GROWTH AND FUNDING 8

Sales Planning, Customer Acquisition Strategy, Selling Skills, Identifying Funding Sources, Mapping Start-Up Cycle to Funding Options, Funding Plan, , Creating business valuation

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Entrepreneurship Rajeev Roy oxford, 2012.
2. https://web.nen.wfglobal.org/en/home - Wadhwani Foundation
3. W. Chan Kim , Renée A. Mauborgne**,** “Blue Ocean Strategy: How to Create Uncontested Market Space and Make the Competition Irrelevant”, Harvard Business Press, 2015.

REFERENCES:

1. Anil Lamba , “Romancing the Balance Sheet: For Anyone Who Owns, Runs Or Manages a Business”, HarperCollins Publishers India, 2016.
2. The Process of social value creation: A multiple case study on Social Entrepreneurship in India, Archana Singh Springer 2016.
3. “Anatomy of Business Plan” – Linda Pinson, OMIM publication, Seventh Edition, 2008.
4. Running Lean: Iterate From Plan A To a Plan That Works, Ash Maurya, "O'Reilly Media, Inc.", 28-Feb-2012.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Build an entrepreneurial mindset and reach out the customer to identify the problem using design thinking process

CO2: Craft solution to the problem through value proposition canvas and develop a business model using lean canvas

CO3: Provide product solution demo and deliver a minimum viable product

CO4: Work as a team and create brand strategy marketing for product/service

CO5: Prepare, make an outstanding sale pitch for startup

PED 3101	**POLYMER COMPOSITES ENGINEERING**	**L**	**T**	**P**	**C**
SDG: 9,11		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To introduce basic fundamentals of polymer composites.

COB2: To impart knowledge of reinforcements and matrix systems used in polymer composites.

COB3: To develop an understanding on processing of polymer composites

COB4: To impart skills in analyzing and characterizing the polymer composite material for various applications

COB5: To provide an understanding in usage of polymer composites in various fields.

MODULE I INTRODUCTION 7

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

MODULE II MATERIALS FOR POLYMER COMPOSITES 12

Polymer composites – classification – theory of composites – matrix materials: unsaturated polyester – vinyl ester – epoxy – phenol formaldehyde – bismaleimide – polyether ether ketone – polyphenylene sulfide – polysulfone – thermoplastic polyimides – reinforcement materials: industrial manufacturing, types, forms and applications of: glass fibre – carbon fibre – aramid fibre – natural fibres (wood, jute).

MODULE III FABRICATION TECHNIQUES 9

Manufacturing process selection criteria – fabrication techniques: hand layup – spray layup – vacuum bag moulding – filament winding – pultrusion – resin transfer moulding – autoclave moulding – injection mouldingand forming of thermoplastic composites - bulk moulding compound – sheet moulding compound

MODULE IV TESTING OF COMPOSITES 9

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

MODULE V APPLICATIONS OF COMPOSITES 8

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

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. P.K. Mallick, “Processing of Polymer Matrix Composites: Processing and Applications”, Taylor and Francis group, 2017.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, “Analysis and Performance of Fiber Composites”, 3rd edition, John Wiley & Sons, 2006.
3. L.holloway, “Hand Book of Composites for Engineers”, Technomic, Lancaster, 1994.
4. Kevin Potter, “An Introduction to Composites Products”, Chapman And Hall Madras India 1997.
5. S.T.Peter, “Hand Book of Composites”, Chapman and Hall Chennai 1998.
6. 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. F.L. Mattews and R.D. Rawlings, “Composites Materials: Engineering and Science”, 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:

Students will be able to

CO1: Gain fundamental knowledge on polymer composites

CO2: Identify suitable materials for preparing polymer composites based on property requirement

CO3: Fabricate polymer composites by using different techniques

CO4: Execute various tests to verify the quality of products

CO5: Select polymer composites for particular application

Board of Studies (BoS) :
BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1			H													M
CO2		L											H			
CO3					M								H			
CO4					M									H		
CO5		M												H		

SDG No. 9: Industry, Innovation and infrastructure

SDG No. 11: Sustainable Cities and Communities

Statement: The holistic understanding of composite materials leads to development of resilient and sustainable infrastructure and industrial diversification.

Statement: The holistic understanding of composite materials leads to smart cities with sustainable buildings.

PED 3102	**POLYMER BLENDS AND NANOCOMPOSITES**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To provide an understanding of the miscibility of polymers and phase morphology of blends

COB2: To impart knowledge on different techniques of blending polymers

COB3: To disseminate the various varieties of polymer nanocomposites, including those derived from natural sources

COB4: To provide knowledge about various methods employed for the manufacture, types, and dispersion of CNTs in the polymer matrix and understand the different properties of polymer nanocomposites

COB5: To acquaint the students with the numerous applications for polymer nanocomposites

MODULE I POLYMER BLENDSAND THEIR MORPHOLOGY 10

Polymer blends – polymer alloys – methods of blending – selection criteria of blending – basic concepts – properties –Flory Huggins theory – factors affecting miscibility – morphology: mechanism of phase separation (nucleation and growth and spinodal decomposition) – semi-crystalline polymer blends

MODULE II BLENDTYPES AND IPNS 8

Types : PC/PET, PC/PBT, PC/ABS, PPO/HIPS,Biodegradable and Natural Polymer Based Blends, Miscellaneous Blends - Interpenetrating Polymer Networks (IPNs): Introduction – classification - method of formation of IPNs - properties and uses –the role of cross-links and their importance.

MODULE III INTRODUCTION - TYPES - NANOCOMPOSITES 10

Introduction to polymer nanocomposites – Types of Nanofillers. Types: ceramic/polymer nanocomposites – metal/polymer nanocomposites. Natural nano biocomposites: biomimetic nanocomposites. Introduction of polymer layered silicate nanocomposites, Types: Nano clays, Types: thermoplastics, thermosets, and elastomer matrices

Carbon nanotube (CNT) reinforced polymer nanocomposites:Types of CNTs – dispersion properties of CNTsin composites – interfacial bonding properties – mechanical properties and conductivity of nanotubes

MODULE IV DISPERSION TECHNIQUES AND PROPERTIES OF POLYMER NANOCOMPOSITES 11

Preparation of polymer layered silicate nanocomposites: solution – melt mixing – latex mixing methods. Techniques for achieving dispersion of nanofillers: intercalation and exfoliation

Properties of polymer nanocomposites: influence of nanofillers on properties of polymer nanocomposites. Mechanical properties – stress, 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 APPLICATIONS OF POLYMER BLENDS AND NANOCOMPOSITES 6

Applications of polymer blends in Emerging technologies:Nanotechnology – Electronics/Optoelectronics – Electrically Conductive Polymers and Blends – Lithium Battery – Fuel Cell Materials – Biomaterials/Biotechnology

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

L –45 ; TOTAL HOURS – 45

TEXT BOOKS:

- ChaudheryMustansar Hussain, Ajay Kumar Mishra, "New Polymer Nanocomposites for Environmental Remediation", Elsevier Publication, 2018
- Joseph H. Koo, "FundamentalsProperties, and Applications of Polymer Nanocomposites",2016
- Vikas Mittal, "Polymer Nanocomposite Coatings", Taylor and Francis,2014
- Mallick, P.K. Processing of Polymer Matrix Composites: Processing and Applications, Taylor and Francis Group, 2017
- Klaus Friedrich, Ulf Breuer, Multifunctionality of Polymer Composites: Challenges and New Solutions, 2015.

REFERENCES:

- Jyotish Kumar Parameswaran Pillai, Nishar Hameed, Thomas Kurian, Yingfeng Yu, "Nanocomposite Materials: Synthesis, Properties and Applications", Taylor and Francis,2017
- Aravind Dasari, Zhong-Zhen Yu, Yiu-Wing Mai, "Polymer Nanocomposites: Towards Multi-Functionality", Springer, 2016

- Rakesh K. Gupta, Elliot Kennel, Kwang-Jea Kim, “Polymer Nanocomposites Handbook”, Taylor and Francis,2010
- Lloyd M. Robeson, “Polymer Blends A Comprehensive Review” Hanser Publishers, 2007
- Polymer Blends and Alloys, “Gabriel O. Shonaike and George P. Simon”, editors. Marcel Dekker, 1999.
- Mathews F.L., and Rawlings, “Composite Material Engineering Science”, Chapman and Hall, London, 1994.

COURSE OUTCOMES:

The student will be able to

CO1: Select the appropriate combination of polymers to have the requiredsynergistic properties in the polymer blend.

CO2: Predict the suitable compatibilizer for enhancing the miscibility ofimmiscibleblends.

CO3: Explain the basics related to polymer nanocomposites and to choose, characterize and analyzethe different types of CNTs in polymer nanocomposites

CO4: Determine and analyze the desired properties of anypolymer nanocomposites

CO5: Suggest the applications of polymer nanocomposites in different fields

Board of Studies (BoS) :
15th BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L			L			L							L		
CO2		L		M		L								L	L	
CO3	L	L		M			M						H	H	M	
CO4	M	L	L	L									L	H	L	
CO5	L	L		M	L								L	L		

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9: To support science, technology development, and innovation in any chemical-based research activities and industrial applications.

The topics mentioned in this course are designed towards understanding the different types of blends, organic, inorganic, and dispersion methods in the preparation of polymer nanocomposites. This course promotes creativity and technological aptitude in recognizing the current business problems and demands of polymer nanocomposites for cutting-edge applications.

PED 3103	**PLASTIC AND RUBBER TESTING TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 9,11		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To provide the fundamental knowledge of basic concepts in testing of polymeric materials.

COB2: To develop an understanding of mechanical properties of polymers

COB3: To impart knowledge on thermal and electrical properties of polymers.

COB4: To develop an understanding of optical and weathering properties of polymers.

COB5: To impart knowledge on testing new products for predicting the performance of products.

MODULE I BASIC CONCEPTS IN TESTING 8

Specification and Standards – National and International Standards – advancement in testing technology – preparation of test specimens: thermoplastic, thermoset, elastomer – conditioning and test atmospheres.

MODULE II MECHANICAL PROPERTIES 9

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

MODULE III THERMAL AND ELECTRICAL PROPERTIES 10

Thermal properties: vicat softening temperature – heat distortion temperature – coefficient of expansion – thermal conductivity – brittleness temperature – flammability: limiting oxygen index (LOI), smoke density, UL-94, glow wire test.

Electrical properties: dielectric strength – dielectric constant – dissipation factor – volume and surface resistivity - arc resistance – electromagnetic interference (EMI) – radio frequency interface (RFI) shielding – conductivity measurements.

MODULE IV OPTICAL AND WEATHERING PROPERTIES 9

Refractive index – light transmittance and haze – photo elastic properties – color – gloss.

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 – moisture absorption.

MODULE V TESTING OF PRODUCTS 9

Plastic films & sheets – pipes – foams – containers – rubber sheets – rubber holes- O rings - introduction to non destructive testing of plastic products.

L – 45 ; 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

COURSE OUTCOMES:

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

CO1: Identify specification , standards and suitable methods for test specimen preparation

CO2: Perform various tests for evaluating the mechanical properties of plastic materials.

CO3: Perform various tests for evaluating the thermal and electrical properties of plastic materials.

CO4: Perform various tests for evaluating the optical and weathering properties of plastic materials.

CO5: Identify the suitable test method for predicting product performance

Board of Studies (BoS) :	**Academic Council:**
16th BoS of Polymer Engineering held on 17.08.2023	21st AC held on 20.12.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1			H													M
CO2		L											H			
CO3					M								H			
CO4					M									H		
CO5		M												H		

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG No. 9: Industry, Innovation and infrastructure
SDG No. 11: Sustainable Cities and Communities

Statement:1 The holistic understanding of polymer testing leads to development of resilient and sustainable infrastructure and industrial diversification.
Statement:2 The holistic understanding of polymer testing leads to smart cities with sustainable buildings.

PED 3104	POLYMER REACTION ENGINEERING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the fundamental ideas of kinetics and reactionengineering

COB2: To familiarize the students withfundamentals, by interpreting data withconstant volume and variable batch reactor systems

COB3: To develop design principles for different reactor systems in reactionengineering

COB4: To develop the ability in analyzing the processes andcontribute to new designs

COB5: To design the reactor of any batch and flow witha heterogeneoussystem

MODULE I KINETICS OF REACTIONS 9

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's law.

MODULE II INTERPRETATION OF BATCH REACTOR DATA 9

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

MODULE III DESIGN OF SINGLE IDEAL REACTORS 9

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

MODULE IV DESIGN FOR SINGLE AND MULTIPLE REACTIONS 9

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 and Autocatalytic reactions. Multiple Reactions–Reactions in Parallel, Reactor size–Batch, Mixed Flow,and Plug FlowReactor.

MODULE V SOLID CATALYSED REACTIONS 9

Heterogeneous reacting systems–catalyst, activity, and specificity of catalyst. Pore diffusion resistance combined with surface kinetics, Heat effects during the reaction. Performance equations fordifferent types of reactors containing porous catalysts. Experimental methods for determining rates–Application to design.

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

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

REFERENCES:

- Anil Kumar and Gupta R. P, "Fundamentals of Polymer Science and Engineering", McGraw Hill, 1998.
- Tapio O. Salmi, Jyri-PekkaMikkola, Johan P. Warna, "Chemical Reaction Engineering and Reactor Technology", CRC Press, 2010.
- DoraiswamyL.K, Deniz Uner, "Chemical Reaction Engineering: Beyond the Fundamentals", CRC Press, 2013.
- Miller. G, "Chemical Reaction Engineering", CBS Publisher, 2005.

COURSE OUTCOMES:

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

CO1: Evaluate the kinetics and reaction rate in chemical reaction engineering

CO2: Interpret the batch reactor data for a particular reaction system

CO3: Identify the various types of reactors used in industries

CO4: Select a reactor, determine its size, and conversion for a givenapplication

CO5: Analyze the solid-catalyzed reactions

Board of Studies (BoS) :
BoS of PE held on 10.03.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L			L									L	L	L	L
CO2	L	M		L											L	L
CO3				L									L		H	H
CO4	L	L	L	M											H	H
CO5	L			L										L	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9: To support science, technology development, and innovation in any chemical-based research activities and industrial applications.

The topics mentioned in this course are designed towards understanding the kinetics of any reaction,interpretation of different reactor data, and design for single, multiple, and solid-catalyzed reactions. This course fosters innovation and technological capabilities in understanding the kinetics of any reactions anddesigningbatch, flow reactors, which will satisfy the current industrial challenges.

PED 3105	**RUBBER PROCESSING**	**L**	**T**	**P**	**C**
SDG: 8	**LABORATORY**	**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To impart skills indeveloping formulation of rubber compounds.

COB2: To develop competency in operating a two-roll mill for mixing rubbers

COB3: To equip with knowledge and skills in conducting cure study using rheometer

COB4: To equip with the skills to operate a hydraulic press in manufacturing rubber sheets and products

COB5: To develop latex products manufacturing skills

PRACTICALS

List of Experiments:

13. Rubber compound development with natural rubber
14. Rubber compound development with styrene butadiene rubber
15. Rubber compound development with butadiene rubber
16. Rubber compound development with NBR
17. Rubber compound development with EPDM
18. Rubber compound development with Silicone rubbers
19. Rubber compound development for rubber blends – NR+SBR
20. Rubber compound development for rubber blends – SBR+BR
21. Rubber compound development for rubber blends – EPDM+PP
22. Vulcanization studies in a rheometer
23. Study on optimizing the curing parameters
24. Manufacturing of rubber ball
25. Latex product manufacturing by strait dipping process
26. Latex product manufacturing by coagulant dipping process
27. Latex foam manufacturing

P – 45 ; TOTAL HOURS – 45

TEXTBOOKS:

- Richard F. Grossman, "The Mixing ofRubber", Chapman & Hall, 1997.
- A.K. Bhowmick, M.M. Hall and H.A. Benaney, “Rubber Products Manufacturing Technology”, Marcel Dekker Inc, New York, 1994.
- Bernie Stritzke, "Custom Molding ofThermoset Elastomers",

Hanser Publications, 2009

REFERENCES:

- Blow. C.M. and Hepburn C, “Rubber Technology and Manufacture”, Butterworths, 1982.

COURSE OUTCOMES:

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

CO1:write compounding recipe and develop rubber formulation based on the requirements

CO2:operate the two-roll mill to mix compounding ingredients with rubber

CO3:interpret the cure curve to report the cure behavior of the rubber compound

CO4:set process parameters and operate a hydraulic press to manufacture rubber products

CO5:manufacture latex products by straight and coagulant dipping process

Board of Studies (BoS) :
BoS of PE held on 10.03.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L	M					M	L	L			M			H	
CO2	L							L	L			L			H	
CO3	L			M	L			M	L			M			H	
CO4	L							L	L			L			H	
CO5	L						M	L	L			L			H	

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 8: Inculcate rubber compounding and processing skills that lead to productive employment and likely to develop entrepreneurship.

Statement:

Ahands-on experience in formulating and manufacturing of different rubber products thus providing ample employment opportunities and motivates for an entrepreneurial mindset.

GED 3101 SDG: 4	COMMUNICATION SKILLS FOR CAREER SUCCESS	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

COB1: To develop students' proficiency in English at CEFR B2 level (Business Vantage)
COB2: To develop students' receptive skills (Listening and Reading) in a wide range of situations
COB3: To develop students' productive skills (Speaking and Writing) in a wide range of situations
COB4: To expose students to the nuances of the English language, grammar and usage.

MODULE I BRIEF EXCHANGES OF COMMUNICATION 08

Listening to telephonic conversations - gap filling exercises- short conversations – Promoting a product-Reading short passages and answering matching tasks-Writing short notes and messages. - Framing questions

MODULE II WORKPLACE COMMUNICATION 07

Listening to monologues - gap filling exercises - Mini presentations- role play-Reading longer texts – gap filling- Writing memo , emails and Fax - Writing reports on conferences, seminars

MODULE III INTERPERSONAL COMMUNICATION 08

Listening to conversations – Collaborative discussion using prompts - Reading comprehension-multiple choice-texts - Writing enquiry letters & replies to customers

MODULE IV NEGOTIATING AND PERSUADING 07

Listening to interviews - Group Discussions - Multiple choice and gap filling-writing work reports- cause and effect - Complaint letter and sales letter

P-30: TOTAL HOURS - 30

REFERENCES:

1. Guy Brook-Hart, 'Business Benchmark-Upper Intermediate, 2nd edition, Cambridge University Press, Shree Maitrey Printech Pvt. Ltd, Noida, 2016.
2. Leo Jones, 'New International Business English' Students book.

Cambridge University Press, Cambridge, 2003.
3. Simon Sweeney, ‘Communicating in Business’ Teacher’s Book. Cambridge University Press, Cambridge, 2004.
4. Simon Sweeney, ‘Communicating in Business’ Student’s Book. Cambridge University Press, Cambridge, 2003.
5. Bill Mascull. ‘Business Vocabulary in Use’. Advanced. Cambridge University Press, Cambridge, 2004

COURSE OUTCOMES:

CO1: Use the LSRW skills effectively in business and general situations

CO2: Demonstrate receptive skills effectively in various formal and informal communication situations.

CO3: Demonstrate productive skills effectively in various formal and informal communication situations

CO4: Use appropriate grammar and vocabulary in any context.

Board of Studies (BoS) :
13th BoS of the Department of English held on 17.6.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O 3	PSO 4	PSO 5
CO1									M	H							H
CO2									M	H							H
CO3									M	H							H
CO4										H							M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

This course helps the students to enhance their communication skills, critical thinking, problem solving, conflict resolution, team building and public speaking. This course also helps them to achieve success in their professional and personal life.

PED 3106	**INTERNSHIP I**	**L**	**T**	**P**	**C**
SDG: 8		**0**	**0**	**0**	**1**

COURSE OBJECTIVES:

COB1: Students must undergo two weeks industrial training in the industries relevant to Polymer Engineering and submit a report based on the internship.

INTERNSHIP:

- The students shall be encouraged to do their internship in core Polymer Industries.
- To develop a project based on the internship work did in the industry for a minimum period of 30 hours.
- Head of the department will constitute an Evaluation Committee to review the project work done through internship during the summer vacation.
- The student shall also submit an internship completion certificate issued by the industry / research / academic organization.
- The percentage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

COURSE OUTCOMES:

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

CO1: Analyze suitable polymeric materials for end-use applications.

CO2: Troubleshoot the different types of defects in polymer products during manufacturing.

CO3: Examine various processing techniques to develop polymer products.

CO4: Characterize and interpret data based on various polymeric products.

Board of Studies (BoS):
17th BoS of Polymer Engineering held on 17.05.2024

Academic Council:
22nd ACM held on 04.09.2024

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3	3		3	3				3	3
CO2						3		3					3	3
CO3					3					1			3	3
AVG	**3**				**3**	**3**		**3**	**3**	**1**			**3**	**3**

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: Students must undergo 15 days of Industrial training in the industries relevant to Polymer Engineering during the summer vacation at the end of 2nd year.

SEMESTER – VI

PED 3201	**PLASTIC AND RUBBER PRODUCT DESIGN**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To impart knowledge stress- strain calculations and diagrams based on the different type of loads on plastic materials.

COB2: To transfer knowledge on the importance of product life cycle assessment and the selection of materials based on end use applications.

COB3: To develop an understanding of the various features incorporated in plastic products to improve their strength, stiffness.

COB4: To provide knowledge on how to design the parts made from rubber materials.

COB5: To educate the students with various type of methods to assemble the plastic parts.

MODULE I STRENGTH OF MATERIALS OF POLYMERS 12

Stress – Normal stress – normal strain – shear stress –shear strain – Tensile strength – proportional limit, elastic limit stress, yield stress, ultimate stress, elastic constants, relation between elastic constants – Biaxial stresses - maximum normal and shear stresses calculations –Factor of Safety for load and materials – Fatigue loading – S-N Curve

MODULE II PLASTIC MATERIAL SELECTION 6

Introduction to Polymer Product Design – Product life cycle; Life cycle assessment (LCA) of plastic parts– Type of fits, limits, and tolerances – selection of materials based on end-user requirements –properties of materials and their significance in designing of plastic products.

MODULE III DESIGN OF PLASTIC PRODUCTS 6

Design for ribs, bosses and gussets – design considerations for stiffness, wall thickness, fillets, and sharp corners - plastic molded thread design – Snap-fit joints

MODULE IV DESIGN OF RUBBER PRODUCTS 12

Design of rubber seals and O-rings, mounts, hoses – design of rubber belts – dimension calculations for belts. Vibration dampers: basic vibration damping – modal analysis - Octave rule for damped systems - under damping, over damping, and critical damping –vibration isolators

MODULE V DESIGNING PLASTIC PARTS FOR ASSEMBLY 9

Ultrasonic welding – equipment – process – common issues with welding – ultrasonic heat stacking, ultrasonic spot welding – vibration welding – equipment – laser welding process – Bonding – Failure theories, advantages, disadvantages of adhesives – Failure Mode Effective Analysis (FMEA)

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

- Dym, J. B., "Product Design with Plastics: A Practical Manual", Industrial Press, 2010
- Crawford, R. J., & Martin, P., "Plastics Engineering". Butterworth-Heinemann, 2020

REFERENCES:

- Miller,E,"Plastics Products Design Handbook", Part A and Part B, CRC Press, 2020
- Levy, S., DuBois, J. H., & Saunders, H., "Plastics Product Design Engineering," 2010

COURSE OUTCOMES:

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

CO1: Apply the strength of material concepts in the design of plastic parts.

CO2: Explain the life cycle assessment of plastic products and select suitable materials based on end use applications.

CO3: Apply the various features incorporated in plastic products for functional requirements.

CO4: Design the rubber parts for various applications.

CO5: Explain the different design considerations to be made in the assembly of plastic parts.

Board of Studies (BoS) :
16th 16th BoS of Polymer Engineering held on 17.08.2023

Academic Council:
21st AC held on 20.12.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		M	L											H		
CO2	M	L	L													H
CO3	H	M												H		H
CO4	H	M	L													H
CO5	L	M														H

Note:L- Low Correlation M -Medium Correlation H –High Correlation

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

Statement: The overall understanding of the materials election process in designing new products leads to the construction of resilient infrastructure and sustainable industrialization.

		L	T	P	C
PED 3202	**POLYMER TESTING LABORATORY**	**L**	**T**	**P**	**C**
SDG: 8		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To emphasize the importance of testing the mechanical and thermal characterization of polymers

COB2: To emphasize the importance of testing the electrical and optical characterization of polymers

COB3: To provide an understanding of various properties of polymers

COB4 To provide an understanding of the working principle and specifications of the apparatus/equipment used for testing

COB5: To impart skills in interpreting the test results

PRACTICALS

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
11. Shear Strength

TESTING OF THERMAL PROPERTIES

1. Vicat softening point
2. Heat distortion temperature

TESTING OF ELECTRICAL PROPERTIES

1. Volume and surface resistivity
2. Dielectric strength
3. Arc resistance
4. Comparative Tracking Index

TESTING OF OPTICAL AND MISCELLANEOUS PROPERTIES

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

P – 30; TOTAL HOURS –30

TEXT BOOKS:

- Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah, "Polymer Processing and Characterization: 1 (Advances in Materials Science)", Apple Academic Press; 1st edition,2013.
- Bershtein, V.A, G.C. Berry, et al, "Polymer Analysis and Characterization (Advances in Polymer Science)", 2013.

REFERENCES:

- Crompton,T.R. "Practical Polymer Analysis", 2012
- Joseph D. Menczel, R. Bruce Prime, "Thermal Analysis of Polymers", Fundamentals and Applications", Wiley; 1st edition, 2009
- Characterization and Analysis of Polymers, Wiley, 2008

COURSE OUTCOMES:

CO1: Identify the test methods to evaluate the properties of a product/sample.

CO2: Execute various tests to verify the quality of the products.

CO3: Compare the structure and properties of polymers

CO4: Analyse the properties of polymers based on application

CO5. Interpret the data from the test results.

Board of Studies (BoS) :
15th BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1		M	L			M								H		H
CO2	H	M	L					M							M	H
CO3	H	M						L		L				H		H
CO4	H	M	L						M							H
CO5	H	L								M						H

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 8: Inculcate polymer testing skills that lead to productive employment and likely to develop entrepreneurship.

Statement: The students will be acquired the skill of testing the polymeric products, troubleshooting the defects and interpreting the results and and will leads to develop new advanced materials for end use applications.

		L	T	P	C
PED 3203	**PLASTIC PRODUCT DESIGN LABORATORY**				
SDG: 9		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To impart skills for 2D part drawing using CAD software.

COB2: To train the students for creating 3-D models with the help of computer.

COB3: To improve the CAD design skill in 3-Dmodeling and assembly of the parts.

Creation of 2D drawings using CAD software **9**

- Part drawing using Auto CAD

Creation of 3D modeling using CAD software **15**

- 3-D models will be given to create models using design software

Assembly drawing **6**

- Assembly of multiple parts together by using design software

P – 30; TOTAL HOURS – 30

REFERENCES:

1 Malloy.R, " Plastic Part Design for Injection Molding", 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 Modelling using CAD/CAE", 1st Edition, Elsevier,e-book,2014

COURSE OUTCOMES:

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

CO1: Create 2D drawings using CAD software

CO2: Read the part and assembly drawings.

CO3: Develop a solid model using CAD software

Board of Studies (BoS) :

15th BoS of PE held on 07.02.2023

Academic Council:

20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1		M	L											H		
CO2	M	L	L												M	H
CO3	H	M												H		H
CO4	H	M	L													H
CO5	L	M														H

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

Statement: The students will be acquired the skill of designing products using computer and leads to the construction of resilient infrastructure and sustainable industrialization.

GED 3201	**REASONING AND APTITUDE FOR ENGINEERS**	**L**	**T**	**P**	**C**
SDG: 4		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To develop students' critical reading skills

COB2: To foster their writing skills

COB3: To enlighten the various methods of solving quantitative problems

COB4: To make students ready for clearing placement and competitive examination

MODULE I OBJECTIVE ENGLISH 07

Reading Comprehension - Sentence Rearrangement - Cloze Test – Error Spotting

MODULE II VOCABULARY DEVELOPMENT 08

Vocabulary (Synonyms and Antonyms, one word Substitutes, Spellings, Idioms and Phrases, etc) - Fill in the blanks - Paragraph Completion

MODULE III GENERAL MENTAL ABILITY 08

Time speed and Distance –Problems on Trains – Boats and Streams - Permutation and Combination - Probability

MODULE IV 07

Data Interpretation (charts, graphs, tables, data sufficiency, etc.) – Time and work-Pipes and Cisterns-Venn Diagrams-Mensuration

L – 30; TOTAL HOURS 30

REFERENCES:

- Whitby, Norman (2014). Business Benchmark: Pre-Intermediate to Intermediate. Cambridge University Press, UK.
- Swan, Michael (2005). Practical English Usage, Oxford University Press.
- Tyra .M, Magical Book On Quicker Maths, BSC Publishing Company Pvt. Limited, 2009
- R. S. Aggarwal , Quantitative Aptitude for Competitive Examinations, S. Chand Limited, 2017

  R. S. Aggarwal , A Modern Approach to Verbal & Non-Verbal

Reasoning, S. Chand Limited, 2010

- Khattar Dinesh , The Pearson Guide to Quantitative Aptitude for Competitive Examinations, 3e, Pearson India , 2016
- Rajesh Verma , Fast Track Objective Arithmetic Paperback , Arihant Publications (India) Limited , 2018
- Arun Sharma Teach Yourself Quantitative Aptitude Useful for All Competitive Examinations, McGraw Hill Education (India) Pvt. Limited, 2019

COURSE OUTCOMES:

CO1: Demonstrate their reading ability

CO2: Exhibit their vocabulary and writing skills

CO3: Apply the problem-solving techniques

CO4: Gain confidence mentally and be successful in their career

Board of Studies (BoS) :

13thBoS of the Department of English held on 17.6.2021

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1										M		
CO2										H		
CO3										L		
CO4												M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG No. 4 : Give Quality Education to all the Engineers

Statement: In future, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

PED 4103 **INTERNSHIP II** **L T P C**

SDG: 8 **0 0 0 1**

COURSE OBJECTIVES:

COB1: Students must undergo two weeks industrial training in the industries relevant to Polymer Engineering and submit a report based on the internship.

INTERNSHIP:

- The students shall be encouraged to do their internship in core Polymer Industries.
- To develop a project based on the internship work did in the industry for a minimum period of 30 hours.
- Head of the department will constitute an Evaluation Committee to review the project work done through internship during the summer vacation.
- The student shall also submit an internship completion certificate issued by the industry / research / academic organization.
- The percentage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

COURSE OUTCOMES:

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

CO1: Analyze suitable polymeric materials for the end-user applications.

CO2: Troubleshoot the different types of defects in polymer products during manufacturing process.

CO3: Examine various processing techniques to develop polymer products.

CO4: Characterize and interpret data based on various polymeric products.

Board of Studies (BoS):

17th BoS of Polymer Engineering held on 17.05.2024

Academic Council:

22nd ACM held on 04.09.2024

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3	3		3	3				3	3
CO2						3		3					3	3
CO3					3					1			3	3
AVG	**3**				**3**	**3**		**3**	**3**	**1**			**3**	**3**

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: Students must undergo 15 days of Industrial training in the industries relevant to Polymer Engineering during the summer vacation at the end of 3rd year.

SYLLABUS –VII

PED 4101	MOULD AND DIE DESIGN	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To impart the knowledge on the material selection for injection moulds and the design features of feed system in injection mould

COB2: To acquire knowledge about the configuration of ejection systems and the cooling mechanism in two and three plate molds.

COB3: To provide an insight to various actuation techniques in the design of split moulds

COB4: To introduce the fundamentals of compression and transfer mould design

COB5: To explore the various design aspects of dies to manufacture plastic parts

MODULE I MATERIALS FOR INJECTION MOULD AND DESIGN OF FEED SYSTEM IN INJECTION MOLD 10

Introduction to Mould and Die Design - Material selection for injection moulds – properties of mould materials, steels for different mould parts, requirement of heat treatment - Classification of injection molds - Calculation of number of cavities in injection mould - Selection of injection molding machines - Feed systems- type of runners-design of runners and runner efficiency - Design of gates – sprue type gate, rectangular gate, overlap gate, tab gate, fan gate, diaphragm gate, submarine gate, pin gate and ring gate

MODULE II DESIGN OF EJECTION SYSTEMS IN INJECTION MOLD 9

Working of ejection systems – constructional features of ejector grid - Ejector grid lay out – type of ejector elements – various ejection techniques in injection mold – cooling system design – insert type cooling system, bubbler, baffle type, heat rod and heat pipe type cooling systems – cooling channel layout and cooling time calculations

MODULE III SPLIT MOLD DESIGN 8

Design and construction features of two plate mold – design features of three plate mould – split type mould – actuation techniques, finger CAM , dog leg cam and cam track actuation techniques – type of locating rings – design of guide pillars - design of hot and cold runners.

MODULE IV COMPRESSION AND TRANSFER MOLD DESIGN 9

Classification of compression mold - Compression mold materials – design features of different type of compression molds – transfer mould classifications – pot and plunger type – design guidelines for transfer molds – advantages and disadvantages of compression and transfer moulds.

MODULE V DIE DESIGN 9

Introduction of extrusion die design - Basic consideration in die design - Constructional features of rod die – Design of pipe dies – inline, cross-head and off-set dies –design of profile dies – design of blown film dies – design of flat film and sheet dies.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Bruce Catoen and Herbert Rees (2021), Injection Mold Design Handbook, Hanser Publications.
2. Rainer Dangel (2020), Injection Molds for Beginners, Carl Hanser Verlag GmbH & Company

REFERENCES:

1. Günter Mennig and Klaus Stoeckhert, “Mold-making Handbook”, Hanser Publications, 2013
2. Ronald George William Pye, “Injection mold design”, 4thedition, Longman Scientific and Technical, Newyork, 2007
3. Dubois and Pribble, “Plastics Mold Engineering Handbook”, Chapman and Hall, 2007
4. Michael, W. “Extrusion Dies. Macmillan, Hanser Publications,1984
5. Fisher E. G. “Extrusion of Plastics”, Newnes - Butterworth, London, England, 1976

COURSE OUTCOMES:

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

CO1:select materials for the various parts of injection mould and calculate the dimensions of runner and gates

CO2:explain the design aspects of ejection and cooling systems in an injection mould

CO3:calculate the split movement of actuation techniques in split moulds and able to explain the function of different parts in injection mould

CO4:classify the compression and transfer moulds and explain the design features

CO5:explain the various design aspects to be considered while designing the dies for extruders

Board of Studies (BoS):

17th BoS of Polymer Engineering held on 17.05.2024

Academic Council:

22nd ACM held on 04.09.2024

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1		M	L											H		
CO 2	M	L	L													H
CO 3	H	M												H		H
CO 4	H	M	L													H
CO 5	L	M														H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

Statement: The overall understanding of the materials election for injection molds and design molds for new plastic products and it leads to the construction of resilient infrastructure and sustainable industrialization.

PED 4102	**MOULD DESIGN AND FLOW**	**L**	**T**	**P**	**C**
SDG: 9	**SIMULATION LABORATORY**	**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To impart basic knowledge and skill in using design software in mold design

COB2: To develop the ability to analyze the different designs of a mould

COB3: To impart basic skill in using mold flow software to design mold

30

List of Experiments

1. Design Calculations - No. of cavities, Selection of injection moulding machine, Shot capacity, clamping force, and tool strength calculation for Two Plate and Three Plate moulds.
2. Design of two plate mold – Plan and sectional views
3. Design of three plate mold – Plan and sectional views
4. Core and cavity extraction for plastic parts
5. Mold flow simulations for plastic parts
6. Compression mold design
7. Transfer mold design
8. Inline pipe die design

P – 30; TOTAL HOURS – 30

REFERENCES:

1. Malloy.R, " Plastic Part Design for Injection Molding", 2E, Hanser Publications, 2010
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 Modelling using CAD/CAE", 1st Edition, Elsevier,e-book,2014.

COURSE OUTCOMES:

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

CO1: Create the plan and sectional views of two and three plate molds.

CO2: Create core and cavity for different types of plastic parts using designsoftware

CO3: Analyze flow, cooling provisions, shrinkage and stress level in plastic products using software

Board of Studies (BoS) :
15th BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1		M	L			M								H		H
CO2	H	M	L					M							M	H
CO3	H	M						L		L				H		H
CO4	H	M	L						M							H
CO5	H	L								M						H

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

Statement: The students will be acquired the skill of designing moulds using computer software and this skill of students leads to develop new advanced materials for end use applications.

PED 4103	**INTERNSHIP II**	**L**	**T**	**P**	**C**
		0	**0**	**0**	**1**

COURSE OBJECTIVES:

COB1: Students must undergo two weeks industrial training in the industries relevant to Polymer Engineering and submit a report based on the internship.

Internship

- The students shall be encouraged to do their internship in core industries to develop a project on any topics in Polymer Engineering.
- Assigned to individuals on different topics for a period not less than 30 hours.
- Department will constitute an Evaluation Committee to review the project work done through internship periodically.

- The student shall also submit an internship completion certificate issued by the industry / research / academic organisation. The weightage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

COURSE OUTCOMES:

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

- Analyze suitable polymeric materials for advanced applications.
- Troubleshoot various defects in polymer products.
- Examine various processing techniques to develop polymer products.
- Characterize and interpret data based on various polymeric products.

Board of Studies (BoS) :	**Academic Council:**
15th BoS of PE held on 07.02.2023	20th AC held on 13.04.2023

SEMESTER – VIII

PED 4211	**PROJECT WORK**	**L**	**T**	**P**	**C**
SDG: 8		**0**	**0**	**18**	**9**

COURSE OBJECTIVES:

COB1: To enhance the practical skills of students in developing new products.

COB2: To encourage students to apply theoretical and practical knowledge to solve real-life problems related to industry and current research.

COB3: To improve the skills on developing new products.

COB4: To improve the skills towards report/documentation preparation.

GUIDELINES:

- Project work can be experimental to tailor-made polymeric materials.
- The project can be any of the topics on Polymer Engineering.
- The students can design, develop and upgrade the products, systems and processes related to various aspects of life, working on polymer materials.
- Provide sustainable solutions to the problems of society within the constraints of economy and environment with polymer based projects.
- The project work is allotted individually or a group of students not more than 4 on different topics.
- The students shall be encouraged to do their project work in the parent institute itself. Industry-oriented projects may also be permitted outside the parent institute.
- The department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of an internal guide and experts in the specified area of the project.
- Three reviews are conducted and project work has been assessed. First review would highlight the topic selection, literature survey, problem definition, objective and methodology. Second review evaluates the project content, teamwork, progress of the work and the third review will be based on presenting the deliverables, interpretation of the results and identification of industry/society relevance.
- The department will constitute an Evaluation Committee with an external subject expert for final viva of project work and evaluation of project

report.

- Based on the project report submitted by the students, an oral examination (viva voce) shall be conducted as semester end examination by an external examiner approved by the Controller of Examinations. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% for the project report and 30% for the viva voce examination.

COURSE OUTCOMES:

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

CO1: Analyze suitable polymeric materials for advanced applications.

CO2: Troubleshoot various defects in polymer products.

CO3: Examine various processing techniques to develop polymer products.

CO4: Characterize and interpret data based on various polymeric materials.

CO5: Produce deliverables and draft project report.

Board of Studies (BoS):

17th BoS of Polymer Engineering held on 17.05.2024

Academic Council:

22nd ACM held on 04.09.2024

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3											1	2
CO2		2	3			2	2						3	3
CO3		3		3	3								3	3
CO4						2		3	3		3	2	1	3
CO5										3			1	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: The project work provides sustainable solutions to the problems of society within the constraints of economy and environment with creative polymer based projects. By undergoing project work, the students will learn to lead a team, design a polymer product and develop employability and entrepreneurship skills.

PROFESSIONAL ELECTIVES

SPECIALIZATION I : MATERIALS

PEDX01	BIOPOLYMERS AND HYDROGEL	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To develop an understanding of biopolymers

COB2: To provide knowledge on the synthesis of various bioplastics.

COB3: To impart knowledge on hydrogels

COB4: To provide an understanding on the various properties of hydrogels.

COB5: To emphasize the applications of hydrogels in various domains.

MODULE I INTRODUCTION TO BIOPOLYMERS 9

Definition of Biopolymers and types of biopolymers -types of bioplastics, Mechanical properties of biomaterials - elasticity, yield stress, ductility, toughness, strength, fatigue, hardness and wear resistance -Polymeric Biomaterials - Polyethylene terephthalate, Poly(methyl methacrylate, Silicon rubber, Polyurethane, Polylactic acid, cellulose and their applications etc.

MODULE II SYNTHESIS OF BIOPOLYMERS 9

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- Vegetable Oil-based Biopolymers -Chitin- Chitosan - Casein Plastics - Gelatins, lignin.

MODULE III HYDROGELS 9

Introduction to hydrogel and brief historical overview - Classification of hydrogels based on origin, type of interaction, ionic/non-ionic characteristics - Different types of gel-forming techniques - Physically and chemically cross-linked hydrogels – surface modification –corona discharge and plasma processes.

MODULE IV PROPERTIES OF BIOPOLYMERS AND HYDROGEL 9

Evaluation of swelling behaviors of hydrogels -Swelling capacity, water retention capacity, kinetic analysis - Effect of pH, ionic strength and temperature on swelling properties of hydrogels - Relationship between morphology and swelling properties -Mechanical and rheological properties of hydrogel – Mechanical properties of interpenetrating (IPN) and multi-networking hydrogel.

MODULE V APPLICATIONS OF BIOPOLYMERS AND HYDROGEL 9

Introduction to hydrogel drug delivery system - Targeted drug delivery and controlled drug delivery systems -pH responsive and glucose responsive delivery- Kinetics of drug diffusion through hydrogels – Hydrogels for bone replacement ,artificial organs, cosmetic implants and dental applications - Hydrogel in agriculture and packaging application.

L – 45 ; TOTAL HOURS –45

TEXT BOOKS:

3. Thakur Raghu Raj Singh, Garry Laverty, Ryan Donnelly, " Hydrogels : Design, synthesis and application in drug delivery and regenerative medicine, CRC Press, 2021.
4. Syed Ali Ashter, 'Introduction to Bioplastics Engineering' Elsevier, 2016.
5. Michael Niaounakis, 'Biopolymers: Reuse, Recycling, and Disposal' Elsevier, 2013.
6. David Plackett, 'Biopolymers: New Materials for Sustainable Films and Coatings'Wiely, 2013.
7. Susheel Kalia, Luc Avérous, 'Biopolymers: Biomedical and Environmental Applications', John Wiley & Sons, 2011.

REFERENCES:

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

COURSE OUTCOMES:

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

CO1: Identify and extract bioplastics from natural sources.

CO2: Synthesis and analyze properties of bio-based plastic materials.

CO3: Analyze and enhance biocompatibility with various surface modification methods of hydrogels

CO4: Demonstrate the knowledge of properties of hydrogels in various advance applications.

CO5: To identify bioplastic materials for specific applications.

Board of Studies (BoS):

BoS of PE held on 07.02.2023

Academic Council:

20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L									M		M
CO2	L				L									H		L
CO3								M						H		L
CO4					M									H		H
CO5														H		

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG No.9 : To encourage innovation in Biopolymers through science, technology, and development.

Statement: The topics covered in this course are intended to help students comprehend the various Bioplastics and Hydrogels. The study of diverse polymeric materials and technological innovation will help to satisfy the need of bioimplants in various applications.

PEDX02	**BIOMEDICAL POLYMERS FOR**	**L**	**T**	**P**	**C**
SDG: 9, 12	**HEALTH CARE**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

To make the student conversant with

COB1:various methods to synthesis biomedical polymers

COB2:the knowledge of different techniques to process biomedical polymers

COB3:applications of biopolymers in prosthesis, tissue engineering, drug delivery and lens

COB4:developments in biopolymer sensors

COB5:an insight into shape memory polymers for biomedical applications

MODULE I BIOMEDICAL POLYMER - SYNTHESIS 9

Various factors of importance in material selection for biomedical applications – Classification – Synthetics polymers, natural polymers. Synthesis of biomedical polymers – Condensation Polymerization – polyesters, polyarylates, polyesteramides, polycarbonates, polyurethanes. Addition Polymerization – Ionic polymerization, coordination polymerization, controlled /living radical polymerization.

MODULE II BIOMEDICAL POLYMERS: PROCESSING 9

Common techniques for processing biomedical polymers - Thermal processing – extrusion, blow moulding, thermoforming, injection moulding – Solution processing – solution spinning, electrospinning, airbrushing, Hollow fibers membranes, Thermally induced Phase Separation, Porogen leaching - Solid free form fabrication (SFF) - Fusion deposition modeling, Inkjet printing, Stereolithography (SLA), 3D printing.

MODULE III BIOPOLYMER FOR PROSTHESIS, TISSUE, DRUG DELIVERY AND LENS APPLICATIONS 9

Polymericscaffolds fortissue engineering – polymericdrug delivery systems– polymers for drug delivery systems – Polymersas replacement materials for heart valvesand arteries – Ocular Implants.

MODULE IV POLYMERS IN BIOSENSORS 9

The development and format of biosensors – Polymer membranes in biosensors – Polymer coatings for biosensors – Conductingpolymers in biosensors – Redox-active polymers in biosensors – Molecularly imprinted polymers in biosensors

MODULE V SHAPE MEMORY POLYMERS FORBIOMEDICAL APPLICATIONS 9

Introduction to shape-memory polymers for biomedical applications – Mechanical propertiesof shape-memory polymers for biomedical applications – Characterization of shape-memory polymers for biomedical applications – Biocompatibilityof shape-memorypolymers for biomedicalapplications.

L – 45 ; TOTAL HOURS –45

TEXTBOOKS:

1. A.K. Bajpai, Jaya Bajpai, Rajesh Kumar Saini, Priyanka Agrawal, Atul Tiwari, SmartBiomaterialDevices - Polymers in BiomedicalSciences, Taylor & Francis Group, LLC, 2017.
2. L'Hocine Yahia, Shape Memory Polymers forBiomedical Applications, Woodhead Publishing, 2015.

REFERENCES:

1. Vinod B. Damodaran Divya BhatnagarN. Sanjeeva Murthy "Biomedical Polymers Synthesis and Processing", Springer Cham, 2016.
2. Sangamesh G. Kumbar, Cato T. Laurencin,Meng Deng. "Natural and SyntheticBiomedical Polymers", Elsevier publications, 2014.

COURSE OUTCOMES:

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

CO1: demonstrate various methods to synthesis biomedical polymers

CO2: illustrate the processing of biomedical polymers

CO3: suggest biopolymers for prosthesis, tissue engineering, drug delivery and lens applications

CO4: appreciate the developmentsof biopolymers used in sensors

CO5:describe the shape memory polymers used in biomedical applications

Board of Studies (BoS):
BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L									M		
CO2	L				L									H		
CO3								M						H		
CO4					M									H		
CO5														H		

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9, 12 – The usage of modern polymers for biomedical applications leads to innovations in the field of medicine and efficient use of resources

Statement

The use of polymer materials in biomedical applications are raising that leads to innovation on new materials and methods to process them there by improve the efficient use of resources.

		L	T	P	C
PEDX03	**POLYMERS FOR ADVANCED**	**L**	**T**	**P**	**C**
SDG: 9	**TECHNOLOGIES**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To develop an understanding on the properties and applications of high temperature resistant specialty polymers.

COB2: To introduce the students with various methods for imparting conductivity in polymers.

COB3: To provide an insight on to the various conducting polymers and ionic polymers.

COB4: To provide an understanding on the various applications of conducting polymers.

COB5: To emphasize on polymer concrete and its applications.

MODULE I HEAT RESISTANT POLYMERS 8

Temperature and fire resistant polymers, fluoropolymers, aromatic polymers, poly sulphide, polysulphones, polyesters, polyamides, polymides, polyketones, heterocyclic polymers , polysiloxanes.

MODULE II IONIC POLYMERS AND LCPS 9

Synthesis, physical properties and applications, ion-exchange hydrophilicity elastomeric ionomers, ionomers based on poly styrene, polyethylene, PTFE and polyaromatic backbones, polyelectrolytes for ion exchange, polyelectrolytes based on carboxylates, polymers with integral ions, polyelectroyte complexes, biological and inorganic ionic polymers. Liquid crystalline polymers, preparation, structure and properties of various liquid crystalline polymers applications.

MODULE III CONDUCTING POLYMERS 10

Conducting polymers, light sensitive -photo conducting polymers, polymers in non linear optics, polymers with piezoelectric, pyroelectric and ferroelectrics properties, photo resist for semiconductor fabrication, polymer coating in electronics. haracterization of conducting polymers – electroanalytical techniques – cyclic voltammetry, chronoamperometry and chronocoulometry.

MODULE IV APPLICATIONS OF ADVANCED POLYMERS 9

Conducting polymers in microelectronics – corrosion and ESD protection EMI shielding and lithography. LED-rechargeable batteries – artificial muscles – electrochromic devices – sensor devices – conductive composites

MODULE V **POLYMER CONCRETE** **9**

Polymer concrete (PC)– Polymer-portland cement concrete (PPCC) – Polymer impregnated concrete (PIC) –Reinforced concrete –Manufacture of polymer concrete –Mixing and Application of Polymer concrete – Physical Properties of Polymer concrete – End- use Applications.

L – 45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Manas Chanda, Salil.K.Roy, "Industrial Polymers, Specialty Polymers, and Their Applications (Plastics Engineering)", CRC Press, 2012.
2. 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.
3. Manas Chanda, Salil.K.Roy, "Plastics Technology Handbook", 2nd edition, Marcel Dekker, New York, 1993.
4. Matrin.T.Goosey, "Plastics for Electronics", Elsevier, Applied Science, 1985.
5. R.W. Dyson, "Specialty Polymers", Chapman & Hall, 2nd edition, 1998.

REFERENCES:

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

COURSE OUTCOMES:

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

CO1: Identify the heat resistant polymers and specific method to synthesize polymers for high temperature applications

CO2: Identify and synthesize ionic polymers and liquid crystalline polymers .

CO3: Analyse and investigate the conducting properties of polymers

CO4: Select polymeric materials for electrical and electronic applications..

CO5: Prepare polymer concrete, binders and analyse its properties for advance applications

Board of Studies (BoS):
BoS of PE held on 07.02.2023

Academic Council:
20^{th} AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L									M		M
CO2	L				L									H		L
CO3								M						H		L
CO4					M									H		H
CO5														H		

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG No.9 : Build, promote sustainable industrialization and innovation

Statement: The topics covered in this course are intended to help the students to develop heat resistant and conducting polymers for advanced applications. The students will able to formulate polymer concrete which leads to develop resilient infrastructure and sustainable industrialization.

PEDX 04 **NANOSCIENCE AND TECHNOLOGY** **L T P C**

SDG : 9 **3 0 0 3**

COURSE OBJECTIVES :

COB1: To acquire basic knowledge about the concept of Nanoscience and Technology

COB2: To impart knowledge about different dimensions of Nanoscale systems

COB3: To provide the fundamental characteristics of Nanoscale systems

COB4: To foster knowledge of various kinds of Nanodevices

COB5: To comprehend the various applications of Nanotechnology in various disciplines

MODULE I BASIC CONCEPTS OF NANOSCIENCE AND TECHNOLOGY 9

Nanoscience – Definition, History – Background to Nanoscience and Nanotechnology – Engineering Principles – Overview of Fundamentals of Nanotechnology – Engineering Principles of Nanomaterials, Scientific Revolutions – Types of Nanotechnology.

MODULE II NANOSCALE SYSTEMS 10

Nanoscale dimension – Zero, One, Two, and Three-dimensional nanostructures–quantum dots, quantum wells, quantum rods, and quantum wires. An overview of natural and classical nano systems – Nanosized effects surface to volume ratio – atomic structure – molecules & phases – energy at the nanoscale molecular and atomic size – quantum effects.

Nanosized metals and alloys, semiconductors, ceramics–comparison with respective bulk materials. Organic semiconductors, carbon nanotubes, graphene, graphene nanorods, and nanocomposites consist of organic, inorganic, and biomaterials.

MODULE III PROPERTIES 7

Size and shape of dependent optical, emission, electronic, transport, photonic, refractive index, dielectric, mechanical, magnetic, catalytic, and photocatalytic properties.

MODULE IV DIFFERENT NANODEVICES 10

Designing advanced integrated nanocomposites, functional nanomaterials, and nanostructured thin films. Development of nanoscale catalysts, photocatalysts, sensors, composites, polymers, ceramics, biomaterials, pharmaceuticals, nano paints, nanofluids, optical, fluorescent, electronic, magnetic, and photonic devices. Future perspectives of nanotechnology in miniaturization of devices and fabrication of value-added products.

MODULE V APPLICATIONS OF NANOTECHNOLOGY 9

Industrial applications, nanomaterials in consumer markets, electronics, photonics, nano optoelectronics – microarray – thin film applications – coating – energy storage –– biotechnology – biomedical applications – nanomedicine and drugs – nano fabrics – defence and security – military – cosmetics – agriculture - precision farming.

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

(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 Infratech. G.J., "Handbook of Nanoscience Engineering and Technology", CRC Press, 2002

REFERENCES:

(1) Pradeep. T, "Textbook of Nanoscience and Nanotechnology", McGraw Hill Education (India) Private Limited, New York, 2012
(2) Chris Mack, "Fundamental Principles of Optical Lithography: The Science of Microfabrication", John Wiley & Sons, 2008
(3) Bandyopadhyay A.K, "Nano-Materials", New Age International Publishers, New Delhi, 2008

COURSE OUTCOMES:

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

CO1: Demonstrate the basics of nanoscience and nanotechnology

CO2: Explain the effects of nanoscale on different materials

CO3: Describe the various types of nanomaterials properties

CO4: Demonstrate the functions of nanodevices

CO5: Apply the theory in the applications of different nanomaterials

Board of Studies (BoS):	**Academic Council:**
16th BoS of Polymer Engineering held on 17.08.2023	21st AC held on 20.12.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1		M		L			L						L			L
CO2			M	M										L		M
CO3	L		M	M			L						H	H	L	L
CO4	L	L		M									M	L	H	L
CO5			L	L		L	L						M	L	H	H

Note: L - Low Correlation M - Medium Correlation H -High Correlation

SDG 9 :To encourage innovative thinking in science, technology, and the creation and use of various nanomaterials.

The topics mentioned in this course are designed towards understanding the basics of different nanomaterials, fabrication techniques, different properties, and distinct applications. This course fosters innovation and technological capabilities in understanding the need and necessity of nanomaterials applications which results in enhanced properties. This ultimately will satisfy the current industrial challenges.

PEDX05	**POLYMERS FOR BATTERY TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES :

COB1: To develop an understanding of batteries.

COB2: To provide knowledge on the various electrolytes for batteries

COB3: To impart knowledge on electrodes for batteries.

COB4: To provide an understanding on the various testing of batteries.

COB5: To emphasize on the supercapacitors.

MODULE I INTRODUCTION TO BATTERY TECHNOLOGY 9

Introduction, basic concepts of battery (power density and energy density), Primary and secondary cells, - battery architecture and design guidelines - Nickel–cadmium battery (NiCd), Nickel–metal hydride battery (NiMH), Lithium-ion battery, Lithium-ion polymer battery, Organic radical batteries, redox flow batteries – lithium-air battery-Zinc-air and Aluminium-air batteries – advantages and limitations.

MODULE II ELECTROLYTES FOR BATTERIES 9

Types of electrolytes-solid electrolytes- liquid electrolytes-gel electrolyes-function and requirement of electrolytes – Sulfonated polymer electroltyte membranes – Nafion membranes-fibre reinforced Nafion membranes –Poly (vinylidene) fluoride ,Poly (ethylene oxide) , Poly(imides), Polyacrylonitrile and its copolymers based electrolytes for batteries.

MODULE III ELECTRODES FOR BATTERIES 9

Requirement of anode and cathode for batteries – anode and cathode materials for batteries – fabrication methods – solution casting, sol-gel method – phase-inversion technique- electrospinning process-fabrication of coil cell battery-batteries for E-vehicles, future trend - failure mechanism of batteries.

MODULE IV TESTING OF BATTERIES 9

Battery testing – elecrochemical stability - interfacial resistance- current density - Impedance spectroscopy- Bode and Nichols plot, Arrhenius plot -cyclic voltammetry-linear sweep voltammetry -lithium-ion transference number – charge-discharge cycle.

MODULE V SUPERCAPACITORS 9

Super Capacitor, Electrochemical supercapacitors, Basic components of supercapacitors - types of electrodes - high surface area, activated carbons, metal oxide aqueous and organic electrolytes. Nanostructured Carbon-based materials, electrical double layer model - Principles and materials design, Redox capacitor Nano Oxides, conducting polymers-based materials, Current status and future trends.

L – 45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Jianhua Fang, Jinli Qiao, David.P, Wilkinson, Jiujun Zhang "Electrochemical Polymer Electrolyte Membranes" National Research Council Institute for Fuel Cell Innovation, British Columbia, Canada, CRC Press, 2015.
2. Achchhe Lal Sharma, Anil Arya, Anurag Gaur, "Polymer Electrolytes and their Composites for Energy storage/ Conversion Devices", CRC Press, 2023.
3. T.Daniel Thangadurai, Manjubaashini Nandhakumar, Sabu Thomas, Ange Nzihou, "Polymer Nanocomposites for Energy Applications",Wiley-VH, 2022.

REFERENCES:

1. Daniel Brandell, Jonas Mindemark, Guiomar Hernández, "Polymer - Based Solid-State Batteries, De Gruyter, 2021.
2. Huisheng Peng, Xuemei Sun, Wei Weng, Xin Fang, "Polymer Materials for Energy and Electronic Applications", Elsevier, 2017.

COURSE OUTCOMES:

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

CO1: Demonstrate the knowledge of batteries.

CO2: Synthesis and analyze electrolytes for batteries.

CO3: Select suitable polymers for the development of electrodes.

CO4: Analyze electrochemical characteristics of batteries.

CO5: Fabricate polymer batteries and supercapacitors.

Board of Studies (BoS):	**Academic Council:**
BoS of PE held on 07.02.2023	20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L									M		M
CO2	L				L									H		L
CO3								M						H		L
CO4					M									H		H
CO5														H		

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG No.9 : To encourage innovation in energy storage based polymers for battery technology through science, technology, and development.

Statement: The topics covered in this course are intended to help students comprehend on Battery technology. The study of diverse polymeric materials and technological innovation will help to satisfy the need of E-vehicles.

PEDX06	SPECIALITY ELASTOMERS	L	T	P	C
SDG: 8		3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1:compounding ingredients for speciality applications

COB2:different moulding methods and troubleshooting process

COB3:manufacture, properties, and applications of HNBR

COB4:usage and uniqueness of FKM

COB5:epichlorohydrin rubbers and their copolymers

MODULE I COMPOUNIDNG INGREDIENTS FOR SPECIALITY RUBBERS 9

Plasticizers, processoils, vulcanizedvegetable oils – peroxides and its selection method, effect of coagents in peroxide cures, sulfur and sulfur related materials, multi-functional crosslinking agents - antioxidants – processing aids – applications in compounding.

MODULE II MOULDING AND TROUBLE SHOOTING 9

Basics of rubber viscoelastic flow - effects of process variables - effects of compounding variables on viscosity, elasticity,and flow – trouble shooting

MODULE III HYDROGENATED NITRILE RUBBER 9

Basic technology of hydrogenated nitrile - physical properties, compounding - vulcanization systems, carbon black and non-black fillers, aging stabilizers, plasticizers, applications.

MODULE IV FKM AND FEPM 9

Why use a fluoroelastomer - choosing the right fluoroelastomer – compounding for special needs – processing – troubleshooting.

MODULE V POLYEPICHLOROHYDRIN AND ITS COPOLYMERS 9

Manufacturing, properties, formulation design – polymer selection, curatives, acid acceptors, protective agents – mixing – applications.

L – 45 ; TOTAL HOURS –45

TEXTBOOKS:

1. Robert C. Klingender, Handbook of Specialty Elastomers, CRC Press, Taylor & Francis Group, 2008.

REFERENCES:

1. James E. Mark, Burak Erman, Science and technology of Rubber, Elsevier Academic Press, 2005.
2. Andrew Ciesielski, AnIntroductionto Rubber Technology, Rapra Technology Limited, 1999

COURSE OUTCOMES:

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

CO1: suggest compounding ingredients for specialty elastomers

CO2: demonstrate various moulding techniques and their troubleshooting

CO3: appreciate the manufacture, properties, and applications of HNBR

CO4: select fluoroelastomers for special needs

CO5:design suitable formulation for epichlorohydrin and its copolymers for specialty applications

Board of Studies (BoS):

BoS of PE held on 07.02.2023

Academic Council:

20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	L			L		L					L		M		
CO2	L				L									L	H	
CO3								M				L		H		
CO4		L		L	M		L					L		H		
CO5	M	L		L			L					L		H		

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 8 – Effective understanding of the course helps in economic growth, entrepreneurship, GDP growth and sustainable employment .

Statement:The understanding the science and technology of advanced elastomer helps in productive employment and enhanced sustainable employment and trigger entrepreneurship

PEDX 07	**POLYMERS FOR ELECTRIC VEHICLES**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To develop an understanding of batteries.

COB2: To provide knowledge on the electrochemical characterization of batteries.

COB3: To impart knowledge on fuel cells for Automotive applications

COB4: To provide an understanding on the design of hydrogen fuel cell system for road vehicles.

COB5: To emphasize on the flexible energy and electronic devices.

MODULE I BATTERY TECHNOLOGY 9

Introduction, basic concepts of battery (power density and energy density), Primary and secondary cells, - battery architecture and design guidelines - Lithium-Ion Batteries -Polymers as Active Materials in Electrode - Polymers as Separators - Polymers as Electrolytes - Supercapacitor- Polymer-Based Electrode and Electrodes.

MODULE II TESTING OF BATTERIES 9

Battery testing – elecrochemical stability - interfacial resistance- current density - Impedance spectroscopy- Bode and Nichols plot, Arrhenius plot -cyclic voltammetry-linear sweep voltammetry -lithium-ion transference number – charge-discharge cycle.

MODULE III FUEL CELLS FOR AUTOMOTIVE APPLICATIONS 9

Basic Concepts of Electrochemistry - Proton Exchange Membrane Fuel Cells: Polymer Electrolyte fuel cells, Hyflon ion ionomers -Phosporic acid doped polybenzimidazole membrane – hydrocarbon based membranes – solid polymer electrolyte fuel cells – parameters influencing long term performance and durability -degradationElectrocatalysts, GDL, Bipolar Plates - Sensitivity of PEM Stacks to Operating Conditions: Polarization Curve, Effect of Operative Parameters on the Polarization Curve - Durability of PEM Fuel Cells

MODULE IV DESIGN OF HYDROGEN FUEL CELL SYSTEMS FOR ROAD VEHICLES 9

Hydrogen Fuel Cell Systems: Preliminary Remarks - Hydrogen Feeling System - Air Feeding System - Thermal Management System - Water/Humidification Management System - Integrated Fuel Cell System: Efficiency, Dynamics, Costs.

MODULE V FLEXIBLE ENERGY AND ELECTRONIC DEVICES BASED ON POLYMERS 9

Flexible Solar Cells – Flexible Piezoelectric Devices – Flexible Supercapacitors – Flexible Lithium-Ion Batteries – Flexible Light-Emitting Devices – Flexible Electrochromic Devices.

L – 45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Jianhua Fang, JinliQiao, David.P, Wilkinson, Jiujun Zhang “Electrochemical Polymer Electrolyte Membranes” National Research Council Institute for Fuel Cell Innovation, British Columbia, Canada, CRC Press, 2015.

2. AchchheLal Sharma, Anil Arya, Anurag Gaur, “Polymer Electrolytes and their Composites for Energy storage/ Conversion Devices”, CRC Press, 2023.

3. T.DanielThangadurai, ManjubaashiniNandhakumar, Sabu Thomas, AngeNzihou, “Polymer Nanocomposites for Energy Applications”,Wiley-VH, 2022.

4. Ed. S.M. JavaidZaidi& Takeshi matsuura, “Polymer Membranes for Fuel Cells “, Springer, 2008.

REFERENCES:

1. Daniel Brandell, Jonas Mindemark, Guiomar Hernández, “Polymer – Based Solid-State Batteries, De Gruyter, 2021.

2. HuishengPeng, Xuemei Sun, Wei Weng, Xin Fang, “Polymer Materials for Energy and Electronic Applications”, Elsevier, 2017.

COURSE OUTCOMES:

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

CO1: Demonstrate the knowledge of batteries.

CO2: Analyze various electrochemical characterization of polymers

CO3: Demonstrate the knowledge of fuel cells for automotive applications.

CO4: Design hydrogen fuel cell system for road vehicles.

CO5: Select and suggest polymers for flexible electronics.

Board of Studies (BoS):
BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L									M		M
CO2	L				L									H		L
CO3								M						H		L
CO4					M									H		H
CO5														H		

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG No.9 : To encourage innovation in developing polymers for E-vehicles through science, technology, and development.

Statement: The topics covered in this course are intended to help students comprehend on Batteries foe E-vehicles. The study of diverse polymeric materials and technological innovation will help to satisfy the need of E-vehicles.

PEDX 08	**THERMODYNAMICS FOR POLYMER ENGINEERS**	**L**	**T**	**P**	**C**
SDG: 9 & 12		**3**	**0**	**0**	**3**

COURSE OBJECTIVES :

COB1: To understand the thermodynamic principles of polymers.

COB2: To analyse thermodynamic processes in different types of polymers.

COB3: To develop the ability in understanding the thermodynamics of polymer solutions and its equilibrium

COB4: To impart knowledge of predicting the phase behaviour of polymers

COB5: To familiarize the students with the knowledge of applying thermodynamics in the polymer processing

MODULE I INTRODUCTION TO POLYMERS AND THERMODYNAMICS 8

Fundamental of thermodynamics-energy-work and heat, types of system and surroundings, state functions and path functions, laws of thermodynamics –entropy and enthalpy its significance.

MODULE II THERMODYNAMIC PROCESSES IN POLYMERS 10

Isothermal heating, cooling, adiabatic compression, and expansion, isobaric heating, cooling, and Isochoric processes (constant volume), phase transitions, solubility equilibrium, energy transfer and transformation in polymers, heat capacity, and thermal conductivity- polymer stability and degradation.

MODULE III THERMODYNAMICS OF POLYMER SOLUTIONS 10

Ideal and non-ideal solutions, solubility parameter and Flory-Huggin's equations, Sanchez-Lacombe equation of state, thermodynamics of liquid-liquid equilibria model and its types, applications of polymer solutions in thermodynamics.

MODULE IV PHASE EQUILIBRIA IN POLYMER SYSTEMS 8

Phase diagram, eutectic, and eutectoid phase reactions, phase behaviour of copolymer, practical applications of the phase diagram, Gibbs phase rule in polymer blends, Helmholtz free energy and polymer phase transitions.

MODULE V THERMODYNAMICS IN POLYMER PROCESSING 9

Heat transfer and energy balance, temperature effects on polymer processing, materials interaction, and compatibility, mixing energy and work input, the role of thermodynamics in extrusion, injection, and fibre spinning processes.

TOTAL HOURS – 45

TEXTBOOKS :

1. Claus Borgnakke and Richard E, "Fundamentals of Thermodynamics" Sonntag, 8th Edition 2022.
2. J.M. Smith, H.C. Van Ness, and M.M. Abbott "Introduction to Chemical Engineering Thermodynamics" 8th Edition 2022.
3. Malcolm P. Stevens "Polymer Chemistry: An Introduction" 3rd Edition 2000
4. David R. Gaskell, Introduction to the Thermodynamics of Materials" 5th Edition, 2008
5. Tim A. Osswald, Juan Pablo Hernandez-Ortiz, and David R. Paul, "Polymer Processing Fundamentals" 1st edition 2015.

COURSE OUTCOMES:

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

CO1: Evaluate the different thermodynamic systems

CO2: Know the thermodynamic process of different polymeric materials

CO3: Explain different equation system of different polymers and its specific applications

CO4: Illustrate the phase rule and phase transition in polymers

CO5: Identify the problems and predict the product performance in different processing methods.

Board of Studies (BoS):	**Academic Council:**
16th BoS of Polymer Engineering held on 17.08.2023	21st AC held on 20.12.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO1	L			L											M	L
CO2	L			M									L	L	M	L
CO3		L		H									L			L
CO4			M											L	H	L
CO5		M													M	

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 and 12 : To impart the industrial needs, polymeric reactions with different materials, energy requirement based on the application of thermodynamics.

Statement: The topics covered in this course are intended to help the students to enhance the basic knowledge in thermodynamics. The study of thermodynamics, phase equilibria in different polymeric materials and polymer processing will help to meet the industrial requirements.

SPECIALIZATION II
(Process Engineering)

PEDX 11	**FIBRE TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 9, 11		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To develop an understanding on the polymeric fibre materials

COB2: To impart knowledge on the various fibre manufacturing techniques

COB3: To provide an understanding on various post processing techniques

COB4: To develop skills on testing of fibres

COB5: To acquire knowledge on different forms of fibre and applications

MODULE I POLYMERIC FIBRE MATERIALS 9

Development of synthetic fibres, properties of synthetic & natural fibres – commercial synthetic fibres – criteria for fibre forming polymers – production of fibres: polypropylene – polyethylene terephthalate – polyacrylonitrile – PVC – polyamides – PVA – aramid – Natural fibres: cotton, flax, hemp, bamboo, sisal, jute, silk, wool, etc.

MODULE II FIBRE MANUFACTURING 10

Melt spinning: polymer feed, melt spinning equipment, high speed spinning, spin draw processes, crystallization method, melt spinning of PET & PP staple fibres – wet and dry spinning: wet spinning, dry spinning, dry jet wet spinning – spin finishes: functions of spin finish , properties of spin finish, methods of application of spin finish, spin finish for polyester staple fibres, spin finish for texturing process, effect of spin finish on dyeing

MODULE III POST PROCESSING 10

Stretching or drawing, conditions of drawing, machines for draw warping – texturing: false twist process, draw texturing – staple fibre production: melt spinning, drawing, heat setting, crimping in fibre line – polyester tops for wool blending – Mass coloration and tow dyeing : polyester, nylon, acrylic, polypropylene – dyeing of synthetic fibres in loose fibre and yarn forms – of polyester, nylon, acrylic, PP – modified synthetic fibres: polyester, nylon, PP

MODULE IV FIBRE TESTING 9

Testing of filament yarns & stable fibres – fibre and end use properties – methods of fibre identification – burning test – chemical test – microscopic test – fibre strength testing: breaking strength, tensile testing, factors affecting fibre strength – interfacial shear strength (IFSS) : fibre pull out test, fragmentation test, microbond test – fibre strength measurement : single fibre strength, fibre bundle strength.

MODULE V FIBRE FORMS AND APPLICATIONS 7

Fibre forms: short fibre, continuous fibre, woven mat, chopped strand mat – Applications of synthetic fibre: energy sector, mechanical sector, electronic sector, medical sector, composite sector.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. V.B. Gupta, V.K.Kothari, “Manufactured Fibre Technology”,2012
2. S. P. Mishra, “A Text Book of Fibre Science and Technology”, 2000
3. Franz Fourne, “Synthetic Fibers Machines and Equipment, Manufacture, Properties”, 1999
4. A.A. Vaidya, “Production of synthetic fibres”, Prentice Hall of India Pvt. Ltd., New Delhi, 1988

REFERENCES:

1. Sanjay Mavinkere Rangappa, Dipen Kumar Rajak, “Natural and Synthetic Fibre Reinforced Compoosites, Synthesis, Properties and Applications”, Willey 2022
2. Menachem Lewin, Stephen Sello, “Handbook of Fiber Science and TechnologyChemical Processing of Fibers and Fabrics - Fundamentals and Preparation Part B”,2019
3. Encyclopedia of Polymer Science and Tech, Vol 1-12, John Wiley and Sons,2003

COURSE OUTCOMES:

Students will be able to

CO1: Select the suitable polymeric fibre for specific applications

CO2: Examine the suitable manufacturing techniques for specific applications

CO3: Demonstrate on the various post processing techniques

CO4: Suggest the specific test for polymeric fibre based on end use applications

CO5: Select specific form of fibre for particular application

Board of Studies (BoS):
16th BoS of Polymer Engineering held on 17.08.2023

Academic Council:
21st AC held on 20.12.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1			H													M
CO2		L											H			
CO3					M								H			
CO4					M									H		
CO5		M												H		

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG No. 9: Industry, Innovation and infrastructure
SDG No. 11: Sustainable Cities and Communities

Statement: The holistic understanding of polymeric fibre materials leads to development of resilient and sustainable infrastructure and industrial diversification.
Statement: The holistic understanding of polymeric fibre materials for sustainable buildings

PEDX 12	POLYMER POST PROCESSING	L	T	P	C
SDG: 9, 11	OPERATIONS	3	0	0	3

COURSE OBJECTIVES:

COB1: To develop an understanding of machining ans finishing operations.

COB2: To provide knowledge on the assembly of plastic parts.

COB3: To impart knowledge on plating.

COB4: To provide knowledge on different types of paint

COB5: To emphasize on the printing and coating methods.

MODULE I MACHINING AND FINISHING 9

Deflashing, smoothing and polishing, routing, milling and turning, filing, grinding, sanding, sawing and cutting, drilling, taping and threading, cleaning and annealing.

MODULE II ASSEMBLY OF PLASTIC PARTS 9

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.

MODULE III PLATING 9

Electroplating process on plastics versus metals, material selection for plating of plastic, importance of surface preparation – electrode less plating, plating rack building sequence, processing steps of interior and exterior plating and their operating parameters, major functions of chrome deposit, physical vapor deposition and its advantages.

MODULE IV PAINTING 9

In-mold decorating process, spray painting, vacuum metallizing process, laser marking, hot stamping process, post-molding finishing operations of hard coating, flocking - data matrix. Plastic finish specifications.

MODULE V PRINTING AND COATINGS 9

Silk printing, Gravure, Graf wave printing, pad transfer printing, letter press printing, dry offset printing, flexographic printing, labels, decal. surface pretreatment-coating selection, coating materials, application methods – Dip coating, electrocoating, Spray coating, Airless coating, Powder coating, Auto-deposition coating and Other coating methods, Curing and baking methods- in mould decoration (IMD).

L – 45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Rodger Talbert, “Paint Technology Handbook”, CRC Press ,September 13, 2012.
2. Arthur A. Tracton ,”Coatings Materials and Surface Coatings”, CRC Press,2006.
3. Arthur A. Tracton,”Coatings Technology: Fundamentals, Testing, and Processing Techniques”, CRC Press, November 7, 2006.
4. Zeno W. Wicks Jr. , Frank N. Jones , S. Peter Pappas, Douglas A. Wicks, “Organic Coatings: Science and Technology”, Wiley-Interscience; 3rd edition,1993.
5. Charles A. Harper, “Modern Plastics Handbook”, McGraw-Hill, 1999.
6. Akira Kobayashi, “Machining of Plastics”, McGraw-Hill, 1990.

REFERENCES:

1. Modern Plastic World Encyclopedia – 2000, Modern Plastics International.
2. Walter Michaeli, “Plastic Processing, an Introduction”, Hanser publications – Munich, 2005.

COURSE OUTCOMES:

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

CO1: Identify machining and finishing operation for different plastic products

CO2: Select suitable printing and coating methods based on application.

CO3: Design post processing method for polymer products.

CO4: Select suitable paint for various applications

CO5: Suggest coatings for various applications.

Board of Studies (BoS):

16th BoS of Polymer Engineering held on 17.08.2023

Academic Council:

21st AC held on 20.12.2023

Note: L- Low Correlation M -Medium Correlation H -High Correlation

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1			H													M
CO2		L											H			
CO3					M								H			
CO4					M									H		
CO5		M												H		

SDG No.9, 11 : To encourage innovation in post processing operations through science, technology, and development.

Statement: The topics covered in this course are intended to help students comprehend on post processing operations in industries. The study of diverse polymeric materials and technological innovation will help to satisfy the need of society.

		L	T	P	C
PEDX 13	**RUBBER PRODUCT MANUFACTURING**	**L**	**T**	**P**	**C**
SDG: 8,9	**TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To impart knowledge of various latex product manufacturing techniques

COB2: To provide fundamental knowledge of belt manufacturing technology

COB3: To illustrate the cable and hose manufacturing process

COB4: To introduce basic concept of vibration damping and rubbers to attenuate it

COB5: To develop knowledge of rubber to metal bonding

MODULE I LATEX PRODUCT MANUFACTING 9

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 II BELT MANUFACTURING TECHNOLOGY 9

Rubber conveyor belt - Process of manufacture of conveyor belt - Belt design - Rubber textile composites - Belt Selection - Belt Strength Calculations.

V-Belt – raw materials – processing of various components – rubber, cord, canvas – method of processing of various v-belts.

MODULE III EXTRUSION TECHNOLOGY 9

Rubber hose - Manufacturing of hose - non-mandrel style, Flexible mandrel style, Rigid mandrel style of manufacturing hose - Type of hoses - Molded hose, Hydraulic hose, Machine-made wrapped hose, Hand-made hose, Circular woven hose, Radiator hoses - Testing methods for hose.

Rubber cables - Constructional Elements of Polymer Insulated Cables - Polymeric Materials for Cable Insulation - Compound Design - Manufacturing Techniques

MODULE IV PRODUCTS FOR VIBRATION DAMPING 9

Definition of Vibration and Shock - Principles of Isolation - Isolation of Vibration - Designing and Compounding for Vibration Isolation and Shock Absorption - Manufacturing Technology

Anti-vibration mounts - Role of rubber in anti-vibration mounts - Manufacturing process - Types of mounts – Applications

MODULE V RUBBER TO METAL BONDING 9

Bonding layer - Selection of bonding agents - Bonding process - Rubber molding - Rubber to metal assemblies - Elastomers of rubber metal bonding - Manufacturing methods - Testing of rubber to metal bond - Applications of rubber to metal bonding.

L – 45 ; TOTAL HOURS –45

TEXTBOOKS:

1. Richard F. Grossman, "The Mixing of Rubber", Chapman & Hall, 1997.
2. Rani Joseph, "Practical Guide to Latex Technology", Smithers Rapra Technology Ltd, 2013.
3. A.K. Bhowmick, M.M. Hall and H.A. Benaney, “Rubber Products Manufacturing Technology”, Marcel Dekker Inc, New York, 1994.
4. S. C. Bhatia and Avishek Goel, Rubber Technology – Volume I & II, Woodhead Publishing India Pvt. Ltd., 2019.

REFERENCES:

1. Blow. C.M. and Hepburn C, “Rubber Technology and Manufacture”, Butterworths, 1982.
2. C.W. Evans, “Hose Technology”, Elsevier Applied Science Publishers, 1979.

COURSE OUTCOMES:

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

CO1: demonstrate the latex products manufacturing process

CO2:describe the belt manufacturing technology

CO3: explain the concept behind hose and cable manufacturing

CO4: appreciate the fundamentals of vibration damping and rubbers employed

CO5:suggest suitable process for rubber to metal bonding

Board of Studies (BoS):

BoS of PE held on 07.02.2023

Academic Council:

20^{th} AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L	L			L		L					L		L	H	
CO2	L	L			L							L		L	H	
CO3	L	L	L					M				L		L	H	
CO4	L	L			M							L		L	H	
CO5	L	L										L		L	H	

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG – 8,9: This course aims to imbibe knowledge to develop productive employment which increases the economic growth of the country

Statement:The knowledge and skill in the understanding the materials selection, compounding improves the employability skills and improves the nation's economy.

PEDX14	**ADVANCED PROCESSING**	**L**	**T**	**P**	**C**
SDG: 8	**TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1:to introduce the advanced processing techniques

COB2:to impart knowledge of foam injection moulding

COB3:to inculcate the fundamental knowledge of gas assisted injection moulding

COB4:to develop the knowledge of thin-walled moulded components

COB5:to provide knowledge of micro injection moulded parts

MODULE I MULTICOMPONENT MOULDING TECHNOLOGIES 9

Development of multicomponent moulding technology - basic bonding mechanism – adhesion, diffusion - influences of material and process controlon the basic bonding mechanism - surface pretreatment - interface temperature – moulding sequences –different material combinations.

MODULE II FOAM INJECTION MOULDING 9

Reason for development - foaming mechanism – processing parameters - physical and chemical blowing agents - morphology of foams - properties of foams – applications.

MODULE III GASAND FLUIDINJECTION MOULDING 9

Principle of gas injection moulding - mechanisms of gas penetration – 3 phases - influencing the form and position ofthe gas bubble - surface quality - influence of material properties - git tools and machine technology – applications - variants of fluid injection technology.

MODULE IV THIN WALL MOULDING 9

Process parameters for thin wall molding – materials for thin wall moulding - processing conditions and material models on the injection pressure and flow length in thinwall parts – troubleshooting – in-mold labelling and decoration.

MODULE V MICRO INJECTION MOULDING 9

Definition of micro moulded components - design of components mouldable by micro injection moulding - mould cavity design - micro component design - moulding machine - analysis on the polymeric materials and their selection - process parameters influence on components quality and their optimization –

applications.

L – 45 ; TOTAL HOURS –45

TEXTBOOKS:

1. Hans-Peter Heim, Specialized Injection MouldingTechniques, Elsevier Inc, 2016.

REFERENCES:

1. Suhas Kulkarni, Robust Process Development and Scientific Molding, Theory and Practice, Hanser Publications, Cincinnati, 2010.

COURSE OUTCOMES:

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

CO1: appreciate the advancement in multicomponent injection moulding process

CO2: demonstrate the fundamental knowledge of foam injection moulding

CO3: explain the gas and fluid assisted injection moulding process

CO4: demonstrate thethin-walled injection moulding process

CO5:exhibit the knowledge of micro injection moulding process

Board of Studies (BoS):
BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L									M		
CO2	L				L									H		
CO3	L							M						H		
CO4	L				M									H		
CO5	L													H		

Note:L– Low Correlation M –Medium Correlation H –High Correlation

SDG 8 – learning this course helps in stable employment, economic productivity, entrepreneurship

Statement:The knowledge and skills in advanced processing helps to acquire stable employment which leads to economic productivity. The development in process engineering can foster entrepreneurial mindset

		L	T	P	C
PEDX15	**TYRE MANUFACTURING**				
SDG: 8,12	**TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To inculcate a sense of appreciation of tyres, its functions and construction

COB2: To provide fundamental knowledge ofreinforcement used in tyre manufacturing

COB3: To impart knowledge of sequences of operations involved in tyre, tube manufacturing and tyre retreading processes.

COB4: To introduce basic concept of inspection and testing of tyres

COB5: To develop knowledge of sustainable tyre development

MODULE I TYRE CONSTRUCTION AND CLASSIFICATION 9

Functions – Construction – Tyre Components and their functions, Tyre Nomenclature and Structural Dimensions, Classification of tyres based on construction, application, tube and tubeless tyres – advantages and functions.

MODULE II TYRE CORD REINFORCEMENTS 9

Tyre cords – Physical Properties of tyre–cords– Rayon, Nylon, Polyester, Fibre glass, Aramid, Steel Wire–Cord Processing – Tyre Cord Construction – Inflation pressure – contact area, tyre deflections – design factors and principles. Rolling resistance, friction, mechanical loss on tyre behavior.

MODULE III MANUFACTURING OF TYRES AND TUBES 9

Tyre manufacturing – tyre building – green tyre – curing methods – post curing inflation – finishing.

Tubes: Principles of tube design – manufacturing of tubes by extrusion, valve jamming, inflation & curing in presses, tube testing.

MODULE IV TYRE INSPECTION AND TESTING 9

Tyre visual inspection –Testing – Destructive and Non–destructive Testing of Tyres, Plunger Tests (Breaking energy), Pulley wheel test Field Tract Testing – Braking, Acceleration, mileage, Regulations, Tyre Labelling.

MODULE V SUSTAINABLE TYRES AND CIRCULAR ECONOMY 9

Green economy and its challenges– Green tyre tread technology –Silica reinforcement – Technical difficulties in using silica – Green tyre tread technology – sustainable carbon black – low rolling resistance tyres – circular economy reclaimed rubber – retreading – criteria – methods of retreading.

L –45; TOTAL HOURS –45

TEXTBOOKS:

1. A.K. Bhowmick, M.M. Hall and H.A. Benaney, "Rubber Products Manufacturing Technology", Marcel Dekker Inc, New York, 1994.
2. S. C. Bhatia and Avishek Goel, Rubber Technology – Volume I & II, Woodhead Publishing India Pvt. Ltd., 2019.

REFERENCES:

1. Blow. C.M. and Hepburn C, "Rubber Technology and Manufacture", Butterworths, 1982.
2. Tom French, "Tyre Technology", Adam Hilger, 1989.

COURSE OUTCOMES:

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

CO1: describe the construction and functions of a pneumatic tyre

CO2:explain the tyre reinforcement by wire cords

CO3: demonstrate the sequences of operations in tyre, tube manufacturing and retreading process

CO4: suggest and perform tyre test procedure

CO5:demonstrate a basic understanding of sustainable tyre development

Board of Studies (BoS):
BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L										H	
CO2	L				L										H	
CO3	L	L						M						L	H	
CO4	L				M										H	
CO5	L					L									H	

Note:L– Low Correlation M –Medium Correlation H –High Correlation

SDG 8,12: learning this course leads to productive employment and inculcate the importance of circular economy

Statement:Tyre being one of the indispensable automotive components. A sound knowledge in tyre and tube technology aids productive employment to tyre industries and usage of renewable and reuse of tyres helps in sustainable and circular economy.

PEDX16	**POLYMER WASTE MANAGEMENT AND RECYCLING**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To facilitate the students for selecting suitable recycling techniques for polymer waste.

COB2: To enable the students in designing simple techniques for the conversion of plastic waste to usable products. .

COB3: To impart knowledge on recycling engineering plastics.

COB4: To demonstrate the various techniques of recycling thermoplastics.

COB5: To acquire knowledge on recycling thermoset and rubbers.

MODULE I IDENTIFICATION AND SEPARATION 9

Plastic production and consumption - Plastic wastes generation source and types - Plastic waste composition, quantities -Plastic & environment value additions,Plastic waste management rules, Global Recycle Standard (GRS) and regulations(WMA2020) - Plastics identification methods physical, chemical and instrumental – sorting and separation technologies –disposal alternatives.

MODULE II SIZE REDUCTION AND METHODS OF RECYCLING 9

Size reduction of recycled plastics – shredding, densification, pulverization and chemical size reduction processes – Recycling of Engineering Plastics and its blends – Mechanical recycling–Chemical recycling – removal paints and plating from engineering plastics.

MODULE III RECYCLING OF THERMOPLASTICS 9

Recycling of polyolefins – HDPE bottles, HDPE Motor – oil containers, HDPE Automotive fuel tanks – LDPE Recycling – stretch film recycling - LLDPE film recycling - Polypropylene battery recycling - PET recycling - PVC recycling – Recycling of Engineering thermoplastics - PC, PBT, Nylon, PPO, ABS and polyacetals and their blends.

MODULE IV RECYCLING OF POLYMER COMPOSITES 9

Recycling of Polymer thermoset composites – Grinding processes of SMC – Chemical degradation of SMC Scrap – solvent recycling of Uncured SMC – Pyrolysis, reverse gasification of SMC scrap – Energy recovery from SMC scrap.

MODULE V RECYCLING OF ELASTOMERS 9

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 – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Michael Tolinski, “Plastics and Sustainability”, John Wiley & Sons, 201
2. Dr. Anandhan Srinivasan “Recycling of Polymer Wastes” VDM Publi 2010
3. Güneri Akovali, “Frontiers in the Science and Technology of Pc Recycling”, Springer Netherlands, 2010.
4. Manas Chanda, “Plastics Fabrication and Recycling”, CRC Press, 200
5. John Scheirs, “Feedstock recycling and pyrolysis of waste plastics”, J. & Sons, 2006.

REFERENCES:

1. Ann – Huangbertson and Samuel J.Huang, “Degradable Poly Recycling and Plastic Waste Management”, Taylor & Francis, 1995.
2. Nabil Mustafa, “Plastics Waste Management”, Marcel Dekker, 1993.

COURSE OUTCOMES:

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

CO1: Demonstrate the knowledge of various policies and legislations related to the environmental issues of plastics waste.

CO2: Select suitable recycling technology for recycling and reusing both commercial and engineering plastics..

CO3: Identify suitable methods for recycling thermoplastics.

CO4: Demonstrate the knowledge of various recycling processes for thermoset and elastomeric wastes.

CO5: Apply recycling techniques for various products and reuse the polymer recyclate.

Board of Studies (BoS):	**Academic Council:**
BoS of PE held on 07.02.2023	20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1			H													M
CO2		L											H			
CO3					M								H			
CO4					M									H		
CO5		M												H		

Note:L– Low Correlation M –Medium Correlation H –High Correlation

SDG No.9: To encourage innovation and development in recycling polymers in industry through science, technology.

Statement: The holistic understanding of polymer recycling leads to development of resilient and sustainable infrastructure and industrial diversification.

The holistic understanding of recycling reduces waste and use the resource efficiently.

PEDX 17	**PLASTICS PACKAGING TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG : 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES :

COB1: To introduce the need and importance of plastic packaging

COB2: To provide knowledge of various packaging material

COB3: To give an insight into the different types of flexible packaging systems

COB4: To impart knowledge about different processes and the importance of rigid packaging

COB5: To provide an understanding of the testing of different packaging materials

MODULE I FUNDAMENTALS OF PACKAGING 9

Definition, Functions of Packaging, Types (Primary, Secondary and Tertiary), 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, and Software

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, Polystyrene (PS), Polyvinyl Alcohol (PVOH) and Ethylene Vinyl Alcohol (EVOH), Polyester – Polyethylene Terephthalate (PET), Polyethylene Naphthalate (PEN) – Polycarbonate (PC), Fluoropolymers, Styrene-Butadiene Copolymers, Thermoplastic Elastomers : Cellophane and Cellulosic Plastics

MODULE III PACKAGING PROESS AND TYPES (FLEXIBLE AND RIGID) 15

Flexible: Manufacturing techniques: Extrusion and Extruders – Cast film, Blown Films, Stretch and Shrink wrap, Film and Sheet Co-extrusion, Co-extruders film, Laminated and coted film, Metalized film, Oriented Polystyrene film, Packaging types – Bags, Pouches, Collapsible tubes, and Bag-in-box.

Rigid: 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, and Shipping Containers, glass container, Plastic Foams – Polyolefin Foams, Polyurethane, Polystyrene, and Bio-based Foams, Thermoforming – Types – Drape, Vacuum and Pressure Forming.

MODULE IV 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, Color, Clarity, Barrier Properties.

MODULE V APPLICATION OF PACKAGING 6

Smart / Intelligent Packaging – Modified Atmospheric Packaging, Thermal Storage, Food Packaging – Shelf-Life Importance - Improvement, Medical Device Packaging - Introduction, Packaging for end use, Consumer Goods Packaging.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

(1) Institute of Packaging Professionals, Walter-Soroka, “Fundamentals of Packaging Technology”, 5th Edition, IOPP, 2014
(2) Mark J. Kirwar, “Paper and Paperboard Packaging Technology”, Blackwell Publishing, 2005
(3) Walter Stern, “Handbook of Package Design Research”, Wiley, 1st Intra Science, 1981
(4) Arthur Hirsch, “Flexible Food Packaging”, Van Nostor and Reinhold, New York, 1991
(5) Bill Stewart, “Packaging Design Strategies”, Pira International Ltd, 2nd Edition 2004
(6) Robertson G.L., Food Packaging: Principles and Practice (3rd edition, 2013), CRC Press, Taylor & Francis Group.

REFERENCES:

1. Joseph F. Hanlon, Robert J. Kelsey Handbook of Package Engineering, CRC Press, 2015
2. Fibre Box Handbook, Fibre Box Association, 2015, ISBN : 0692810862, 9780692810866
3. Aaron L. Brody and Kenneth S. Marsh, “The Wiley Encyclopedia of Packaging Technology”, 2nd Edition, Wiley, 1997
4. Walter Soroka, “Fundamentals of Packaging Technology”, 3rd Edition, Institute of Packaging Professionals, 2002
5. Athayle A.S, “Handbook of Packaging Plastics”, Multi-Tech publishing Co, 1st edition, 1999

COURSE OUTCOMES:

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

CO1: Identify the type, hazards, and recycling of packaging material

CO2: Select suitable polymer material for packaging

CO3: Evaluate the flexible packaging material and its specific applications

CO4: Know the process of making rigid packaging and its importance

CO5: Identify the suitable test method for predicting the product performance and analyze the failures in packaging material

Board of Studies (BoS):
16th BoS of Polymer Engineering held on 17.08.2023

Academic Council:
21st AC held on 20.12.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L			L									L		M	M
CO2	L			M										L	M	L
CO3		L	M	H											M	L
CO4	L	M	M	M									L	L	H	L
CO5	L	M		M											M	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : To encourage innovation in any packaging industry through science, technology, and development.

Statement: The topics covered in this course are intended to help students comprehend the various packaging materials and the necessary tests for flexible and rigid packaging. The study of diverse polymeric materials and technological innovation will help to meet the packaging requirements of a variety of industries, including the automotive and food packaging sectors.

PEDX 18	ADDITIVE MANUFACTURING TECHNOLOGY	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To study the importance of rapid prototyping and its applications in polymer industries

COB2: To understand the various tools in design for additive manufacturing

COB3: To study the SLA and SLS-type additive manufacturing techniques

COB4: To gain knowledge on fused deposition models(FDM) and selective laser melting techniques

COB5: To familiarize with various printing and beam deposition processes

MODULE I INTRODUCTION 9

Overview – Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Benefits – Materials used for additive manufacturing technology.

MODULE II DESIGN FOR ADDITIVE MANUFACTURING 9

Design tools: Data processing - CAD model preparation – Part orientation and support structure generation – Model slicing –Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – DFAM for part quality improvement -Software additive manufacturing - Model reconstruction.

MODULE III PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES 9

Photopolymerization: Stereolithography (SLA) – Equipment, working principle, Photo polymerization – Process - Advantages and Applications. Powder Bed Fusion: Selective Laser Sintering (SLS) – Equipment, Process description – Process Parameters – Typical Materials and Application.

MODULE IV EXTRUSION-BASED PROCESSES 9

Extrusion-Based System: Fused Deposition Modelling (FDM) – Equipment, Process, variables, merits and demerits, applications. Introduction – Basic Principle – Materials – Applications and Limitations – Material Jetting (MJ): Types, Process, Working principle, Applications, Advantages and Disadvantages.Selective Laser Melting (SLM): Three Dimensional Printing - Equipment, Principle, Process and its variables, advantages, and applications

MODULE V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES 9

Droplet formation technologies – Continuous mode – Drop on Demand mode – Three Dimensional Printing – Advantages – Bio-plotter - Beam Deposition Process: LENS- Process description – Material delivery – Process parameters – Materials – Benefits – Applications. Electron Beam Melting: Equipment, Principle, Process and its variables, advantages, and applications – Binder Jetting: Equipment, Principle, Process and its variables, advantages, and applications

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. Chua C.K., Leong K.F., and LIM C.S "Rapid prototyping: Principles and Applications", World Scientific publications, 3rd ed., 2010.
2. Ian Gibson, Davin Rosen, Brent Stucker "Additive ManufacturingTechnologies", Springer, 2nd Ed, 2014.
3. Hariprasad I., "Additive Manufacturing Technology", CENGAGE Publications,1st edition, 2019, ISBN: 97893500481
4. C.P Paul, .NJnoop, " Additive Manufacturing – Principles, Technologies and Applications", Mc Graw Hill publications, 2021, ISBN:13:978-93-90727-48-3

REFERENCES:

1. Andreas Gebhardt, "Understanding additive manufacturing: rapidprototyping, rapid tooling, rapid manufacturing", Hanser Publishers,2011.
2. J.D. Majumdar and I. Manna, "Laser-assisted fabrication of materials", Springer, Series in Material Science, 2013.
3. L. Lu, J. Fuh, and Y. S. Wong, "Laser-induced materials andprocesses for rapid prototyping", Kluwer Academic Press, 2001.
4. Zhiqiang Fan and Frank Liou, "Numerical modeling of the additivemanufacturing (AM) processes of titanium alloy", InTech, 2012.
5. Gibson, Rosen, Stucker, "Additive Manufacturing Technologies: RapidPrototyping to Direct Digital Manufacturing". Springer, 2009.

6. Hopkinson, Hague, Dickens, “Rapid Manufacturing: An IndustrialRevolution for the Digital Age”, Wiley, 2005.

COURSE OUTCOMES:

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

CO1: Explain the classification, applications, and benefits of additive manufacturing in polymer industries.

CO2: Create the CAD models for additive manufacturing

CO3: Elaborate on the working principles of SLA and SLS manufacturing techniques

CO4: Illustrate the principle of working of FDM and SLM techniques

CO5: Set the process parameters of 3-D printing and beam deposition methods.

Board of Studies (BoS):

16th BoS of Polymer Engineering held on 17.08.2023

Academic Council:

21st AC held on 20.12.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L			M												L
CO2		M		L												L
CO3				L												H
CO4	M	M	L	H											L	H
CO5	L			L											L	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: To support science, technology development, and innovation in any polymer industry.

The study of this course will provide the basic knowledge of additive manufacturing and 3-D printing technology, which can be used to develop new products through innovations.

SPECIALIZATION III
(Product & Mould Design)

PEDX 31	**ADVANCED MOULD MANUFACTURING TECHNIQUES**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To select the proper mould materials and metal cutting method to manufacture an injection mould.

COB2: To demonstrate advanced mould manufacturing techniques like EDM and Electroforming.

COB3: To elaborate on the working principle, metal removal rate, and the effect of process parameters of the CNC die sinking process.

COB4: To Prepare an NC Part Programming Manual for computer-aided manufacturing.

COB5: To explain the various standards used in measurement and the different types of instruments used for linear and angular measurement.

MODULE I MOULD MATERIALS 9

Introduction of mold parts, Mould material, Material selection for mould making, Properties of steels for moulds. Non-ferrous metals for molds - Zinc base alloys and aluminum alloys, Beryllium Copper, Polyesters, Epoxies, and Silicones.

MODULE II ADVANCED MOLD MANUFACTURING TECHNIQUES 9

Electrical discharge machining -Characteristics, physical processes, special technological features, types of EDM, design consideration & and functions, and technological planning. Applications of wire cut EDM in mold making. Electroforming for mold manufacturing - materials for electroforming, machining for electroformed blanks

MODULE III CNC DIE SINKING EDM 9

CNC DIE SINKING EDM: Introduction – theory of metal removal- Working Principle and Construction – Process parameters- Electrode materials and selection- Electrode Design - Dielectric fluid – Functions, requirements, and properties – Factors affecting Metal Removal Rate -Applications, advantages, and disadvantages- Programming and Manufacturing of mould elements.

MODULE IV COMPUTER-AIDED MANUFACTURING AND MEASUREMENT 9

Automated Manufacturing system; Need for 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 systems, Incremental open loop control, Incremental close loop, Absolute close loop; Control loop in contouring systems;

MODULE V ADVANCED METROLOGY 9

Standards of linear measurement, line and end standards, Interchangeability and standardization, linear and angular measurement devices, and measurement of geometric forms like straightness, flatness, and roundness. Co-ordinate measuring machine (CMM) – construction features – types – applications of CMM – Computer Aided Inspection – Machine Vision

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. P.N.Rao, "CAD/CAM Principles and Applications" - 3rd edition, Tata McGraw Hill, New Delhi, 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. P.Radhakrishnan and S.Subramanian, "CAD/CAM/CIM", 3rd edition. New Age International, New Delhi, 2009.
2. John. M. Nicholas, "Lean Production Competitive Advantage", A Productivity Press Book, 2011.
3. Anupam Saxena & B. Sahay "Computer Aided Engineering Design" Anamaya Publishers

COURSE OUTCOMES:

CO1: Select the proper mould materials and metal cutting method to manufacture an injection mould.

CO2: Demonstrate the advance mould manufacturing techniques like EDM and Electroforming.

CO3: Able to explain the working principle, metal removal rate, and the effect of process parameters of the CNC die sinking process.

CO4: Prepare an NC Part Programming Manual for computer aided manufacturing.

CO5: Able to select the standards for measurement and also able to explain the different types of instruments for linear and angular measurement.

Board of Studies (BoS):

16th BoS of Polymer Engineering held on 17.08.2023

Academic Council:

21st AC held on 20.12.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L			M	L											H
CO2	L			M												H
CO3	M	H		M				M								H
CO4	M			H												H
CO5	L			L						H						M

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation

Statement: The holistic understanding of mould materials and the manufacturing of moulds for making new plastic parts and leads to sustainable industrialization.

		L	T	P	C
PEDX32	**COMPUTER AIDED MODELING**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To make a list of computer hardware requirement for executing computer aided modeling.

COB2: To impart knowledge on various computer graphics techniques used for computer aided designing.

COB3: To explaindifferent types of geometric modeling techniques used for computer aided modeling.

COB4: To demonstrate the various techniques of drafting in computer aided modeling.

COB5: To explain the various standards followed in computer aided design

MODULE I INTRODUCTION 9

Computers in industrial Manufacturing, Product cycle, CAD/CAM Hardware, Basic structure, CPU, Memory types, input devices, display devices, hard copy devices, and Storage devices.

MODULE II FUNDAMENTALS OF COMPUTER GRAPHICS 9

Computer Graphics - Raster scans graphics coordinate system - database for graphics modeling - transformation of geometry – 2D and 3D transformations - mathematics of projections, clipping, and hidden surface removal.

MODULE III GEOMETRIC MODELLING 9

Representation of curves- Hermite curve, Bezier curve, and B-spline curves - surface modeling – surface Entities, Representation of surface, Bezier surface, B-spline surfaces, and Coons surface - Solid modeling - Solid Entities, Solid Representation, Boundary Representation (B-Rep), Sweeps Representation, and Constructive Solid Geometry (CSG).

MODULE IV PART ASSEMBLY 9

Mass properties - Assembly modeling – Inference of position and orientation –Geometric Dimensioning and Tolerance – Functional importance of various types of fits, Geometrical dimensioning and Tolerancing.

MODULE V CAD STANDARDS 9

Standards for computer graphics- Graphical Kernel System (GKS) - Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, ACIS and DXF - communication standards

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. P.N.Rao, "CAD/CAM Principles and Applications" - 3rd edition, Tata McGraw Hill, New Delhi, 2010.
2. Ibrahim Zeid, R.Siva Subramanian, "CAD/CAM Theory and Practice" - 2nd edition, Tata McGraw Hill, 2009.

REFERENCES:

1. P.Radhakrishnan and S.Subramanian, "CAD/CAM/CIM", 3rd edition. New Age International, New Delhi, 2009.
2. John. M. Nicholas, "Lean Production Competitive Advantage", A Productivity Press Book, 2011.

COURSE OUTCOMES:

At the end of the course, the students will be

CO1: Able to prepare a list of computer hardware requirement for executing computer aided modeling.

CO2: To demonstrate the knowledge on various computer graphics techniques used for computer aided designing.

CO3: To explain different types of geometric modeling techniques used for computer aided modeling.

CO4: To demonstrate the various techniques of drafting in computer aided modeling.

CO5: Able to explain the various CAD standards and communication systems.

Board of Studies (BoS):	**Academic Council:**
BoS of PE held on 07.02.2023	20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H				L										M	H
CO2	H														M	H
CO3	H	H						M							L	H
CO4	H														L	H
CO5	H									H					M	H

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: The students will be able to design new products and able to assemble the various parts using computers which leads to develop resilient infrastructure and sustainable industrialization.

PEDX 33	**COMPUTER AIDED**	**L**	**T**	**P**	**C**
SDG: 09	**MANUFACTURING**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To list out the basic computer hardware required for computer aided manufacturing.

COB2: To draw the structure of an NC and CNC machine and to schedule the CNC part programming.

COB3: To prepare a production planning for material requirement and manufacturing resources.

COB4: To Evaluate the benefits of computer integrated manufacturing in industrial applications.

COB5: To classify the various types of robots for industrial applications and the type of sensors used in robots.

MODULE I INTRODUCTION 9

Computers in industrial Manufacturing - Product cycle - CAD/CAM Hardware - Basic structure - CPU, Memory types, input devices, display devices, hard copy devices, and storage devices.

MODULE II COMPUTER AIDED MACHINING 9

Numerical control - NC modes, NC elements, NC machine tools - structure of CNC machine tools, features of machining center, turning center, - CNC part programming - fundamentals, manual part programming methods

MODULE III COMPUTER AIDED PRODUCTION PLANNING 9

Part family - coding and classification, production flow analysis, advantages and limitations - Computer Aided Process Planning - Etrival type and generative type - Material requirement planning.

MODULE IV FLEXIBLE MANUFACTURING SYSTEMS 9

Flexible manufacturing systems - FMS equipment, system layouts, FMS control - CIM: Integration - CIM implementation, major functions in CIM, Benefits of CIM, Lean manufacturing, and Just-in-time.

MODULE V INDUSTRIAL ROBOTICS 9

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. P.N.Rao, “CAD/CAM Principles and Applications” - 3rd edition, Tata McGraw Hill, New Delhi, 2010.
2. Ibrahim Zeid, R.Siva Subramanian, “CAD/CAM Theory and Practice” - 2nd edition, Tata McGraw Hill, 2009.

REFERENCES:

1. P.Radhakrishnan and S.Subramanian, “CAD/CAM/CIM”, 3rd edition. New Age International, New Delhi, 2009.
2. John. M. Nicholas, “Lean Production Competitive Advantage”, A Productivity Press Book, 2011.

COURSE OUTCOMES:

At the end of the course, the students will be

CO1: Able to prepare a list of hardware requirement for computer aided manufacturing

CO2: Able to draw the structure of NC and CNC machine and explain the parts of these machines

CO3: Able to prepare a production planning for material requirement and manufacturing resources.

CO4: Able to predict the benefits of computer integrated manufacturing in industrial applications.

CO5: Able to classify the various types of robots in industrial applications and the different type of sensors used in robotics.

Board of Studies (BoS): BoS of PE held on 07.02.2023

Academic Council: 20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	L			L										L	H
CO2	M														L	H
CO3	L	H						M							M	H
CO4	H															H
CO5	H	L								H						H

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: The students will be able to select the type of machining operations and manufacture a mould which leads to develop resilient infrastructure and sustainable industrialization.

PEDX 34 SDG: 09	FAILURE ANALYSIS OF POLYMERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

COB1: To identify the weaknesses of failure in plastic products.

COB2: To interpret the failure of plastic products due to environmental stress cracking.

COB3: To predict the failure of plastic materials due to thermo – oxidation issues.

COB4: To evaluate the failure of plastic materials due to chemical attacks.

COB5: To identify the mechanisms of degradation in plastic parts

MODULE - I TYPES OF FAILURE ANALYSIS 9

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, and tools to Failure Analysis. Case Studies. Mechanical failures of plastic parts – microstructure root cause analysis.

MODULE - II FAILURE DUE TO ENVIRONMENTAL STRESS CRACKING 9

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-molded polyvinyl chloride bottles

MODULE - III FAILURE DUE TO THERMO - OXIDATION 9

The influence of polymer chemistry, the efficacy of stabilizing additives, the influence of stress, Oxidising medium. Case studies: Low-density polyethylene insulation covers, Rubber expansion joints, Vehicle tires, Lift pump diaphragms, Acrylic bulkhead light covers, and Flexible hose.

MODULE - IV FAILURE DUE TO CHEMICAL ATTACK 9

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.

MODULE - V FAILURE DUE TO DEGRADATION 9

Degradation mechanisms, radiation resistance of polymers, the performance of specific materials, and specific examples

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. David Wright “Failure of Plastics and Rubber Products”,Rapra Technology Limited,2006
2. Friedrich Kurr, “Handbook of Plastic Failure Analysis”,Hanser Publication, 2014

REFERENCES:

1.John Maolli, “Plastic Failure Analysis and Prevention”, Society of Plastic Engineers, Plastic Design Library, 2001

COURSE OUTCOMES:

At the end of the course, students will be

CO1: Able to identify the weaknesses of failure in plastic products.

CO2: Able to interpret the failure of plastic products due to environmental stress cracking.

CO3: Able to predict the failure of plastic materials due to thermo – oxidation issues.

CO4: Able to evaluate the failure of plastic materials due to chemical attack.

CO5: Able to identify the various degradation mechanisms in plastic parts

Board of Studies (BoS):
BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M				L											M
CO2																H
CO3		H						M								
CO4			L													H
CO5										H						H

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation

Statement: Able to analyze the failure of plastic and rubber components and it helps to innovate new components

		L	T	P	C
PEDX35	**AUTOMATION IN POLYMER INDUSTRIES 4.0**				
SDG: 8,9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To introduce the need for digital transformation in industries

COB2: To inculcate the fundamental knowledge of IoT and I4.0

COB3: To develop the knowledge of automation in polymer process industries

COB4: To provide knowledge of advancement in drives and control system for robots

COB5: To introduce the applications of automation in process industries

MODULE I UNDERSTANDING DIGITAL TRANSFORMATION 9

Introduction to digital transformation - transformation and the basic challenges - smart factories, smart and secure networks, big data and internet of things - mobile systems - cyber-physical system

MODULE II DIGITALIZATION IN INDUSTRY IoT AND INDUSTRY 4.0 9

Background and Current Situation - Industry 4.0 and the IoT: Strengths and Weaknesses - Main Applications and Sectors of the IoT - Future Scenarios of the IoT - Case Studies of the IoT - Manufacturing Industry, Automotive Industry, Healthcare Industry.

MODULE III AUTOMATION IN POLYMER PROCESSING 9

Definition of automation and its necessarily - History of Robots in Plastics Injection Moulding - Robots and Flexibility - Robot Configurations - Sprue Pickers, Top-Entry, Traverse-Type Robots, Side-Entry, Linear-Drive Robots, Articulated Robots, Combination Cells

MODULE IV ADVANCES IN DRIVES AND CONTROLS 9

Drives - Pneumatic Drives, Electric Drives, Combination Drives – Controls - Operator Interfac, Sequence Programmability, Expandability, Communications and Controller Integration - Integration of Automation Systems - Requirements for Phase III and IV Integration - Implementation of Phase III and IV Automation

MODULE V APPLICATIONS IN PROCESS INDUSTRIES 9

Design Criteria for Higher Levels of Automation - Applications - Small Machines, Cells that Extend Production Hours Without Labour, Automated Packaging with Manual Value-Added Operations, In-Mould Decorating, Insert Moulding, Two-Component Moulding.

L – 45 ; TOTAL HOURS –45

TEXT BOOKS:

1. J.M. Mallon, Advances in Automation for Plastics Injection Moulding, Rapra Review Reports, 2001.
2. Antonio Sartal, Diego Carou, and J. Paulo Davi, Enabling Technologies for the Successful Deployment of Industry 4.0, CRC Press, 2020
3. Ibrahim H. Garbie and Hamid R. Parsaei , Reconfigurable Manufacturing Enterprises for Industry 4.0, CRC Press, 2022

REFERENCES:

1. Anand Nayyar, Akshi Kumar, A Roadmap to Industry 4.0: Smart Production, Sharp Business and Sustainable Development, Springer Nature Switzerland AG, 2020.

COURSE OUTCOMES:

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

CO1: appreciate the digital transformation in industries

CO2: demonstrate the fundamental knowledge of IoT and I4.0

CO3: explain the implication of automation in polymer process industries

CO4: demonstrate theadvancement in drives and controls for robots

CO5: appreciate the applications of automation in manufacturing industries

Board of Studies (BoS):
BoS of PE held on 07.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				M							L			H	
CO2	L				M							L			H	
CO3	L				M			M				L			H	
CO4	L				M							L			H	
CO5	L				M							L			H	

Note:L– Low Correlation M –Medium Correlation H –High Correlation

SDG 8, 9 – automation leads to proper usage of information and communication technologies, being a new field creates new job market in polymer processing industries

Statement:A sound knowledge in the I 4.0 leads to effective utilization of ICT and improvement in the process and products leads to reduction in scraps and improves production. This being a emerging field in the polymer industries a deep understanding the technology leads to entrepreneurship there by create jobs.

SPECIALIZATION IV
(Composites, Adhesives and Coatings)

PEDX 41	MECHANICS OF COMPOSITES	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the basics of the macro mechanical behavior of a lamina.

COB2: To communicate the fundamentals of the micro behavior of composite lamina

COB3: To impart knowledge on the basics of the macro behavior of laminate.

COB4: To design the joints to transmit mechanical loads by composites

COB5: To emphasize the use of failure theories in composite design

MODULE I MACRO MECHANICAL BEHAVIOUR OF LAMINA 9

Stress-strain relations for anisotropic materials, stiffness, compliances, and engineering constants for orthotropic materials, elastic constants of isotropic and orthotropic material, and stress-strain relations for plane stress in an orthotropic material. Introduction to integration of computational material engineering.

MODULE II MICRO MECHANICAL BEHAVIOUR OF LAMINA 9

Mechanics of material approach to stiffness, 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 9

Classical lamination theory, laminate code, symmetric laminates, theoretical and experimental angle–ply laminate stiffness, anti-symmetric laminates, non-symmetric laminates, balanced laminates, quasi-isotropic laminates.

MODULE IV JOINING OF COMPOSITES AND THEIR FAILURE 9

Adhesive bonding – Science of adhesive bonding – mechanical theory, adsorption theory, electrostatic and diffusion theory, theoretical stress analysis of bonded joints, the failure mode of bolted joints, and preparation and design parameters of bolted joints.

MODULE V FAILURE THEORIES 9

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 – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Robert Jones, ”Mechanics of Composite Materials”, McGraw Hill Company, New Delhi, 1998
2. P.K.Mallick, “Fiber Reinforced Composite”, Marcel Deckar,1988
3. Autar K.Kaw, “Mechanics of Composite Materials”, CRC Press, 2005.
4. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, “Analysis and Performance of Fiber Composites,3rd edition, John Wiley & Sons, 2006.

REFERENCES:

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

COURSE OUTCOMES:

Students will be able to

CO1: Able to analyze the stress – strain behavior of anisotropic and orthotropic materials.

CO2: Able to apply the strength and stiffness approach of composite mechanics

CO3: Able to apply the classical laminate theory in symmetric and non-symmetric laminates

CO4: Able to design bonded and mechanical joints of plastic composites

CO5: Able to predict the failure of plastic composites by using various failure theories.

Board of Studies (BoS):	**Academic Council:**
BoS of PE held on 07.02.2023	20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1					L											H
CO2	M														L	H
CO3	M	H						M							L	M
CO4	L															M
CO5	H									H					M	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement: The overall understanding of developing new lighter materials using the mechanics and various failure analysis in design of the new products leads to the construction of resilient infrastructure and sustainable industrialization.

PEDX 42	**ADHESIVES AND SURFACE**	**L**	**T**	**P**	**C**
SDG: 9	**COATING TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To impart knowledge on various theories of adhesion

COB2: To provide knowledge on adhesives types

COB3: To introduce the surface preparation methods for adhesive joints

COB4: To provide an understanding on the surface coatings

COB5: To emphasize the applications of paints.

MODULE I INTRODUCTION TO ADHESIVES 9

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 9

Adhesives types: Structural adhesives, Urethane structured adhesives, Modified acrylic structural adhesives, phenolic adhesives and modifiers, anaerobic adhesives, cyanoacrylate adhesives, Hot melt adhesives, pressure sensitive adhesives, RTV Silicone adhesives, sealants, water based adhesives. Specialty adhesives, adhesives in aerospace, adhesive in automobile industry, conductive adhesives, adhesives in building construction, adhesive in electrical industry.

MODULE III JOINT DESIGN 8

Joint design: Stress, types of joints, selection of joint detail, joint criteria, surface preparation of adherents – metals, plastics and rubbers. Adhesive bonding process – methods for adhesives application and bonding equipment, adhesives for specific substrates, testing of adhesives, adhesive specifications and quality control.

MODULE IV INTRODUCTION TO SURFACE COATINGS 9

Introduction to surface coatings: Components of paints, Pigments, pigment properties, different types, extenders, solvents, oils, driers, diluents, lacquers, varnishes, paint preparation, formulation, factors affecting pigment dispersion, preparation of pigment dispersion.

MODULE V SURFACE COATING METHODS 10

Paints - Surface preparation and paint application: Paint properties and their evaluation – mechanism of film formation – Different types of paints – classification based on polymeric resin, emulsion, oil and alkyd paints, acrylic paints – Coatings - epoxy coatings, polyurethane, silicones, formaldehyde based resins, chlorinated rubbers, hydrocarbon and other resins-Classification based on application - appliance furnishes, automotive finishes, coil coatings, can coatings, marine coatings, aircraft coatings. factors affecting coating – properties of coatings - powder coatings - fluidized bed, electrostatic fluidized bed, electrostatic spray, vacuum deposition and cathodic electro deposition.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Arthur Landrock, “Adhesion Technology Handbook”, Applied Science Publishers, 2009.
2. Gerald L. Schreberger, “Adhesive in manufacturing”, Marcel Dekker Inc., New York, 1983.
3. W.C. Wake, “Adhesion and the formulation of adhesives” Applied Science Publishers, London, 1976.
4. Swaraj Paul, “Surface Coatings”, John Wiley & Sons, NY, 1985.

REFERENCES:

1. George Mathews, “Polymer Mixing Technology”, Applied Science Publishers. London, 1982.
2. Sheilds, “Hand book of adhesives”, Butterworth’s, 1984.

COURSE OUTCOMES:

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

CO1: Illustrate basic concepts ,various types and requirement of adhesives

CO2: Suggest suitable adhesives and joint design for specific applications

CO3: Select appropriate coatings for specific applications

CO4: Identify the defect in coatings and suggest suitable solutions

CO5: Identify relevant surface preparation method and application techniques based on the coatings selected.

Board of Studies (BoS):

16th BoS of Polymer Engineering held on 17.08.2023

Academic Council:

21st AC held on 20.12.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L				L									M		M
CO2	L				L									H		L
CO3								M						H		L
CO4					M									H		H
CO5														H		

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG No.9: To encourage innovation in Adhesives through science, technology, and development.

Statement: The topics covered in this course are intended to help students comprehend surface coating techniques. The study of diverse polymeric materials and technological innovation will help to satisfy the need of Adhesives and surface coatings in various applications.

PHYSICS ELECTIVE

PHDX 01	**NON DESTRUCTIVE TESTING OF MATERIALS**	**L**	**T**	**P**	**C**
SDG: 4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To understand the importance, principle, concept and inspection methods of various surface NDT methods and develop the skills of interpretation of results effectively.

COB2: To study the working and instrumentation of thermography and eddy current testing methods and apply to interpret the results and investigate the possible defects.

COB3: To get full exposure about principle, instrumentation and standards of various radiographic NDT methods and improve the skill to identify the defects suitably.

COB4: To get deep insight into the principle, types of waves, instrumentation, standards, calibration methods of ultrasonic NDT methods.

COB5: To understand the importance, principle, concept and inspection methods of various surface NDT methods and develop the skills of interpretation of results effectively.

MODULE I SURFACE NDT METHODS 7

Liquid Penetrant Inspection – Principles, Types of dye and methods of application,developers, advantages and limitations of various methods, Interpretation of results. Magnetic Particle Inspection- Magnetic particle testing, Basic theory of magnetism, Magnetization methods, Interpretation of field indicators, Particle application, Inspection,Residual magnetism Principles and methods of demagnetization.

MODULE II THERMOGRAPHY AND EDDY CURRENT TESTING 7

Thermography- Principles, Contact and non contact inspection methods, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Applications, advantages, Limitations, Interpretation/Evaluation.

MODULE III RADIOGRAPHY 8

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square law, characteristics of films -graininess, density, speed, contrast, characteristic curves. Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Digital Radiography.

MODULE IV ULTRASONIC TESTING 8

Ultrasonic Testing: Basic principles of sound propagation, types of sound waves, Principle of UT, methods of UT, their advantages and limitations, Piezoelectric Material, Various types of transducers/probe, Calibration methods, use of standard blocks, technique for normal beam inspection.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. ASM Metals Handbook,Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, 2018.
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.

REFERENCES:

1. Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age International Publishers, 2010.
2. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition New Jersey, 2005.
3. Charles, J. Hellier, Handbook of Nondestructive evaluation, McGraw Hill, New York 2001.
4. B.P.C. Rao, Practical Eddy Current Testing, Alpha Science International Limited (2006).

COURSE OUTCOMES:

CO1: Demonstrate the importance, principle, concept and inspection methods of various surface NDT methods and apply the same to interpret the results effectively.

CO2: Comprehend the ideas behind working of thermography and eddy current testing methods and apply them to interpret the results of testing and analyse the defects and problem.

CO3: Grasp the fundamental principles, and standards of various radiographic NDT methods and utilise them to identify the defects and defect location suitably.

CO4: Assimilate the ideas concerning the principle, types of waves, instrumentation, standards, calibration methods of ultrasonic NDT methods and identify the areas for their application.

Board of Studies (BoS) :
BOS of Physics was held on 21.6.21

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	L	M	L	M	M	M	L	L	L	M	-	-	-
CO2	M	L	M	H	L	M	H	M	L	L	L	M	-	-	-
CO3	L	M	H	H	L	H	M	M	L	H	L	M	-	-	-
CO4	M	L	H	M	L	M	M	H	L	M	L	M	-	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement: The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

PHDX 02	**MATERIALS SCIENCE FOR ENGINEERING**	**L**	**T**	**P**	**C**
SDG: 4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To impart knowledge on the fundamentals of materials science and engineering.

COB2: To provide a basis for understanding properties and applications of dielectric materials.

COB3: To expose the students to different classes of materials, their properties, structures and imperfections

COB4: To aid the teaching learning process through relevant illustrations, animations, web content and practical examples

MODULE I CLASSIFICATION OF MATERIALS 6

Concept of amorphous, single crystals and polycrystalline materials, crystallinity and its effect on physical properties, metal, ceramic, polymers, classification of polymers, structure and properties, additives for polymer products, effect of environment on materials, composites

MODULE II PROPERTIES OF MATERIALS 10

Mechanical Properties: Stress-strain response of metallic, ceramic and polymer materials, yield strength, tensile strength and modulus of elasticity, toughness, plastic deformation, fatigue, creep and fracture- Electronic Properties:Free electron theory, Fermi energy, density of states, band theory of solids, semiconductors, Hall effect, dielectric behaviour, piezo, ferro, pyroelectric materials - Magnetic Properties: Origin of magnetism in metallic and ceramic materials, para-magnetism, diamagnetism, ferro and ferrimagnetism- Thermal Properties: Specific heat, thermal conductivity and thermal expansion, thermoelectricity- Optical Properties: Refractive index, absorption and transmission of electromagnetic radiation in solids, electro-optic and magneto-optic materials.

MODULE III CRYSTALLOGRAPHIC STRUCTURES AND IMPERFECTIONS 7

Crystal symmetry, point groups, space groups, indices of planes, close packing in solids, bonding in materials, coordination and radius ratio concepts, point defects, dislocations, grain boundaries, surface energy and equilibrium shapes of crystals.

MODULE IV THERMODYNAMICS AND KINETICS 7

Phase rule, phase diagrams, solid solutions, invariant reactions, lever rule, basic heat treatment of metals, solidification and phase transformations, Fick's laws of diffusion, mechanisms of diffusion, temperature dependence of diffusivity.

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1. Nanotechnology: An introduction to nanostructuring techniques by Michael Köhler and Wolfgang Fritzsche, Wiley-VCH; 2Rev Ed edition, 2007.

REFERENCES:

1. William D. Callister, Jr., David G. Rethwisch, Materials Science and Engineering, Edition 9, Wiley, 2014.
2. Michael F. Ashby, David R.H. Jones , Engineering Materials 1 An Introduction to Properties, Applications and Design · Volume 1, Elsevier Science, 2012
3. Michael F. Ashby, David R.H. Jones , Engineering Materials 2: An Introduction to Microstructures, Processing and Design · Volume 2, Elsevier Science, 2013
4. Reza Abbaschian, Robert E. Reed-Hill, Physical Metallurgy Principles - SI Version, Cengage Learning, NY, 2009
5. "Encyclopedia of Polymer Science and Technology" 3rd Edition, Vol.1-12, Wiley Interscience , 2003

COURSE OUTCOMES

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

CO1: select suitable material for specific application.

CO2: analyse crystallographic structure of metals and their imperfections.

CO3: develop metal alloys with varying properties by selecting suitable heat treatment

CO4: correlate the various properties of material with their structure.

Board of Studies (BoS) :	**Academic Council:**
BOS of Physics was held on 21.6.21	17th AC held on 15.07.2021

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	L	M	L	M	M	M	L	L	L	M	-	-	-
CO2	M	L	M	H	L	M	H	M	L	L	L	M	-	-	-
CO3	L	M	H	H	L	H	M	M	L	H	L	M	-	-	-
CO4	M	L	H	M	L	M	M	H	L	M	L	M	-	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

PHDX 03	**BIOMATERIALS**	**L**	**T**	**P**	**C**
SDG: 4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1:To gain basic knowledge in classification of biomaterials and their properties.

COB2:To provide a basis for understanding properties of metallic implant materials.

COB3:To enable the students to correlate theoretical principles with practical applications.

COB4:To help students understand biocompatibility & toxicological screening of biomaterials

MODULE I INTRODUCTION TO BIOMATERIALS 8

Introduction: Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Surface properties of materials, physical properties of materials, mechanical properties-Materials for biophotonic applications.

MODULE II IMPLANT MATERIALS 10

Metallic implants: Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion-ceramic implants : bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics-Polymer implants: Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin.

MODULE III BIOCOMPATIBILITY AND TOXICOLOGICAL SCREENING OF BIOMATERIALS 6

Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situ-implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.

MODULE IV PRACTICAL ASPECTS OF BIOMATERIALS 6

Preparation of biomaterials - Microscopic study & analysis of different biomaterials- alginate – material preparation and characterization - Testing of various biomaterials- case studies on industrial and clinical applications of biomaterials.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill, 2003
2. Monika Saini, Yashpal Singh, Pooja Arora, Vipin Arora, and KratiJain. Implant biomaterials: A comprehensive review, World Journal of Clinical Cases, 2015.

REFERENCES:

1. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, Introduction to Biomedical Engineering, Elsevier, 2005.
2. Park J.B., Biomaterials Science and Engineering, Plenum Press, 2007.
3. A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran,Woodhead Medical Textiles and Biomaterials for Healthcare, Publishing Limited 2006.
4. D F Williams, Materials Science and Technology: Volume 14, Medical and Dental Materials: A comprehensive Treatment Volume, VCH Publishers 1992.

COURSE OUTCOMES:

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

CO1: differentiate common use of biomaterials as metals, ceramics, polymers and apply them to classify its chemical structure, properties and morphology.

CO2: comprehend ideas involving general properties of implant materials and apply the same to identify the benefits of implant materials.

CO3: attain knowledge about the biocompatibility & toxicological screening ofbiomaterials and realize its usage in real life.

CO4: reflect upon the practical ideas of using biomaterials

Board of Studies (BoS) :

BOS of Physics was held on 21.6.21

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	L	M	L	M	M	M	L	L	L	M	-	-	-
CO2	M	L	M	L	L	M	M	M	L	L	L	M	-	-	-
CO3	M	L	H	H	L	H	M	M	L	H	L	M	-	-	-
CO4	M	L	H	M	L	M	M	M	L	M	L	M	-	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement: The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

PHDX 04	OPTICAL FIBRE COMMUNICATION	L	T	P	C
SDG: 4		2	0	0	2

COURSE OBJECTIVES:

COB1:To facilitate the knowledge about optical fibres and its transmission characteristics.

COB2:To make the students to learn about LED and laser diodes.

COB3:To make the students understand the various types of optical Receiversand sensors.

COB4: To enrich the knowledge on optical amplifiers and networks.

MODULE I INTRODUCTION TO OPTICAL FIBRES 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.

MODULE II FIBER OPTICAL SOURCES 7

Light Emitting Diodes (LED) – power and efficiency - double hetero LED – LED structure - LED characteristics – Semiconductor Lasers diode, Homojunction and Heterojunction laser diodes - Optical processes in semiconductor lasers - applications.

MODULE III FIBER OPTICAL RECEIVERS AND SENSORS 8

Photo detectors - photodiodes - phototransistors - noise characteristics - PIN diode Avalanche Photodiode (APD) characteristics - APD design of detector arrays – Charged Couple Device - Solar cells - Materials and design considerations, Thin film solar cells, amorphous silicon solar cells - Fiber optic sensors: Intrinsic and Extrinsic sensors, amplitude, phase, wavelength and polarization modulation.

MODULE IV OPTICAL AMPLIFIERS AND NETWORKS 8

Optical amplifiers, Semiconductor optical amplifiers, Erbium-doped fiber amplifiers - Optical Networks: Basic networks, SONET/SDH, WDM Networks, Nonlinear effects on network performance, Performance of WDM + EDFA systems, Solitons, Optical CDMA, Ultrahigh capacity networks.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Gerd Keiser, Optical Fiber Communication, 3rd Edition, McGraw-Hill International, Singapore, 2013.

REFERENCES:

1 Govind P. Agrawal, Fiber-Optic Communication Systems (Wiley Series in Microwave and Optical Engineering) , Wiley 4th Edition, 2010.
2 J. Senior, Optical Communication, Principles and Practice, Prentice Hall of India, 3rd Edition, 2010.
3 D. C. Agrawal, Fiber Optic Communication, S.Chand& Co Ltd., 2005.
4 Rajiv Ramaswami, KumarSivarajan, Galen Sasaki, Optical Networks: A Practical Perspective, 3rd Edition, Morgan Kaufmann, 2009.
5 B. Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd, 2014.

COURSE OUTCOMES:

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

CO1: realize basics of optical fiber and differentiate various modes and configurations.

CO2: understand and assimilate the working principle of LED and Diode Laser.

CO3: select suitable photodetectors/sensorsfor different types of applications.

CO4: analyze the mechanism of optical amplifiers and analyze optical networks.

Board of Studies (BoS) :

BOS of Physics was held on 21.6.21

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	L	M	L	M	M	M	L	L	L	M	-	-	-
CO2	M	L	M	H	L	M	H	M	L	L	L	M	-	-	-
CO3	L	M	H	H	L	H	M	M	L	H	L	M	-	-	-
CO4	M	L	H	M	L	M	M	H	L	M	L	M	-	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement: The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

PHDX 05	SEMICONDUCTOR PHYSICS FOR INFORMATION TECHNOLOGY	L	T	P	C
		2	0	0	2

SDG: 4

COURSE OBJECTIVES:

COB1: To study about electronic states of semiconductors.

COB2: To understand the physics of semiconductor devices

COB3: To gain knowledge on various methods involved in nanofabrication of semiconductor devices

COB4: To study the working principle of optoelectronic devices and various display devices

MODULE I ELECTRONIC STATES OF SEMICONDUCTORS 8

Energy bands in solids – Dynamics of electrons in periodic potential: Kronig – Penny model – Direct and Indirect Bandgaps – Brillouin Zone – Energy band structure in semiconductors (ZnO, GaAs) – concept of effective mass of electron and concept of holes.

MODULE II INTRODUCTION TO SEMICONDUCTOR DEVICES 6

Semiconductors: N and P type (Qualitative), PN junction diode under forward and reverse bias –– Zener diode, Schottky diode – Tunnel diode –bipolar junction transistor (BJT) - metal–oxide–semiconductor field-effect transistor (MOSFET), CMOS.

MODULE III DEPOSITION TECHNIQUES OF SEMICONDUCTING MATERIALS 6

Deposition of Semiconductor thin films – molecular beam epitaxy (MBE), chemical vapour deposition (CVD), pulsed laser deposition (PLD),magnetron sputtering, Types of lithography: Photo/ultraviolet /Electron-beam/Focused ion beam, Dip pen nanolithography, Etching process :Dry and Wet etching

MODULE IV OPTOELECTRONIC DEVICES 10

Light Emitting Diodes (LED) - double hetero LED structure - LED characteristics - White LED – Applications, Semiconductor Lasers, Homojunction and Heterojunction laser diodes - Optical detection – PIN and avalanche photodiodes, Luminescence, Cathode Luminescence, Electro Luminescence, Transparent Conductors, Liquid crystal displays – Dynamic scattering and Twisted nematic display, Charge-coupled devices (CCD)

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1) W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate(Eds.), Handbook of NanoScience, Engg. and Technology, CRC Press, 3rd Edition, 2018
2) Chris Mack, Fundamental Principles of Optical Lithography: The Science of Microfabrication, Wiley, 2008
3) D. S. Dhaliwal et al., Prevail :Electron projection technology approach for next-generation lithography, IBM Journal Res. & Dev. 45, 615, 2001.

REFERENCES:

1. V.K. Mehta, Rohit Mehta, Principles of Electronics (Multicolour Edition) S. Chand Publishers, 10th Rev. Edn. 2006 Edition
2. Albert Malvino, David J. Bates Electronic Principles (SIE), McGraw Hill, 7th Edition, 2017
3. U. Mishra, J. Singh, Semiconductor Device Physics and Design, Springer, 2014
4. S.M. Sze, Kwok K. Ng, Physics of Semiconductor Devices, Wiley Publishers, 3ed 2008.
5. Bhattacharya Pallab, Semiconductor Optoelectronic Devices, Second Edition, By Pearson 2017
6. Joseph A. Castellano, Handbook of Display Technology, Springer, 1992
7. Yoshio Nishi, Advances in Non-volatile Memory and Storage Technology, Elsevier 2014

COURSE OUTCOMES:

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

CO1: study about electronic states of semiconductors.

CO2: understand the physics of semiconductor devices and identify its significance towards information technology (IT).

CO3: gain insight into various fabrication techniques towards the realization of nano-dimensional semiconductor devices.

CO4: attain knowledge on working principles of optoelectronic devices and display technologies and can recognize their importance in commercial applications.

Board of Studies (BoS) :
13th BoS of Physics held on 14.09.2023

Academic Council:
21st AC held on 20.12.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	L	M	L	M	M	M	L	L	L	M	M	M	M
CO2	M	L	M	H	L	M	H	M	L	L	L	M	M	M	M
CO3	L	M	H	H	L	H	M	M	L	H	L	M	M	M	M
CO4	M	L	H	M	L	M	M	H	L	M	L	M	M	M	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

		L	T	P	C
PHDX 06	**SENSORS AND ACTUATORS**				
SDG: 4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1:To understand the basic concept of measurements and sensors

COB2:To avail knowledge on variable resistance, capacitance and Inductance sensors.

COB3: To study about special sensors.

COB4: To get introduced towards MEMS technology and various actuators.

MODULE I INTRODUCTION TO MEASUREMENTS AND SENSORS 8

Sensors: functions – main technical requirement and trends, units and trends – calibration methods – classification of errors – error analysis – limiting error – probable error – propagation of error – odds and uncertainity – principle of transduction – classification: static and dynamic characteristics – mathematical model of transducers: zero, first and second order transducers.

MODULE II VARIABLE RESISTANCE, CAPACITANCE AND INDUCTANCE SENSORS 8

Characteristics and operation of resistive potentiometers – resistive pressure sensor – resistive position sensor - strain gauges: types, gauge factor calculation – resistive thermometer – thermistor Capacitive pressure sensor, Inductive sensor: Change in self-inductance with number of turns, change in self-inductance with change in permeability – inductive pressure transducer – inductive position transducer, LVDT – piezo resistive sensors.

MODULE III SPECIAL SENSORS 7

Photoconductors – optical detectors -photodiodes, phototransistors – charge coupled device (CCD) – Fabry Perot sensor - Hall effect – magneto resistive, magneto strictive sensors – microphones: resistive, capacitive, Fiber optic – thermocouple.

MODULE IV MICROSYSTEMS AND ACTUATORS 7

Microelectro-mechanical systems (MEMS), Micro fabrication and Applications, micro actuators– actuation principle, shape memory actuator: one way, two way and pseudo elasticity – types of micro actuators – electrostatic, inverse piezoelectric effect – Solid-state switches, relays Solenoids, D.C. Motors, A.C. Motors, Stepper motors.

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1. Jacob Fraden, Hand Book of Modern Sensors: physics, Designs and Applications, 3rd edition, Springer, New York, 2015.
2. Jon. S. Wilson, Sensor Technology Hand Book, 1st edition, Elsevier, Netherland, 2011.
3. John G Webster, Measurement, Instrumentation and sensor Handbook, 2nd edition, CRC Press, Florida, 2014.

REFERENCES:

1. W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate (Eds.), Handbook of NanoScience, Engg. and Technology, CRC Press, 3rd Edition, 2018
2. Chris Mack, Fundamental Principles of Optical Lithography: The Science of Microfabrication, Wiley, 2008
3. D. S. Dhaliwal et al., PREVAIL :Electron projection technology approach for next-generation lithography, IBM Journal Res. & Dev. 45, 615, 2001.
4. Tai-Ran Hsu, MEMS & Microsystem, Design and Manufacture, 1st ed., McGraw Hill India, New Delhi, 2017.
5. MassoodTabibArar, Microactuators – Electrical, Magnetic Thermal, Optical, Mechanical, Chemical and Smart structures, 1st ed., Kluwer Academic publishers, New York, 2014.

COURSE OUTCOMES:

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

CO1: get exposed to the basics of measurements and sensors

CO2: familiarize towards variable inductance, capacitance and resistance sensors and recognize their importance in commercial applications.

CO3: gain knowledge about special sensors and their applications.

CO4:apply the ideas to conceptualize MEMS technology and different actuators in engineering field

Board of Studies (BoS) :
13th BoS of Physics held on 14.09.2023

Academic Council:
21st AC held on 20.12.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

CO1	M	L	L	M	L	M	M	M	L	L	L	M	M	M	M
CO2	M	L	M	L	L	M	M	M	L	L	L	M	M	M	M
CO3	M	L	H	H	L	H	M	M	L	H	L	M	M	M	M
CO4	M	L	H	M	L	M	M	M	L	M	L	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement: The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

PHDX 07	**FUNDAMENTALS OF NANOTECHNOLOGY AND ITS APPLICATIONS**	**L**	**T**	**P**	**C**
SDG: 4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1:To introduce the basic concepts of Nanoscience through quantum mechanical theories and solid state physics.

COB2: To provide knowledge about the various synthesis methods applicable to different nano materials

COB3:To enrich the knowledge of students in various characterisation techniques.

COB4:To provide knowledge on applications of poymer based nano materials in various fields.

MODULE I BASICS OF NANO SCIENCE 7

Introduction to Nanoscience &Nanotechnology : Review of classical mechanics – overview Quantum Mechanics. Background to nanoscience and nanotechnology - scientific revolutions - nanosized effects – surface to volume ratio – atomic structure – molecular and atomic size - quantum effects - formation of nano sized particles – energy at the nanoscale.

MODULE II SYNTHESIS OF NANOMATERIALS 8

Nanomaterial Fabrication: Bottom-up vs. top-down - Preparations of Nanomaterials by mechanical and physical methods : – High energy ball milling – melt quenching and annealing – vapour deposition – Pulsed laser deposition – Magnetron sputtering - Microwave plasma evaporation. Chemical Methods of Preparation : Sol-gel method –Electrodeposition – Electrospinning. Arc method for carbon nanotubes – nanofibres and rods – synthesis of Graphene- Handling of nano particles - Health hazards –

Precautions.

MODULE III CHARACTERIZATION OF NANOMATERIALS 8

Characterisation of Nanomaterials: XRD – particle size determination - SEM - FESEM - TEM – AFM – Nanoindentor – UV-VIS spectroscopy – FTIR, FT-Raman, Photoluminescence, NMR, ESR - Dielectric characterization – Magnetic characterization

.

MODULE IV APPLICATION OF NANO MATERIALS 7

Applications of Carbon based nanomaterials (CNT, CNF, Graphene) - Biosensor (principle, component, types, applications) - agriculture (nano-fertilizers, herbicides, nano-seed science, nano-pesticides) and food Systems (encapsulation of functional foods, nano-packaging) – Nano - electronics, Nano-optics.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Nanotechnology: An introduction to nanostructuring techniques by Michael Köhler and Wolfgang Fritzsche, Wiley-VCH; 2Rev Ed edition, 2007.

REFERENCES:

1 Nanotechnology: basic science and emerging technologies by Mick Wilson, Kamali Kannangara, Geoff Smith, and Michelle Simmons, Chapman & Hall/CRC; I edition, 2002.
2 Handbook of NanoScience, Engineering and Technology by Gaddand. W., Brenner. D., Lysherski. S. and Infrate. G.J., CRC Press, 2012.
3 Nanocomposite Science and Technology by P. M. Ajayan, L. S. Schadler, P. V. Braun, WILEY-VCH Verlag GmbH, 2003.
4 Nanotechnology Applications in Agriculture – C.R. Chinnamuthu, B.Chandrasekaran and C. Ramasamy – 2008.

COURSE OUTCOMES:

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

CO1: understand basic principles of nanomaterials and apply them to differentiate the significance of nanomaterials compared to bulk materials.

CO2: familiarize the various synthesis methods of nanomaterials and compare them with the preparation of materials in bulk form.

CO3: get useful ideas about characterization techniques and differentiate different techniques.

CO4: understand the various applications of nanomaterilas and realize the role of nanomaterials in various fields

Board of Studies (BoS) :
BOS of Physics was held on 21.6.21

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	L	M	L	M	M	M	L	L	L	M	-	-	-
CO2	M	L	M	H	L	M	H	M	L	L	L	M	-	-	-
CO3	L	M	H	H	L	H	M	M	L	H	L	M	-	-	-
CO4	M	L	H	M	L	M	M	H	L	M	L	M	-	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement: The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

MATHEMATICS ELECTIVE
(SEMESTER III)

MADX 01	**TRANSFORMS AND PARTIAL**	**L**	**T**	**P**	**C**
SDG: 4	**DIFFERENTIAL EQUATIONS**	**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

COB1: To formulate and solve partial differential equations of first, second and higher orders

COB2: To introduce basics and engineering applications of Fourier series

COB3: To develop Fourier transform techniques

COB4: To introduce analytic solutions of PDEs by using Fourier series

COB5: To acquaint with Z -Transform techniques for discrete time systems

MODULE I PARTIAL DIFFERENTIAL EQUATIONS 9+3

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 9+3

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

MODULE III FOURIER TRANSFORMS 9+3

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

MODULE IV APPLICATIONS OF FOURIER SERIES 9+3

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

MODULE V Z – TRANSFORM 9+3

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 –45 ; T-15; TOTAL HOURS – 60

TEXT BOOKS:

1 Kreyszig .E., "Advanced Engineering Mathematics", 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2011.
2. Grewal B.S., "Higher Engineering Mathematics", 44th edition, Khanna Publishers, New Delhi, 2017.
3. Ramana, B.V, "Higher Engineering Mathematics" Tata Mc Graw Hill Publishing Co. New Delhi, 2010.

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.

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: form and solve the partial differential equations using different methods

CO2: derive a Fourier series of a given periodic function by evaluating Fourier coefficients

CO3: apply integral expressions for the forward and inverse Fourier transform to a range of non-periodic waveforms

CO4: solve partial differential equations by using Fourier series

CO5: solve difference equations using Z-transform

Board of Studies (BoS) :

12th BOS of Mathematics & AS held on 23.06.2021

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2		PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M															
CO2	M															
CO3	H															
CO4	M															
CO5	M															

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4 : Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

Statement: Learning of various mathematical techniques like matrices and calculus will lead to knowledge of applications in Computer Science

		L	T	P	C
MADX 02	**DISCRETE MATHEMATICS**	**L**	**T**	**P**	**C**
SDG: 4		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

COB1: To introduce logical and mathematical ability to deal with abstraction

COB2: To acquaint with the concepts of predicate calculus.

COB3: To introduce the notations and concepts used in set theory

COB4: To apply and use the terms function, domain, codomain, range, image, inverse image and composition

COB5: To introduce basic concepts from abstract algebra, especially the essential concepts in group theory

MODULE I PROPOSITIONAL CALCULUS 9+3

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 9+3

Predicates – Statement function – Variables – Free and bound variables – Quantifiers – Universe of discourse – Logical equivalences and implications for quantified statements – Theory of inference – The rules of universal specification and generalization – Validity of arguments.

MODULE III SET THEORY 9+3

Basic concepts –Notations-Subset –Algebra of sets –The power set – Ordered pairs and Cartesian product- Relations on sets – Types of relations and their properties – Relational matrix and the graph of a relation – Partitions –Equivalence relations –Partial ordering –Poset – Hasse diagram – Lattices and their properties– Boolean algebra – Homomorphism.

MODULE IV FUNCTIONS 9+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 V ALGEBRAIC SYSTEMS 9+3

Groups, Cyclic Groups, Subgroups, Cosets, Lagrange's theorem, Normal subgroups – Codes and group codes – Basic notions of error correlation – Error recovery in group codes.

L –45 ; T-15; TOTAL HOURS – 60

TEXT BOOKS:

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.

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: form truth tables and write principal normal forms

CO2: write the negation of a quantified statement involving either one or two quantifiers.

CO3: prove that a proposed statement involving sets is true, or give a counterexample to show that it is false.

CO4: compute the connection between bijective functions and inverses. Be able to find the inverse of an invertible function.

CO5: give intrinsic structure of groups both abstract and specific examples illustrating the mathematical concepts involved.

Board of Studies (BoS) :

12th BOS of Mathematics & AS held on 23.06.2021

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M														
CO2	M														
CO3	H														
CO4	M														
CO5	M														

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4 : Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

Statement: Learning of various mathematical techniques will lead to knowledge of applications in Communication Engineering

MADX 03	PROBABLITY AND STATISTICS	L	T	P	C
SDG:4		3	1	0	4

COURSE OBJECTIVES:

COB1: To impart knowledge on the basic concepts of probability

COB2: To understand random variables and distribution functions

COB3: To acquaint with joint density function and generating functions

COB4: To introduce sampling techniques and estimation

COB5: To perform hypothesis testing and draw inference

MODULE I PROBABILITY 9+3

Sample space, events- axioms of probability and interpretation – Addition, multiplication rules – conditional probability, Independent events - Total probability – Baye's theorem - Descriptive Statistics.

MODULE II RANDOM VARIABLE AND DISTRIBUTION FUNCTIONS 9+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 9+3

Joint, marginal, conditional probability distributions –covariance, correlation - transformation of random variables- Generating functions.

MODULE IV SAMPLING AND ESTIMATION 9+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 9+3

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.

L –45 ; T-15; TOTAL HOURS – 60

TEXT BOOKS:

1. T.Veerarajan, "Probability and Statistics", Tata McGraw-Hill New Delhi, 2008.
2. Miller, I., Miller, M.,Freund, J. E., "Mathematical statistics", 7th Edition, Prentice Hall International, New Jersey 1999.
3. S.P.Gupta, "Applied Statistics",Sultan Chand & Sons 2015.

REFERENCES:

1. S.M.Ross, "Introduction to Probability and Statistics for Engineers and Scientists" Fifth Edition, Elesvier 2016
2. S.C.Gupta and V.K.Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons New Delhi 2012
3. Arora and Arora, "Comphrensive Statistical Methods", S. Chand, New Delhi 2007.

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: do problems on probability, Baye's theorem and descriptive statistics.

CO2: evaluate moment generating functions and calculate probabilities using distributions.

CO3: calculate probabilities and derive the marginal and conditional distributions of bivariate random variables

CO4: classify random samplings and calculate point and interval estimates

CO5: make an informed decision, based on the results of inferential procedures

Board of Studies (BoS) :

12th BOS of Mathematics & AS held on 23.06.2021

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L													
CO2	M	L													
CO3	M	L													
CO4	M	L		M											
CO5	H	L		M											

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4 : Ensure inclusive and equitable quality education and promote lifelong opportunities for all

Statement: Learning of various statistical methods will lead to knowledge of applications in Electronics and communication Engineering

MADX 04	**RANDOM PROCESSES**	**L**	**T**	**P**	**C**
SDG: 4		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

COB1: To acquire knowledge of the theory of probability, Baye's theorem and Tchebechev inequality

COB2: To understand random variables and discrete and continuous probability distributions

COB3: To demonstrate the techniques of two dimensional random variables and its distributions

COB4: To introduce the random process, stationary, Markov process and the study of correlation functions

COB5: To study spectral analysis and Weiner-Khinchine theorem

MODULE I PROBABILITY 9+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 RANDOM VARIABLES AND ROBABILITY DISTRIBUTIONS 9+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 9+3

Joint, marginal, conditional probability distributions - covariance, correlation and regression lines - transformation of random variables.

MODULE IV RANDOM PROCESSES 9+3

Classification of Random process - Stationary process - WSS and SSS processes - Poisson process – Markov Chain and transition probabilities- Autocorrelation function and its properties - Cross Correlation function and its properties.

MODULE V SPECTRAL DENSITY 9+3

Linear system with random inputs – Ergodicity-Power spectral Density Function - Properties - System in the form of convolution - Unit Impulse

Response of the System – Weiner-Khinchine Theorem - Cross Power Density Spectrum

L –45 ; T-15; TOTAL HOURS – 60

TEXT BOOKS:

1. Veerarajan T., "Probability, Statistics and Random Processes", Tata McGraw Hill,3rd edition, New Delhi, 2008.
2. Papoulis, "Probability, Random Variables and Stochastic Processes", 4th Edition, Tata McGraw Hill Company, New Delhi,2002.
3. S.M.Ross, "Introduction to Probability and Statistics for Engineers and Scientists" Fifth Edition, John Wiley & Sons, New Jersey 2007.

REFERENCES:

1. Scott L. Miller,Donald G. Childers, Probability and Random Processes, Academic Press,London,2009.
2. Trivedi K S, " Probability and Statistics with reliability, Queueing and Computer Science Applications",Prentice Hall of India, 2nd edition, New Delhi, 200

COURSE OUTCOMES: At the end of the course students will be able to

CO1: evaluate probability, apply Baye's theorem and calculate bounds using Tchebechev inequality

CO2: calculate probabilities and expected values for distributions

CO3: calculate probabilities and derive the marginal and conditional distributions of bivariate random variables

CO4: evaluate stationary process, compute correlation functions and related identities

CO5: compute power spectral density functions and apply Weiner-Khinchine theorem

Board of Studies (BoS) :

12th BOS of Mathematics & AS held on 23.06.2021

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L													
CO2	M	L													
CO3	M	L													
CO4	H	M													
CO5	H	M													

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4 : Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

Statement: Learning of various techniques in Random Processes will lead to knowledge required for applying in many projects.

MADX 05	**NUMERICAL METHODS**	**L**	**T**	**P**	**C**
SDG: 4		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

COB1: To familiarize with the methods of solving equations numerically

COB2: To introduce interpolation techniques and finite difference concepts

COB3: To acquire knowledge on Numerical differentiation and integration

COB4: To solve ordinary differential equations numerically

COB5: To solve partial differential equations numerically

MODULE I NUMERICAL SOLUTIONS OF EQUATIONS 9+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 9+3

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 9+3

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 9+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 BOUNDARY VALUE PROBLEMS FOR PDE 9+3

Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace equation

L – 45 ; T-15; TOTAL HOURS – 60

TEXT BOOKS:

1. Grewal, B.S., "Numerical methods in Engineering and Science", 7th edition, Khanna Publishers,New Delhi, 2007.
2. Gerald C.F., 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, New York, 2006.
2. Jain M.K., S.R.K.Iyengar, R.K.Jain, "Numerical methods for Scientific and Engineering Computation", New Age International Publishers, New Delhi, 2003
3. Sastry.S.S,"Introductory Methods of Numerical Analysis",Fifth Edition,PHI Learning Private Ltd., New Delhi, 2012.

COURSE OUTCOMES: At the end of the course students will be able to

CO1: solve algebraic, transcendental and system of equations by numerical methods

CO2:apply various interpolation techniques and finite difference concepts

CO3:carry out numerical differentiation and integration using different methods whenever regular methods are not applicable

CO4: solve first order ODE using single and multi step methods

CO5: solve the boundary value problems in PDE by finite differences

Board of Studies (BoS) :
12th BOS of Mathematics and AS department held 23.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L													
CO2	M														
CO3	M	L													
CO4	M	L													
CO5	M	L													

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4 : Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

Statement: Learning of various methods in numerical analysis will lead to use of applications in many projects in Engineering.

HUMANITIES ELECTIVE – I
(SEMESTER III)

SSDX 01	**ENGINEERING ECONOMICS**	**L**	**T**	**P**	**C**
SDG: 4, 8, 9,12	**AND MANAGEMENT**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To present the major concepts and techniques of engineering economic analysis that is needed in the decision making process by providing insights to the basic microeconomic concepts of demand, supply and equilibrium.

COB2: To generate theoretical knowledge and understanding of macroeconomic aggregates such as national income and inflation and the major challenges associated with the measurement of these aggregates.

COB3: To develop analytical and critical thinking skills on money, banking and public finance and use them to judge the appropriateness of economic development and policy options.

COB 4: To introduce the basic concepts of management and planning and highlight the contribution of planning to the attainment of organization's objectives.

COB 5: To apprise the students about important management concepts and create awareness about the corporate social responsibilities and ethical aspects.

MODULE I DEMAND AND SUPPLY ANALYSIS 9

Introduction to Engineering Economics – Engineering efficiency – Economic efficiency - Scope of Engineering Economics, Engineers' contributions to economic growth- Problem solving and decision making - Laws of Demand and Supply - Difference between Microeconomics and Macroeconomics - Equilibrium between Demand and Supply, Elasticity of Demand - Pricing strategies.

MODULE II NATIONAL INCOME AND INFLATION 8

Concepts of National Income and measurement – GDP Growth Rate - Importance and difficulties of estimating National Income in India - Aggregate demand and aggregate supply, Macroeconomic equilibrium – Meaning of Inflation, its types causes and preventive measures.

MODULE III MONEY, BANKING AND PUBLIC FINANCE 10

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) – Economic Reforms in India – LPG Policy.

MODULE IV PRINCIPLES OF MANAGEMENT AND PLANNING 8

Nature of management and its process - Importance of Management-Functions and Principles of Management - Nature, Purpose and Kinds of Planning.

MODULE V ENGINEERING MANAGEMENT 10

Strategic Management-Manager and Environment - Globalization and Technology Intermediation, Corporate Social Responsibility of business - meaning, importance, arguments for and against Corporate Social Responsibility - Business Ethics- Role of Ethics in Engineering Practice-meaning, importance - State intervention in business - Pros and Cons of intervention.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Krugman, P, Wells, R, and Graddy, K., "Essentials of Economics", Worth Publishers, 4th Edition, New York, 2016.
2. Hussain, Moon Moon, "Economics for Engineers", Himalaya Publishing House, 1st Edition, New Delhi, India, 2015.

REFERENCES:

1. Andrew Gillespie, "Foundations of Economics", OUP Oxford, England, 2007.
2. Acemoglu, D., Laibson, D., & List, J., "Microeconomics", Pearson Education, 2nd Edition, Boston, 2017.
3. Brinkman John , "Unlocking the Business Environment", Routledge, 1st Edition, London, United Kingdom, 2010.(ISBN 9780340942079)
4. Cleaver Tony, "Economics: The Basics", Routledge, 3rd Edition, London, United Kingdom, 2014.
5. H. L. Ahuja, "Macroeconomics", S Chand Publishing; Twenty Edition, New Delhi, India, 2019.

6. Koutsoyiannis A, “Modern Microeconomics”, Palgrave Macmillan, 2nd Edition, U.K, 2003.
7. R.A. Musgrave and P.B. Musgrave, “Public Finance in Theory and Practice” ,McGraw Hill Education India, Fifth Edition, India, 2017.
8. Mell Andrew and Walker Oliver, “The Rough Guide to Economics”, Rough Guide Ltd, 1st Edition, London, 2014.
9. R. Paneerselvam, “Engineering Economics”, PHI Publication, 2nd Edition, New Delhi, India, 2014.
10. Robbins S.P. Decenzo David A and Coulter, “Fundamentals of Management: Essential Concepts and Applications”, Pearson Education, 9th Edition, London, England, 2014.

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: interpret the forces driving demand and supply and their impact on market conditions.

CO2: demonstrate various dimensions of macroeconomic variables like national income, money supply, employment, etc. in analyzing the effects on business.

CO3: explicate the different aspect of Governmental activities and their rationality and describe how they can be pursued through fiscal and monetary policy.

CO4: develop skills to plan, organize, direct and control the resources of the organization for obtaining common objectives or goals.

CO5: augment managerial skills and adopt ethical practices in various functional areas and engineering practices.

Board of Studies (BOS) :

5thBoS of SSSH held on 29.12.2021

Academic Council:

18th Academic council held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1		H	H	M		H	H				H	H
CO2		H	M			M					H	H
CO3			M	M		H	H		H			H
CO4						M	H	H	M		M	H
CO5						M	H	H	M		M	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all.
SDG 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation.
SDG 12: Ensure sustainable consumption and production patterns.

Statement: Inclusive and equitable quality education can make a critical difference to production patterns, consumer understanding of more sustainably produced goods, promote inclusive and sustainable economic growth along with productive employment and decent work for all.

SSDX 02 SDG: 17	SOCIOLOGY OF SCIENCE AND TECHNOLOGY	L T P C 3 0 0 3

COURSE OBJECTIVES:

COB1: To recognize and define the basic concepts of society and the ways in which sociologists use these concepts in constructing explanations for individual and group problems.

COB2: To illustrate the convergence and divergence of sociology with engineering subjects in terms of the subject matter, nature and scope of the discipline and its approach.

COB3: To demonstrate the relationship between science, technology and society.

COB4: To understand the issues relating to science, technology and change in India both in the historical and globalization contexts.

COB5: To appraise the impact of science and technology on different socio-cultural institutions and processes.

MODULE I INTRODUCTION 8

Sociology - Definition, scope and importance, relationship with other social sciences - Major theoretical perspectives: Functionalism, Conflict Theorizing and Interactionism - Elements of social formation - Society, Community, Groups and Association - Institutions, family and kinship, religion, education, politics - Social process - Associative Social Process - Co-operation, Accommodation and Assimilation - Dissociative Social Process - Competition and Conflict.

MODULE II INDIVIDUAL AND SOCIETY 9

Culture - characteristics, functions, types, cultural lag and civilization - Socialization – process, stages, agencies and anticipatory socialization - Social Control - characteristics, importance, types and agencies - Social stratification. - Meaning, forms - caste and class.

MODULE III SCIENCE, TECHNOLOGY AND SOCIETY 9

Relationship between society and science and vice-versa - Science as a social system - Norms of science - Relationship between science and technology - History of modern science in India – colonial–independence and post-independence science - Science education in contemporary India – primary level to research level - Performance of universities in the development of technology - Interrelationship between industry and universities.

MODULE IV SCIENCE, TECHNOLOGY AND SOCIAL ISSUES 10

Technology, media, identity and global society - Conformity and deviance and role of science and technology - Technology and development issue - S&T and sustainable development -Role of science and technology in the creation of environmental crisis - Social inequality, social exclusion and digital divide - Science, technology and ethical issues -Gender and technology.

MODULE V GLOBALIZATION, SCIENCE, TECHNOLOGY AND CHANGE 9

Social Change - nature, direction, forms - Technology and rate of social change – Globalization - characteristics, historical and social context- Social consequences of science and technology on civil society - Globalization - Liberalization - Their impact on Indian science and technology - WTO and issues related to intellectual property rights - MNCs and Indian industry.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Giddens A. “Sociology” Wiley India Pvt. Ltd2017
2. Heald Haralambos, R.M “Sociology Themes and Perspectives”, Oxford, New Delhi-92. 2014
3. Sergio Sismondo. An Introduction to Science and Technology Studies Malden: Wiley Blackwell.2010
4. R.K. Merton, Sociology of Science, Theoretical and Empirical Investigations, University of Chicago Press, 1973.

REFERENCES:

1. Atal Yogesh, “Changing Indian Society” Rawat Publications, Jaipur, 2006.
2. Bilton, T. et al “Introductory Sociology”, Palgrave, New York. 2002
3. Das Gupta, Samir and ‘‘An Introduction to Sociology”, Pearson, Delhi. 2012.
4. Francis Abraham M. “Contemporary Sociology: An Introduction to Concepts and Theories”**,** New Delhi, Oxford University Press. 2014
5. Inkless, A, “What is Sociology”, Prentice Hall, New Delhi. 1987
6. Tumin, Melvin M “Social Stratification”, Prentice Hall, New Delhi. 1969.

COURSE OUTCOMES:

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

CO1: recognize the fundamental tenets of Sociology.

CO2: interpret the relationship between individual and society in a sociological perspective.

CO3: categorize and constructively identify their own assumptions about the relationships among society, science and technology

CO4: appraise the dynamics of human society with special reference to the science, technology and contemporary trends of globalization.

CO5: able to link and reflect on current and ongoing sociological debates on development and role of technology.

Board of Studies (BOS) :

5th BoS of SSSH held on 29.12.2021

Academic Council:

18th Academic council held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1			H			H	H	M	L	H	L	
CO2			M			H	H	M	H	H	M	L
CO3			H	M	H	H	M		M	H	H	M
CO4			M			H	H	L	L	M	H	H
CO5			M			H				M		L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Statement: To inculcate knowledge and socialize youth in building participation, institutions and partnership for inclusive development for the implementation of sustainable development goals.

SSDX 03	**INDUSTRIAL ECONOMICS AND MANAGEMENT**	**L**	**T**	**P**	**C**
SDG: 8 and 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To provide a wholesome idea about the concept of industrial economics and identify the classifications of firms based on ownership and control.

COB2: To impart theoretical and analytical knowledge on the different market structures, pricing practices and government policies.

COB3: To equip the students with the framework that will be useful for applying economic models in business strategy, competition policy and regulations.

COB4: To understand the importance of Industrial Policy in the development of Industries in India.

COB5: To elucidate industrial growth in India by examining its performance and problems in industrial sector.

MODULE I INTRODUCTION TO INDUSTRIAL ECONOMICS 9

Definition and scope of industrial economics - Concept and importance of industry; Concept and organization of a firm - Classification of firms based on ownership - sector (industries, formal vs. Informal) - size and use - based classification - Separation of ownership and control - Localization of industries .

MODULE II MARKET STRUCTURE 9

Perfect Competition – Imperfect Competition: Monopoly – Monopolistic – Oligopolistic Strategy, Cartels, Cournot Kinked Demand and Price Leadership – Measurement of economic concentration – Policy against monopoly and restrictive trade practices – Competition Law – Pricing Practices: Objectives – Determinants – Pricing Methods – Government Policies and Pricing.

MODULE III PRODUCTION ECONOMICS AND THEORY OF FIRM 9

Production and Production function – Types, Factor Inputs – Input-Output Analysis**,** Undifferentiated Products - Cournot, Stackelberg, Dominant firm model, Bertrand-Heterogeneous products - Chamberlin’s small and large number case - Kinked demand curve theory - Bain’s limit pricing – Production Possibility Frontier.

9

MODULE IV INDUSTRIAL POLICY

Industrial Policy: Industrial Policy in India -1948, 1956, 1977, 1980, 1990, 1991 - Industrial Performance after Independence.

MODULE V INDUSTRIAL GROWTH IN INDIA 9

Trends and prospects - Public enterprises; efficiency - Productivity and performance constrain - Small scale industries: definition, role - Policy issues and performance - Capacity utilization - Industrial sickness and Exit - Technology transfer - Privatization.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

- Barthwal R R “Industrial Economics: An Introductory Textbook”, New Age International Pvt. Ltd Publishers, 2017
- P.J. Devine, N. Lee, R.M. Jones, W.J. Tyson, “An Introduction to Industrial Economics”, Routledge.2019.

REFERENCES:

1. Ferguson, Paul R. and Glenys J. Ferguson, “Industrial Economics - Issues and Perspectives”, Macmillan, London. 1994
2. Gregory Mankiw “Principles of Microeconomics”, Havcourt Asia Publishers, 2001.
3. Mohanty Binode Ed. “Economic Development Perspectives”, Vol. 3, Public Enterprises and Performance, Common Wealth Publishers, New Delhi, 1991
4. Mote and Paul “Managerial Economics, Tata McGraw Hill, 2001
5. Peterson and Lewis “Managerial Economics”, 4th Ed., Prentice Hall, 2004

COURSE OUTCOMES:

CO1: Develop knowledge on the concept and organization of firms and the implications of the separation of ownership and control.

CO2: Acquire familiarity with various market structures and formulate appropriate pricing strategies.

CO3: Think analytically using various economic models concerning market structures and apply them to the real world of industry.

CO4: To compare the various Industrial Policies introduced in India and recognize the role of these policies in making required industrial development in India.

CO5: Clearly diagnose and illustrate the challenges in industrial economy in India and develop effective and comprehensive solution on them.

Board of Studies (BoS) :
Mention details of BoS
5thBoS of SSSH held on 29.12.2021

Academic Council:
18th Academic council held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1			H	M			H		M		M	L
CO2			H		M		H		M		M	L
CO3			H				H		M		M	M
CO4			H				H		M		H	M
CO5			H				H		M		H	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 8 - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

SDG 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation.

Statement: A comprehensive and holistic approach towards the way for sustainable development and economic growth through the inclusive economic strategy and thereby to reduce the poverty, hunger among people by familiarizing them industry and its importance as survival strategy for earning decent standard of living.

SSDX 04 **DYNAMICS OF INDIAN SOCIAL STRUCTURE**

SDG: 10, 16

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

COB1: To provide knowledge on the components of the Indian social structure.

COB2: To learn the nature and contemporary structure of Indian social institutions.

COB3: To sensitize students about social stratification in Indian Society.

COB4: To create awareness about the social problems occurring in contemporary India.

COB5: To explicate the changing institutions, the processes, the agents and the interventions that brings about change in the Indian society.

MODULE I INDIAN SOCIAL STRUCTURE 9

Demographic composition - Racial, religious, ethnic and linguistic -Types of communities - rural, urban, agrarian and tribal - Social backwardness - OBC, SC, ST and EWS - Indian minorities- religious, ethnic, linguistic and LGBT.

MODULE II INDIAN SOCIAL INSTITUTIONS 9

Family - types, characteristics, functions of family - Joint Family- definition features, functions of joint family , dysfunctions of joint family, disintegration of joint family – Marriage - definition, characteristics, marriage as sacrament or contract.

MODULE IIISOCIAL STRATIFICATION IN INDIA 9

Social stratification - Concept of hierarchy - inequality, meaning and characteristics - Social Stratification and Social Mobility - Functions of Social Stratification - Caste, definition, principles, contemporary changes, dominant caste - Caste - class interface - Religious minorities.

MODULE IV SOCIAL PATHOLOGY 9

Social Problem - nature, social disorganization - Population explosion- causes, effects, relationship with development - Child Labour- causes, magnitude and consequences – Unemployment - nature, types, causes and effects - Gender issues - social status of women, violence against women and women in work place - Contemporary issues - communalism, terrorism and corruption.

MODULE V SOCIAL CHANGE IN INDIA 9

Socio-cultural change - Sanskritization – Westernization - Secularization, Modernization - Processes of Social change - Industrialization – Urbanization – Globalization - Social movement - concept, characteristics, functions - New social movement-Women and Environment movement.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Sharma,K.L., “Indian Social Structure and Change”, Jaipur: Rawat Publications, 2008.
2. Ahuja Ram., “Social Problems in India”, Rawat Publication: New Delhi, 2014.
3. Ahuja Ram., “Society in India”, Rawat Publication: New Delhi, 2014.

REFERENCES:

1. Atal Yogesh, “Changing Indian Society” Rawat Publications, Jaipur, 2006.
2. Dube S.C., “India's Changing Villages: Human Factors in Community Development”, London, Routledge and Kegan Paul, 2003.
3. Hasnain N., “Indian Society: Themes and Social Issues”, Mc Graw Hill, 2019.
4. Jayapalan, N., “Indian Society and Social Institutions” Atlantic Publishers, 2001.
5. Pandey Vinita., “Indian Society and Culture”, Rawat Publications, New Delhi, 2016
6. Rao Sankar., “Sociology of Indian Society”, S. Chand Publisher, New Delhi, 2004.

COURSE OUTCOMES:

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

CO1: explain about the social structure and social institutions that constitute society in India.

CO2: differentiate the various categories of inequalities and their challenges.

CO3: describe the social stratification and its impact in society.

CO4: analyze the social problems encountered in contemporary India.

CO5: correlate the various forms and trends of the social change in Indian society and realize the relevance of their role in bringing about development.

Board of Studies (BoS) :

5th BoS of SSSH held on 29.12.2021

Academic Council:

18th Academic council held on 24.02.2022

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1			H			H	M			M		
CO2			M			M	H	L				H
CO3			M			M	H	L				H
CO4			H			H	H		M			M
CO5			H		H	M	H	M		H		H

Note: L- Low Correlation M - Medium Correlation H - High Correlation

SDG 10: Reduce inequality within and among countries.

SDG16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

Statement: To sensitize and impart pertinent knowledge to youths to combat the contemporary issues and challenges facing Indian society in order to remedy its social pathos and injustices in the path of achieving sustainable development in India.

HUMANITIES ELECTIVE – II
VI SEMESTER

SSDX 11	**ECONOMICS OF SUSTAINABLE DEVELOPMENT**	**L**	**T**	**P**	**C**
SDG: 1-17		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To inculcate the knowledge base on sustainable development with a view to balance our economic, environmental and social needs, allowing prosperity for now and future generations.
COB2: To develop a capacity to undertake a theoretically grounded analysis of environment issues and identify and describe what the United Nations and other governing bodies are doing to assist in a more sustainable world.
COB3: To have an insight of the emerging debate about reconciling ecological sustainability with poverty alleviation in the context of globalization and development.
COB4: To establish a clear understanding of the policy instruments of sustainable development.

MODULE I CONCEPT OF SUSTAINABLE DEVELOPMENT 8

Evolution of the Concept – Rio Summit and sustainable development - various definitions of sustainable development - Components of sustainable development: Social, environmental and economic components – Sustainable Development Goals – Quality education, Gender equality, innovation and infrastructure, peace and justice - Sustainable engineering practices.

MODULE II NEED FOR SUSTAINABLE DEVELOPMENT 6

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, Paris Agreement, Montreal Protocol, Basel Convention.
Community Participation in Sustainable Development, Common Property Resource Management, Innovation, Industry and Sustainable Development.

MODULE III GLOBALIZATION AND ENVIRONMENT SUSTAINABILITY 7

Impact of Globalization on sustainable development, Co - existence of globalization and Environment sustainability - Globalization and Global Governance.

Green economy - Renewable energy, sustainable transport, sustainable construction, land and water management, waste management.

MODULE IV POLICIES FOR ACHIEVING SUSTAINABLE DEVELOPMENT 9

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 ; TOTAL HOURS – 30

TEXT BOOKS:

1. Peter P. Rogers, Kazi F. Jalal, John A. Boyd, "An Introduction to Sustainable Development", Glen Educational Foundation, 1st Edition, England, UK, 2008.

2. Sayer, J. and Campbell, B, "The Science of Sustainable Development: Local Livelihoods and the Global Environment" (Biological Conservation, Restoration &Sustainability), Cambridge University Press, London, 2003.

REFERENCES:

1. Anderson, David A, "Environmental Economics and Natural Resource Management", Routledge, 3rd edition, England, UK, 2010.
2. Berck, P., "The Economics of the Environment", New Delhi: Pearson India, 2015.
3. Karpagam M, "Environmental Economics: A Textbook.pdf", Sterling Publishers Pvt. Ltd, New Delhi, 2021.
4. Kumar, Pushpam, "Economics of the Environment and Development",Ane Book Publication, New Delhi, India, 2009.
5. Karpagam M and Jaikumar Geetha, "Green Management Theory and Applications", Ane Books Pvt. Ltd, New Delhi, India, 2010.
6. Sengupta Ramprasad, "Ecology and Economics: An Approach to Sustainable Development", Oxford University Press, New Delhi, 2004.
7. Muthukrishna, S, "Economics of Environment", PHI Learning Pvt. Ltd., New Delhi, India, 2010.

COURSE OUTCOMES:

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

CO1: Develop awareness of the ethical, economic, social and political dimensions that influence sustainable development.

CO2: Clearly articulate their views and beliefs with regards to environmental issues.

CO3: Identify and describe the major economic forces that shape our approach to the environment issues and demonstrate responsible globalization through global governance.

CO4: Account for strategies, international agreements and major policy instruments for a sustainable use of resources and ecosystem services.

Board of Studies (BoS) :
4th BoS of SSSH held on 28.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1		H	H		H	H	H		H		H	H
CO2			H			H	H		H		H	H
CO3	M	M	H			H	H		H		H	H
CO4			H			H	H	H	H		H	H

Note: L- Low Correlation   M - Medium Correlation   H -High Correlation

SDG 1: End poverty in all forms and everywhere.

SDG 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.

SDG 3: Ensure healthy lives and promote well-being for all at all ages

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG 5: Achieve gender equality and empower all women and girls

SDG 6: Ensure availability and sustainable management of water and sanitation for all.

SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all.

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

SDG 9: Build resilient infrastructure, promote inclusive and sustainable

industrialization, and foster innovation
SDG 10: Reduce income inequality within and among countries
SDG 11: Make cities and human settlements inclusive, safe, resilient, and sustainable.
SDG 12: Ensure sustainable consumption and production patterns
SDG 13: Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy.
SDG 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

The holistic understanding of all the 17 SDGs aims to end poverty, ensure prosperity, and protect the planet.

SSDX 12	**SOCIOLOGY OF INDUSTRIAL RELATION**	**L**	**T**	**P**	**C**
SDG: 8, 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To familiarize sociological approaches and perspectives to understand the social relationship in manufacturing industries and corporate sector.

COB2: To highlight the structure and functions of industrial organizations

COB3: To explicate the dynamics of organizational behavior, leadership and communication.

COB4: To provide an overview in labour legislation and labour welfare

MODULE I INTRODUCTION 7

Sociology of Industrial relation - 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 -The Industrial Employment (Standing Orders) Act, 1946 Industrial conflict-strike, lockout and trade unions- Emerging role of trade unions in India.

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 7

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. Grievance Handling and Disciplinary Action, Code of Conduct, Industrial Relations in changing scenario, Employers’ organisations.

MODULE IV LABOUR LEGISLATION AND LABOUR WELFARE 9

Labour Legislation-Objectives, Principles, Classification and Evolution. International Labour Organisation. Social Justice and Labour Legislation, Indian Constitution and Labour Laws- The Factories Act, 1948, The Inter-state Migrant Workmen Act, 1979, The Contract Labour (Regulation and Abolition) Act, 1970, The Child Labour (Prohibition and Regulation) Act, 1986. Labour welfare-Concept, Scope, Types, and Principles, Industrial Health and Hygiene, Industrial Accidents and safety, Occupational Diseases. Social Security-Concept and Scope, Social Assistance and Social assurance.

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1. Mamoria ,Gankar., "Dynamics of Industrial relations", Himalaya Publishing House,Mumbai, 2007.
2. Narender Singh ., "Industrial Sociology", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.
   Kumar., "Industrial Sociology", Lakshmi Narain Agrawal Publishers, Agra, 2019.
3. SharmisthaBhattacharjee, "Industrial Sociology", Aavishkar Publishers, Jaipur, 2016.

REFERENCES:

1. Bhatnagar M., "Industrial Sociology",S. Chand Publications, New Delhi, 2012.
2. MisraRajan., "Industrial Sociology", University Science Press (An Imprint of Laxmi Publications Pvt. Ltd.), New Delhi, 2013.
3. Newstorm W John, "Organizational Behavior", Mc. Graw Hill Publishing Co., New Delhi, 2006.
4. Nina, Bandlej (ed)., "Economic Sociology of Work", Bingley: Emerald Group Publishing Ltd, 2009.
5. Richard Brown, John Child, S.R. Parker, "The Sociology of Industry", Routledge Publisher, 2015.
6. Sushil Kumar Saxena, Satish Mittal, "Industrial Sociology",Common Wealth Publishers, 2012.
7. Watson, Tony, "Sociology, Work and Industry (5th edition), Oxon: Routledge, 2008.

COURSE OUTCOMES:

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

CO1: Understand the sociological perspectives for dealing with social relationships in production and service organizations.

CO2: Have deeper knowledge in structure of authority, roles and responsibility in organizational settings.

CO3: Assess the role of leadership, communication and behavioral acumen to govern the organization.

CO4: Describe the importance of labour legislation and labour welfare

Board of Studies (BoS) :

4th BoS of SSSH held on 28.06.2021

Academic Council:

17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1			H						M	H		M
CO2						M	L	M	M		H	M
CO3			M			M		M	H	H	H	M
CO4						H						H

Note: L- Low Correlation   M - Medium Correlation   H -High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement: The holistic understanding of industrial relations leads to equal access to opportunity, and equal pay for work of equal value for male and female contributions is necessary for gender equality as well as for inclusive economic growth. Explore work opportunities, understand career processes and appreciate the meaning and purpose of work in people's lives which leads to decent work and safe working practices.

SSDX 13	**PROFESSIONAL ETHICS AND HUMAN VALUES**	**L**	**T**	**P**	**C**
SDG: 8		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To render basic insights and inputs to the students to inculcate human values to grow as responsible human beings with a proper personality.

COB2: To create awareness on senses of engineering ethics.

COB3: To inculcate knowledge and exposure on safety and risk, risks benefit analysis and professional rights.

COB4: To instill social values and loyalty and to appreciate the rights of others

.

MODULE I HUMAN VALUES 7

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

MODULE II ENGINEERING ETHICS 7

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - Theories about right action - Self-interest - Customs and Religion - Uses of ethical theories - Valuing Time – Co-operation – Commitment.

MODULE III SAFETY, RESPONSIBILITIES AND RIGHTS 8

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

MODULE IV CONTEMPORARY ISSUES 8

Globalisation-Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral

Leadership –Code of Ethics-Ethics and codes of business conduct in MNC.

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1. Govindarajan M, Natarajan S, Senthil Kumar V. S., "Engineering Ethics", Prentice Hall of India, New Delhi, 2019.
2. Kiran. D R, "Professional Ethics and Human Values", Mc Graw Hill Publishers,New Delhi, 2013.
3. Naagarazan R.S., "Professional Ethics and Human Values", New Age International Publishers, New Delhi, 2006.
4. R Sangal, RR Gaur and G P Bagaria, "Foundational Course in Human Values & Professional Ethics", Excel Books, India, 2010.

REFERENCES:

1. Charles D. Fleddermann , "Engineering Ethics", Pearson Education / Prentice Hall, New Jersey, 2004.
2. Charles E Harris, Michael S.Protchard and Michael J Rabins., "Engineering Ethics – Concepts and Cases", Wadsworth Thompson Leatning, United States, 2000.
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
5. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.
6. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New York, 2010.
7. Subramanian. R,"Professional Ethics - Includes Human Values", Oxford HED Publishers, 2017.\

COURSE OUTCOMES:

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

CO1: Apply moral and ethical values scrupulously that ought to guide the engineering profession.

CO2: Understand the ethical issues related to engineering aspects.

CO3: Assess safety and risk and execute risk benefit analysis.

CO4: Become responsible engineers, experimenters, researchers or businessmen

Board of Studies (BoS) :	**Academic Council:**
4th BoS of SSSH held on 28.06.2021	17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1			H				H	H				M
CO2			M			M		H		H	M	
CO3			M		M	H		H				H
CO4			L				H	H	H		M	M

Note:L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8 :Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Statement: Holistic understanding of professional ethics explores work opportunities, understand career processes and appreciate the meaning and purpose of work in people’s lives leading to a decent work and safe working practices and environments.

SSDX 14	**GENDER, TECHNOLOGY AND DEVELOPMENT**	**L**	**T**	**P**	**C**
SDG: 8		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To conceptualize what is gender and sex and draw a line of distinction between the two.

COB2: To develop students' sensibility to the difference in gender roles, responsibilities, rights and injustice.

COB3: To reflect critically on the ways in which new technologies have sharpened and/or blurred gender difference.

COB4: To develop an insight to the gender and development with the paradigm shift from time to time.

MODULE I UNDERSTANDING GENDER 7

Basic Concepts: Sex/Gender, Gender roles, Gender socialization, - Construction of Gender- Making Women, Making Men Gender stereotyping, Femininity and Masculinity, Patriarchy, Heteronormativity, LGBTIQ - Theoretical Background to gender and feminist thinking: Liberal, Radical, Marxist, Socialist, Post-modern Feminism.

MODULE II GENDER ROLES AND GENDER INJUSTICE 7

Gender Roles and Relations-Types of Gender Roles Gender Roles and Relationships Matrix. Health conditions, Sex Ratio, Education: Literacy & Gender Bias - Work Related Issues: Existing Prejudices, gender Related Violence, Gender Discrimination - Political participation: Lack of women's representation - Economic Conditions- Social Conditions: divorce, rape, domestic violence.

MODULE III GENDER, TECHNOLOGY AND CHANGE 8

A historical perspective – Technology as masculine culture – Household technology – medical technology: New Reproductive technologies – Impact of Technological Change on Women. The Digital Divide: Unequal Access, Unequal Effects – Outcome and impact of ICT's Policies and projects for women. How gender influences technologies and the social organization of scientific and technical workspaces.

MODULE IV GENDER AND DEVELOPMENT 8

Gender, Governance and Sustainable Development - Women's role in Development - Women in Development (WID), Women and Development (WAD) - Gender and Development (GAD); Gender Mainstreaming and Gender Budgeting - Gender and Human Rights

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1. Bhasin, Kamala., "Understanding Gender", New Delhi: Kali for Women, 2000.
2. John, Mary E., "Gender and Development in India, 1970-90's: Some reflections on the constitutive role of context' Chaudhuri, Maitrayee. (ed.) Feminism in India", New Delhi: Kali for women. pp. 246-258, 2004.
3. Menon, Nivedita, "Embodying the Self: Feminism, Sexual Violence and the Law" in Partha Chatterjee and Pradeep Jeganathan (ed)- Subaltern Studies XI: Community, Gender and Violence", Permanent Black and Ravi Dayal, 2000.
4. Gender and Technology: A reader ., Edited by Nina E. Lerman, Ruth Oldenziel, and Arwen P. Mohun, John Hopkins University Press, Baltimore , 2003.

REFERENCES:

1. Lourdes Beneria , GünseliBerik , Maria Floro .,"Gender, Development and Globalization: Economics as if All People Mattered", 2nd edition , Routledge, 2015.
2. Moser, Caroline, "Gender Planning and Development: Theory, Practice and Training", Routledge, 1993.
3. Rege, Sharmila., "Sociology of Gender: The Challenge of Feminist Sociological Knowledge", Sage publications: New Delhi, 2003.
4. Jain S.C., Women and Technology, Rawat Publication, Jaipur Begh, 1985.

COURSE OUTCOMES:

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

CO1: Distinguish important concepts related to gender in contemporary society.

CO2: Interpret the gender discrimination works in our society and how to counter it.

CO3: Illustrate how the intersection of gender and technology involves gender shaping technology and technology shaping gender.

CO4: Apply gender sensitive perspective on development and human rights.

Board of Studies (BoS) :
4th BoS of SSSH held on 28.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1			H			H	H		H		H	L
CO2			H			H	M			H		L
CO3			H			H	H	H			M	H
CO4			H			H	H		H			H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 5: Achieve gender equality and empower all women and girls

Statement: To imbibe gender concern and gender perspective in the invention, and application of technology, planning and designing production and innovating strategies for engendering gender equality.

CHEMISTRY ELECTIVE

CHDX 01	**CHEMISTRY OF CONSTRUCTION MATERIALS**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

To impart knowledge on

COB1: chemistry of cement and concrete

COB2: properties of steel and mechanism of corrosion

COB3: quality of water and its impact on concrete

COB4: analytical techniques for concrete research

MODULE I CHEMISTRY OF CEMENT AND CONCRETE 8

Cement - chemical composition - Bogue's compounds - hydration of cement - hydrated products - influence of hydrated products on properties of cement - types of cement - microstructure of aggregate phase and hydrated cement paste - Interfacial transition zone in concrete : significance and microstructure

MODULE II CHEMISTRY OF STEEL AND CORROSION 8

Steel for construction - chemical composition - types of steels - influence of chemical composition on properties. Corrosion of steel - mechanism of corrosion of steel in water and concrete medium - types of corrosion of steel associated to civil engineering. Corrosion prevention and control : coatings & inhibitors - working mechanism. Cathodic protection to steel : Concept - working mechanism - sacrificial anodes

MODULE III WATER CHEMISTRY FOR CONCRETE 7

Water quality parameters – pH, solids, hardness, alkalinity, chloride and sulphates in water and their determination- Water quality for building construction – Effect of water impurities on concrete strength and durability- Carbonate and Sulphate attack-Chloride attack –Alkali-Silica reactions in concrete-Case studies

MODULE IV ANALYTICAL TECHNIQUES FOR CONCRETE RESEARCH 7

Analytical techniques for cement concrete research - FITR spectroscopy - SEM - XRD - Cyclic voltammetry (CV) - Thermo-gravimetric analysis (TGA) and Differential thermal analysis (DTA) - Advanced chloride and water analysis techniques.

L – 30; Total Hours– 30

TEXT BOOKS:

1. Wieslaw Kurdowski, Cement and Concrete Chemistry, Springer Netherlands, 2014.

REFERENCES:

1. P.C Jain and Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd.,New Delhi , 2013.
2. S SUmare and S S Dara, A text Book of Engineering Chemistry, S. Chand and Company Ltd, New Delhi, 2014.
3. M.G. Fontana and N.G. Green, Corrosion Engineering, McGraw Hill Book Company,NewYork, 1984.
4. B. Sivasnakar, Engineering Chemistry, Tata McGrow - Hill Publication Limited, New Delhi,second reprint 2008.
5. P. Kumar Mehta and Paulo J.M. Moteiro, "Concrete : Microstructure, Properties and Materials", McGraw Hill Education (India) Pvt. Ltd., 4th Edition, New Delhi, 2014
6. APHA Standard Methods for the Examination of Water & Wastewater, American Public Health Association, USA, 2005.

COURSE OUTCOMES:

CO1: Explain the properties of cement and concrete

CO2: Describe the properties of steel, mechanism of corrosion and its prevention

CO3: Enumerate the impact of water quality on the concrete

CO4: elaborate the principle, instrumentation and applications of various analytical techniques for concrete research

Board of Studies (BoS) :
11th BoS of Chemistry held on 17.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	L	-	-	-	-	-	-	-	-	M	-	-
CO2	-	-	-	M	-	-	-	-	-	-	-	-	M	-	-
CO3	-	-	-	-	-	-	M	-	-	-	-	-	L	-	-
CO4	-	-	-	M	-	-	-	-	-	-	-	-	L	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

CHDX 02	CHEMISTRY OF MATERIALS AND	L	T	P	C
SDG: 9	ELECTROCHEMICAL DEVICES	2	0	0	2

COURSE OBJECTIVES:

The students will be conversant with

COB1: concepts of corrosion, types and various methods to control corrosion.

COB2: the chemicals, chemical reactions, construction and working of different batteries and fuels cells.

COB3: the types, properties and manufacture of refractories and abrasives.

COB4: types, functions of lubricants and mechanism of lubrication.

MODULE I CORROSION AND ITS CONTROL 8

Types of corrosion - chemical corrosion – electrochemical corrosion – galvanic corrosion – differential aeration corrosion - factors influencing rate of corrosion. Corrosion control – selection of materials - cathodic protection: sacrificial anode - corrosion inhibitors – paints: constituents & functions – treatment of metal surface for inorganic coatings - metallic coatings: hot dipping: galvanizing and tinning – electroplating — electroless plating.

MODULE II ELECTROCHEMICAL DEVICES 8

Electrochemical cell, electrolytic cell - introduction to batteries – classification – primary: dry alkaline – secondary: lead–acid, nickel–cadmium and lithium batteries, Fuel cells – classification based on temperature and electrolyte - hydrogen–oxygen fuel cell, applications – solar cells: construction and working – dye sensitised solar cells.

MODULE III REFRACTORIES AND ABRASIVES 7

Refractories: Introduction - refractory - classification – based on chemical nature - characteristic and selection of good refractory - properties of refractories: refractoriness - refractoriness under load - thermal spalling - porosity and dimensional stability – general manufacture of refractory – components, properties and uses of: silica, magnesite, zirconia refractories - super refractories - application of refractories.

Abrasives: classification - Moh's scale – properties - natural abrasives: diamond, corundum, emery, garnet, quartz - synthetic abrasives: preparation, properties and uses: carborundum, alundum, boron carbide (norbide), tungsten carbide, zirconium silicate – grinding wheel – abrasive paper and cloth - Rockwell scale test - knoop hardness test.

MODULE IV LUBRICANTS 7

Introduction – functions of lubricant- mechanism of lubrication - classification of lubricant – selection of lubricants - lubricating oils - properties of lubricant: viscosity index - flash point and fire point - cloud point and pour point – oiliness - aniline point - carbon residue - semisolid: grease (sodium, calcium, lithium, aluminium) - solid lubricant: graphite, graphene, molybdenum disulphide – lubricating emulsions - cutting fluids – synthetic and semi-synthetic lubricants.

L – 30; Total Hours – 30

TEXT BOOKS:

1. Jain P.C and Monika Jain, Engineering Chemistry, Dhanpat Rai Publishing Co., New Delhi. 2016.

REFERENCES:

1. E. McCafferty, “*Introduction to Corrosion Science*” Springer, May 2010.
2. Tulika Sharma “*Electrochemical devices*” LAP Lambert Academic Publishing, 2011.
3. Jeffry S Gaffney, Nancy A Marley *General chemistry for engineers*, Elsevier, 2018.
4. Don M Pirro, Martin Webster, Ekkehard Daschner “*Lubrication Fundamentals*”, Taylor & Francis Gp,LLC, 2016.
5. Theo Mang, Wilfred Dresel “*Lubricants and Lubrication*” Wiley-VCH, 2017

COURSE OUTCOMES:

The students will be able to

CO1: apply specific methods to control corrosion of different materials.

CO2: illustrate the construction and working of different types of cells, batteries and fuel cells.

CO3: compare the properties and devise a method of manufacture of refractories and abrasives.

CO4: analyze and choose the right type of lubrication based on the type of machines.

Board of Studies (BoS) :	**Academic Council:**
11th BoS of Chemistry held on 17.06.2021	17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	-	-	-	-	-	L	-	-	-	-	M	-	M	-
CO2	H	-	-	-	-	-	M	-	-	-	-	L	-	M	-
CO3	M	-	-	-	-	-	-	-	-	-	-	-	-	L	-
CO4	H	-	-	-	-	-	L	-	-	-	-	L	-	M	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

		L	T	P	C
CHDX 03 **SDG: 9**	**CHEMISTRY AND INSTRUMENTATION FOR ELECTRICAL AND ELECTRONIC APPLICATIONS**	**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: Synthesis, properties and applications of electrical and electronic devices.

COB2: Classification and types of fuel cells.

COB3: Types of sensors and their applications.

COB4: Principle, instrumentation and applications of analytical techniques.

MODULE I ELECTRICAL AND ELECTRONIC DEVICES 7

Solar Cell- Si solar cell, quantum dot solar cell, LCD : components, liquid crystals and their composition, electrodes – OLEDS: components, synthesis and modification of small molecules, polymers, phosphors - FRP-synthesis, properties and electrical applications - Solders : composition and uses – Capacitors : synthesis and modification of capacitor materials, fabrication.

MODULE II FUEL CELLS 7

Difference between batteries and fuel cells - classification 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) microbial fuel cell, - hydrogen storage materials, challenges in using hydrogen as a fuel.

MODULE III SENSORS 7

Definition, receptor, transducer, classification of chemical sensors based on operating principle of transducer, Ion-selective electrodes, Conductometric gas sensors (chemoresistors), Electrochemical sensors, Potentiometric MOSFET gas sensor, Touch sensors (oximeter, glucometer), Chemocapacitors, Biochips and microarray.

MODULE IV ANALYTICAL TECHNIQUES 9

Voltammetry: cyclic voltammetry, electrogravimetry - principle, instrumentation and applications of: UV-Vis spectrophotometry, Atomic emission spectroscopy- Photoluminescence spectrophotometry, atomic absorption spectrophotometry –- FT-IR spectroscopy, Raman spectroscopy, TGA-DTA analyzer, TEM.

L –30 ; Total Hours– 30

TEXT BOOKS:

1. P.C. Jain & Monica Jain, Engineering Chemistry, Dhanpatrai Publishing Company (P) Ltd., New Delhi (2016).

REFERENCES:

1. K.M. Gupta & Nishu Gupta, Advanced electrical and electronic materials: process and applications, Wiley-Scrivener (2015).
2. S. Vairam, P. Kalyani and Suba Ramesh, Engineering Chemistry, Wiley India Ltd., New Delhi (2011).
3. B. Viswanathan & M. Aulice Scibioh, Fuel Cells: Principles and Applications, University Press (2008).

COURSE OUTCOMES:

CO1: Illustrate the construction and applications of electrical and electronic devices.

CO2: Classify the fuel cells and elaborate the different types of fuel cells.

CO3: Explain the different types of sensors and their applications.

CO4: State the principle and illustrate the instrumentation of various analytical techniques.

Board of Studies (BoS) :

11th BoS of Chemistry held on 17.06.2021

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	L	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	H	-	-	-	-	-	M	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	H	-	-	-	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

CHDX 04 SDG: 11 & 12	FUNCTIONAL MATERIALS AND APPLICATIONS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES: To make the students conversant with

- **COB1:** specific materials for hardware components fabrication, data storage and their related properties
- **COB2:** selection of advanced materials for various current applications
- **COB3:** materials for the fabrication of sensors
- **COB4:** essential characterization techniques and software tools with chemistry background

MODULE I **MATERIALS FOR HARDWARE AND DATA STORAGE** **7**

Specific materials for electrical and electronic gadgets-computers, instruments (Semiconductors-N, S doped Silicon, CdX QDs, metal nano and other applications). Networking of networks and connecting devices - materials used in robotic construction (metal alloys, kevlor, biodegradable smart materials). Data storage and magnetic hard disk and devices-pendrive (flash memory-ferro magnetic and super paramagnetic materials, optical dics). Nanomaterials to enhance the lifetime and storage of CD, DVD and BD (Nano incorporated Polycarbonate, Al and lacquer) - Nanomaterials and small molecules for data storage.

MODULE II **ADVANCED MATERIALS AND APPLICATIONS** **8**

Materials for 3D printing (Nylon, ABS, PLA, Ti, Au and Ag). Solar panels function monitoring-IOT enabled (crystalline Si, organometallics) – Displays and LCD, LEDs and its types-OLEDs (Group III-V materials). RGB analysis -sensing and TV/system screen (QDs and anthocyanins). Semiconductor chemistry for VLSI processing technology (metalloid staircase, Si, Ge, GaAs)-materials for inkjet printable circuit board (nanocarbon based) - Right material for signal speed and right thermal coefficient of expansion - Remote sensing (photodectectors and radiometers). Solder:-Lead based solder - issues and alternative for lead free solder (Conductive inks).

MODULE III **MATERIALS FOR FABRICATION OF SENSORS** **8**

Wireless Sensors – Introduction to sensors (chemo/bio/gas sensors)-Wearable/touch sensors-Components - selection of materials - Device fabrication and function monitoring - wireless, Smartphone based and IOT enabled-Properties of materials, anti-corrosive, water proof, insulation and lamination. Robotics in surgery, gene coding and molecular modelling. Biochips and DNA microarray chips (fluorescent dyes, glass/nylon).

MODULE IV ANALYTICAL TECHNIQUES AND SOFTWARE SOLUTIONS 7

Characterization tools – UV-Visible (DRS), FT-IR, SEM, TEM, AFM, TG-DTA and XRD (Principle and applications only). Introduction to softwares- ChemOffice, Image J, Origin - Molecular modelling, comparison of old drug structures with new, drug designing-drug for COVID-19 and drug delivery. Molecular docking (drug interaction in a human body).

L – 30; Total Hours– 30

TEXT BOOKS:

1. P. Roy, S.K. Srivastava, Nanomaterials for Electrochemical Energy Storage Devices (Book), John Wiley & Sons, 2019.
2. K. Brun, T. Allison, R. Dennis, Thermal, Mechanical, and Hybrid Chemical Energy Storage Systems (Book), Elsevier, 2000.

REFERENCES:

1. B.J. Cafferty, A.S. Ten, M.J. Fink, S. Morey, D.J. Preston, M. Mrksich, G.M. Whitesides, Storage of Information Using Small Organic Molecules, ACS Central Science, 2019, 5, 911−916.
2. Nabeel Ahmad P. Gopinath and Rajiv Dutta, 3D Printing Technology in Nanomedicine (Book), Elsevier, 2019.
3. Aaftaab Sethi, Khusbhoo Joshi, K. Sasikala and Mallika Alvala, Molecular Docking in Modern Drug Discovery: Principles and Recent Applications, IntechOpen, (2019), DOII: 10.5772/intechopen.85991.
4. W-L. Xing, J. Cheng, Frontiers in Biochip Technology, Springer, 2006.
5. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, 3rd Edition, Springer, 2015.

COURSE OUTCOMES: The students will be able to

CO1: Identification of suitable materials in electronic gadgets and data storage systems.

CO2: Application of specific functionalized materials for advanced applications

CO3: Choose appropriate materials for fabricating the different types of sensors

CO4: Hands on experience of software and exposure to material properties

Board of Studies (BoS) :

15th BoS of Department of Chemistry held on 15.06.2021

Academic Council:

17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	L	-	H	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	H	-	-	-	-	-	-	-	-
CO3	-	-	-	L	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	H	-	-	-	-	-	-	-	-	-	-	-	-

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG : 11 & 12

Statement : Identification of suitable materials towards the manufacturing of electronic gadgets and data storage systems without much affecting the natural resources and application of the fabricated devices to the sustainable cites and communities.

		L	T	P	C
CHDX 05	**CHEMISTRY OF FUELS,**				
SDG: 9	**COMBUSTION AND LUBRICANTS**	**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

The students will be conversant with

COB1: types, composition and process of manufacture of solid, liquid and gaseous fuels.

COB2: determination of calorific value and calculation of GCV and NCV.

COB3: types, concepts of corrosion and different methods for control of corrosion.

COB4: types, functions of lubricants and mechanism of lubrication.

MODULE I FUELS 8

Introduction – classification of fuels – calorific value – characteristics of a good fuel – comparison of solid, liquid and gaseous fuel – solid fuels – coal – ranking of coal – proximate analysis of coal – pulverised coal – metallurgical coke – manufacture of coke (Otto Hoffman) – Liquid fuel – petroleum – refining of petroleum – cracking – fixed bed catalytic cracking - synthetic petrol – Fischer-Tropsch process – biodiesel - Gaseous fuel – CNG – LPG – Biogas – producer gas – water gas

MODULE II COMBUSTION 8

Introduction – calorific value - Calorific value: Gross and net calorific value - Bomb Calorimeter - Gas calorimeter - Definition of combustion – theoretical calculation of calorific values (Dulong’s formula) - Gross and net calorific values (problems) - air-fuel ratio - minimum requirement of air for complete combustion of fuels (problems) –– Analysis of flue gas - Orsat’s gas analysis method

MODULE III CHEMISTRY OF CORROSION 7

Types of corrosion - chemical corrosion – electrochemical corrosion – galvanic corrosion – differential aeration corrosion - factors influencing rate of corrosion.

Corrosion control – selection of materials - cathodic protection: sacrificial anode - corrosion inhibitors – paints: constituents & functions – treatment of metal surface for inorganic coatings - metallic coatings: hot dipping: galvanizing and tinning – electroplating –– electroless plating.

MODULE IV LUBRICANTS 7

Introduction – functions of lubricant- mechanism of lubrication - classification of lubricant – selection of lubricants - lubricating oils-properties of lubricant: viscosity index - flash point and fire point - cloud point and pour point – oiliness - aniline point - carbon residue - semisolid: grease (sodium, calcium, lithium, aluminium) - solid lubricant: graphite, graphene, molybdenum disulphide – lubricating emulsions - cutting fluids – synthetic and semi-synthetic lubricants.

L – 30; Total Hours– 30

TEXT BOOKS:

1. Jain P.C and Monika Jain, "Engineering Chemistry", Dhanpat Rai Publishing Co., New Delhi. 2016.

REFERENCES:

1. Stephen R Turns, "*An Introduction to Combustion: Concepts and Applications*", McGraw Hill Education, July 2017,
2. Samir Sarkar, "*Fuels and Combustion*", University Press, 2009
3. Dipak K Sarkar "*Thermal power plant: Design and operations* – Chapter-3", Elsevier, 2015.
4. E. McCafferty, "Introduction to Corrosion Science" Springer, May 2010.
5. Don M Pirro, Martin Webster, Ekkehard Daschner "*Lubrication Fundamentals*", Taylor & Francis Gp,LLC, 2016.
6. Theo Mang, Wilfred Dresel "*Lubricants and Lubrication*" Wiley-VCH, 20172nd Edition, India, 2012. (ISBN 13: 9788131704370)

COURSE OUTCOMES:

The students will be able to

CO1: compare and interpret the different purpose of application, composition, and calorific value of different fuels.

CO2: calculate the minimum amount of air required, GCV and NCV for the combustion of the fuels.

CO3: apply specific methods to control corrosion of different materials.

CO4: analyze and choose the right type of lubrication based on the type of machines.

Board of Studies (BoS) :
11thBoS of Chemistry held on 17.06.2021

Academic Council:
!7th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	-	-	-	-	M	-	-	-	-	-	-	M	-
CO2	H	H	-	L	-	-	M	-	-	-	-	-	-	L	-
CO3	H	L	-	-	-	-	-	-	-	-	-	-	M	M	-
CO4	H	M	-	-	-	-	L	-	-	-	-	-	M	L	-

Note:L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Industry, Innovation & Infrastructure

The holistic understanding of the materials used as fuels and lubricants and devices towards sustainable solutions for the advances in mechanical systems.

		L	T	P	C
CHDX 06	**INSTRUMENTAL METHODS OF POLYMER ANALYSIS**				
SDG 4		**2**	**0**	**0**	**2**

OBJECTIVES:

COB1: To impart knowledge on spectroscopic analysis of polymers.

COB2: To equip with the knowledge of optical methods and X-ray diffraction methods for understanding the morphology and orientation of molecules

COB3: To develop an understanding on separation of various mixtures by different chromatographic techniques.

COB4: To understand the chemical elemental structure of polymers by NMR and mass spectroscopic technique.

MODULE I ULTRAVIOLET, VISIBLE AND IR SPECTROSCOPY 9

Principle- Instrumentation-Double beam spectrophotometers – single beam spectrophotometers -sources of radiation – Detectors – I operational procedure – qualitative and quantitative analysis – applications in polymer analysis.

Fourier Transform Infrared Spectroscopy -principle- instrumentation – optical materials – sources- detectors – typical spectrophotometers — calibration and standardization – sample preparation - analysis – interpretation of FTIR spectra- principle of identification and characterization of polymers using IR

MODULE II NMR SPECTROSCOPY 7

Fundamental concepts – chemical shift – spin –spin- coupling. Instrumentation - data acquisition and spectral interpretation. Solid state NMR (magic angle), Applications of NMR and FT NMR in the characterization of polymers

MODULE III CHROMATOGRAPHY AND THERMAL ANALYSIS 7

Thermal analysis: DSC, TG/DTA, TMA, DMA, DETA with examples. gel permeation chromatography (GPC) – High pressure liquid chromatography (HPLC) – Thin layer chromatography (TLC - Gas chromatography (GC) – sample preparation. Chromatographic process and instrumentation – compositional separation and detectors – various types – Analyses. The uses and applications of various chromatographic techniques – pyrolysis gas chromatography.

MODULE IV X-RAY DIFFRACTION & NEWTON SCATTERING 7

Principle & basic concept of absorption of X-rays- monochromatic X-ray sources – X-ray detectors - Instrumentation – Experimental technique -Analysis by X-ray absorption. Absorption apparatus – X-ray diffraction – Diffraction apparatus. Application to polymer analysis.

L – 30; Total Hours– 30

TEXT BOOKS

1. Douglas A. Skoog, F. James Holler, Stanley R. Crouch “Principles of Instrumental Analysis” 7th edition, Publisher Cengage Learning ,2016
2. Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, “Introduction to Spectroscopy” 5th edition, Publisher Cengage Learning ,2015
3. Yang, Rui “Analytical methods for polymer characterization” CRC Press, 2018.
4. Joseph D. Menczel, R. Bruce Prime “Thermal analysis of polymers: fundamentals and applications” John Wiley, 2019.

REFERENCES:

1. Galen W. Euring, “Instrumental methods of chemical analysis”, McGraw Hill International editions, New York, 1985.
2. B.J. Hunt & MI Jones Blackie, “Polymer Characterisation”, Academic professional, London, 1997.
3. Hubert Lobo, Jose V.B.Bonilla, “Handbook of Plastic analysis” , Marcel Dekker inc, New York, 2003.
4. RA pethrick & JV Daukins, “Modern techniques for polymer characterization” , John Wiley & sons Chichester, UK, 1999.
5. D. Campbell and R. White, “Polymer characterization”, Chapman & Hall, London 1989.
6. Arza Seidel, “Characterization and Analysis of Polymers”, John wiley and sons, New jersey, 2008.
7. Nicholas P. Cheremisinoff, “Polymer Characterization: Laboratory Techniques and Analysis”, Noyes publications, New jersey, 1996.
8. John M Chalmers, Robert J Meier, “Molecular characterization and analysis of polymers” Elsevier, 2008

COURSE OUTCOMES

CO1: Gaining knowledge on principles of various instruments

CO2: Understand about various characterization techniques

CO3: Interpretation the polymer by different techniques

Board of Studies (BoS) :	**Academic Council:**
11th BoS of Chemistry held on 17.06.2021	!7th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	L	-	-	-	-	-	-	-	-	M	-	-
CO2	-	-	-	M	-	-	-	-	-	-	-	-	M	-	-
CO3	-	-	-	-	-	-	M	-	-	-	-	-	L	-	-
CO4	-	-	-	M	-	-	-	-	-	-	-	-	L	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4 : Aims at ensuring inclusive and equitable quality education and promote lifelong learning opportunities for all

This course will provide deep knowledge on analysis of polymers using different instrumental methods.

CHDX 07	**MEDICINAL CHEMISTRY**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

To impart knowledge on

COB1: basic factors governing drug design.

COB2: software tools for molecular docking.

COB3: synthetic pathway of antinfective, antineoplastic, cardiovascular and steroidal drugs.

COB4: mode of action and side effects of synthetic drugs.

MODULE I INTRODUCTION TO DRUG DESIGN 7

Development of new drugs: Procedure followed in drug design – Literature survey - Search for Active Pharmaceutical Ingredient(s) - Molecular modification – Types of pharmaceutical form / mode of administration, Chemical Characterization of Medicinal Drugs - Molecular docking.

MODULE II ANTIINFECTIVE DRUGS 8

Synthesis, mode of action and side effect of Dapsone and Clofazimine (antileprotic) – Isoniazid, Rifampicin, Pyrazinamide and Ethambutol (antitubercular) – Fluconazole and griseofulvin (antifungal) – Chloroquine and Primaquine (antimalarial) - Semisytheticpencillin, Streptomycin, Ciprofloxacin (Antibiotics) - Nevirapine and Zidovudine (Antiviral)

MODULE III ANTINEOPLASTIC AND CARDIOVASCULAR DRUGS 8

Synthesis, mode of action and side effect of Mechlorethamine, Cyclophosphamide, Melphalan, Fluorouracil, 6-Mercaptopurine (Antineoplastic) – Sorbitrate, methylprednisolone, Methyldopa, quinidine (Cardiovascular).

MODULE IV STEROIDS AND RELATED DRUGS 7

Synthesis, uses and mode of action - (A) Androgens -testosterone (B) Estrogens and progestational agents – progesterone, (C) Adrenocorticoids – prednisolone, dexamethasone, Remdesivir (D) Glucocorticoids – Cortisol (E)Anabolicsteroids - nandrolone, oxandrolone (F) Neurosteroids – allopregnanolone.

L – 30; Total Hours– 30

TEXT BOOKS:

1. An Introduction to Drug Design, S. N. Pandeya and J. R.Dimmock, New Age International, 1997.
2. Burgers's Medicinal Chemistry and Drug Discovery, Fifth Edition; M. E. Wolff, John Wiley and Sons, 1996.
3. The organic chemistry of drug design and drug action, R. B. Silverman and M. W. Holladay, Academic Press, 3rd Edition, 2014.
4. Introduction to medicinal chemistry**:** How Drugs Act and Why, A. Gringuage, Wiley-VCH, 1996.
5. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry; Eleventh Edition; Lippincott Williams & Wilkins, 2004.

REFERENCES:

1. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley, 2nd Edition 2008.

COURSE OUTCOMES:

CO1: Carry out searches to retrieve information relevant to the development of a new drug.

CO2: Describe and justify the role and importance of the various disciplines involved in the different phases of drug discovery and development.

CO3: Explain how synthetic methods are used to make early decisions in the drug discovery and development.

CO4: Elaborate the mode of action and side effect of the drugs.

Board of Studies (BoS) :
11thBoS of Chemistry held on 17.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	M	-	-	-	-	-	-	-	M	-	-
CO2	-	-	-	M	-	-	-	-	-	-	-	-	M	-	-
CO3	-	-	-	-	-	L	-	-	-	-	-	-	L	-	-
CO4	-	-	-	M	-	-	-	-	-	-	-	-	L	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 :Industry, Innovation & Infrastructure

Understanding of drugs preparation and usage in sustainable method reduces unwanted side effects and help to environments.