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 (I – IV semesters)
(Amendments updated upto February 2022)

B.Tech.
(Polymer Engineering)

B.S. Abdur Rahman Crescent Institute of Science & Technology
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REGULATIONS 2021

CURRICULUM AND SYLLABI (I - IV Semesters)

(Amendments updated upto February 2022)

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)

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

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

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 3281	Entrepreneurship	3	0	0	3
2.	PCC	PED 3101	Polymer Nanocomposite Technology	2	0	0	2
3.	PCC	PED 3102	Polymer Composites and Polymer Bends	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 2201	Communication Skills For Career Success **	0	0	2	1
9.	PROJ	PED 3106	Internship I ##	0	0	0	1
			Credits				**23**

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				**23**

SEMESTER VIII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PROJ	PED 4211	Project Work	0	0	18	9
			Credits				**9**

Overall Total Credits – 169

* 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	Biopolymers Technology	3	0	0	3
2.	PEC	PEDX 02	Biomedical Polymers	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 Energy Technology	3	0	0	3
6.	PEC	PEDX 06	Speciality Elastomers	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	Injection Moulding Technology	3	0	0	3
3	PEC	PEDX 13	Extrusion and Forming Process	3	0	0	3
4	PEC	PEDX 14	Post Processing Operations	3	0	0	3
5	PEC	PEDX 15	Rubber Product Manufacturing Technology	3	0	0	3
6	PEC	PEDX 16	Advanced Processing Technology	3	0	0	3
7	PEC	PEDX 17	Tyre Manufacturing Technology	3	0	0	3
8	PEC	PEDX 18	Polymer Recycling and Waste Management	3	0	0	3

9	PEC	PEDX 19	Additive Manufacturing Technology	3	0	0	3
10	PEC	PEDX 20	Plastic Packaging 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 26	Computer Aided Modelling	3	0	0	3
2	PEC	PEDX 27	Computer Aided Manufacturing	3	0	0	3
3	PEC	PEDX 28	Design of Composite Structures	3	0	0	3
4	PEC	PEDX 29	Industrial Hydraulics and Pneumatics	3	0	0	3
5	PEC	PEDX 30	Failure Analysis of Polymers	3	0	0	3
6	PEC	PEDX 31	Mould Manufacturing Techniques	3	0	0	3
7	PEC	PEDX 32	Finite Element Analysis	3	0	0	3
8	PEC	PEDX 33	Computational Analysis of Polymeric Materials	3	0	0	3
9	PEC	PEDX 34	Automation in Polymer Processing Industries	3	0	0	3

SPECIALIZATION IV: BLENDS, COMPOSITES, ADHESIVES AND COATINGS

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1	PEC	PEDX 41	Bio-Nanocomposite Technology	3	0	0	3
2	PEC	PEDX 42	Mechanics of Composites	3	0	0	3
3	PEC	PEDX 43	Analysis of Composite Structures	3	0	0	3
4	PEC	PEDX 44	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 Information Technology	2	0	0	2
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 Values	2	0	0	2
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 / Chemistry
19	GEDX 219	Numerical Computational Tools for Engineers	2	0	2	3	EIE
20	GEDX 220	Optimization Techniques	3	0	0	3	EEE
21	GEDX 221	Polymers for Emerging Technologies	3	0	0	3	Polymer
22	GEDX 222	Programming Language Principles	3	0	0	3	CSE
23	GEDX 223	Public Speaking and Rhetoric	2	1	0	3	English
24	GEDX 224	Python Programming *	2	0	2	3	IT
25	GEDX 225	R Programming	3	0	0	3	CA

26	GEDX 226	Smart Sensors for Healthcare Applications	3	0	0	3	EIE
27	GEDX 227	Total Quality Management	3	0	0	3	Mech.
28	GEDX 228	Value Education	3	0	0	3	Commerce
29	GEDX 229	Waste Water Management	3	0	0	3	Civil
30	GEDX 230	Web Application Development	3	0	0	3	CA

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 104	Behavioural Psychology	3	0	0	3	SSSH
5	GEDX 105	Building Repair Solutions	3	0	0	3	Civil
6	GEDX 106	Cloud Services and Management	3	0	0	3	CA
7	GEDX 107	Cost Management for Engineers	3	0	0	3	Commerce
8	GEDX 108	Cyber Law and Ethics	3	0	0	3	CSL
9	GEDX 109	Data Analytics and Visualization	3	0	0	3	CA
10	GEDX 110	Deep learning Essentials	3	0	0	3	CSE
11	GEDX 111	Drone Technologies	2	0	2	3	Aero
12	GEDX 112	Electric Vehicle	3	0	0	3	EEE
13	GEDX 113	Emerging Technologies in Mobile Networks	3	0	0	3	ECE
14	GEDX 114	Fundamentals of Data Science and Machine Learning	3	0	0	3	IT
15	GEDX 115	Genetic Engineering	3	0	0	3	SLS
16	GEDX 116	Green Design and Sustainability	3	0	0	3	Civil
17	GEDX 117	Image Processing and its Applications	3	0	0	3	ECE
18	GEDX 118	Industrial Automation and Control	3	0	0	3	EIE
19	GEDX 119	Industrial Safety	3	0	0	3	Mech.
20	GEDX 120	Industry 4.0	3	0	0	3	Mech.
21	GEDX 121	Introduction to Artificial	3	0	0	3	IT

		Intelligence					
22	GEDX 122	Introduction to Artificial Intelligence and Evolutionary Computing	3	0	0	3	EEE
23	GEDX 123	Motor Vehicle Act and Loss Assessment	3	0	0	3	Automobile
24	GEDX 124	National Service Scheme	3	0	0	3	SSSH
25	GEDX 125	National Cadet Corps	3	0	0	3	SSSH
26	GEDX 126	Personal Finance and Investment	3	0	0	3	Commerce
27	GEDX 127	Soft Computing Techniques	3	0	0	3	CSE
28	GEDX 128	Value Analysis and Engineering	3	0	0	3	Mech.
29	GEDX 129	Vehicle Maintenance	3	0	0	3	Automobile

SEMESTER I

PHD 1181	**APPLIED PHYSICS**	**L**	**T**	**P**	**C**
SDG: 4		**3**	**0**	**2**	**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 – I Shape Girders-Viscosity.

MODULE II CRYSTAL PHYSICS 9

Miller Indices-Interplanar distance-closely packed crystal structures and Diamond 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 OSCILLATIONS, OPTICS AND LASERS 9

Simple harmonic motion - resonance - waves on a string - standing waves - traveling waves - Energy transfer of a wave - 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 AND ULTRASONICS 9

Basic requirement for the acoustically good halls - Reverberation and time of reverberation – Sabine's formula for reverberation time - Absorption coefficient and its measurement - Factors affecting the architectural acoustics and their remedy-Sound absorbing materials - Introduction to Ultrasonics - Properties - Production methods – MagnetostrictionOscillator 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 andthe principles of elastic behaviour of materials & apply them toanalyze the various substances based on elasticity.

CO2: Get acquainted with the topics concerning types, defects in crystalstructures, methods of preparation and apply the same to categorize differentcrystal systems in real time

CO3: Comprehend the importance &principles of quantum mechanics andutilize 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) : 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	H	M	L	L	M	M	M	L	L	L	M	M	-	-	-
CO2	H	M	M	L	L	M	L	L	L	L	L	M	-	-	-
CO3	H	M	M	L	L	L	L	L	L	L	L	M	-	-	-
CO4	H	M	M	L	M	M	M	L	L	L	M	M	-	-	-
CO5	H	M	M	L	M	M	M	L	L	L	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.

CHD 1181	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.

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) :
11thBoS of Chemistry held on 17.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	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.

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) :
12th BOS of Mathematics & AS held on 23.06.2021

Academic Council:
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 on Design, 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. Machining 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:**
18thBoS 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.

		L	T	P	C
GED 1104	**PROGRAMMING FOR**				
SDG: 8	**PROBLEM SOLVING**	**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) :
13thBoS 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) :	**Academic Council:**
12th BOS of Mathematics & AS held on 23.06.2021	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	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.

		L	T	P	C
GED 1202	**BASIC ELECTRICAL AND**				
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.

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, , Thread cutting, Grinding and turning machine Drilling and reaming.

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

Electrical discharge machining– characteristics, design consideration and typical applications. 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.

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. Exercise on slotting
7. Exercise on EDM
8. 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) :
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									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	PRINCIPLES OF CHEMICAL ENGINEERING	L	T	P	C
SDG: 4		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.

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:

1. Erach Bharucha, “Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education for University Grants Commission”, Orient Blackswan Pvt. Ltd., Hyderabad, India, 2013.
2. Benny Joseph, “Environmental Studies”, Tata McGraw-Hill Education, India, 2009.
3. Ravikrishnan A, “Environmental Science and Engineering”, Sri Krishna Publications, Tamil Nadu, India, 2018.
4. Raman Sivakumar, “Introduction to Environmental Science and Engineering”, McGraw Hill Education, India, 2009.
5. Venugopala Rao P, “Principles of Environmental Science and Engineering”, Prentice Hall India Learning Private Limited; India, 2006.
6. Anubha Kaushik and Kaushik C.P., “Environmental Science and Engineering”, New Age International Pvt. Ltd., New Delhi, India, 2009.

REFERENCES:

1. Masters G.M., “Introduction to Environmental Engineering and Science”, Prentice Hall, New Delhi, 1997.
2. Henry J.G. and Heike G.W., “Environmental Science and Engineering”, Prentice Hall International Inc., New Jersy, 1996.
3. Miller T.G. Jr., “Environmental Science”, Wadsworth Publishing Co. Boston, USA, 2016.
4. “Waste to Resources: A Waste Management Handbook”, The Energy and Resources Institute, 2014.
5. https://www.teriin.org/article/e-waste-management-india-challenges-and-opportunities.
6. https://green.harvard.edu/tools-resources/how/6-ways-minimize-your-e-waste.
7. https://www.aiims.edu/en/departments-and-centers/central-facilities/265-biomedical/7346-bio-medical-waste-management.html.
8. 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.

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.

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

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 REINFORCING 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 EQUIPMENTS 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 POLYMER FORMULATIONS 6

Polyolefins – polyvinyl chloride – nylon – ABS – phenolic and melamine moulding powders – epoxy resin and unsaturated polyester resins.

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):
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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		
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 theplastic 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

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	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	ANALYSIS AND CHARACTERISATION OF POLYMERS	L	T	P	C
SDG: 9, 12		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.

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	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; 8th Edition, 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, 2nd Edition, 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.

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	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, MarIeneG.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

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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 LABORATORY	L	T	P	C
SDG: 8		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:

1. Suhas Kulkarni, “Robust ProcessDevelopment andScientific Moulding”, Carl Hanser Verlag, München, Germany, 2010. (ISBN 978-3-446-42275-9)
2. 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)
3. 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) :
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	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) :
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	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**	**L**	**T**	**P**	**C**
SDG: 8	**FOR ENGINEERS**	**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) :
13thBoS 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) :
4thBoS 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			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.

PROFESSIONAL ELECTIVE COURSES

PEDX04	NANOSCIENCE AND TECHNOLOGY	L	T	P	C
SDG: 9		3	0	0	3

To make the student conversant with

COB1: the concepts of nano sized particles and their importance in modern material technology.

COB2: the knowledge on process technologies for nanomaterial production.

COB3: comprehensive account on critical characterization techniques of nano materials.

COB4: the knowledge on carbon-based materials.

COB5: the diverse of applications of the nano particles for advanced, improved devices and smart materials.

MODULE I BACKGROUND 6

Background to nanoscience and nanotechnology - scientific revolutions - nanosized effects –- surface to volume ratio– atomic structure – molecular and atomic size -quantum effects - molecules & phases - formation of nano sized particles – energy at the nanoscale.

MODULE II PREPARATION METHOD – PHYSICAL 9

Preparation of nanomaterials by mechanical and physical methods : High energy ball milling –severe plastic deformation – melt quenching and annealing – vapour deposition – pulsed laser deposition – laser ablation - magnetron sputtering- –microwave plasma evaporation. Control of grain size. Scale up process. handling of nano particles - health hazards – precautions.

MODULE III PREPARATION METHOD – CHEMICAL 10

Chemical Methods of Preparation : Sol-gel method -gel combustion - Co-precipitation hydrolysis – sono chemical method-combustion-electrodeposition- electrospinning - arc method for carbon nanotubes - Chemical methods with organic precursors for carbon nanotubes, nanofibres and rods – synthesis of graphene- scale up methods with precautions.

MODULE IV PROPERTIES AND APPLICATIONS 10

Properties and application of nanomaterials – optical - mechanical - electronic and electrical - quntum Dot (QD) sensitized Solar Cells (QD-SSC) - smart coatings (Self Cleaning) - superhyrophobic Coating For drag Reduction

– application of polymer-nanocomposites for improvement in properties - smart sensors.

MODULE V **CARBON NANO MATERIALS & POLYMER NANOFIBRES** **10**

Applications of carbon based nanomaterials (CNT, CNF, Graphene) - polymers nanofibers and their applications in bioengineering – functional polymers for bone tissue engineering applications – DNA - RNA- Nanoproducts.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Introduction to Nanoscience and Nanotechnology, Gabor .L et al.
2. A. Roth, Vacuum Technology North – Holland Pub.,II Edition (1982.)

REFERENCES:

1. Challa S.S.R. Kumar (Ed) Biological and pharmaceutical nanomaterials : Wiley - VCH Verlag GmbH& Co, KgaA.
2. H.S. Nalwa (Ed) Handbook of Nanostructured Bioaterials and their applications in nanobiotechnology, American Scientific Publishers,2005.

COURSE OUTCOMES:

The student will be able to

CO1: Acquire the knowledge of formation of nano sized particles and size dependency of material properties and their energy levels.

CO2: Apply the knowledge on physical, mechanical and chemical methods of production of nano materials.

CO3: Apply the knowledge of various critical and advanced techniques to characterize nano particles..

CO4: Apply the knowledge gained in different types of nanomaterials for various engineering applications.

CO5: Synthesize, characterize and apply the knowledge of the various nano carbons and polymer nano fibres in advanced material technologies and bio engineering.

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															H	
CO2				L											H	
CO3								M							H	
CO4															H	
CO5															H	

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

SDG No. 7: Affordable and Clean Energy.
SDG No. 9: Industry, Innovation and infrastructure.

- The holistic understanding of nanomaterials materials leads to development of affordable and clean energy.
- The holistic understanding of nanomaterials preparation will lead to innovation in various applications.

PEDX 17	TYRE MANUFACTUING TECHNOLOGY	L	T	P	C
SDG: 9		3	0	0	3

To make the student conversant with

COB1: interest and sense of appreciation of all about pneumatic tyre.

COB2: tyre components and construction of a pneumatic tyre.

COB3: the knowledge and insight to the mechanics of tyre.

COB4: knowledge of tyre reinforcements with respect to tyre cords.

COB5: the tyre manufacturing, retreading processes, tyre testing and evaluation procedures.

MODULE I TYRE COMPOUNDING **7**

Introduction to tyre technology – tyre compound and fundamental properties – compound development – raw materials for compounding- different tyre components – designing the compound matrix for the reinforced composite.

MODULE II TYRE COMPONENTS AND STRUCTURE **8**

Tyres – Function – Construction – Basic tyre design-Tyre Components and their functions, Tyre Materials, Tyre Nomenclature and Structural Dimensions, Classification of tyres based on applications and its requirements. Tubeless Tyre-Function, Construction, Materials and advantages.

MODULE III TYRE MECHANICS **8**

Mechanics of rubber – cord rubber composite and its properties, failure mechanism of cord reinforced rubbers composites. Inflation pressure – contact area, tyre deflections – design factors and principles. Rolling resistance, friction, mechanical loss on tyre behavior.

MODULE IV TYRE CORD REINFORCEMENTS **8**

Tyre cords – Physical Properties of tyre-cords- Rayon, Nylon, Polyester, Fibre glass, Aramid, Steel Wire-Cord Processing – Heat Treatment, Adhesive treatment, Bonding systems, Rubber to Cord Mechanism, Tyre Cord Construction, Evaluation of adhesive systems.

MODULE V TYRE AND TUBE MANUFACTURING AND TESTING **14**

Tyre manufacturing – tyre building – green tyre – curing methods – post curing inflation – finishing. Retreading – criteria – methods of retreading.Tubes: Principles of tube design – manufacturing of tubes by extrusion, valve jamming, inflation & curing in presses, tube testing.

Tyre Testing – Destructive and Non-destructive Testing of Tyres, Plunger Tests (Breaking energy), Pulley wheel test Field Tract Testing – Braking, Acceleration, mileage, Regulations, Tyre Labelling.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. A.K. Bhowmick, M.M. Hall and H.A. Benaney, “Rubber Products Manufacturing Technology”, Marcel Dekker Inc, New York, 1994.
2. Tyre Technology, Tom French, Adam Hilger, 1989
3. Mechanics of Pneumatic Tyres, (ed) Samuel K Clark, US Dept of Transportation.
4. Tyre Technology, F J Kovac, The Goodyear Tyre & Rubber Company, 1973.

REFERENCES:

1. Blow. C.M. and Hepburn C, “Rubber Technology and Manufacture”, Butterworths, 1982.
2. James E. Mark, Burak Erman "Science and Technology of RUBBER", Academic Press, 2005
3. R.A. Ridha and M. Theves, "Advances in tyre mechanics", Rapra Technology Limited, 1997.

COURSE OUTCOMES:

The student will be able to

CO1: Identify suitable compounding ingredients for pneumatic tyre.

CO2: Explain tyre components and construction of a pneumatic tyre.

CO3: Apply the mechanics of tyre in tyre design

CO4: Illustrate the tyre manufacturing and retreading processes.

CO5: Suggest suitable tyre testing and evaluation procedures.

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	
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 tyres to enable industrialization and foster innovation.

Statement: The holistic understanding the tyre mechanics and their applications to industrialization and innovative rubber materials and products.

PEDX 31 MOULD MANUFACTURING TECHNIQUES L T P C

3 0 0 3

SDG: 09

COURSE OBJECTIVES:

COB1: To select the proper mold materials and metal cutting method to manufacture an injection mold.

COB2: To demonstrate advancedmold manufacturing techniques like EDM and Electroforming.

COB3: To develop the Hobbing process for the use of mold manufacturing.

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 INTRODUCTION TO MOULD MANUFACTURING 9

Introduction of mold parts, Mould material, Material selection for mold making, Properties of steel for molds. Non-ferrous metals for molds - Zinc base alloys and aluminum alloys, Beryllium Copper, Polyesters, Epoxies, Silicones.

MODULE – II ADVANCED MOLD MANUFACTURING TECHNIQUES 9

Electrical discharge machining -Characteristics, physical processes, special technological features, types of EDM, design consideration & functions, and technological planning. Applications of wire cut EDM in mold making. Electroforming for mold manufacturing -materials for electroforming, machining for electroformed blanks.

MODULE – III HOBBING PROCESS OF MOULD MANUFACTURING 9

Hobbing for mold making – Discussion of the hobbing process & its advantages, elements of hobbing like hobbing punch, the shape of the hob, materials used for a cavity, lubrication, and depth of hobbing, Hobbing presses, Hobbing operations & its economy with examples.

MODULE – IV COMPUTER-AIDED MANUFACTURING AND MEASUREMENT 9

Automated Manufacturing system, Need of automation, classification of NC machine tools, NC Part Programming Manual (word address format) programming- APT programming. Geometry, Motion and Additional

statements, Macro- statement Open and closed loops. Control of point-to-pointsystems incrementalopen-loop control, Incremental close loop, Absolute close-loop; Control loop in contouring systems.

MODULE – V METROLOGY 9

Standards of linear measurement, line and end standards, Interchangeability and standardization, linear and angular measurement devices, measurement of geometric forms like straightness, flatness, and roundness.

L – 45; TOTAL HOURS – 45

TEXT BOOK

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.
4.

COURSE OUTCOMES:

CO1: Select the proper mold materials and metal cutting method to manufacture an injection mold.

CO2: Demonstrate advanced mold manufacturing techniques like EDM and electroforming.

CO3: Develop the Hobbing process for the use of mold manufacturing

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) :
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
CO2																
CO3		H						M								
CO4																H
CO5										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: Able to select the proper material for mold manufacturing and select the standards for measurement. It will help in building infrastructure and sustainable industrialization.

PEDX 42 **MECHANICS OF COMPOSITES** **L T P C**

3 0 0 3

SDG: 09

COURSE OBJECTIVES:

COB1: To introduce the basics of the macro mechanical behavior of a lamina.

COB2: To communicate the fundamentals of 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, stress-strain relations for plane stress in an orthotropic material.

MODULE II MICROMECHANICAL 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 the fiber direction.

MODULE III MACRO MECHANICAL BEHAVIOUR OF LAMINATE 9

Classical lamination theory, laminate code, symmetric laminates, theoretical and experimental angle–ply laminate stiffness, antisymmetric laminates, nonsymmetric 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, design parameters of bolted joints, and preparation 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

TEXTBOOKS:

1. Robert Jones,"Mechanics of Composite Materials", McGraw Hill Company, New Delhi, 1998
2. P.K.Mallick, "Fiber Reinforced Composite", Marcel Decker,1988
3. AutarK.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:

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) :
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				L											H
CO2																
CO3		H						M								H
CO4	L															
CO5										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: This course provides a holistic approach to designing new plastic composites and it promotes the building of new infrastructure.

PHYSICS ELECTIVE

		L	T	P	C
PHDX 01	**NON DESTRUCTIVE TESTING OF MATERIALS**				
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) : BOS of Physics was held on 21.6.21

Academic Council: 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 of biomaterials 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
		2	0	0	2

SDG: 4

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	L	T	P	C
SDG: 4	INFORMATION TECHNOLOGY	2	0	0	2

COURSE OBJECTIVES:

COB1: To understand the physics of semiconductor devices

COB2: To gain knowledge on various methods involved in nanofabrication of semiconductor devices

COB2: To study the working principle of optoelectronic devices and various display devices

COB4: To get insight to different types of data storage technologies

MODULE I INTRODUCTION TO SEMICONDUCTOR DEVICES 6

Semiconductors: N and P type, 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-concepts and fabrication.

MODULE II FABRICATION OF SEMICONDUCTOR DEVICES 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 III 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, Applications: Optical mouse, traffic lights, Luminescence, Cathode Luminescence, Electro Luminescence, Transparent Conductors, Liquid crystal displays – Dynamic scattering and Twisted nematic display, Display Glasses, Organic LEDs display, Charge-coupled devices (CCD), Inorganic Semiconductor TFT Technology, Organic TFT Technology; Flexible Displays, Touch Screen Technology.

MODULE IV MEMORY STORAGE DEVICES 8

Introduction to memory storage, Resistive Random Access Memory (ReRAM), Phase Change Memory (PCM); Magnetoresistive Random Access Memory

(MRAM)- Gaint Magnetoresistance (GMR), Tunnel Magnetoresistance (TMR), Ferroelectric Random Access Memory (FeRAM); Comparison and future directions, Hardware circuits, working analysis.

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: understand the physics of semiconductor devices and identify its significance towards information technology (IT).

CO1: gain insight into various fabrication techniques towards the realization of nano-dimensional semiconductor devices.

CO2: attain knowledge on working principles of optoelectronic devices and display technologies and can recognize their importance in commercial applications.

CO4: learn the principle of data storage and its application towards futuristic

memory technology.

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.

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PHDX 06	SENSORS AND ACTUATORS	L	T	P	C
SDG: 4		2	0	0	2

COURSE OBJECTIVES:

COB1: To understand the basic concept of sensors towards detection of pressure, position, velocity and temperature.

COB2: To avail knowledge on sensor which are sensitive to light, magnetic field, and acoustic waves

COB3: To study the different types of fabrication techniques towards realization of various sensors.

COB4: To get introduced towards MEMS technology and various actuators.

MODULE I INTRODUCTION TO SENSORS: PRESSURE, POSITION, VELOCITY AND TEMPERATURE 8

Introduction to sensors – working principles– classification – static and dynamic characteristics, Error Analysis, Pressure sensors – strain gauge, piezoelectric force sensor, vacuum sensors, Position sensor -Proximity sensor, Capacitive, Inductive and displacement sensor, velocity and acceleration sensors, Temperature sensor-thermocouples- thermistors-Thermo-EMF Sensors, metal Junction and metal Semiconductor junction types.

MODULE II SENSORS : LIGHT, MAGNETIC FIELD AND ACOUSTIC 8

Photocondutors- Optical Detectors - Photodiodes, Phototranistors, Optical encoder-Charge Coupled Device (CCD), Fabry Perot sensor, Hall effect, magneto resistive, magneto strictive sensors, Acoustic sensors-microphones-resistive, capacitive, piezoelectric, fiber optic, solid state - electrect microphone.

MODULE III SENSORS FABRICATION TECHNIQUES 7

Fabrication techniques – 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 MICROSYSTEMS AND ACTUATORS 7

Microelectro-mechanical systems (MEMS) - RF- MEMS, Micro fabrication and Applications, Classification of transducers: electrostatic, piezoelectric,

thermal, Microsystem design and fabrication.working principles of Actuators. Piezoelectric and Piezoresistive actuators, micropumps and micro actuators with practical applications Solid-state switches, relays Solenoids, D.C. Motors, A.C. Motors, Stepper motors. Shape memory alloy actuators.

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 various types of sensors and apply the ideas to distinguish between pressure, position, velocity and temperature based sensors

CO2: familiarize towards light, magnetic field, and acoustic based sensors and recognize their importance in commercial applications.

CO3: gain insight into various fabrication techniques towards the realization of sensors

CO4:apply the ideas to conceptualize MEMS technology and different actuators in engineering field

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.

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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.

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MATHEMATICS ELECTIVE
(SEMESTER III)

		L	T	P	C
MADX 01	**TRANSFORMS AND PARTIAL**				
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.

Learning of various mathematical techniques like matrices and calculus will lead to knowledge of applications in Computer Science

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.

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

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.

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.

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.

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	**SOCIOLOGY OF SCIENCE AND TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 17		**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) :
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	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.

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.

MODULE IV INDUSTRIAL POLICY 9

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:

7. Barthwal R R “Industrial Economics: An Introductory Textbook”, New Age International Pvt. Ltd Publishers, 2017
8. 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) :	**Academic Council:**
Mention details of BoS	18th Academic council held on
5thBoS of SSSH held on 29.12.2021	24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	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.

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**	**L**	**T**	**P**	**C**
SDG: 10, 16		**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 III SOCIAL 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.

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.