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

Regulations 2021
Curriculum and Syllabi
(Updated upto April 2023, as per 20th Academic Council)

B.Tech.
(Mechanical Engineering)

REGULATIONS 2021

CURRICULUM AND SYLLABI

(Updated upto April 2023, as per 20th Academic Council)

B.TECH. MECHANICAL 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 MECHANICAL ENGINEERING

VISION AND MISSION

VISION

To excel in providing quality education and training through Undergraduate and Postgraduate programs and carryout quality research in the field of Mechanical Engineering.

MISSION

- To provide a good learning experience through appropriate design of curriculum and syllabi that facilitate students to gain thorough understanding of the fundamental concepts and applications in Mechanical Engineering

- To equip students to solve challenging problems in Mechanical Engineering and related areas taking in to account their impact on the society

- To facilitate students to develop good communication, leadership and managerial skills through team approach in conducting experiments and projects

- To pursue academic and collaborative research activities with industry and other research institutions ensuring high quality in publications and other research outputs

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

B.TECH. (MECHANICAL ENGINEERING)

PROGRAMME EDUCATIONAL OBJECTIVES

- To induce a sense of excitement in learning by adapting a holistic approachthrough well designed curriculum, pedagogy and evaluation for a successful professional career

- To provide a strong foundation in physical sciences and analytics to enablecomprehensive understanding of the basic principles of Mechanical Engineering

- To develop knowledge and skill in applying engineering principles to conceive, design, analyze, manufacture, maintain and recycle engineering systems and components

- To equip the students with essential fundamental knowledge not only in thefacets of Mechanical Engineering but also from other relevant disciplines to infuse a multi-disciplinary approach

- To enhance the spirit of inquiry through projects, internships leading todevelopment of creativity, self-confidence and team spirit

- To provide necessary ambience with scope for developing communicationand life skills so as to meet the needs of the society in the globalized environment

PROGRAMME OUTCOMES

- Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

- Identify, formulate, review research literature, and analyze 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 toolsincluding prediction and modelling to complex engineering activities with an understanding of the limitations

- Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professionalengineering 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

PROGRAMME SPECIFIC OUTCOMES

- Apply the principles of Engineering to Model, Analyze, Design and realize physical components, processes and systems
- Work professionally in the Mechanical Systems

REGULATIONS - 2021

B.TECH. DEGREE PROGRAMMES

(Under Choice Based Credit System)

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

1.0 PRELIMINARY DEFINITIONS & NOMENCLATURE

In these Regulations, unless the context otherwise requires:

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

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

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

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

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

vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) ofthe 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 ofthe Institution who is responsible for the conduct of examinations and declaration of results.

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

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

2.0 ADMISSION

2.1a) Candidates for admission to the first semester of the eight semester B. Tech. degree programme shall be required to have passed the Higher Secondary Examination of the 10+2 curriculum

(Academic stream) prescribed by the appropriate authority or any other examination of any University or authority accepted by the Institution as equivalent thereto.

2.1b) The student shall have studied at least any three of the following courses: Physics, Mathematics, Chemistry, Computer Science, Electronics, Information Technology, Biology, Informatics Practices, Biotechnology, Technical Vocational Subjects, Agriculture, Engineering Graphics, Business Studies, Entrepreneurship at 10+2 level. In case if the student has not studied any or all the courses viz., mathematics, physics and chemistry, he / she shall undergo bridge course(s) in the concerned course(s) at 10+2 level knowledge.

2.2 Notwithstanding the qualifying examination, the candidate might have passed at 10+2, the candidate shall also write an entrance examination prescribed by the Institution for admission. The entrance examination shall test the proficiency of the candidate in the courses considered eligible for admission on the standards prescribed for 10+2 academic stream.

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

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

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

3.0 BRANCHES OF STUDY

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

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

4.0 STRUCTURE OF THE PROGRAMME

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

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

4.1.1 Mandatory Induction Programme for First year Students

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

4.1.2 Personality and Character Development

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

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

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

4.1.3 Online Courses for Credit Transfer

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

4.1.4 Value Added Courses

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

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

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

4.1.5 Industry Internship

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

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

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

4.1.6 Industrial Visit

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

4.2 Each course is normally assigned certain number of credits:

- one credit per lecture period per week
- one credit per tutorial period per week
- one credit for two to three periods and two credits for four periods of laboratory or practical sessionsper 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 theprescribed 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 facultyconcerned.

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 7^{th} 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

14.1A 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 concerneddepartment, based on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

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

16.0 PASSING AND DECLARATION OF RESULTS AND GRADE SHEET

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

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

I	-

"W" - denotes withdrawal from the course

"I" - denotes inadequate attendance in the course and prevention from appearance of semester end examination

"U" - denotes unsuccessful performance in the course.

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

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

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

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

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

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

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

Where n = number of courses

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

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

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

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

Percentage equivalent of marks = CGPA X 10

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

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

16.6.1 Eligibility for First Class with Distinction

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

16.6.2 Eligibility for First Class

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

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

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

17.0 SUPPLEMENTARY EXAMINATION

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

18.0 DISCIPLINE

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

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

19.0 ELIGIBILITY FOR THE AWARD OF DEGREE

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

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

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

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

iv) No disciplinary action pending against him/her.

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

20.0 MINOR DEGREE PROGRAMMES OFFERED FOR STUDENTS

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

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

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

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

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

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

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

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

21.0 POWER TO MODIFY

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

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B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE ANDTECHNOLOGY

B.TECH. MECHANICALENGINEERING

CURRICULUM FRAME WORK, 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	CHD1181	Engineering Materials and Applications*	3	0	2	4
3.	BSC	MAD1181	Algebra and Differential Calculus	3	1	0	4
4.	ESC	GED1101	Engineering Graphics *	2	0	2	3
5.	ESC	GED1102	Engineering Design	2	0	0	2
6.	ESC	GED1103	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.	BSC		Chemistry Elective	2	0	0	2
4	BSC	MAD1283	Partial Differential Equations and Transforms	3	1	0	4
5.	ESC	GED 1201	Engineering Mechanics	3	1	0	4
6.	ESC	GED 1202	Basic Electrical and Electronics Engineering *	3	0	2	4
7.	PCC	MED 1211	Engineering Materials	3	0	0	3
8.	PCC	MED 1212	Design Appreciation Laboratory **	0	0	2	1
9.	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	MED 2101	Solid Mechanics*	2	0	2	3
4.	PCC	MED 2102	Engineering Thermodynamics	2	1	0	3
5.	PCC	MED 2103	Theory of Machines	3	1	0	4
6.	PCC	MED 2104	Basic Manufacturing Processes*	2	0	2	3
7.	PCC	MED 2105	Machine Drawing Laboratory**	0	0	2	1
8.	PCC	MED 2106	Mechanics Laboratory**	0	0	2	1
9.	HSC	GED 2101	Essential Skills and Aptitude for Engineers**	0	0	2	1
			Credits				**23**

SEMESTER IV

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	MED 2211	Thermal Engineering*	2	1	2	4
2.	PCC	MED 2212	Fluid Mechanics and Machinery*	2	1	2	4
3.	PCC	MED 2213	Design of Machine Elements	3	1	0	4
4.	PCC	MED 2214	Materials Engineering and Technology*	2	0	2	3
5.	PCC	MED 2215	Machine Tools and Metrology*	3	0	2	4
6.	PEC		Professional Elective courses	3	0	0	3
7.	HSC	GED 2201	Workplace Skills and Aptitude for Engineers**	0	0	2	1
8.	MC	GED 2202	Indian Constitution and Human Rights	2	0	0	0
			Credits				**23**

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	MED 3101	Heat and Mass Transfer*	2	1	2	4
3.	PCC	MED 3102	Mechatronics*	3	0	2	4

4.	PCC	MED 3103	Automation in Manufacturing*	2	0	2	3
5.	PCC	MED 3104	Product Modelling Laboratory**	0	0	2	1
6.	PEC		Professional Elective courses				6
7.	HSC	GED 3101	Communication Skills for Career Success**	0	0	2	1
8.	PROJ	MED3105	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.	GE		Open Elective I	3	0	0	3
3.	PCC	MED 3211	Finite Element Analysis *	3	0	2	4
4.	PCC	MED 3212	Additive Manufacturing*	2	0	2	3
5.	PCC	MED 3213	Simulation Laboratory **	0	0	2	1
6.	PEC		Professional Elective Courses				6
7.	HSC	GED 3201	Reasoning and Aptitude for Engineers**	0	0	2	1
			Credits				**20**

SEMESTER VII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	GE		Open Elective II				3
2.	GE		Open Elective III				3
3.	PCC	MED 4101	Automobile Engineering *	2	0	2	3
4.	PE		Professional Elective Courses				12
5.	PROJ	MED 4102	Internship II[###]	0	0	2	1
6.	HSC	GED 4101	Employability Skills [$]	0	0	2	1
			Credits				**22**

SEMESTER VIII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PROJ	MED 4211	Project Work	0	0	18	9
			Credits				**09**

Overall Total Credits – 165

* 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 5^{th} Semester.

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

DESIGN STREAM

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PEC	MEDX 01	Advanced Strength of Materials	3	0	0	3
2.	PEC	MEDX 02	Design of Hydraulics and Pneumatics	3	0	0	3
3.	PEC	MEDX 03	Noise, Vibration and Harshness	3	0	0	3
4.	PEC	MEDX 04	Design of Jigs, Fixtures and Press Tools	3	0	0	3
5.	PEC	MEDX 05	Industrial Problem-Solving Techniques	3	0	0	3
6.	PEC	MEDX 06	Product Design and Manufacturing	3	0	0	3
7.	PEC	MEDX 07	Design of Transmission Systems	3	0	0	3
8.	PEC	MEDX 08	Mechanics of Composite Materials	3	0	0	3
9.	PEC	MEDX 09	Design of Material handling Equipment	3	0	0	3
10.	PEC	MEDX 10	Tribology	3	0	0	3
11.	PEC	MEDX 11	Design of Electric Vehicle Components	3	0	0	3
12.	PEC	MEDX 12	Shipment Packaging Design and Development	3	0	0	3
13.	PEC	MEDX 13	Design of Pressure Vessels and Piping Engineering	2	0	2	3
14.	PEC	MEDX 14	Geometric Modelling	2	0	0	2
15.	PEC	MEDX 15	Reliability Engineering	2	0	0	2
16.	PEC	MEDX 16	Micro Electro Mechanical Systems (MEMS)	2	0	0	2
17.	PEC	MEDX 17	Instrumentation and Control	2	0	0	2
18.	PEC	MEDX 18	Advanced System Simulation (1D Modelling)	1	0	0	1
19.	PEC	MEDX 19	Product Design using Value Engineering	1	0	0	1

THERMAL STREAM

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PEC	MEDX 31	Refrigeration and Air Conditioning	3	0	0	3
2.	PEC	MEDX 32	Advanced I.C. Engines	3	0	0	3
3.	PEC	MEDX 33	Nuclear Engineering	3	0	0	3
4.	PEC	MEDX 34	Gas Dynamics and Jet Propulsion	3	0	0	3
5.	PEC	MEDX 35	Energy Conversion Systems	3	0	0	3
6.	PEC	MEDX 36	Computational Flow and Heat Transfer	3	0	0	3
7.	PEC	MEDX 37	Renewable Sources of Energy	3	0	0	3
8.	PEC	MEDX 38	Solar Engineering	3	0	0	3
9.	PEC	MEDX 39	Design of Heat Transfer Equipment’s	3	0	0	3
10.	PEC	MEDX 40	Electric and Hybrid vehicles *	2	0	2	3
11.	PEC	MEDX 41	Energy Conservation and Management	2	0	0	2
12.	PEC	MEDX 42	Automotive Pollution and Control	2	0	0	2
13.	PEC	MEDX 43	Combustion of Fuels	2	0	0	2
14.	PEC	MEDX 44	Alternate Fuels	1	0	0	1
15.	PEC	MEDX 45	Design of Compact and Micro Heat Exchangers	1	0	0	1

MANUFACTURING STREAM

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PEC	MEDX 51	Process Planning and Cost Estimation	3	0	0	3
2.	PEC	MEDX 52	Production Planning and Control	3	0	0	3
3.	PEC	MEDX 53	Statistics and Quality control	3	0	0	3
4.	PEC	MEDX 54	Project Management	3	0	0	3
5.	PEC	MEDX 55	Advanced Machining Processes	3	0	0	3
6.	PEC	MEDX 56	Surface Mounting Technology	3	0	0	3
7.	PEC	MEDX 57	Operation Research	3	0	0	3

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
			Techniques				
8.	PEC	MEDX 58	Total Productive Maintenance	3	0	0	3
9.	PEC	MEDX 59	Agile Manufacturing	3	0	0	3
10.	PEC	MEDX 60	Composite Materials for Manufacture *	2	0	2	3
11.	PEC	MEDX 61	Advanced Welding Processes	2	0	2	3
12.	PEC	MEDX 62	Advanced Casting and Forming Process	3	0	0	3
13.	PEC	MEDX 63	Industrial Engineering	3	0	0	3
14.	PEC	MEDX 64	Green Manufacturing Design and Practices	3	0	0	3
15.	PEC	MEDX 65	Rubber Product Manufacturing Technology	3	0	0	3
16.	PEC	MEDX 66	Tyre Manufacture and Testing	3	0	0	3
17.	PEC	MEDX 67	Plant Layout and Material Handling	2	0	0	2
18.	PEC	MEDX 68	Production Management	2	0	0	2
19.	PEC	MEDX 69	Internet of Things for Manufacturing	2	0	0	2
20.	PEC	MEDX 70	Digital Manufacturing	1	0	0	1
21.	PEC	MEDX 71	Geometric Dimensioning and Tolerancing	1	0	0	1
22.	PEC	MEDX 72	Tool and Die Design	1	0	0	1

MATERIALS STREAM

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PEC	MEDX 76	Aerospace Materials	3	0	0	3
2.	PEC	MEDX 77	Thin films, Coatings and Applications	3	0	0	3
3.	PEC	MEDX 78	Advanced Engineering Materials	3	0	0	3
4.	PEC	MEDX 79	Fracture of Engineering Materials	3	0	0	3
5.	PEC	MEDX 80	Design and Applications of Biomaterials	3	0	0	3
6.	PEC	MEDX 81	Powder Metallurgy	3	0	0	3

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
7.	PEC	MEDX 82	Friction Materials: Formulation and Characterization	3	0	0	3
8.	PEC	MEDX 83	Rubber Recycling and Waste Management	3	0	0	3
9.	PEC	MEDX 84	Polymer Rheology	3	0	0	3
10.	PEC	MEDX 85	Rubber Technology	3	0	0	3
11.	PEC	MEDX 86	Characterization of Materials	3	0	0	3
12.	PEC	MEDX 87	Science and Technology of Nanomaterials	2	0	0	2
13.	PEC	MEDX 88	Materials for Modern Device Technology	2	0	0	2
14.	PEC	MEDX 89	Materials for Energy Technologies	2	0	0	2
15.	PEC	MEDX 90	Materials for Extreme Environment	2	0	0	2
16.	PEC	MEDX 91	Dynamic behavior of Materials	2	0	0	2
17.	PEC	MEDX 92	Physical Metallurgy	1	0	0	1
18.	PEC	MEDX 93	Corrosion Engineering	1	0	0	1

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

CHEMISTRY ELECTIVES – II 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

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 Snd 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

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	3	0	0	3	CA

		Analytics					
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 Applictoins	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 Intelligence	3	0	0	3	IT
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 & 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 – 30; Total Hours – 75

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 theirapplications.

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.

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

COURSE OBJECTIVES: To make the students conversant with

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

COB2: synthesis, properties and applications of nanomaterials

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

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

COB5: different types of sensors and its applications.

MODULE I POLYMER AND COMPOSITES 9

Introduction – classification: source, heat, composition and structure- glass transition temperature – synthesis, properties and applications of polycarbonate, polyurethane, teflon, ABS, kevlar, bakelite, epoxy resin, acrylic polymers (PAN) - biopolymers : importance and applications of biodegradable polymers (PLA, PHBV).

Composites- Introduction - properties and applications: fibre-reinforced plastics (glass, carbon and aramid), ceramic matrix composites (CMC) –- bio-composites.

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.

		L	T	P	C
MAD 1181	**ALGEBRA AND DIFFERENTIAL CALCULUS**				
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

	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	M	L	-	-	-	-	-	-	-	-	-	-	-	-	-

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, 53rd Edtion, 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):
18thBoS 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**
SDG:9		**2**	**0**	**0**	**2**

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):

18thBoS 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.

		L	T	P	C
GED 1103	**MANUFACTURING PRACTICES LABORATORY**	**L**	**T**	**P**	**C**
SDG: 9		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

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

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

COB3: To impart knowledge onsand mould preparation for simple components

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

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

PRACTICALS

List of Experiments:

CIVIL ENGINEERING PRACTICE:

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

MECHANICAL ENGINEERING PRACTICE

1. Fabrication of a small Table frame with Butt, Lap and Fillet Joints using Arc Welding - Gas cutting (Demo)
2. 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):
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	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	M	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	L	-	-	-	-	-	-	-	-	-	-	-	-	-

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

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

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

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

COURSE OBJECTIVES:

COB1: To explore the hardware and software components of the computer

COB2: To learn the structured and procedural programming concepts using C.

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

MODULE III USER-DEFINED FUNCTIONS AND FILE OPERATIONS 05

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

PRACTICALS

LIST OF PROGRAMS IN C:

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

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

L – 15; P – 30; Total Hours – 45

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

Students who complete this course will be able to

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

CO2: bring out the importance of structural and procedural programming

CO3: write C coding using conditional and iteration statements

CO4: develop programs using Functions, Pointers and Files

CO5: implement program to build a real time application.

Board of Studies (BoS) :

18th BoS of CSE held on 26.07.2021

Academic Council:

17th AC held on 15.07.2021

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

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

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

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

SEMESTER II

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

COURSE OBJECTIVES:

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

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

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

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

COB5: To sharpen their academic writing skills

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

MODULE I HUMAN RESOURCES 10

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

S: Introducing one self – exchanging personal info.

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

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

Voc. development: Prefixes, Suffixes

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

MODULE II TRANSPORT 10

L: Listening to long scientific talks

S: Sharing personal information – greeting, leave taking.

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

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

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

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

MODULE III ENERGY 9

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

S: Asking about routine actions & expressing opinions.

R: Locating Specific Information

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

Voc. development: Sequence words, misspelt words.

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

MODULE IV OUR LIVING ENVIRONMENT 8

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

S: Speaking about one's friend.

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

W: Argumentative writing.

Voc. Development: Synonyms, antonyms, phrasal verbs.

Lang. development: If clauses, Subject - Verb Agreement

MODULE V TECHNOLOGY 8

L: Listening to talks (General & Scientific).

S: Short group conversations.

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

W: Short essays, Dialogue writing.

Voc. Development: Idioms & Phrases.

Lang. development: Modal verbs.

L - 45; Total Hours - 45

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

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

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

CO3: Comprehend conversations and short talks delivered in English

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

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

Board of Studies (BoS) :

13th BoS of Department of English held on 17.6.2021

Academic Council:

17th AC held on 15.07.2021

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

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

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

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

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

COURSE OBJECTIVES:

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

COB2: To introduce basics and engineering applications of Fourier series

COB3: To develop Fourier transform techniques

COB4: To introduce techniques and engineering applications of Laplace Transforms

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

MODULE I PARTIAL DIFFERENTIAL EQUATIONS 9+3

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

MODULE II FOURIER SERIES 9+3

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

MODULE III FOURIER TRANSFORMS 9+3

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

MODULE IV LAPLACE TRANSFORM 9+3

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

MODULE V Z – TRANSFORM 9+3

Introduction and Definition of Z-transform - Properties of Z- Transform - Convolution Theorem of Z-Transform - Inverse Z–transform - Convolution

Theorem of Inverse Z-Transform - Formation of difference equations - Solving Difference Equations using Z-Transform

L – 45; T - 15; Total Hours – 60

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

At the end of the course students will be able to

CO1:form and solve the partial differential equations

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

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

CO4:solve ordinary differential equations using Laplace transforms

CO5: solve difference equations using Z-transform

Board of Studies (BoS) :

12th BOS of Mathematics & AS held on 23.06.2021

Academic Council:

17th AC held on 15.07.2021

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

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

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

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

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

COURSE OBJECTIVES:

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

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

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

COB4: To impart knowledge on friction and its applications

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

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

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

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

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

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

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

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

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

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

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

L – 45; T – 15; Total Hours – 60

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

After completion of the course, students should be able to

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

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

CO3: determine the properties of surfaces

CO4: analyse and evaluate the frictional forces between the bodies

CO5: apply the laws of motion in solving dynamics problems

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

Academic Council:
17th AC held on 15.07.2021

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

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

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

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

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

17^{th} 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	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.

MED 1211	**ENGINEERING MATERIALS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To study the classification of materials and selection of materials.

COB2: To learn about ferrous materials and their applications.

COB3: To impart the knowledge about various non-ferrous materials.

COB4: To educate different types of polymer materials and their applications.

COB5: To learn about different ceramic, glasses and carbon materials.

MODULE I CLASSIFICATION OF MATERIALS AND MATERIAL SELECTION L:7

Engineering materials and their classification: Metals/ Ceramics/Polymers/Glasses, Composites - Material Properties: Mechanical, Physical, Chemical, Electrical, Thermal, Dielectric, Semi-conducting properties of materials, and Degradation of materials - Structure-Property-Processing relationship, Selection of materials for different engineering applications.

MODULE II FERROUS MATERIALS AND THEIR APPLICATIONS L:10

Wrought iron - Types of steel and its applications: Carbon steels (low, medium, high), Alloy steel (manganese, silicon, nickel, titanium, copper, chromium, and aluminum), Stainless steel (austenitic, ferritic, martensitic), Tool steel (tungsten, molybdenum, cobalt and vanadium), Special steels - Cast iron types, properties and applications: Grey cast iron, White cast iron, Malleable cast iron, Nodular cast iron, Chilled cast iron, Alloy cast iron.

MODULE III NON-FERROUS MATERIALS AND THEIR APPLICATIONS L:10

Properties and applications: Copper and its alloys - Aluminium and its alloys - Lead and its alloys - Zinc and its alloys - Tin and its alloys - Titanium and its alloys - Nickel and its alloys - Magnesium and its alloys.

MODULE IV POLYMER MATERIALS L:9

Properties and applications of thermoplastic materials: Polyethylene or Polythene (HDPE, LDPE), Polyvinylchloride (PVC), Polycarbonate (PC), Polypropylene(PP), Teflon or Polytetrafluoroethylene (PTFE), Polystyrene (PS), Acrylics (Polymethyl Methacrylate PMMA), ABS (Acrylonitric Butadiene Styrene), Silicones, Polyvinylidene Chloride, Polyamides (PA), Polybutylene terephthalate (PBT), Polyether ether ketone (PEEK), Polyphenylene sulfide (PPS) - Properties and applications of thermoset materials: Polyester resin, Polyurethanes, Bakelite, Urea-formaldehyde, Epoxy resin, Polyimides, Furan - Properties and applications of rubber materials - Natural rubber and Synthetic rubber

MODULE V GLASS, CERAMIC AND CARBON MATERIALS L:9

Properties and applications of glasses: Float glass, Shatterproof glass, Laminated glass, Chromatic glass, Tinted glass, Toughened glass, Glass blocks - Properties and applications of ceramic materials: Clay products, Cements, Oxides: Alumina, Beryllia, Ceria, Zirconia. Non-oxides: Carbide, Boride, Nitride, Silicide, Properties and applications of Carbon, Graphite, Graphene and Diamond.

L – 45; Total Hours – 45

TEXT BOOKS:

1. J.W. Martin, “Materials for Engineering”, Third edition, Woodhead Publishing Limited and CRC Press LLC, 2006.
2. George Murray, Charles V. White, Wolfgang Weise, “Introduction to Engineering Materials”, 2nd Edition, CRC Press LLC, 2007.
3. C. P. Sharma, “Engineering Materials: Properties and Applications of Metals and Alloys”, PHI Learning Pvt. Ltd., 2003.
4. B.K.Agarwal, “Introduction to Engineering Materials”, Tata McGraw Hill, 2008.

REFERENCES:

1. Michael F. Ashby, Kara Johnson, “Materials and Design”, Third Edition. The Art and Science of Material Selection in Product Design, Butterworth-Heinemann, 2014.
2. Hans Berns, Werner Theisen, “Ferrous Materials: Steel and Cast Iron”,1st Edition, Springer-Verlag Berlin Heidelberg, 2008.
3. M. Spittel, T. Spittel (auth.), H. Warlimont, “Landolt-Börnstein - Group VIII Advanced Materials and Technologies 2C2: Advanced Materials and Technologies, Part 1& 2& 3: Non-ferrous Alloys - Light Metals”, 1st Edition, Springer-Verlag Berlin Heidelberg, 2011.
4. James F. Shackelford, William Alexander, “Polymer Materials Science and Engineering Handbook”, 3rd Edition, CRC Press, 2000.

5. Philippe Boch, "Jean-Claude Nièpce Ceramic Materials: Processes, Properties and Applications", 1st edition, Wiley-ISTE, 2007.
6. Hugh O. Pierson, "Materials Science and Process Technology, Handbook of Carbon, Graphite, Diamond, and Fullerenes: Properties, Processing, and Applications", William Andrew, 1995.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:select the suitable materials based on their properties

CO2:explain the different types of ferrous materials and its applications

CO3:compare the properties of different non-ferrous materials

CO4:recognize the different types of polymer materials and its applications

CO5:choose ceramic materials, glasses and carbon materials for specific Applications

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

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 engineering materials and components leads to construction of resilient infrastructure and sustainable industrialization.

MED 1212	**DESIGN APPRECIATION LABORATORY**	**L**	**T**	**P**	**C**
SDG: 9		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To learn the use of standard components such as fasteners, gears, bearings, valves and tools

COB2: To get trained in preparing teardown plan and dismantle products

COB3: To realize the use of various materials and mechanisms involved in engineering products

COB4: To impart knowledge in building engineering products.

COB5: To kindle students creativity, ideation and team working skills

PRACTICALS

List of Experiments:

STUDY EXERCISE:

1. Study of Standard Components (Threaded fasteners, gears, bearings, valves, tools, cutting tools, Belt / chain drives, etc).
2. Study of Automobile Components (Front axle, Rear axle, Differential, Transmission system and Braking system).

TEAR DOWN EXERCISE:

Dismantle and assemble the following engineering products to identify the components and its functions.

3. Gear pump, vane pump, axial piston pump and radial piston pump.
4. Reciprocating pump, centrifugal pump and submersible pump.
5. Reciprocating compressor / Blower / Rotary compressor.
6. Work and tool holding devices.
7. Internal combustion engine, gearbox and carburetor.
8. Mechanical components of electronic devices (Motors and generators, CDD, HDD, Printer, CPU and Monitor).

TOY DESIGN PROJECT:

Group of students will design simple toys, or products that perform functions like move / respond / shake / jump / flip-flop, etc, when pulled or pushed or turned on. They can work with different materials and mechanisms to create a moving toy.

P – 30; Total Hours –30

TEXT BOOKS:

1. Todd McLellan, “Things Come Apart:A Teardown Manual for Modern Living”, Thames & Hudson Ltd, 2013.
2. Design Appreciation lab Manual of BSARCIST.

REFERENCES:

1. Jerry Kaufman, & Yoshihiko Sato “Value Analysis Tear-down: A New Process for Product Development and Innovation”, Industrial Press Inc., 2005.
2. Robert W. Messler, “Reverse Engineering: Mechanisms, Structures, Systems & Materials”, McGraw Hill Education, 2014.
3. Kevin Otto, Kristin wood, Product Design, Pearson Publishers, 2013.
4. Chris Van, “Toy Design”, Thames& Hudson Ltd, 2009.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:explain the use of standard components such as fasteners, gears, bearings, valves and tools

CO2:dismantle products by preparing teardown plan

CO3:identify the materials, design features and mechanisms in engineering systems

CO4:develop simple products that perform a function

CO5:demonstrate creativity, ideation and team working skills

Board of Studies (BoS):

18th BoS of MECH held on 21.06.2021

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
CO1			L					L			L		L	L
CO2			L							H			L	L
CO3					L		L				M		L	L
CO4			H		L							M	L	L
CO5			L						M			L	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 understanding of various mechanisms and materials involved in the design of mechanical products shall be used to provide innovative and sustainable solutions for the industry.

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) :	**Academic Council:**
11th BoS of Chem held on 17.06.2021	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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

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

MED 2101	SOLID MECHANICS	L	T	P	C
SDG:9		2	0	2	3

COURSE OBJECTIVES:

COB1: To gain knowledge about stresses and strains of solids
COB2: To study about shear force and bending moment of the beams
COB3: To familiarize with deflection of beams and thin cylinders
COB4: To acquire knowledge about torsion of shafts and springs

MODULE I STRESSES AND STRAINS OF SOLIDS L:9 P:12

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses : Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads - Biaxial stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress.

MODULE II SHEAR FORCE, BENDING MOMENT OF BEAMS L:8 P:6

Types of beams: Supports and Loads – Shear force and Bending Moment in beams: Cantilever, Simply supported and Overhanging beams – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section.

MODULE III DEFLECTION OF BEAMS AND THIN CYLINDERS L:7 P:6

Beam deflection – Evaluation of beam deflection and slope - Double integration method- Macaulay's method-Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells.

MODULE IV TORSION OF SHAFTS AND SPRINGS L:6 P:6

Analysis of torsion in circular bars – Shear stress distribution – Bars of solid and hollow circular section –Twist and torsion stiffness –Composite Shaft—Strength of shaft of varying sections-Close-coiled helical springs –Deflection of helical coil springs under axial loads – Design of helical coil springs – stresses in helical coil springs under torsion loads.

PRACTICALS

List of Experiments

1. Stress - Strain evaluation for mild steel
2. Double shear test on Mild steel
3. Double shear test on Aluminum rod.
4. Determination of Strain energy
5. Deflection test on cantilever beam
6. Deflection test on simply supported beam
7. Torsion test on mild steel rod
8. Compression test on helical springs
9. Buckling test on column
10. Biaxial stresses on thin cylinder

L – 30; P – 30; TOTAL HOURS – 60

TEXT BOOKS:

1. Bansal, R.K, “A text book of strength of material”, Laxmi Publication (P) Ltd., 2018.
2. Ramamrutham S & Narayanan R, “Strength of materials”, Dhanpat Rai Publication, 2020.

REFERENCES:

1. Popov E.P, “Engineering Mechanics of Solids”, Prentice-Hall of India, New Delhi, 2015.
2. Beer F. P. and Johnston R, “Mechanics of Materials”, 3rd Edition, McGraw-Hill Book, 8th Edition, 2009.
3. Nash W.A, “Theory and problems in Strength of Materials”, Schaum’s Outline, McGraw-Hill Book, 6th Edition, 2013.
4. Timoshenko S.P, “Elements of Strength of Materials”, Tata McGraw-Hill, 5th edition, 2018.
5. Kazimi S.M.A, “Solid Mechanics”, Tata McGraw-Hill Publishing Co, New Delhi, 2017.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:explain about the stresses, strains and deformation of solids

CO2:compute and analyse shear force and bending moment of beams

CO3:determine the deflection of beams and stresses on thin cylinders

CO4:analyse stresses induced in circular shafts and springs due to torsion

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

The understanding of solid mechanics influences the structural integrity within manufacturing industry which is reflected in the production of technically complex components.

MED 2102	ENGINEERING THERMODYNAMICS	L	T	P	C
SDG:9		2	1	0	3

COURSE OBJECTIVES:

COB1: To study the fundamentals and laws of thermodynamics

COB2: To familiarize the concept of entropy and availability

COB3: To learn the properties of pure substances and principle of steam power cycles

COB4: To gain knowledge on gas mixtures and thermodynamic relations

COB5: To study the properties of moist air and psychrometric processes

MODULE I FIRST LAW OF THERMODYNAMICS **L:6 T:3**

Basic concepts - Thermodynamic systems and control volume - Property, state, path and process - quasi-static process, work, modes of work - Zeroth law of thermodynamics – First law of thermodynamics - Concepts of internal energy, Specific heat capacities, Enthalpy - Energy balance for closed and open systems - First law applied to steady flow devices.

MODULE II SECOND LAW, ENTROPY AND AVAILABILITY **L:7 T:3**

Second law of thermodynamics – Kelvin's and Clausius' statements -Thermal energy reservoirs - Reversibility and irreversibility - Carnot cycle -Reversed Carnot cycle -Efficiency and COP - Thermodynamic temperature scale-Clausius inequality-Concept of entropy -Entropy of ideal gas and principle of increase of entropy – Carnot theorem -Absolute entropy and availability-Concept of Exergy analysis – Exergy efficiency - Application of Exergy to thermal systems

MODULE III PROPERTIES OF PURE SUBSTANCES AND STEAM POWER CYCLES **L:6 T:3**

Properties of pure substances - Thermodynamic properties of pure substances in solid, liquid and vapour phases -Phase rule, P-V, P-T, T-V, T-S, H-S diagrams - PVT surfaces- Thermodynamic properties of steam - Calculations of work done and heat transfer in non-flow and flow processes - Rankine cycle -Reheat and regenerative cycles – Simple problems - Exergy analysis of vapour power cycles.

MODULE IV GAS MIXTURES AND THERMODYNAMIC RELATIONS **L:6 T:3**

Gas mixtures - Properties of ideal and real gases - Equation of state - Vander Waal's equation of state - Compressibility factor and compressibility chart - Dalton's law of partial pressure, Amagut law - T-ds equations - Maxwell's relations - Clausius Clapeyron equations - Joule – Thomson coefficient

MODULE V PSYCHROMETRY **L:5 T:3**

Psychrometry and psychrometric chart - Property calculations of air vapour mixtures - Psychrometric processes: Sensible and Latent heat exchange processes, Humidification and dehumidification, Adiabatic mixing, Evaporative cooling – Problems –Moisture control techniques - Application of Refrigeration systems

L – 30; T – 15; TOTAL HOURS – 45

TEXT BOOK:

1. Nag. P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw-Hill, 2013.

REFERENCES:

1. Yunus Cengel and Michael Boles,"Thermodynamics: An Engineering Approach", Ninth Edition – Tata Mc Graw Hill, 2019.
2. Robert T. Balmer, "Modern Engineering Thermodynamics", Elsevier Science, 2011.
3. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2017.
4. Chattopadhyay P "Engineering Thermodynamics", Oxford University Press, 2015.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: apply the fundamentals of thermodynamics to quantify energy transfer.

CO2: explain the second law of thermodynamics applied to heat and refrigerators.

CO3: analyse the properties of pure substances and explain the principles of steam power cycles

CO4: explain the properties of gas mixtures and thermodynamic relations

CO5: demonstrate various Psychrometric processes and their relations

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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 thermodynamic principles enables to design and develop a sustainable thermal system.

MED 2103	**THEORY OF MACHINES**	**L**	**T**	**P**	**C**
SDG:9		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

COB1: To gain knowledge about the basics of mechanisms

COB2: To learn about the velocity and acceleration in mechanisms

COB3: To acquire knowledge on different types of transmission mechanisms

COB4: To gain knowledge on balancing and vibrations in machines

COB5: To study about the various controlling mechanisms

MODULE I FUNDAMENTALS OF MECHANISMS L:10 T:2

Introduction - Terminologies associated with theory of machines:Links, pairs, mechanisms, inversion, structure and machines - Different mechanisms and its inversions: Four bar chain mechanism,slider crank mechanism, double slider crank mechanism- Indexing mechanisms – Straight line Mechanisms - Design of Mechanisms – Mobility - Grubler's criterion - Grashoff's law-Mechanical Advantage-Transmission angle.

MODULE II VELOCITY AND ACCELERATION IN MECHANISMS L:7 T:3

Displacement and velocity analysis in mechanisms - Graphical Method – Velocity polygons - Approach to solve velocity and acceleration related to mechanisms using relative velocity method for single slider crank mechanism and four bar chain mechanism - Klein's construction for single slider cranks mechanism - Coriolis component of acceleration-Force analysis-static and dynamic analysis

MODULE III TRANSMISSION MECHANISMS L:9 T:3

Cams and Followers - Types of cams - Types of followers -Displacement, Velocity and Acceleration time curve for cam profiles- Follower motions: uniform velocity, SHM, Uniform acceleration and retardation and Cycloidal motion.

Gears - Spur gear terminology and definitions - Fundamental Law of toothed gearing and involute gearing - Interference and undercutting – Gear Trains – Epicyclic gear trains

MODULE IV BALANCING AND VIBRATIONS L:11
T:4

Balancing - Concepts and types of balancing - Effects of unbalanced masses - Balancing of revolving masses in same and different planes - Analytical and graphical method - Balancing of reciprocating masses – Variation in tractive force - Hammer blow - Balancing of locomotives- V-Engines.
Vibrations –Undamped free vibrations –Natural frequency of single degree of freedom system - Transverse vibration with point load and UDL-Dunkerley's method - Critical speed of the shaft - Damping factor and Logarithmic Decrement in free vibration - Forced vibrations - Steady state amplitude - Vibration isolation and transmissibility ratio -Problems–Torsional vibrations-Single and two rotor systems.

MODULE V CONTROL MECHANISM L:8
T:3

Governors - Types : Watt Governor, Porter governor, Proell Governor–Characteristics of governor - Applications
Flywheel - Turning moment diagram – Concept – Use of flywheel for different machines-Fluctuations of energy- Co-efficient of fluctuation of speed and energy – Gyroscopes – Introduction and applications- Problems.

L – 45; T – 15; TOTAL HOURS – 60

TEXT BOOKS:

1. S.S.Rattan, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, 5th Edition, 2017.
2. R.S. Khurmi & J.K.Gupta "Theory of Machines", S. Chand Publications, 14th edition, 2020.

REFERENCES:

1. Thomas Beven, "Theory of Machines", CBS Publishers & Distributors, 3rd Edition, 2009.
2. Gordon R. Pennock& Joseph E. Shigley John J. Uicker, "Theory of Machine and Mechanisms", Oxford University Press; 4th edition, 2014.

COURSE OUTCOMES:

After completion of the course, students should be able to
CO1: explain the basics of differentmechanisms
CO2: determine the velocity and acceleration for different mechanisms

CO3: analysedifferent transmission mechanisms

CO4: solve balancing and vibration problems in machines

CO5: analyse various controlling mechanism in machines

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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

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

The understanding of different components and forces acting on various mechanisms lead to construction of robust engineering systems.

MED 2104	**BASIC MANUFACTURING PROCESSES**	**L**	**T**	**P**	**C**
SDG:9		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To study the principles of various casting processes and gatingsystem.

COB2: To familiarize the various types of metal joining processes

COB3: To acquire knowledge on different metal forming operations.

COB4: To gain knowledge on the principles of metal cutting processes

MODULE I CASTING PROCESSES **L:7 P:8**

Casting: Basic principles of metal casting - Patterns and allowances - moulding sand properties and testing -Core making -Types of furnaces – Steps involved in sand casting - Fettling - Defects and Inspection of castings - Casting Design: Gating system, Mould filling velocity and time, Determination of solidification time, Riser design and placement - Principle of special casting processes: Shell, Lost wax process, Centrifugal casting, Pressure die casting and Stir casting.

MODULE II METAL JOINING PROCESSES **L:7 P:8**

Principle of welding, soldering, Brazing and adhesive bonding -Gas welding - Principle - Equipment - Flame characteristics- Welding symbols - Metallurgical aspects of welding – Arc welding power sources – Flux covering -Different types of electrodes and their applications - Processes -Resistance welding: Principle, Spot, Seam, Butt – Special welding processes -Electron beam welding - Friction stir welding- Under water welding -Welding Inspection – Defects, Causes & Remedies.

MODULE III METAL FORMING PROCESSES **L:10 P:6**

Classification of Forming Processes– Hot and cold working- Forging operations – Rolling- Types of Rolling mills - Rolling operations -Extrusion - Rod, wire and tube drawing - Mannessmann process of seamless pipe manufacturing -Deep drawing - Principle and Types - Powder Metallurgy: Principle andapplications-Sheet metal forming process: Shearing and blanking, bending, drawing, spinning, stretch forming - Formability studies - Forming limit diagram - Defects- Explosive forming - Hydro forming.

MODULE IV METAL REMOVAL PROCESSES L:6 P:8

Machining processes: Turning, Drilling, Reaming, Boring and Milling processes - Tool geometry- Mechanics of orthogonal and oblique cutting - Mechanism of chip formation- Forces in Metal cutting – Tool life – Simple problems - Types of chips - Cutting tool materials- Cutting tool reconditioning- Cutting fluids -Unconventional Machining processes -Types and applications.

PRACTICALS

LIST OF EXPERIMENTS

1. Hands on Exercise on wooden Pattern Making
2. Development of simple parts using sand casting techniques
3. Manual Arc welding: Butt joints, Tee and lap joints
4. TIG/MIG welding: Butt joints, Tee and lap joints
5. Detection of welding defects
6. To prepare bolt head using forging
7. To make metal components using Powder metallurgy technique
8. To prepare a sheet metal product (Tray and Funnel).
9. Characterization of Chips based on materials and machining processes
10. To make simple components using different lathe operations.

L – 30; P-30; TOTAL HOURS – 60

TEXT BOOKS:

1. Serope Kalpakjian, Steven R. Schmid, “Manufacturing Engineering and Technology”, Pearson Education Sixth Edition, Inc.2018.
2. Mikell P. Groover, “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, 7th Edition, Wiley Publications, 2019.
3. S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirijhar Roy, “Elements of Workshop Technology”, Media Promoters Pvt. Ltd, Mumbai,14th Edition, 2011.

REFERENCES:

1. P.N. Rao, “Manufacturing Technology”, Tata McGraw- Hill Publishing Limited, III Edition, 2009.
2. J.T. Black, Ronald A. Kosher, “DeGarmo’s Materials and Processes in Manufacturing”, John Wiley & Sons, Inc, Tenth Edition, 2008.

3. R.K. Rajput, "A Textbook of Manufacturing Technology", Laxmi Publications Pvt Ltd., Second Edition, December 2007.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:explain various casting processes and design the appropriate gating system

CO2:choose appropriate metal joining process

CO3:explain different metal forming operations and its applications

CO4:describe about the principles of metal cutting processes

Board of Studies (BoS):

19th BoS of MECH held on 21.12.2021

Academic Council:

18th AC held on 24.02.2022

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

The holistic understanding of basic manufacturing processes enhances the proportion of small-scale industries which will improve the resilient infrastructure and sustainable industrialization.

MED 2105	**MACHINE DRAWING LABORATORY**	**L**	**T**	**P**	**C**
SDG:9		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To familiarize with the codes and specifications of BIS, limits, fits and tolerances

COB2: To learn about drawing of orthographic and isometric views of various machine components using conventional drafting instruments

COB3: To acquire knowledge on drafting of machine components and assembly using AutoCAD

PRACTICALS

List of Experiments:

STUDY EXERCISE:

- Study of drawing standards, limits, fits and tolerances.

MANUAL DRAFTINGEXERCISE:

Draft the following engineering products using orthographic and isometric projection standards.

1. Machine components such as brackets, jigs and fixtures.
2. Machine block and Shaft support.
3. Sliding block and Bearing bracket.
4. Assembly drawing of Cotter joint with socket and spigot ends.
5. Assembly drawing of Screw Jack.

DRAFTING EXERCISE USING AUTOCAD:

Draft the following engineering products using orthographic and isometric projection standards.

1. Machine components like brackets, jigs and fixtures.
2. Machine block and Shaft support.
3. Sliding block and Bearing bracket.
4. Flange connector and centering bearing.
5. Assembly drawing of Cotter joint with socket and spigot ends.
6. Assembly drawing of Screw Jack.

PROJECT:

Perform reverse engineering and draw the orthographic views of real time products with exact dimensions using AUTOCAD software.

P - 30; TOTAL HOURS – 30

TEXT BOOKS:

1. N. D. Bhatt and V.M. Panchal, “Machine Drawing”, 50th Edition, Charotar Publishers,2016.

2. K. L. Narayana, P. Kannaiah& K. Venkata Reddy, “Machine Drawing”, New age International (P) Ltd, 2019.
3. Machine Drawing lab Manual of BSACIST.

REFERENCES:

1. Bertoline, Wiebe, Miller, Nasma., “Technical Graphics Communication”, IRWIN Graphic Series, 2008.
2. Brain Griffiths., Engineering Drawing for Manufacture, Kogan PageScience, USA, 2002.
3. David L., Goetsch Williams Chaulk John A., Nelson, “Technical Drawing” (Drafting and Design), Savee Informatics, 2008.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:implement the codes and specifications of BIS in drafting process.

CO2:draw the orthographic and isometric views of machine components using conventional method.

CO3:draft the assembly drawing of any system / Machine component.

CO4:design and draft using AutoCAD software.

CO5:demonstrate reverse engineering of machine components

Board of Studies (BoS):
19th BoS of MECH held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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

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

Understanding of drafting and designing of mechanical components shall be used to provide innovative and sustainable solutions for the industry.

MED 2106	**MECHANICS LABORATORY**	**L**	**T**	**P**	**C**
SDG:9		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To learn about the properties of solids

COB2: To study the dynamic control system such as governor and gyroscope

COB3: To acquire knowledge on balancing of dynamic system

COB4: To familiarize the dynamics of cam and its profile

COB5: To gain knowledge on the basics of vibration

PRACTICALS

List of Experiments:

1. Governors - Determination of sensitivity, effort, for watt, porter and proell governors.
2. Cam - Study of jump phenomenon and drawing profile of the cam.
3. Motorised Gyroscope-Verification of law's -Determination of gyroscopic couple.
4. Whirling of shaft-Determination of critical speed of shaft
5. Balancing of reciprocating masses.
6. Balancing of rotating masses.
7. Determination of Moment of inertia by oscillation method for connecting rod and flywheel.
8. Vibrating spring mass system -Determination of damping co-efficient of single degree of freedom system.
9. Determination of torsional frequencies for compound pendulum and flywheel –system with lumped Moment of inertia
10. Transverse vibration – Determination of natural frequency of undamped and damped vibration of beam.

P - 30; Total Hours – 30

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:calculate the geometric properties of components.

CO2:analyse the dynamic control system.

CO3:determine the unbalanced forces in machinery

CO4:construct the profile of different cams.

CO5: analyse the vibrations in the mechanical system

Board of Studies (BoS):
19th BoS of MECH held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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

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

The understanding of various mechanisms and their characteristics shall be used to provide innovative and sustainable solutions for the industry.

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

COURSE OBJECTIVES:

COB1:To enable them to make effective business presentations

COB2:To train them to participate in group discussions

COB3: To enhance the problem-solving skills

COB4: To train students in solving analytical problems

MODULE I ORAL DISCOURSE 07

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

MODULE II VERBAL COMMUNICATION 08

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

MODULE III BASIC NUMERACY 08

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

MODULE IV ANALYTICAL COMPETENCY 07

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

L – 30; TOTAL HOURS- 30

REFERENCES:

1. Whitby, Norman (2014). Business Benchmark: Pre-Intermediate to Intermediate. Cambridge University Press, UK
2. Swan, Michael (2005). Practical English Usage, Oxford University Press
3. Bhattacharya. Indrajit (2008). An Approach to Communication Skills, DhanpatRai& Co., (Pvt.) Ltd. New Delhi.
4. Tyra .M, Magical Book On Quicker Maths, BSC Publishing Company Pvt. Limited, 2009
5. R. S. Aggarwal , Quantitative Aptitude for Competitive Examinations, S. Chand Limited, 2017

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

COURSE OUTCOMES:

CO1: Make effective business presentations

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

CO3: To apply the various problem-solving techniques

CO4: Understand and solve aptitude problem

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

Academic Council:
17th AC held on 15.07.2021

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

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

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

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

SEMESTER IV

MED 2211	**THERMAL ENGINEERING**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**1**	**2**	**4**

COURSE OBJECTIVES:

COB1: To learn the working principle of internal combustion engines and its sub systems

COB2: To study gas power cycles and performance of IC engines

COB3: To gain knowledge on working and performance of steam nozzles and turbines

COB4: To familiarize about various types of compressors and their performance

COB5: To acquire knowledge on refrigeration and air conditioning systems

MODULE I I.C. ENGINES L:9 P:6

Classification of IC engine: Components and functions, Two stroke and Four stroke engines, working principle – Actual and theoretical valve timing diagrams- Port timing diagrams and PV diagrams-Comparison – Two stroke and four stroke engines: Petrol and Diesel engines – Fuel supply systems and ignition systems – Lubrication and cooling systems – Introduction toHybrid IC Engines.

MODULE II AIR STANDARD CYCLES AND IC ENGINE PERFORMANCE L:9 P:6

Air cycles: Otto, Diesel, Dual and Brayton cycles – Calculation of mean effective pressure and air standard efficiency – Actual and theoretical PV diagram of two stroke and four stroke engines – Performance test on IC engine and Heat balance calculation – Knocking and Detonation – Exhaust gas analysis – Current trends in IC engines (BS VI)

MODULE III STEAM NOZZLES AND TURBINES L:9 P:6

Flow of steam through nozzles: Shapes of nozzles, Effect of friction, Critical pressure ratio, Super saturated flow – Impulse and reaction principles: Compounding -Velocity diagrams for single and multistage turbines – Speed regulations - Governors –Introduction to Advanced Ultra Super critical (AUSC) power plants.

MODULE IV AIR COMPRESSORS L:9 P:6

Air Compressor: Classification and working principle, Work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency – Multistage air compressor and inter cooling - Working of multistage air compressor - Problems in single and two stage air compressors – Various types of rotary compressors (Descriptive treatment only).

MODULE V REFRIGERATION AND AIR CONDITIONING SYSTEMS L:9 P:6

Vapour compression refrigeration cycle: Super heating, Sub cooling, Performance calculations – Working principle of vapour absorption system-Ammonia-water – Psychrometry-Psychometric chart -Cooling load calculation – Air conditioning Systems - Summer and winter air conditioning systems – Requirements for comfort and industrial air-conditioning – Star Rating in R & AC systems.

PRACTICALS

LIST OF EXPERIMENTS:

1. (a) Experimental study on valve timing diagram in 4-stroke engine cut model.
   (b) Experimental study on port timing diagram in 2-stroke engine cut model.
2. Experiment on Fuel properties a) Viscosity b) Fire and Flash point c) Calorific Value
3. Performance test on constant speed 4-stroke diesel engine.
4. Heat balance test on 4-stroke twin cylinder diesel engine.
5. IC engine performance and heat balance evaluation using PC interface.
6. Motoring test on 4-stroke diesel engine with electrical loading.
7. Retardation test on 4-stroke diesel engine with mechanical loading.
8. Study on the composition of Exhaust gas of an IC engine using Orsat Apparatus under various loads.
9. Performance test on high pressure two stage reciprocating air compressor.
10. Experiment on air conditioning unit.
11. Experiment on vapour compression refrigeration unit.
12. Experiment on vapour absorption refrigeration unit.

L – 30; T – 15; P-30; TOTAL HOURS – 75

TEXT BOOKS:

1. Rajput, R.K, “Thermal Engineering”, 9th Edition, Laxmi Publications Pvt Ltd., 2019.

REFERENCES:

1. Rudramoorthy R, "Thermal Engineering", Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2017.
2. Sarkar B.K, "Thermal Engineering", Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2017.
3. Ganesan V, "Internal Combustion Engine", 4th Edition, Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2012.
4. Rajput, R.K, “Thermal Engineering”, 9th edition, Laxmi publications Pvt Ltd., 2019.
5. Arora. C.P. “Refrigeration and Air conditioning” 4th edition, Tata McGraw Hill Publishers Co. Ltd., 2020.
6. Frank Kreith, “Hand Book of thermal Engineering”, CRC press, 2013.
7. Manohar Prasad, “Refrigeration and Air-conditioning” Revised 2nd edition, new age international, 2009.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: describe the construction and working of IC engines and sub systems

CO2: determine the thermal efficiency of gas power cycles and IC engines

CO3: analyze the performance of steam nozzles and turbines

CO4: explain andevaluate the performance of air compressors

CO5: describe the refrigeration and air conditioning systems and perform cooling load calculations.

Board of Studies (BoS):

19th BOS held on 21.12.2021

Academic Council:

18th AC held on 24.02.2022

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

The knowledge of thermal engineering enables to design and develop thermal power equipment.

MED 2212	**FLUID MECHANICS AND MACHINERY**	**L**	**T**	**P**	**C**
SDG:9		**2**	**1**	**2**	**4**

COURSE OBJECTIVES:

COB1: To learn the fundamental concepts and properties of fluids

COB2: To study the kinematics and dynamics of fluid flow and their measurements

COB3: To familiarize with fluid flow equations for incompressible fluid

COB4: To acquire knowledge on boundary layer concepts and dimensional analysis

COB5: To gain knowledge on hydraulic turbines and pumps

MODULE I FUNDAMENTALS OF FLUID MECHANICS L:9 P:6

Fluid Properties – Definition -Distinction between solid and fluid – Units and Dimensions – Properties of fluid: Density and its measurements, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension – Fluid statics: concept of fluid static pressure, absolute and gauge pressure – Pressure measurements by manometer pressure gauges.

MODULE II FLUID KINEMATICS AND FLUID DYNAMICS L:9 P:6

Fluid Kinematics - Flow visualization – Lines of flow – Types of flow– Velocity field and acceleration – Continuity equation (1D and 3D forms) – Equation of stream line: Stream function, Velocity potential function, Circulation, Flow net – Fluid dynamics: Equation of motion, Euler's equation along streamline, Bernoulli's equation – Applications: Venturimeter, Orifice meter, Pitot tube.

MODULE III INCOMPRESSIBLE FLUID FLOW L:9 P:6

Viscous flow – Navier's Stoke equation (statement only) : Shear stress, pressure gradient relationship – Laminar flow between parallel plates – Laminar flow through circular tubes (Hagen poiseulle's law) – Hydraulic and energy gradient – Flow through pipes - Darcy's Weisback's equation – Pipe roughness - friction factor – Moody's diagram - minor losses – Flow through pipes in series and in parallel power transmission – Case studies in pressure loss calculations.

MODULE IV BOUNDARY LAYER & DIMENSIONAL ANALYSIS L:9 P:6

Boundary Layer theory - Boundary layer separation – Drags and lifts coefficients – Buckingham's π Theorem – Applications - Similarity laws and models – Introduction to Computational Fluid Dynamics (CFD).

MODULE V HYDRAULIC MACHINES L:9 P:6

Hydraulic Turbines: Definition and classification – Exchange of energy – Euler's equation for turbo machines - Impulse and Reaction turbines: Working principles and construction of velocity vector diagrams, performance curve for turbines.

Hydraulic Pumps: Definition and classifications – Centrifugal pump: classifications and velocity triangles, specific speed, efficiency and performance curves – Reciprocating Pump: Classification, working principle, indicator diagram, Air vessels – Criteria for selection of pumps.

PRACTICALS

LIST OF EXPERIMENTS:

1. Comparison of coefficient of discharge of given orifice meter and Venturi meter.
2. Calibration of Rotameter.
3. Determination of various losses for the given set of pipes.
4. Performance study of centrifugal pumps / Submersible pumps.
5. Determination of maximum efficiency for the given reciprocating pump.
6. Characteristic curves for Gear pump / Vane pump.
7. Determination of maximum power at constant speed / constant load for an impulse turbine.
8. Performance characteristic of reaction turbine.
9. Impact of jet on flat and curved vanes.
10. Performance test on a jet pump.
11. Flow visualization: Laminar and Turbulent flows.

L – 45; P-30; TOTAL HOURS – 75

TEXT BOOKS:

1. Bansal. R.K "Fluid Mechanics and hydraulics Machines", Revised 9th edition , Laxmi Publications (P) Ltd, New Delhi, 2015.

REFERENCES:

1. Kumar.K.L., "Engineering Fluid Mechanics", Eurasia Publishing House(P) Ltd, New Delhi, (8th Revised multi-color edition), 2014.

2. Kumar DS, "Fluid Mechanics and Fluid Power Engineering", Kataria SKand Sons, NewDelhi, 9^{th} edition, 2018.
3. Streeter V. Land Wylie, E.B “Fluid Mechanics”,McGrath-Hill, 9^{th} edition, 2017.
4. White, F.M., Fluid Mechanics”, Tata McGraw-Hill, 8^{th} Edition, NewDelhi, 2016.
5. John.D.Anderson, “Computational Fluid Dynamics–The Basics with Applications”, Mc Graw Hill, New Delhi, Indian edition, 2017.
6. Robert W Fox, "Introduction to Fluid Mechanics", 10^{th} Edition, John Wiley and sons, Singapore, 2020.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: explain the fundamental concepts and properties of fluids.

CO2: apply thekinematics and dynamics of fluid to perform flow measurement.

CO3: analyse incompressible fluid flow through pipes

CO4: describe theboundary layer concepts andperform dimensional analysis

CO5: demonstrate the performance of hydraulic turbines and pumps

Board of Studies (BoS):
19^{th} BOS held on 21.12.2021

Academic Council:
18^{th} AC held on 24.02.2022

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

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 fundamentals of fluid mechanics provides foundation for design and development of hydraulics and fluid machinery.

MED2213 DESIGN OF MACHINE ELEMENTS L T P C
SDG:9 3 1 0 4

COURSE OBJECTIVES:

COB1: To learn steady and variable stresses in a machine element
COB2: Togain knowledge on design of shafts, keys and couplings
COB3: Tofamiliarize on design of springs
COB4: Tostudy the design process of bolted, riveted and welded joints
COB5: Toacquire knowledge on design of bearings

MODULE I STEADY AND VARIABLE LOADING L:10 T:3

Machine design: Definition, Design process, Machine element design, Standards and codes in design - Design for static loading: Modes of failure, Factor of safety, Eccentric loading, Theories of failure- Design for variable loading: Stress concentration, Fatigue failure, Endurance limit - Design equations: Soderberg, Goodman and Gerber equations -Combined stresses - Curved beams- Crane hook – C Frame

MODULE II SHAFTS, KEYS AND COUPLINGS L:8 T:3

Design of shafts: Forces on shafts due to gears, belts and chains - Design for strength and rigidity – Lateral stiffness -Torsional rigidity - Critical speed - Design of keys – Design of Couplings: Rigid, flange and muff couplings.

MODULE III SPRINGS L:9 T:3

Helical springs -Stresses and deflection in helical springs for variable loading - Concentric springs - Design of leaf springs - Stress and deflection equation – Nipping -Springs in automobile suspension system.

MODULE IV RIVETED, BOLTED AND WELDED JOINTS L:9 T:3

Riveted joints: Design, Modes of failure, Strength and efficiency – Axial loading and Eccentric loading - Lozenge joints - Bolted joints - Design of eccentrically loaded bolted joints - Welded joints: Types, Design of welded joints for different types of loading, Unsymmetrical sections.

MODULE V BEARINGS **L:9**
T:3

Rolling contact bearings: Types, Method of assembly, Load ratings, Bearing failure, Preloading - Design of deep groove ball bearings and roller bearings - Bearing mounting for machine tool spindles and axles of automobiles - Sliding contact bearings - Theory of lubrication -Hydrodynamic bearings - Sommerfeld number - Design of hydrodynamic bearings.

L – 45; T – 15; TOTAL HOURS – 60

- *Use of PSG Design data book is permitted for semester end examinations*

TEXT BOOKS:

1. Bandari V.B, "Design of Machine Elements", 4th Edition, Tata McGraw Hill Publishers Co. Ltd,2017.
2. Jalaludeen S, “A text book of machine Design”, 3rd Edition, Anuradha Publications.,2006.

REFERENCES:

1. Robert L Norton, "Machine Design - An integrated approach", 1st Edition, Pearson publishers, 2013.
2. Jacobson B O, Bernard J Hamrock, Steven R Schmid, "Fundamentals of Machine Elements", 2nd Edition, McGraw Hill, 2004.
3. Faculty of Mechanical Engineering, PSG College of Technology, "PSG Design Data Book",KalaikathirAchagam, 2012.
4. Richard G Budynas, J Keith Nisbett "Shigley‟s Mechanical Engineering Design", 10th Edition, McGraw Hill Publishers Co. Ltd, 2017.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: explain the steady and variable stresses in a machine element

CO2: design the shafts,keys and couplings

CO3: design the key parameters of springs

CO4: analyse and design the bolted, riveted and welded joints

CO5: design different types of bearings for various loading

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

The holistic understanding of different machine elements and their design aspects lead to a path for providing innovative solutions to the complex engineering problems.

MED 2214	**MATERIALS ENGINEERING AND TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG:9		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To learn different microstructures and phase diagrams

COB2: To study about various heat treatment processes

COB3: To gain knowledge on different mechanical testing methods

COB4: To familiarize with various strengthening mechanisms and acquire knowledge about fracture and its prevention

MODULE I MICROSTRUCTURAL CHARACTERISATION &PHASE DIAGRAMS L:6 P:9

Introduction to microstructures - Optical microscopes –Types -Working principle - Metallographic preparation techniques - ASTM grain size standards - Grain size estimation - Basics of electron microscopy -Solid solutions - Gibbs phase rule- Lever rule- Unary and binary eutectic phase diagram- Examples and applications of phase diagrams - Iron- Iron carbide phase diagram - Phase transformations: Basic concepts, Isothermal and Continuous cooling transformation diagrams.

MODULE II HEAT TREATMENT L:6 P:6

Heat treatment processes – Purpose – Procedures – Applications of various heat treatment processes- Hardness vs hardenability - Jominy end quench test -Full annealing- Process annealing -Stress relief annealing- spheroidising annealing - Isothermal annealing- Normalizing - Hardening- Tempering- quenching medium - Different types and their relative merits-Case hardening : pack carburizing, cyaniding, nitriding , induction hardening and flame hardening.

MODULE III MECHANICAL TESTING OF MATERIALS L:6 P:12

Scope and significance of parameters in the test and standards -Tensile testing - Effect of strain rate and temperature on flow properties – Compressive testing -Torsion Test -Mechanical properties in torsion - Torsional stresses for large plastic deformation - Hardness Test - Hardness testing system - Concept of micro hardness - Major hardness testing systems: Brinell, Rockwell and Vickers - Special hardness tests: Shore and Mohs -Fatigue Tests - Stress cycles and SN curve statistical nature of fatigue - Fatigue testing machines and equipment’s - Impact test - DBTT - Creep curve and its analysis - Stress rupture test- Presentation of engineering creep data - Equipment test set up in creep testing.

MODULE IV STRENGTHENING MECHANISMS AND THEORY OF FRACTURE L:12 P:3

Basic concepts - Dislocations and plastic deformations - Solid solution strengthening - Strengthening by grain size reduction -Precipitation hardening - Particle and fiber dispersion strengthening -Strain hardening - Recovery, Recrystallisation and grain growth - Fundamentals - Mechanism of plastic deformation: Slip and Twinning - Types of fracture - Ductile fracture - Mechanism and prevention - Brittle fracture- Principles of fracture mechanics - Griffith's theory on fracture- Stress intensity factor and Fracture toughness - Creep and Fatigue fracture - Factors affecting fracture –Prevention.

PRACTICALS

LIST OF EXPERIMENTS:

1. Specimen preparation for microstructural examination- cutting, grinding, polishing, etching.
2. Identification of microstructures of ferrous and Non-ferrous materials.
3. Heat treatment: Annealing, normalizing, hardening and tempering of steel- Hardness and its microstructure.
4. Identification of microstructure of welded (HAZ) and cast component.
5. Hardenability test -Jominy End quench test.
6. Compression test.
7. Deflection test
8. Impact test.
9. Double Shear test
10. Fatigue test

L – 30; P - 30; TOTAL HOURS – 60

TEXT BOOKS:

1. W. Bolton, "Engineering Materials Technology", United Kingdom:Elsevier Science, 2013.
2. V. Raghavan, "Materials Science and Engineering", A First CourseIndia, PHI Learning, 2015.

REFERENCES:

1. L. Wojnar, "Image Analysis: Applications in Materials Engineering", United States:CRC Press, 2019.
2. "Materials Science and Mechanical Engineering", Switzerland:Trans Tech Publications Limited, 2013.

3. “Elements of Metallurgy and Engineering Alloys”, United States:ASM International, 2008.
4. William Bolton, Mathew Philip, Bill Bolton, “Technology of Engineering Materials”, Elsevier Science, 2002.
5. G.F. Carter, “Materials Science and Engineering”, United States:A S M International, 1991.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: interpret different microstructures and phase diagrams

CO2: demonstrate the various heat treatment processes

CO3: explainand evaluate material properties by various mechanical testing methods

CO4: describe various strengthening mechanisms, fracture and its prevention

Board of Studies (BoS):

19th BOS held on 21.12.2021

Academic Council:

18th AC held on 24.02.2022

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

Holistic understanding of microstructure of metals, strengthening mechanism and testing protocol enhances the performance and life of the components.

MED 2215 MACHINE TOOLS AND METROLOGY

		L	T	P	C
MED 2215	**MACHINE TOOLS AND METROLOGY**	**L**	**T**	**P**	**C**
SDG:9		**3**	**0**	**2**	**4**

COURSE OBJECTIVES:

COB1: To gain knowledge on centre and CNC lathes

COB2: To familiarise with special machine tools

COB3: To learn the basics of measurement system, devices and calibration

COB4: To study various comparators and form measurement techniques

COB5: To learn various industrial mechanical parameter measurements

MODULE I CENTRE AND CNC LATHES L:6 P:6

Centre lathe - Constructional features - Cutting tool geometry - Basic operations - Taper turning methods - Machining time calculation - Capstan and turret lathes - CNC turning centre - Constructional features – Turret - Linear motion guide ways - Ball screw - Axes feed drive arrangement - Hydraulic chuck – ATC - Feedback devices - Linear encoder - Rotary encoder.

MODULE II SPECIAL MACHINE TOOLS L:12 P:6

Reciprocating machine tools : Shaper, Planer and Slotter- Milling- Types of milling machines - Horizontal and Vertical – Drilling - Column and radial drilling machines - Abrasive processes - Grinding wheel designation and selection - Types of grinding processes - Cylindrical grinding - Surface grinding - Centreless grinding – Honing – Lapping - Gear cutting – Forming – Generation – Hobbing - Broaching machine - Types – Broaching operation.

MODULE III BASICS OF MEASUREMENT SYSTEM, DEVICES AND CALIBRATION L:9 P:9

Definition of metrology – Accuracy - Precision and sensitivity - Three stages of generalized measurement system - Mechanical loading - Factors considered in selection of instruments - Commonly used terms – Uncertainty – Traceability - Error analysis and classification - Sources of error - Linear and Angular Measurements – Verniers and micrometers – Sine bar and sine centre -Tool makers microscope -Principle of interferometry - Michelson interferometer - Laser interferometer - Principles of calibration - Calibration of measuring instruments - Slip gauges - Dial indicator - Surface plates.

MODULE IV COMPARATORS AND FORM MEASUREMENT L:9 P:9

Comparators – Mechanical – Electrical - Optical and pneumatic - Tool makers microscope - Limit gauge – Types - Design of plug gauge - Taylor's principle - Components of surface texture – Roughness – Lay – Waviness - Ra and Rz - Surface roughness meter - ISO metric thread - Measurement of major, minor and effective diameters - Gear terminology - Spur gear measurement - Base pitch measurement – Constant chord method - Roundness measurement – CMM : Construction and types.

MODULE V INDUSTRIAL MEASUREMENTS L:9

Position sensors – Potentiometer – LVDT - Proximity sensors – Types - Vibration sensors - Seismic instrument - Torque sensors - Strain gauges - Temperature sensors - Resistance temperature detector – Thermistor – Thermocouples – Thermopiles - Optical pyrometer - Pressure sensor - Elastic transducers - Pressure cell - Bulk modulus pressure gauge - Low pressure measurement - Flow measurement – Orifice and venturi meter - Turbine type meter - Hotwire anemometer - Magnetic flow meter.

PRACTICALS

List of Experiments

Machining:

1. Step turning and drilling by Capstan lathe
2. Machining of bush and shaft as per dimensions
3. Machining the double start V thread
4. Spur gear milling
5. Machining a keyway using slotting machine
6. Grinding a rectangular mild steel block using surface grinder.

Measurement:

1. Calibration and Error analysis of measuring instruments
2. Angular measurement using sine bar, sine center and standard balls and rollers
3. Tool geometry measurement using toolmaker'smicroscope
4. Gear roll testing (i) Tooth to tooth composite error (ii) Tooth thickness measurement using gear tooth vernier caliper.
5. Measurement of effective diameter of external parallel screw threads using floating carriage micrometer
6. Study of Coordinate Measuring Machine (CMM) and surface

roughness measurement

L – 45; P – 30; TOTAL HOURS – 75

TEXT BOOKS:

1. Rao P N, "Manufacturing Technology", 4thEdition, Vol. 2, McGraw-Hill Education, USA, 2018.
2. S.K. Hajra Choudhury, Nirjhar Roy, "Elements of Workshop technology" 15th Edition, Vol II, Media promoters & Publishers Pvt. Ltd, 2018.
3. Gupta I C, "A text book of Engineering Metrology", rep. of 7th rev. ed, Dhanpat Rai Publications, New Delhi, 2013.
4. R.K. Jain, Engineering Metrology - 21st Edition, Khanna Publishers, 2004.

REFERENCES:

1. Serope Kalpakjian and Stephen Schmid, "Manufacturing, Engineering and Technology", 7thEdition, Pearson Education,USA, 2018.
2. Mikell P Groover, "Principles of Modern Manufacturing", 5thEdition, Wiley& Sons Pvt. Ltd, India, 2013.
3. Radhakrishanan P, "Computer Numerical Control Machining and Computer Aided Manufacturing", 1stEdition, New Age International Publishers, India, 2018.
4. Alan S Morris, Reza Langari, "Measurement and Instrumentation: Theory and Application", Academic Press, 2012.
5. Venkateshan S P, "Mechanical Measurements", John Wiley& Sons, 2015.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: demonstrate the production ofcomponents using Centre and CNC lathes

CO2: explain the manufacturing of components using special machine tools

CO3: explain the basics of measurementsystem, devices and calibration.

CO4: elucidate the use of various comparators and form measurement techniques

CO5: describe different industrial mechanical parameter measurements.

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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

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

The understanding of various machine tools and measurement science enhance the industrial technologies and promote sustainable industrialisation.

GED 2201 **WORKPLACE SKILLS AND APTITUDE FOR ENGINEERS**
SDG: 8

L	T	P	C
0	0	2	1

COURSE OBJECTIVES:

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

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

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

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

MODULE I EXTENSIVE READING & WRITING 07

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

MODULE II INTENSIVE READING & WRITING 08

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

MODULE III QUANTITATIVE APTITUDE 08

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

MODULE IV LOGICAL COMPETENCY 07

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

L – 30; TOTAL HOURS - 30

REFERENCES:

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

Reasoning , S. Chand Limited, 2010

6. Khattar Dinesh , The Pearson Guide to Quantitative Aptitude for Competitive Examinations, 3e, Pearson India , 2016
7. Rajesh Verma , Fast Track Objective Arithmetic Paperback , Arihant Publications (India) Limited , 2018
8. Arun Sharma Teach Yourself Quantitative Aptitude Useful for All Competitive Examinations, McGraw Hill Education (India) Pvt. Limited, 2019.

COURSE OUTCOMES:

CO1: Demonstrate reading skills with reference to business related texts

CO2: Draft professional documents by using the three stages of writing

CO3: Apply various short cut techniques for solving complicated aptitude problems

CO4: To understand various problems and patterns of different ways to solve it

Board of Studies (BoS) :

13th BoS of the Department of English held on 17.6.2021

Academic Council:

17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PS O1	PSO 2	PS O3
CO1		L		H						H					
CO2			L							H					
CO3			L				M								
CO4		H		M											
CO5															

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

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

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

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

COURSE OBJECTIVES:

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

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

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

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

MODULE I INTRODUCTION AND BASIC INFORMATION ABOUT INDIAN CONSTITUTION 8

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

MODULE II FUNDAMENTAL RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES 7

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

MODULE III GOVERNANCE IN INDIA 8

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

MODULE IV HUMAN RIGHTS AND INDIAN CONSTITUTION 7

Human rights – meaning and significance - Covenant on civil and political rights - Covenant on Economic, Social and Cultural rights - UN mechanism and agencies - The Protection of Human Rights Act, 1993 – watch on human rights and enforcement - Roles of National Human Rights Commission of India - Special Constitutional Provisions for SC & ST, OBC - Special Provision for Women, Children & Backward Classes.

L – 30; TOTAL HOURS –30

TEXT BOOKS:

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

REFERENCES:

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

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

CO1: describe the emergence and evolution of Indian Constitution.

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

CO3: compare the various structure of Indian government.

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

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

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

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

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

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

SEMESTER V

MED 3101	HEAT AND MASS TRANSFER	L	T	P	C
SDG:9		2	1	2	4

COURSE OBJECTIVES:

COB1: To familiarize about heat conduction in steady and transient states

COB2: To gain knowledge on free and forced convective heat transfer

COB3: To learn boiling heat transfers and design of heat exchangers.

COB4: To study thermal radiation from solids and gases.

COB5: To learn the basic concepts of mass transfer

MODULE I CONDUCTION **L:10 P:8**

Basic concepts - Mechanism of heat transfer : Conduction, Convection and radiation - General differential equation of heat conduction – Fourier's law of conduction - Cartesian and cylindrical coordinates - One dimensional steady state heat conduction - Conduction through plane wall, cylinders and spherical systems - Composite systems - Critical radius of insulation- Conduction with internal heat generation - Extended surfaces - Unsteady heat conduction - Lumped heat capacity analysis – Semi-infinite and infinite solids - Use of Heisler's chart.

MODULE II CONVECTION **L:9 P:8**

Basic concepts - Convective heat transfer coefficients - Boundary layer concept - Types of convection - Forced convection - Dimensional analysis - External flow - Flow over plates, cylinders and spheres - Internal flow - Laminar and turbulent flow - Flow over bank of tubes – Non circular tubes - Free convection - Dimensional analysis - Flow over vertical, horizontal and inclined plates, cylinders and spheres - Combined free and forced convection.

MODULE III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS **L:10 P:7**

Nusselt's theory of condensation- Pool boiling and flow boiling - Correlations in boiling and condensation - Types of heat Exchangers - Heat exchanger analysis – Logarithmic Mean Temperature Difference (LMTD) and Effectiveness – Number of Transfer Units (NTU) methods - Overall heat transfer coefficient - Fouling factors – Pressure drop and pumping power – Design of compact heat exchangers. Heat transfer enhancement techniques in heat exchangers

MODULE IV RADIATION L:9 P:7

Basic concepts - Laws of radiation: Stefan Boltzmann's law and Kirchoff's law - Black body radiation - Grey body radiation - Reradiating surfaces- Shape factor algebra - Electrical analogy - Radiation shields – Radiation from gas.

MODULE V MASS TRANSFER L:7

Basic concepts - Diffusion mass transfer - Fick's law of diffusion - Steady state molecular diffusion - Convective mass transfer - Momentum, heat and mass transfer analogy - Convective mass transfer correlations - Applications of mass transfer

L – 30; T – 15; P- 30 TOTAL HOURS – 75

PRACTICALS

List of Experiments:

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2. Heat transfer through composite wall.
3. Thermal conductivity measurement using guarded plate apparatus.
4. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
5. Determination of heat transfer coefficient under forced convection from a tube.
6. Heat transfer from pin-fin (natural & forced convection modes)
7. Determination of Stefan – Boltzmann constant.
8. Determination of emissivity of a grey surface.
9. Heat transfer studies on pool boiling.
10. Effectiveness of Parallel / counter flow heat exchanger.
11. Drop and Film-wise condensation study
12. Transient heat conduction study

TEXT BOOKS:

1. Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer", 5th edition, New Age International Publishers, New Delhi, 2017.
2. Holman J P, "Heat Transfer", 10th edition, Tata McGraw Hill Inc., New

York, 2010.

REFERENCES:

1. Yunus A Cengel, "Heat and mass transfer: A Practical Approach", 5th Edition, McGraw Hill Inc., New York, 2014.
2. Nag P K., "Heat and Mass Transfer", 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2011.
3. Frank P Incropera, David P Dewitt and Theodore L. Bergman "Principles of Heat and Mass Transfer", Wiley Publishing, 2018.
4. S. P. Sukhatme, "Text book of Heat transfer" 4th edition, University Press (India) Pvt. Ltd., 2013.
5. Suhas V Patankar, "Numerical Heat transfer and fluid flow", CRC Press, 2017.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Solve heat conduction problems in steady and transient states

CO2: Apply principle of convection and their relation to fluid dynamics

CO3: Analyse boiling heat transfers and design the heat exchangers

CO4: Demonstrate thermal radiation from solids and gases.

CO5: Explain the basic concepts of mass transfer

Board of Studies (BoS):

19th BOS held on 21.12.2021

Academic Council:

19th AC held on 29 .09.2022

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

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 heat transfer principle enables to design and develop heat transfer equipment in engineering industries.

MED 3102	**MECHATRONICS**	**L**	**T**	**P**	**C**
SDG:9		**3**	**0**	**2**	**4**

COURSE OBJECTIVES:

The objective of the course is

COB1: To study the basic concepts of mechatronics and various types of sensors

COB2: To acquire knowledge on different actuators and their applications

COB3: To learn about the programmable logic controllers

COB4: To gain knowledge on different system models and controllers

COB5: To be conversant with mechatronic design and its applications

MODULE I INTRODUCTION L:9 P:4

Introduction to Mechatronics – Systems - Concepts of Mechatronics approach – Sequential controllers - Need for Mechatronics- Emerging area of Mechatronics - Introduction to Sensors & Transducers – Performance Terminology- Types: Sensors for motion, position measurement, force, torque, tactile, temperature sensors, hall-effect sensors - Selection of sensors - Signal Conditioning - Analogue to Digital Converter - Digital to Analogue Converter.

MODULE II ACTUATORS L:9 P:10

Basics of Pneumatic and Hydraulic Systems - Control Valves - Actuators - Mechanical Actuation Systems – Electrical Actuation Systems – Mechanical Switches - Solid State Switches – Solenoids - Construction and working principle of DC and AC Motors –Speed control of AC and DC drives - Stepper Motors - Switching circuitries for stepper motor - Servo motor

MODULE III PROGRAMMABLE LOGIC CONTROLLER L:9 P:10

Programmable Logic Controllers – Basic Structure - Input / Output Processing – Programming – Mnemonics – Timers - Internal relays and counters - Shift Registers - Master and Jump Controls - Data Handling - Analog Input / Output - Selection of a PLC.

MODULE IV SYSTEM MODELLING AND CONTROL L:9

System Models - Building blocks of Mechanical, Electrical, Fluid and Thermal Systems - Modelling of spring, mass & damper systems - Rotational – Translational Systems - Electromechanical Systems - Dynamic response of systems - Closed-Loop Controllers - Control Modes: Two–Step mode, Proportional Mode, Derivative Mode, Integral Mode, PID —Adaptive Control - Fault findings

MODULE V MECHATRONICS DESIGN & CASE STUDIES L:9
P:6

Mechatronics Design process - Stages - Traditional and Mechatronics design concepts - Introduction to data acquisition and control systems - Virtual instrumentation - Interfacing of various sensors and actuators with PC - Case studies: Robotics and automation in manufacturing and process industries, Mechatronics control in automotive, prosthetics and artificial limbs, agriculture and energy systems and Automatic car park barrier.

PRACTICALS

List of Experiments:

1. DC motor control using microcontrollers
2. Stepper motor control using microcontrollers
3. Line following robot.
4. Design of circuits with logic sequence using Electro pneumatic trainer kits
6. Simulation of hydraulic and pneumatic circuits using software
7. Timing operations using PLC
8. Counting operations using PLC
9. Modelling and analysis of basic mechanical, electrical, hydraulic and pneumatic systems using LabVIEW
10. Characterization of sensors like strain, LVDT, thermocouple, etc,
11. Interfacing DAC for Control application using LabVIEW

L – 45; P-30; TOTAL HOURS – 75

TEXT BOOKS:

1. Bolton. W, “Mechatronics”, Pearson Higher Education, 7th edition, 2019.
2. Sabri Cetinkunt, " Mechatronics with Experiments ", Wiley, 2015.

REFERENCES:

1. Michael B. Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, McGraw-Hill International, 5th edition, 2018.
2. Sanjay Gupta and Joseph John, "Virtual Instrumentation and LabVIEW", Tata McGraw Hill Publications, Co., 2012.
3. Clarence W. de Silva, Mechatronics: A Foundation Course, CRC press, 1st edition, 2010.
4. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, 2nd edition, Cengage learning India Pvt. Ltd, 2012.
5. Nitaigour Premchand Mahalik, Mechatronics Principles, Concepts and Applications, McGraw Hill Education, 2015.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basic concepts of mechatronics and use of sensors

CO2: Elucidate and select actuators for different applications

CO3: Describe and program the programmable logic controllers.

CO4: Explain and analyse the system model and controller for a given application

CO5: Design mechatronic systems for different applications

Board of Studies (BoS):

19th BoS of MECH held on 21.12.2021

Academic Council:

19th AC held on 29 .09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1				L					M		M		L	
CO 2									M		M		L	L
CO 3									M		M		M	M
CO 4	M								M		M		H	M
CO 5	M			M					M		M		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.

Learning mechatronic support technology development, research and innovation leading to automation in industries and value addition in commodities.

MED 3103	**AUTOMATION IN MANUFACTURING**	**L**	**T**	**P**	**C**
SDG:9		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To gain knowledge about designing and fabrication of automated systems.

COB2: To study about microprocessor, and drives in automation

COB3: To familiarise about robots and mechanisms of automated manufacturing systems

COB4: To acquire knowledge on hydraulic, pneumatic and CNC systems

MODULE I INTRODUCTION, DESIGN AND FABRICATION OF AUTOMATED SYSTEM L:7

Importance of automation in the manufacturing industry - Use of mechatronics system requirement - Design of an automated system - Degree of Freedom-Building blocks of an automated system - Working principle and examples - Fabrication or selection of various components of an automated system - Specifications of various elements - Use of design data books and catalogues.

MODULE II MICROPROCESSOR, AND DRIVES IN AUTOMATION L:6

Microprocessor Technology - Signal conditioning and data acquisition - Use of microprocessor or micro controllers – Configurations and working – Drives - Electrical drives – Types - Selection criteria - Construction and operating principle.

MODULE III INDUSTRIAL ROBOTICS AND MECHANISMS OF AUTOMATED MANUFACTURING SYSTEMS L:8

Anatomy of a robot and robot end effectors - Classification of robots based on physical configuration – Transducers and sensors - Tactile sensors - Proximity and range sensors - Velocity sensors - Robot programming methods - Concepts of forward and inverse kinematics – Mechanisms - Ball screws - Linear motion bearings – Cams - Systems controlled by camshafts - Electronic cams - Indexing mechanisms -Tool magazines and transfer systems.

MODULE IV HYDRAULIC, PNEUMATIC AND CNC SYSTEMS L:9; P:30

Hydraulic systems - Hydraulic power pack – Pumps – Valves - Designing of hydraulic circuits - Pneumatic systems – Configurations – Compressors- Valves - Distribution and conditioning - CNC technology - Basic elements of CNC lathe and machining centres - Interpolators - Part programming.

PRACTICALS

List of Experiments

CNC Lathe:

1. Part programming for Linear and Circular interpolation.
2. Part programming using standard canned cycles for Turning.

CNC Mill:

1. Part programming for Linear, Circular interpolation and Contour motions.
2. Part programming involving canned cycles for Drilling, Peck drilling and boring.
3. Modelling and Simulation in CAD/CAM software:
4. Tool path generation and Mould design from 3D models using CAD/ CAM software.
5. Post processing for standard CNC Controllers like FANUC, Sinumerik etc.
6. Generate NC codes and interface with CNC machine to realize the product.

L – 30; P – 30; TOTAL HOURS – 60

TEXT BOOKS:

1. M.P.Groover,“4e - Automation, Production Systems and Computer Integrated Manufacturing”, PHI, 2014.
2. Frank Lamb,“Industrial Automation”, Mc Graw Hill, 2013.

REFERENCES:

1. HMT Ltd.,“Mechatronics”, Tata McGraw Hill, New Delhi, 2017.
2. Regtien, P. P. L., Sensors for mechatronics, Elesevier, USA,2012.
3. Tonshoff, H.K. and I. Inasaki, “Sensors in manufacturing”,Wiley-VCH, 2001.
4. Gaonkar, R. S., “Microprocessor architecture, programming,and applications with the 8085”, Penram International Publishing (India), Delhi, 2000.

5. Bradley, D. A., Dawson D., Burd, N. C. and Loader A. J., "Mechatronics: Electronics in products and processes", CRC Press, Florida, USA, 2010.
6. Rothbart, H. A., "CAM Design Handbook", McGraw-Hill, 2004.
7. Norton, R. L., "Cam Design and Manufacturing Handbook",Industrial press Inc, 2002.
8. Smid, P., "CNC Programming Handbook", Industrial Press,New York, USA, 2008.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain about designing and fabrication of automated systems

CO2: Select the microprocessor, and drives used in automation

CO3: Describe the robotics and its associated mechanisms for automated manufacturing systems

CO4: Design hydraulic/pneumatic circuits and to prepare part programs in CNC machining

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
19th AC held on 29 .09.2022

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

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 the robots and their mechanism, along with the CNC systems can upgrade the technological capabilities of Industries by providing automation.

MED 3104	**PRODUCT MODELLING LABORATORY**	**L**	**T**	**P**	**C**
SDG:9		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To be conversant with the CAD software's for creating standard 3D models of the given component

COB2: To train in creating 3D models and their assemblies

COB3: To gain knowledge in parametric modeling of standard fasteners

COB4: To acquire knowledge on reverse engineering procedure

PRACTICALS

List of Experiments:

Practicing the CAD software

1. Create 3D models of standard machine components by reading 3D isometric views.
2. Create 3D models of standard machine components by reading 2D orthographic views of Brackets, V Blocks, and Stop Block.

Practicing the assembly drawing creation

Create part model, assembly, exploded view, sectional views and detail drawings of

1. **Joints**: Cotter joints, knuckle joints, Hook's joint.
2. **Shaft Couplings**: rigid, flexible.
3. **Bearings**: Journal, footstep, thrust or collar bearing, Plummer block.
4. **Engine parts**: Stuffing box, connecting rod.
5. **Machine tool components**: Drill jig, tool post, machine vice, screw jack.
6. **Valves**: Safety valve, relief valve, non-return valve.

Parametric modelling

Create the parametric models of standard screw threads, and threaded fasteners.

Reverse engineering

Creating production drawing of real-life components adopting reverse engineering procedure

P-30: TOTAL HOURS –30

TEXT BOOKS:

1. N. D. Bhatt and V.M. Panchal, "Machine Drawing", 48th Edition, Charotar Publishers,2013

2. Gopalakrishna K.R., “Machine Drawing”, 22nd Edition, Bangalore, 2013.

REFERENCES:

1. David L., Goetsch Williams Chaulk John A., Nelson, “Technical Drawing (Drafting and Design) Savee Informatics”, 2008.
2. Brain Griffiths., “Engineering Drawing for Manufacture”, Kogan Page Science, USA, 2002
3. Bertoline, Wiebe, Miller, Nasma., “Technical Graphics Communication”, IRWIN Graphic Series, 1997.
4. William P. Spence, “Engineering Graphics”, Printice - Hall Inc, Engle Wood Cliff, 1987.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Create CAD 3D models from standard CAD packages

CO2: Assemble the 3D models of standard mechanical components

CO3: Create parametric model of fasteners

CO4: Develop production drawing by reverse engineering of real-life components

Board of Studies (BoS):

19th BoS of MECH held on 21.12.2021

Academic Council:

19th AC held on 29 .09.2022

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

The understanding of various modelling methods involved in the design of mechanical components shall be used to provide innovative and sustainable solutions for the industry.

GED 3101	COMMUNICATION SKILLS FOR CAREER SUCCESS	L	T	P	C
SDG: 4		0	0	2	1

COURSE OBJECTIVES:

COB1: To develop students' proficiency in English at CEFR B2 level (Business Vantage)

COB2: To develop students' receptive skills (Listening and Reading) in a wide range of situations

COB3: To develop students' productive skills (Speaking and Writing) in a wide range of situations

COB4: To expose students to the nuances of the English language, grammar and usage.

MODULE I BRIEF EXCHANGES OF COMMUNICATION 08

Listening to telephonic conversations - gap filling exercises- short conversations – Promoting a product-Reading short passages and answering matching tasks-Writing short notes and messages. - Framing questions

MODULE II WORKPLACE COMMUNICATION 07

Listening to monologues - gap filling exercises - Mini presentations- role play-Reading longer texts – gap filling- Writing memo , emails and Fax - Writing reports on conferences, seminars

MODULE III INTERPERSONAL COMMUNICATION 08

Listening to conversations – Collaborative discussion using prompts - Reading comprehension-multiple choice-texts - Writing enquiry letters & replies to customers

MODULE IV NEGOTIATING AND PERSUADING 07

Listening to interviews - Group Discussions - Multiple choice and gap filling-writing work reports- cause and effect - Complaint letter and sales letter

P-30: TOTAL HOURS - 30

REFERENCES:

1. Guy Brook-Hart, 'Business Benchmark-Upper Intermediate, 2nd edition, Cambridge University Press, Shree Maitrey Printech Pvt. Ltd, Noida, 2016.
2. Leo Jones, 'New International Business English' Students book. Cambridge University Press, Cambridge, 2003.

3. Simon Sweeney, ‘Communicating in Business’ Teacher’s Book. Cambridge University Press, Cambridge, 2004.
4. Simon Sweeney, ‘Communicating in Business’ Student’s Book. Cambridge University Press, Cambridge, 2003.
5. Bill Mascull. ‘Business Vocabulary in Use’. Advanced. Cambridge University Press, Cambridge, 2004

COURSE OUTCOMES:

CO1: Use the LSRW skills effectively in business and general situations

CO2: Demonstrate receptive skills effectively in various formal and informal communication situations.

CO3: Demonstrate productive skills effectively in various formal and informal communication situations

CO4: Use appropriate grammar and vocabulary in any context.

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

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PS O1	PS O2	PS O 3	PSO 4	PSO 5
CO1									M	H							H
CO2									M	H							H
CO3									M	H							H
CO4										H							M

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

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

This course helps the students to enhance their communication skills, critical thinking, problem solving, conflict resolution, team building and public speaking. This course also helps them to achieve success in their professional and personal life.

MED 3105	**INTERNSHIP I**	**L**	**T**	**P**	**C**
SDG:08		**0**	**0**	**0**	**1**

Students must undergo 15 days of Industrial training in the industries relevant to Mechanical Engineering during the summer vacation of second year

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
By undergoing industrial training/Internship, interns gain valuable work or research experience and time management which are key for success to job, entrepreneurship, to sustain per capita economic growth in accordance with national circumstances.

SEMESTER VI

MED 3211	**FINITE ELEMENT ANALYSIS**	**L**	**T**	**P**	**C**
SDG:9		**3**	**0**	**2**	**4**

COURSE OBJECTIVES:

COB1: To study the basic concepts of mathematical modeling of engineering problems

COB2: To learn the principles of discretization and finite element formulation

COB3: To acquire knowledge on application of FEA in bars, beams and thermal fins in 1D

COB4: To gain knowledge on 2D approximation techniques and solve 2D structural and thermal problems

COB5: To familiarize about isoparametric formulation and numerical integration

MODULE I INTRODUCTION TO FINITE ELEMENT ANALYSIS L:8 P:6

Basic Concept and terminologies - Comparison with FDM and FVM - Advantages and disadvantages - History of development - Applications – Application to the continuum – Discretization– Governing equations for continuum – Variational methods – Weighted residual method – Ritz variation method.

MODULE II BASICS OF FINITE ELEMENT FORMULATION L:10 P:6

Finite Element Analysis of 1D structural and thermal Problems : Element type, Spring element, two noded line element, lower order and higher order element – Types of discretization – Displacement function - Shape function - Ritz weak formulation - Element equations - Assembly - Boundary conditions - Solution of equations – Post processing - Convergence criteria -Examples from solid mechanics and heat transfer in composite wall and fins.

MODULE III ONE DIMENSIONAL ANALYSIS L:9 P:6

Structural analysis of bars with uniform and varying cross sections – Beams - Truss–Different support/boundary conditions - Load conditions - Thermal analysis of 1D fins - Thermal insulating walls with different conduction/convection boundary conditions and thermal loads.

MODULE IV TWO DIMENSIONAL STRUCTURAL ANALYSIS L:9 P:6

Theory of elasticity – Plane stress, Plane strain and axisymmetric concepts – CST –LST – Shape function – Strain displacement matrix – Constitutive matrix – Stiffness matrix – Assembly – Solutions – Examples: Finite element formulation of plate, beam, dam, pipe, pressure vessels problems.

MODULE V ISOPARAMETRIC FORMULATION AND NUMERICAL INTEGRATION L:9 P:6

Natural co–ordinate systems –Lagrangian interpolation polynomials– Serendipity formulation–Isoparamatric elements formulation – Rectangular elements –Numerical integration – Simple problems using Gauss quadrature technique.

PRACTICALS

List of Experiments:

1. Study of basics of FEA software
2. Analysis of uniform and stepped bar using different boundary conditions.
3. Analysis of Cooling fins using 1D elements with the conduction and convection boundary conditions.
4. Analysis of planar and spatial truss
5. Analysis of 1D and 2D beams with different loading conditions – point, distributed load, bending moment
6. Analysis of thin plate with circular/elliptical hole (Plane stress)
7. Analysis of pressure vessels, tunnels with internal pressures (Plane strain)
8. Analysis of thick cylinders with measureable length (Axisymmetric problems)
9. Analysis of 2D and 3D complex problems with quadrilateral and brick elements respectively
10. Modal Analysis of Beams and extraction of natural frequencies and mode shapes
11. Buckling analysis of orthotropic materials
12. Harmonic analysis of 1D and 2D structures

L – 45; P–30; TOTAL HOURS – 75

TEXT BOOKS:

1. Reddy J.N. – "An Introduction to Finite Element Method", McGraw Hill, Fourth Edition, 2019.
2. Seshu. P – "Textbook of Finite Element Analysis", Prentice–Hall India Pvt. Ltd, 2006.

REFERENCES:

1. David V Hutton "Fundamentals of Finite Element Analysis", McGraw–Hill, Paper back edition, 2007.
2. O.C.Zienkiewicz and R.L.Taylor, "The Finite Element Methods", Vol.1, "The basic formulation and linear problems", Vol.1, Butterworth Heineman, 5th Edition, 2000.
3. Rao.S.S, – Finite Element Method in Engineering, Pergamon Press, 5th Edition, 2020.
4. Chandrupatla T.R., and Belegundu A.D., "Introduction to Finite Elements in Engineering", Pearson Education, 3rd Edition, 2002.
5. Krishnamoorthy C.S – "Finite Element Analysis: Theory and Programming", Tata McGraw Hill Publishing Company .Ltd, 2nd Edition, 2017.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Formulate mathematical modeling of engineering problems

CO2: Discretize the given complex geometry into FE model

CO3: Solve various 1Dstructural and thermal problems using FEA

CO4: Solve 2D structural and thermal problems using FEA

CO5: Explain isoparametric formulation and numerical integration

Board of Studies (BoS):

19thBoS of MECH held on 21.12.2021

Academic Council:

19th AC held on 29 .09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	H	H											H	
CO 2	H	H											H	
CO 3	H		M										M	L
CO 4	H												M	L
CO 5	H		H										H	

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

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

The deeper understanding of the analysis of Mechanical systems using finite element method leads to provide sustainable and robust solutions for the engineering problems.

MED 3212	**ADDITIVE MANUFACTURING**	**L**	**T**	**P**	**C**
SDG:9		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To study the Various AM processes and applications

COB2: To Learn modelling concepts

COB3: To gain knowledge about liquid based system

COB4: To familiarize about solid and powder based system

MODULE I INTRODUCTION L:5

Overview - Rapid Prototyping - Rapid Tooling - Need of additive manufacturing- Classification- Role of additive manufacturing in Industry 4.0 - Characteristics of AM- Product accuracy and surface quality - Speed and Various parameters (strength, homogeneity and isotropy) - Economic analysis- Materials used for additive manufacturing technology – Applications.

MODULE II MODELING TECHNIQUES L:5 P:15

Basic concepts - CAD Model Preparation - Digitization Techniques-Data Processing- Model Slicing – Tool path generation- Part orientation and support generation – Software additive manufacturing - Model reconstruction.

MODULE III LIQUID BASED SYSTEM L:5 P:0

Stereo lithography (SLA): Equipment, Working Principle, Photopolymers, Photo polymerization, Process and its variables, advantages and applications – Solid ground curing (SGC): Process, working principle, applications, advantages and disadvantages – Material Jetting (MJ): Types, Process, Working principle, Applications, Advantages and Disadvantages.

MODULE IV SOLID BASED SYSTEM L:15 P:15

Fused Deposition Modeling (FDM) : Equipment, Principle, Process and its variables, advantages and applications – Laminated Object Manufacturing (LOM) : Equipment, Principle, Process and its variables, advantages and applications - Selective Laser Sintering (SLS) : Equipment, Principle, Process and its variables, advantages and applications – Selective Laser Melting (SLM) :Three Dimensional Printing - Equipment, Principle, Process and its variables, advantages and applications – Electron Beam Melting : Equipment, Principle, Process and its variables, advantages and applications – Binder Jetting : Equipment, Principle, Process and its variables, advantages and applications - WAAM (Wire Arc Additive Manufacturing) - Equipment, Principle, Process and its variables, advantages and applications.

PRACTICALS

LIST OF EXPERIMENTS:

1. Design a simple part using CAD software and understand the digitization techniques.
2. Design a simple part using AM software and understand the Part orientation and support structure generation
3. Simulate the designed part using AM software and understand the parameters of AM and tool path generation
4. Practice with reverse scanning software and understand its requirements
5. Demonstration of simple component fabrication using FDM technique in real time.

L – 30; P-30; TOTAL HOURS – 60

TEXT BOOKS:

1. Chua C.K., Leong K.F. and LIM C.S “Rapid prototyping: Principles an Applications”, World Scientific publications, 3rdEd., 2010.
2. Ian Gibson, Davin Rosen, Brent Stucker “Additive Manufacturing Technologies”, Springer, 2nd Ed, 2014.

REFERENCES:

1. Andreas Gebhardt, “Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing”, Hanser Publishers, 2011.
2. J.D. Majumdar and I. Manna, “Laser-assisted fabrication of materials”, Springer, Series in Material Science, 2013.
3. L. Lu, J. Fuh and Y. S. Wong, “Laser-induced materials and processes for rapid prototyping”, Kluwer Academic Press, 2001.
4. Zhiqiang Fan and Frank Liou, “Numerical modeling of the additive manufacturing (AM) processes of titanium alloy”, InTech, 2012.
5. Gibson, Rosen, Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”. Springer, 2009.
6. Hopkinson, Hague, Dickens, “Rapid Manufacturing: An Industrial Revolution for the Digital Age”, Wiley, 2005.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the different AM processes and its applications

CO2: Use different CAD and AM software and understand the slicing concepts

CO3: Understand the operating principles of liquid based AM systems

CO4: Explain the Solid and powder based AM system

Board of Studies (BoS):

19thBoS of MECH held on 21.12.2021

Academic Council:

19th AC held on 29 .09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	M		L	L									L	H
CO 2	M		L	L									H	H
CO 3	M		L	L									H	H
CO 4	L		L	L									H	M
CO 5	L		L	L									H	M

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

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

Holistic understanding of additive manufacturing fundamentals enhances the industries and other enterprises for future readiness

MED 3213	**SIMULATION LABORATORY**	**L**	**T**	**P**	**C**
SDG:9		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To learn the basics of Matlab environment

COB2: To study the response in vibratory systems with and without damping.

COB3: To acquire knowledge on controlling the vibration behaviour

COB4: To familiarize with multibody modelling and simulation of hydraulic systems

PRACTICALS

List of Experiments:

Basics of Matlab software

1. Matrix,Matrix Operators, Accessing Parts of a Matrix.
2. Syntax and Semantics, Plotting 1D, 2D & 3D.
3. Exercise on creating function, Syntax and Scripts.

Modelling and simulation of Vibration System

4. Simulation of simple pendulum.
5. Single degree of freedom spring-mass system with free and forced vibration.
6. Two degree of freedom spring-mass system with free and forced vibration.
7. Controlling the response of vibration system using PID controller.

Multibody simulation

8. Simulation of Four bar mechanism.
9. Simulations of Slider crank mechanism.

Simulation of Hydraulic systems

10. Simulation of Hydraulic system with Single-Acting Cylinder.
11. Simulation of Hydraulic system with Double-Acting Cylinder.

TEXT BOOKS:

1. SS Rao, "Mechanical Vibrations, An Introduction", Pearson, 6th Edition,2018.
2. "SIMULATION LABARATORY" Manual of BSARCIST.

REFERENCES:

1. DingyuXue, YangQuan Chen, "System Simulation Techniques withMatlab and Simulink", John Wiley & Sons, 2014.

2. Devendra K. Chaturvedi, “Modeling and Simulation of Systems Using MATLAB and Simulink”, CRC Press, 2010.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Perform basic MATLAB programming

CO2: Model and simulate the response of various vibrating systems

CO3: Simulate and control the vibrating systems

CO4: Model and simulate multibody and hydraulic systems.

Board of Studies (BoS):

19th BoS of MECH held on 21.12.2021

Academic Council:

19th AC held on 29 .09.2022

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

The understanding of programming fundamentals and simulation leads to development of automation.

GED 3201	**REASONING AND APTITUDE FOR ENGINEERS**	**L**	**T**	**P**	**C**
SDG: 4		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To develop students' critical reading skills

COB2: To foster their writing skills

COB3: To enlighten the various methods of solving quantitative problems

COB4: To make students ready for clearing placement and competitive examination

MODULE I OBJECTIVE ENGLISH 07

Reading Comprehension - Sentence Rearrangement - Cloze Test – Error Spotting

MODULE II VOCABULARY DEVELOPMENT 08

Vocabulary (Synonyms and Antonyms, one word Substitutes, Spellings, Idioms and Phrases, etc) - Fill in the blanks - Paragraph Completion

MODULE III GENERAL MENTAL ABILITY 08

Time speed and Distance –Problems on Trains – Boats and Streams - Permutation and Combination - Probability

MODULE IV 07

Data Interpretation (charts, graphs, tables, data sufficiency, etc.) – Time and work-Pipes and Cisterns-Venn Diagrams-Mensuration

L – 30 ; TOTAL HOURS 30

REFERENCES:

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. 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 their reading ability

CO2: Exhibit their vocabulary and writing skills

CO3: Apply the problem-solving techniques

CO4: Gain confidence mentally and be successful in their career

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

Academic Council:
17th AC held on 15.07.2021

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

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

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

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

SEMESTER VII

		L	T	P	C
MED 4101	**AUTOMOBILE ENGINEERING**	**L**	**T**	**P**	**C**
SDG:9		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To study the vehicle structures, steering geometry and wheel alignment.

COB2: To obtain knowledge on the suspension and braking system.

COB3: To familiarize the working of vehicle power train system

COB4: To learn about automotive electrical and electronic systems.

MODULE I CHASSIS SYSTEM L:8 P:8

Types of automobiles - Vehicle construction - Chassis – Frame and body - Vehicle aerodynamics - Steering geometry and types of steering gearbox - Manual steering - Power steering - Wheel alignments parameters - Wheels and tires

MODULE II SUSPENSION AND BRAKING SYSTEMS L:7 P:7

Suspension system – Components of suspension system – Dependent and independent suspension system – Air suspensions systems - Braking systems – Components of braking system - Types and constructions – Diagonal braking systems - Antilock Braking Systems (ABS)

MODULE III POWER TRAIN SYSTEM L:8 P:8

Classification of internal combustion engines - Engine components - Fuel injection systems - Engine emission control systems - Cooling and lubrication systems in engine – Ignition system - Clutch: Working principle and Types - Gearbox (manual and automatic) - Fluid flywheel – Torque convertors - Propeller shaft – Differential.

MODULE IV AUTOMOTIVE ELECTRICAL AND ELECTRONICS L:7 P:7

Battery - Charging system - Starter motor & drives - Lighting circuits - Safety systems: Active safety & passive safety, Seat belts, airbag - Adaptive Cruise Control (ACC) - Variable Valve Timing (VVT) - Electronic Brake-force Distribution (EBD) – Electronic Stability Program (ESP) - Traction Control

System (TCS) - Electric & Hybrid vehicles.

PRACTICALS

List of Experiments:

1. Dismantle & Assembly of petrol engine.
2. Dismantle & Assembly of diesel engine.
3. Study of oil filter, fuel filter, fuel injection system, MPFI
4. Study of ignition system components – coil, magneto and electronic ignition systems.
5. Study of engine cooling system components
6. Study of engine lubrication system components
7. Dismantle & Assembly of Differential
8. Dismantle & Assembly of gear box
9. Dismantle & Assembly of Clutch assembly
10. Dismantle & Assembly of brake systems

L – 30; P-30; TOTAL HOURS – 60

TEXT BOOKS:

1. Kirpal Singh, "Automobile Engineering", Standard Publishers, Vol-I & II, 14^{th} Edition, 2018.
2. William B. Ribbens, "Understanding Automotive Electronics", 7^{th} Edition, Elsevier Publishing, 2013.

REFERENCES:

1. Bosch, Robert Bosch GmbH,"Automotive Handbook", Germany 10^{th} edition, 2018.
2. N. K. Giri, "Automobile Mechanics", 8^{th} Edition, Khanna Publishers, 2014.
3. Robert Bosch Gmbh (Ed) Bosch,"Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive", 5^{th} edition, John Wiley& Sons Inc., 2014.
4. K. Newton, W. Steeds, T. K. Garrett, "The Motor Vehicle", SAE International,13^{th} edition,2000.
5. Heinz Heisler, "Advanced Vehicle Technology", Elsevier Ltd, 2^{nd}Edition,2002.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Suggest suitable vehicle layout and, explain about steering system and wheel alignment

CO2: Elucidate about the suspension and braking system

CO3: Describe the working of automotive powertrain systems

CO4: Discuss the latest trends in automotive electrical and electronic systems

Board of Studies (BoS):
19th BOS held on 21.06.2021

Academic Council:
19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M						L						H	L
CO2	M						L						H	L
CO3	M						L						H	L
CO4	M					L	L		M				H	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 automotive principles leads to design of automotive component and its sub systems ensuring safety, reliability and efficiency

MED 4102	**INTERNSHIP II**	**L**	**T**	**P**	**C**
SDG:08		**0**	**0**	**2**	**1**

Students must undergo 15 days of Industrial training in the industries relevant to Mechanical Engineering during the summer vacation of third year

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

By undergoing industrial training/Internship, interns gain valuable work or research experience and time management which are key for success to job, entrepreneurship, to sustain per capita economic growth in accordance with national circumstances.

SEMESTER VIII

		L	T	P	C
MED 4211	**PROJECT WORK**				
SDG:08		**0**	**0**	**18**	**9**

COURSE OBJECTIVES:

COB1: To encourage students to apply the knowledge and skills gained through various courses.

COB2: To create a platform for students to demonstrate their practical competence.

Students should do a project which involves themselves with innovative ideas of design, analysis, fabrication and new development. The project work identified in collaboration with industry should be preferred. Frequently, progress in the project work is evaluated by conducting reviews. At end semester students should appear for their project viva-voce and submit the report based on the data obtained by the way of experiments conducted in the laboratory/industry.

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

The project work allows students to expand their creative abilities by building a new system from scratch, develop their communication skills there by improving the employability and entrepreneurship skills and encourage the formation and growth of micro, small and medium-sized enterprises.

LIST OF PROFESSIONAL ELECTIVE COURSES
DESIGN STREAM

MEDX 01	**ADVANCED STRENGTH OF MATERIALS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To study the stress strain relations and torsion of non-circular sections

COB2: To learn about shear centre of various sections

COB3: To gain knowledge on unsymmetrical bending

COB4: To familiarize the stresses in flat plates, rotary sections and contacts

COB5: To acquire knowledge about various theories of plasticity

MODULE I STRESS - STRAIN RELATIONS AND TORSION OFNON-CIRCULAR SECTIONS L:10

Elastic and Inelastic response of a solid - Transformation of stress, strain, principal stresses and strains - General equations of elasticity in Cartesian, differential equations of equilibrium- Compatibility- Boundary conditions - Representation of three-dimensional stress of a tension -Generalized hook's law – St. Venant's principle- Plane stress-Airy's stress function.

MODULE II SHEAR CENTRE L:7

Shear Centre – Location of shear centre for various sections: thin wall beam cross section, channel section, box beams, beams formed from stringers and thin webs, shear flows-Plastic bending

MODULE II UNSYMMETRICAL BENDING L:8

Flexible Members – Circumference and radial stresses-Deflections-Curved beam with restrained ends - Closed ring subjected to concentrated load and uniform load - Chain links and crane hooks.

MODULE IV STRESSES DUE TO ROTARY SECTIONS AND CONTACTS L:12

Stresses in circular and rectangular plates due to various types of loading and end conditions, buckling of plates - Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds - Contact Stresses – Methods of computing contact stress -

Deflection of bodies in point and line contact applications.

MODULE V THEORY OF PLASTICITY L:8

Theory of plastic deformation – Yield criteria – Tresca and Von-mises-Distortion energy – Stress-Strain relation – Mohr's circle representation of a state of stress.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

3. Boresi A.P., Schmidt R.J., "Advanced Mechanics of Materials", JohnWiley and Sons, Sixth edition, 2009.
4. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill, 2017.

REFERENCES:

4. Seely and Smith, "Advanced Mechanics of Materials", John WileyInternationalEdn, 1963.
5. Wang, "Applied Elasticity", McGraw Hill, 1963.
6. Robert D. Cook, Warren C. Young, "Advanced Mechanics ofMaterials", Mcmillan pub. Co., 1998.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the stress strain relations and torsion of non-circular sections

CO2: Determine shear centre of various sections

CO3: Describeunsymmetrical bending phenomenon in various sections

CO4: Evaluate stresses in flat plates, rotary sections and contacts

CO5: Apply various theories of plasticity for stress analysis

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The understanding of stress strain relations and various theories related to strength of materials leads to construction of robust engineering systems.

MEDX 02	**DESIGN OF HYDRAULICS AND PNEUMATICS**	**L**	**T**	**P**	**C**
SDG:9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

The objective of the course is

COB1: To learn the working principles of fluid power systems and hydraulic pumps

COB2: To study functioning of hydraulic actuators and control valves

COB3: To gain knowledge on the hydraulic circuits and systems

COB4: To acquire knowledge on working of pneumatics and electro pneumatic systems

COB5: To familiarize the design, development and troubleshooting of fluid power systems

MODULE I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS L:9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque- Problems –Pumps:Pumping Theory, Pump Classification, Construction, Working, Design, Advantages, Disadvantages, Performance - Selection criteria of pumps – Fixed and Variable displacement pumps – Problems

MODULE II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS L:9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary actuators-Hydraulic motors - Control Valves: Direction Control, Flow control and pressure control valves, Construction and Operation – Servo and Proportional Valves - Accessories: Reservoirs, Pressure Switches,Accumulators, Intensifiers, Filters –Fluid Power ANSI Symbols – Problems

MODULE III HYDRAULIC CIRCUITS AND SYSTEMS L:9

Industrial hydraulic circuits: Regenerative, Pump Unloading, DoublePump, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Accumulator and Pressure Intensifier circuits -

Hydrostatic transmission –Mechanical Hydraulic Servo systems

MODULE IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS L:9

Properties of air – Perfect Gas Law – Compressors – Filters, Regulator, Lubricator – Muffler- Air control Valves, Quick Exhaust Valves- Pneumatic actuators- Design of Pneumatic circuit –Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Introduction to fluidics and Pneumatic logic circuits

MODULE V DESIGN, DEVELOPMENT AND TROUBLE SHOOTING OF FLUID POWER SYSTEMS L:9

Hydraulic and Pneumatic systems: Installation, Selection, Maintenance, Trouble Shooting and Remedies - Conditioning of hydraulic fluids - Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications - Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. – Low cost Automation – Hydraulic and Pneumatic power packs.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education, Seventh Edition, 2019.
2. Andrew Parr, "Hydraulics and Pneumatics A Technician's and Engineer's Guide", Third Edition, Elsevier, 2011.

REFERENCES:

1. Jagadeesha. T., "Pneumatics Concepts, Design and Applications", Universities Press, 2015.
2. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", Tata McGraw Hill, 2017.
3. Srinivasan.R., "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: demonstrate the working principle of fluid power systems and hydraulic pumps

CO2: describe the working of hydraulic actuators and valves

CO3: explain the various components of the hydraulic circuits

CO4: articulate the working of pneumatic systems and appreciate the role of electrical devices in fluid power

CO5: perform the design, development and troubleshooting of fluid power systems

Board of Studies (BoS):
19th BoS of MECH held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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

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

Holistic understanding of fluid power fundamentals helps various sectors of industries in automation of processes

MEDX03	**NOISE, VIBRATIONAND AND HARSHNESS**	**L**	**T**	**P**	**C**
SDG:9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To study the fundamental concepts of NVH.

COB2: To acquire knowledge on modelling of vibrating systems.

COB3: To learn about different types of vibration measurement techniques

COB4: To familiarize about noise and measurement techniques

COB5: To gain knowledge on different vibration and noise controlling techniques

MODULE I INTRODUCTION TO NVH L: 7

Definition of NVH - Importance and applications of NVH –Sources and Physiological effects of vibration and noise – Standards and limits of vibration and noise –Concept of Harshness - Effect and acceptable degree of Harshness- Subjective and objective evaluation of harshness.

MODULE II MODELLING OF VIBRATING SYSTEM L: 12

Basic Concepts of Vibrations: Periodic motion, Simple Harmonic Motion, Frequency, Amplitude time period and Resonance - Types of Vibrations: Free & Forced Vibrations – Need for vibration analysis – Mathematical modelling of vibrating systems - Single degree and two degrees of freedom of spring mass damper system.

MODULE III VIBRATION MEASUREMENT L:10

Vibration measuring Instruments - Vibration pick-up - Types of Transducers: Accelerometer, Impact Hammer – Sensor location and mounting techniques – Free and forced vibration test – Experimental Modal analysis test – Signal conditioning and recording systems – Sampling, aliasing and resolution - Statistical analysis- Frequency analysis - Campbell's plots- cascade diagrams- coherence and correlation functions.

MODULE IV NOISE AND ITS MEASUREMENT L:8

Sound generation mechanism - Acoustic variables - Attributes of sound: wavelength, period, frequency and speed of sound -Decibel scale- Wave equation - types of sound fields - Measures of sound: Sound pressure, sound intensity and sound power - Combining sources: dB arithmetic, Standing wave, Beating, Impedance - Measuring microphones - Sound level meter-Time and frequency weighting- Sound spectra – Octave band analysis- Order analysis and waterfall plot- Various types of acoustic testing chambers -Two- microphone probe for measuring.

MODULE V VIBRATION AND NOISE CONTROL TECHNIQUES L:8

Methods of Vibration Control - Vibration isolation - Vibration absorber - Design of a Vibration Absorbers -Unconstrained and constrained layer damping treatment - Active Vibration Control - Methods of Noise Control- Automotive noises – Internal and External noise sources in vehicles - Sound package solution to reduce the interior noise: acoustic isolation, acoustic absorption and damping material solutions - Exterior noise sources in vehicles such as air intake systems and exhaust systems - Tyre noise-NVH in Electric Vehicles Sources - Solutions to reduce NVH.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. William Thomson. “Theory of Vibration with Applications”, 5th edition, CRC Press, 2018.
2. Singiresu S Rao. “Mechanical Vibrations”, 6th edition, Pearson Education, 2017.
3. L.G. Lasithan, “Mechanical Vibrations and Industrial Noise Control”, PHI Learning Pvt. Ltd., 2014
4. Dr.Sadhu Singh, “Mechanical Vibrations and Noise Control”, Khanna Publisher, 2006.

REFERENCES:

1. M.P. Norton, “Fundamentals of Noise and Vibrations Analysis for Engineers”, Cambridge University Press, 2012.
2. V.Ramamurti, “Mechanical Vibration Practice and Noise Control”, Alpha Science International, 2012.
3. M. Harrison, Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles, Elsevier Butterworth-Heinemann, 2004.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: explain the fundamental concepts of NVH

CO2: model the simple vibrating systems

CO3: apply various vibration measurement techniques

CO4: analyse the sources of noise and propose appropriate measurement techniques.

CO5: select vibration and noise controlling techniques for a given condition.

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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

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

Understanding the components of Noise and Vibration leads to construction of fault free and sustainable engineering systems.

MEDX 04	**DESIGN OF JIGS, FIXTURES AND PRESS TOOLS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To study about the elements of jigs and fixtures

COB2: To familiarize with clamps and tolerance

COB3: To learn the procedures for the design of different types of jigs

COB4: To gain knowledge about the procedures for the design of different types of fixtures.

COB5: To study about press working terminology and die design.

MODULE I INTRODUCTION TO JIGS AND FIXTURES L:8

Objectives of tool design –Production devices - Inspection devices – Types of Jigs - Types of Fixtures - Function and advantages of Jigs and fixtures – Basic elements – Principles of location – Locating methods and devices – Redundant Location –Materials used for jigs and fixtures.

MODULE II CLAMPS AND TOLERANCE L:9

Introduction - Types of clamps – Mechanical actuation - Pneumatic and hydraulic actuation – Analysis of clamping force – Tolerance and error analysis.

MODULE III JIGS L:10

Types of Jigs: Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – Drill bushes – Design and development of jigs for given components.

MODULE IV FIXTURES L:10

General principles of milling: Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems – Quick change fixtures – Design and development of Fixtures for given component.

MODULE V DESIGN OF DIES AND PRESS WORKING L:8

Press working terminology – Presses and press accessories – Computation of capacities and tonnage requirements – Elements of progressive, Combination and compound dies – Die block - Die shoe - Bolster plate -

Punch plate- Punch holder-Guide pins and bushes – Strippers – Knockouts-Stops –Pilots-Selection of standard die sets – Design and development of progressive and compound dies for Blanking and piercing operations - Bending dies - Development of bending dies - Forming and drawing dies - Development of drawing dies.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Donaldson, C., “Tool Design”, Tata Mc-Graw Hill, 2006.
2. Edward G Hoffman, “Jigs & Fixture Design”, Thomson – Delmar Learning, Singapore 2004.

REFERENCES:

1. Design Data: Data Book of Engineers by PSG College - KalaikathirAchchagam - Coimbatore, 2020.
2. Joshi, P.H., “Jigs & Fixtures”, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.
3. Hiram E Grant, “Jigs and Fixture” Tata McGraw-Hill, New Delhi, 2003.
4. “Fundamentals of Tool Design”, CEEE Edition, ASTME, 1983.
5. Kempster, “Jigs & Fixtures Design”, The English Language Book Society”,1978.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain about the elements of jigs and fixtures

CO2: Use suitable clamps and tolerance

CO3: Design different types of jigs

CO4: Design different types of fixtures

CO5: Describe press working terminology and design different types of dies.

Board of Studies (BoS):	**Academic Council:**
20^{th} BOS held on 08.08.2022	19^{th} AC held on 29 .09.2022

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

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 the design concepts in jigs, fixtures and press tools leads to enhance the overall manufacturing efficiency of industries.

MEDX 05	**INDUSTRIAL PROBLEM SOLVING TECHNIQUES**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn about various techniques for problem solving

COB2: To gain knowledge on statistical techniques for problem solving

COB3: To study different optimization techniques

COB4: To acquire knowledge on PERT / CPM

COB5: To familiarize about various AI based techniques for problem
Solving

MODULE I PROBLEM SOLVING TECHNIQUES – AN INTRODUCTION L:9

Introduction –Eight step problem solving methodology – Symptoms - Root cause- Difference between symptoms and root cause – Role of problem solving for continuous improvement – Various tools and techniques for problem solving – Action plan for execution of problem solving

MODULE II STATISTICAL TECHNIQUES L:9

Introduction to statistical quality control (SQC) – Need for SQC in industries – Different Techniques – Failure Mode and Effect Analysis – Quality function Deployment – Control charts for variable and attributes – Sampling techniques- Numerical problems - Case study

MODULE III OPTIMIZATION TECHNIQUES L:9

Transportation – Mathematical model- Algorithm – Methods for finding initial solutions: North West corner method, Least cost method, Vogel's Approximation method – Variations in transportation problem –Assignment – Mathematical formulation – Hungarian method for solving assignment problem – Traveling salesman problem – Variations in assignment problems –Game theory – Numerical problem-Linear Programming model – Case study in Marketing, agriculture and finance

MODULE IV PERT AND CPM L:9

Introduction – Difference between PERT and CPM – Different phases for project management – PERT/CPM network components – Precedence relationships – Critical Path Method – Forward pass method – Backward pass method – Project Time – Cost Trade-off– Resource Allocation – resource leveling and Resource smoothing

MODULE V ARTIFICIAL INTELLIGENCE TECHNIQUES L:9

Definition of Artificial Intelligence - Application and methods - Neural Computing – Artificial Neural Network- Feed forward back propagation, concept of hidden layer – Learning from big data – Data processing – Prediction- Genetic Algorithms – Introduction - Fuzzy Logic – Rule based learning

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. J K Sharma, Operations Research- Theory and Applications, Trinity Press, Edition 6,2015.

REFERENCES:

1 Montgomery, Douglas C. Introduction to Statistical Quality Control, Sixth Edition. John Wiley and Sons, Inc. Edition 8, 2019. (ISBN: 978 -1-119-39930-8)

2 Stuart Russell, Peter Norvig, "Artificial Intelligence - A Modern Approach", 3rd Edition, Pearson Education / Prentice Hall of India, 2010.

3 Stephen Lucci, Danny Kopec," Artificial Intelligence in the 21st Century", Mercury Learning and Information, Edition 2,2015.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe various techniques for problem solving

CO2: Apply statistical techniques for a specific problem

CO3: Identify suitable optimization technique for problem solving

CO4: Explain about PERT /CPM

CO5: Identify the suitable AI based technique to the problem

Board of Studies (BoS):	**Academic Council:**
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M		L	L				L			L	M	M
CO2	H	M		L	L				L			L	M	M
CO3	H	M		L	L				L			L	M	M
CO4	H	M		L	L				L			L	M	M
CO5	H	M		L	L				L			L	M	M

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 various problem solving techniques supports domestic technology development, research and innovation in developing countries

MEDX 06	**PRODUCT DESIGN AND MANUFACTURING**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To study the need and importance of new product development

COB2: To learn the product design process.

COB3: To acquire knowledge on detail designing and value engineering techniques.

COB4: To gain knowledge on product manufacturing and its costing.

COB5: To familiarize the importance of quality and sustainable manufacturing process.

MODULE I INTRODUCTION TO PRODUCT DESIGN L:8

Product design needs and evolution - Creativity and Innovation: Patents, Role of innovation in product design - Product life cycle - Product design morphology - Problem Identification - Market opportunity - Plan for products.

MODULE II PRODUCT DESIGN PROCESS L:10

Identifying customer needs - Product specification – Benchmarking - Quality Function Deployment (QFD) - Concept Generation – Concept Selection and Testing.

MODULE III DETAIL DESIGNING L:8

Value Engineering: Elements of Value Engineering, Value Engineering tools - Architecture design - Industrial Design - Methods and types of prototyping -Laboratory demonstration on 3D printing.

MODULE IV PRODUCT MANUFACTURING AND COSTING L:10

Materials and Manufacturing Process selection - Design for Manufacturing and Assembly (DFMA) - Design for Maintenance - Plant Layout design - Process simulation – Product Costing: Elements of product cost, Estimation and reduction of manufacturing cost, Life Cycle Costing.

MODULE V QUALITY AND SUSTAINABLE MANUFACTURING PROCESS L:9

Design for Environment - Design for Quality Control - Life Cycle Impact

Assessment - Reverse Engineering – Outsourcing - Mass customization - Managing Competitiveness - Computer Integrated Manufacturing.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Karl T. Ulrich, Steven D. Eppinger, "Product Design and Development ",McGraw-Hill Education, 5th Edition, 2017.
2. Kevin Otto, Kristin Wood, "Product Design", Pearson Education, New Delhi, 2001.

REFERENCES:

1. Clive L. Dym, Patrick Little, and Elizabeth J. Orwin, "Engineering Design: A Project Based Introduction", 4thEdition, Wiley, 2014.
2. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", Cengage Learning Inc, 2ndEdition, 2010.
3. Chitale A K, Gupta R C, "Product Design and Manufacturing", Prentice Hall India Learning Private Limited, 6th Edition, 2014.
4. David Ullman, "The Mechanical Design Process", McGraw-Hill Education,2015.
5. Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., Integrated product and process design and development: The product realization process, CRC Press, 2009.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the importance of new products and plan for product design.

CO2: Execute quality function deployment to generate selection and test concepts.

CO3: Perform detailed design using value engineering techniques.

CO4: Apply the concept of design for manufacture and costing principles.

CO5: Implement quality and sustainability in manufacturing process.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The knowledge of new product design through creativity and innovation techniques leads to manufacturing of quality and sustainable product for the benefit of the society and foster industrialization.

MEDX 07 DESIGN OF TRANSMISSION SYSTEMS L T P C

SDG: 9 3 0 0 3

Use of PSG Design data book is permitted for semester end exam

COURSE OBJECTIVES:

COB1: To learn the design principles of flexible drives

COB2: To gain knowledge on the design aspects of spur and helical gears

COB3: To acquire knowledge on design of bevel and worm gears

COB4: To study the design of gear box and speed reducers

COB5: To familiarize the design of clutches and brakes

MODULE I FLEXIBLE DRIVES L:9

Belt drives: Design using basic equations, design of flat and V-belt drives based on manufacturer's data, timing belt - Chain drives: Chordal action, drive failures, design of chain drive, silent chain - Design of wire rope and pulley.

MODULE II SPUR AND HELICAL GEARS L:9

Review of gear fundamentals: Types of gears, Interference and Undercutting, Gear force analysis - Spur gears: Failures in gears, beam strength, comparison of tooth shapes, design of spur gears including non-metallic gears - Helical gear: Virtual number of teeth, design of helical gears.

MODULE III BEVEL AND WORM GEARS L:10

Overview of bevel gear design- Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth estimating the dimensions of pair of straight bevel gears.

Worm gears: Materials, modes of failure and design stresses, efficiency, and thermal considerations - Design of worm gears.

MODULE IV GEAR BOXES L:8

Progression – Standard step ratio – Ray diagram - Kinematic layout – Design of Sliding mesh gear box- Constant mesh gearbox – Design of multi speed gear box - Speed reducers: Design of single stage speed reducer, gear tooth forces, shaft design and bearing selection.

MODULE V CLUTCHES AND BRAKES L:9

Clutches: Role of clutches, positive and gradually engaged clutches, design of single plate and multiple plate clutches - Brakes: Role of brakes, types of brakes, self-energizing and de-energizing brakes, thermal considerations, design of single shoe and double shoe brakes, design of disc brakes, design of internally expanding shoe brakes-Overview of band brakes and anti-lock braking system.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Bandari V.B, "Design of Machine Elements", 4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi, 2017.
2. Robert L Norton, "Machine Design - An Integrated Approach", 2nd Edition, Pearson Education, 2013.

REFERENCES:

1. Richard G Budynas, J Keith Nisbett, "Shigley’s Mechanical Engineering Design", 10th Edition, McGraw Hill Publishers Co. Ltd., 2017.
2. Sundararajamoorthy T. V and Shanmugam.N, "Machine Design", Anuradha Publications, Chennai, 2003.
3. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.
4. Robert L Mott, "Machine Elements in Mechanical Design", 4th Edition, Pearson/Prentice Hall, 2004.
5. Faculty of Mechanical Engineering, PSG College of Technology, "PSG Design Data Book", KalaikathirAchagam, 2019.
6. Jalaludeen S, “A text book of machine Design”, 3rd Edition, Anuradha Publications.,2006.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Design the flexible drives

CO2: Design spur and helical gears for the given power conditions

CO3: Design bevel and worm gears

CO4: Design the gear box and speed reducers

CO5: Design the clutches and brakes

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The holistic understanding of design of different transmission systems leads to innovative solutions for complex engineering problems

MEDX 08	**MECHANICS OF COMPOSITE MATERIALS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To familiarise the various nomenclature of composites

COB2: To study the different manufacturing process of the composites

COB3: To learn the fundamentals of lamina constitutive equations

COB4: To acquire knowledge on strength of composite laminate

COB5: To study the thermal behaviour of layered composites

MODULE I INTRODUCTION TO COMPOSITE MATERIALS L:7

Definition – Matrix materials, polymers, metals, ceramics– Reinforcements: particles, whiskers, inorganic fibers, metal filaments– Ceramic fibers–Fiber fabrication– Natural composite wood, Jute –Merits and demerits of composites over monolithic materials - Mechanical properties and applications of composites, Particulate–Reinforced composite Materials, Dispersion–Strengthened composite, Fiber– Reinforced composites, rule of mixtures–Characteristics of fiber reinforced composites -Manufacturing fiber and composites.

MODULE II MANUFACTURING OF COMPOSITES L:10

Manufacturing of Polymer Matrix Composites (PMCs): Hand lay–up, spray technique, filament winding, pultrusion, Resin Transfer Moulding (RTM), bag moulding, injection moulding– Sandwich Mould Composites (SMC) – Manufacturing of Metal Matrix Composites (MMCs): Solid state, liquid state, vapour state processing, manufacturing of Ceramic Matrix Composites (CMCs) – Hot pressing– Reaction bonding process– Infiltration technique-Direct oxidation– Interfaces

MODULE III LAMINA CONSTITUTIVE EQUATIONS L:11

Lamina constitutive equations -Lamina assumptions – Macroscopic viewpoint - Generalized Hooke’s Law -Reduction to homogeneous orthotropic lamina – Isotropic limit case, Orthotropic Stiffness matrix, Definition of stress and moment resultants - Strain displacement relations - Basic assumptions of laminated anisotropic plates - Laminate constitutive equations –Laminate structural Moduli - Evaluation of Lamina Properties from Laminate Tests

MODULE IV LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES L:9

Introduction – Maximum stress and strain criteria - Von–misses yield criterion for isotropic materials - Generalized Hill's Criterion for anisotropic materials - Tsai–Hill's failure criterion for composites - Tensor Polynomial (Tsai–Wu) failure criterion - Prediction of laminate failure equilibrium equations of motion

MODULE V THERMAL ANALYSIS OF COMPOSITES L:8

Assumption of constant Co–efficient of Thermal Expansion (C.T.E.) – Modification of Hooke's Law - Modification of laminate constitutive equations: Unidirectional, off–axis, Symmetric Balanced Laminates

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Chung, Deborah D.L., "Composite Materials: Science and Applications", Ane Books Pvt. Ltd./Springer, New Delhi, 1st Indian Reprint, 2009.

REFERENCES:

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 2006.
2. Gibson, R.F., Principles of Composite Material Mechanics, McGraw–Hill, 2016, Fourth Edition – CRC press in progress.
3. Halpin, J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., 2017. Second Edition (Revised).
4. Issac M. Daniel and OriIshai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2013, Second Edition.
5. MadhujitMukhopadhyay, "Mechanics of Composite Materials and Structures", University Press (India) Pvt. Ltd., Hyderabad, 2004. (Reprinted 2008)
6. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.
7. Mallick, P.K., Fiber – "Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the ingredients and its importance in composites

CO2: Describe the manufacturing process of the composites

CO3: Analyse the fiber reinforced lamina with different boundary conditions

CO4: Design laminate with different orientation of plies for required load and supports

CO5: Analyse the thermo– mechanical behaviours of laminates

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th AC held on 29 .09.2022

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

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

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

The clear understanding of the mechanics of materials will lay a path for innovation of newer materials.

MEDX 09	**DESIGN OF MATERIAL HANDLING**	**L**	**T**	**P**	**C**
SDG: 9	**EQUIPMENT**	**3**	**0**	**0**	**3**

Use of PSG Design data book is permitted for semester end exam

COURSE OBJECTIVES:

COB1: To study the principles of various material handling process and its applications

COB2: To learn the design of various elements and attachments of Hoists

COB3: To familiarize various drives of hoisting gears

COB4: To gain knowledge on the design of conveyors for different applications

COB5: To acquire knowledge on various elements of elevator

MODULE I INTRODUCTION TO MATERIALS HANDLING EQUIPMENT L:7

Introduction - Types of material handling equipment – Applications: aerospace, automotive, chemical, e–commerce, material processing and manufacturing industries – Principles of material handling– Planning: standardization, work, ergonomics, and automation systems.

MODULE II DESIGN OF HOISTS L:11

Design of hoisting elements: Hemp and wire ropes – Welded and roller chains – Design of ropes, pulleys, pulley systems, sprockets and drums – Load handling attachments – Design of forged hooks and eye hooks – Crane grabs – Lifting magnets – Grabbing attachments – Design of arresting gear – Brakes: shoe, band and cone types.

MODULE III DRIVES OF HOISTING GEAR L:10

Hand and power drives – Traveling gear – Rail traveling mechanism – Cantilever and monorail cranes – Slewing, jib and luffing gear – Cogwheel drive – Selecting the motor ratings.

MODULE IV CONVEYORS L:9

Types – Description – Design and applications: Belt conveyors, apron conveyors and escalators, Pneumatic conveyors, Screw conveyors and vibratory conveyors.

MODULE V ELEVATORS **L:8**

Bucket elevators: design – Loading and bucket arrangements – Cage elevators: shaft way, guides, counter weights – Hoisting machine– Safety devices – Design of fork lift trucks.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.

REFERENCES:

1. Siddhartha Ray., Introduction to Materials Handling, New Age International Publishers, 2008.
2. Raymond A. Kulwiec., Materials Handling Handbook, Wiley India, 2ndEdision, 2009.
3. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
4. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.
5. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers, Bangalore, 1983.
6. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Select suitable material handling equipment for a specific application

CO2: Design various elements and attachments of hoists

CO3: Design the components of hoisting drives

CO4: Design the components of various conveyor systems

CO5: Design the elevator system and its components

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The understanding of material handling systems and its components supports domestic technology development, research and innovation in developing countries

MEDX 10 **TRIBOLOGY** **L T P C**

SDG: 9 **3 0 0 3**

COURSE OBJECTIVES:

COB1: To learn the basics of friction.

COB2: To study the various types of wear.

COB3: To familiarize with tribology and its measurements.

COB4: To gain knowledge about the different types of lubricants and lubrication.

COB5: To study the various applications of tribology.

MODULE I FRICTION **L:8**

Introduction- Laws of friction- Types of friction- Causes of friction- Area of contact- Friction measurement standards- Theories of friction: Adhesion, Abrasive and Junction Growth -Laws of Rolling Friction-Friction Instability-Causes of Friction.

MODULE II WEAR **L:10**

Theories of wear- Wear Mechanisms: Adhesive Wear, Abrasive Wear, Corrosive Wear and Fretting Wear - Wear Analysis - Techniques to improve wear resistance- Various factors affecting wear- Measurement of wear- Wear between solids and liquids.

MODULE III TRIBOLOGY **L:10**

Importance of Tribology in Design- Tribology in Industry- Economic Considerations- Measurement of friction: Tribometer, Brake pad testing- Parameters- Different testing methods.

MODULE IV LUBRICATION **L:9**

Types and properties of lubricants- Importance of lubrication- Standard Grades of lubricants- Lubricants additives - Selection of lubricants - Recycling of lubricants-Boundary lubrication-Mixed lubrication- Full Fluid Film lubrication- Hydrostatic lubrication – Hydrodynamic – Elasto-hydrodynamic lubrication-Viscosity and its measurements.

MODULE V TRIBOLOGICAL APPLICATIONS L:8

Application of tribological study on Bearings: Journal bearings, Roller bearings, Needle bearings and Ball bearings-Gears: Spur gear, Helical gear and Herring bone gears –Clutches: Single plate, Multi plate and Cone clutches- Brakes: Drum and Disc –Bio Joints: Ball and Socket Joints and Hinge Joints.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Bharat Bhushan, Introduction to Tribology, Second Edition, John Wiley & Sons, Ltd, 2013.
2. 2. Prasanta Sahoo, Engineering Tribology, PHI Learning Private Ltd, New Delhi, 2011.

REFERENCES:

1. Ghosh, Mazumdar, and Sarangi, Theory of Lubrication, Tata McGraw Hill Education, 1st Ed.2013.
2. H Hirani, Fundamentals of Engineering Tribology with Applications, Cambridge University press, 1st Ed.2016.
3. Ludema K C, Friction, Wear, Lubrication: A textbook in Tribology, CRC Press, 2010.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain thebasics of friction.

CO2: Elucidatethe various types of wear.

CO3: Describe the tribology and its measurements.

CO4: Discuss thedifferent types of lubricants and lubrication.

CO5: Demonstrate the various applications of tribology.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

Understanding the effects of friction, wear and its measurements leads to minimize the damage of the industrial components and increase its lifespan.

MEDX 11 SDG: 9	DESIGN OF ELECTRIC VEHICLE COMPONENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

COB1: To study about the basics of electric vehicles

COB2: To learn the motor torque calculations for electric vehicle

COB3: To familiarize with the electric vehicle architecture

COB4: To acquire knowledge on different electric drives and controllers used in the electric vehicles

COB5: To learn about electric vehicle control units and charging station

MODULE I INTRODUCTION TO ELECTRIC VEHICLE L:10

History - Components of Electric Vehicle - Comparison with Internal combustion Engine: Technology, Benefits and Challenges - Electric Vehicle (EV) classification and their electrification levels - EV Terminology

MODULE II MOTOR TORQUE CALCULATIONS FOR ELECTRIC VEHICLE L:7

Calculation of Rolling Resistance, grade resistance and acceleration force - Finding the total tractive effort, torque required on the drive wheel

MODULE III ELECTRIC VEHICLE ARCHITECTURE L:10

Types of electric vehicle and components - Electrical protection and system requirement - Battery electric vehicle (BEV) - Hybrid electric vehicle (HEV) - Plug-in hybrid vehicle (PHEV) - Fuel cell electric vehicle (FCEV) - Electrification Level of EV - Comparison of fuel versus electric and solar power - Solar power operated electric vehicles - Photovoltaic solar based EV design.

MODULE IV ELECTRIC DRIVES AND CONTROLLERS L:9

Types of motors - Selection and sizing of motor - RPM and torque calculation of motor - Motor controllers - Component sizing - Physical locations - Mechanical and electrical connections of motor.

MODULE V CONTROL UNIT AND ELECTRIC VEHICLES CHARGING STATION L:9

Function of control unit - Development Process – Software - Hardware - Data Management – GUI (Graphical User Interface)/HMI (Human Machine Interface) -Types of charging station - Selection and sizing of charging station - Components of charging station - Line diagram of charging station

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2017.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

REFERENCES:

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press.
2. MehrdadEhsani, YiminGao, Sebastian E.Gsay, Ali Emadi, "Modern Electric, HybridElectric and Fuel Celll vehicles-Fundamentals - Theory and Design", CRC Press.
3. James Larminie, John Lowry, "Electric Vehicle Technology", Wiley publications.
4. Rajendran, G., Vaithilingam, C. A., Misron, N., Naidu, K., & Ahmed, M. R. A comprehensive review on system architecture and international standards for electric vehicle charging stations. Journal of Energy Storage, 42, 2021.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: To explain the basics, benefits and challenges of electric vehicles

CO2: To perform motor torque calculations for electric vehicle

CO3: Todescribe the different types of electric vehicle architecture design

CO4: To analyze the different electric drive and controllers used in an electric vehicle

CO5: To explain the control units and electric vehicles charging station

Board of Studies (BoS):
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	M				H					L	M	L
CO2	H	H	M				L					L	M	L
CO3	M	M	M		M		H					L	M	L
CO4	H	H	M				L					L	M	L
CO5	M	M	M		M		H					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 understanding of fundamentals of the electric vehicles enables to design and develop an eco-friendly automobiles.

MEDX 12	**SHIPMENT PACKAGING DESIGN AND DEVELOPMENT**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To study various elements of shipment packaging

COB2: To learn about the product fragility and related strategies

COB3: To familiarize the design aspects of cushioning and packaging box

COB4: To gain knowledge on testing of shipment packaging.

COB5: To acquire knowledge on the recent trends in shipment packaging

MODULE I ELEMENTS OF SHIPMENT PACKAGING L:7

Introduction to Shipment packaging – Types: Cushioning elements, Carton box - Unconventional packaging methods - An Overview of Containers and Warehouses.

MODULE II PRODUCT FRAGILITY AND PACKAGING SPECIFICATIONS L:8

Introduction to Product fragility - Experiments to identify the product fragility - Packaging strategies related to fragility – Packaging Specifications.

MODULE III DESIGN AND DEVELOPMENT OF CUSHIONING AND PACKAGING BOX ELEMENTS L:12

Cushioning elements and its specifications - Plastic wraps types and definitions - Carton box elements and specifications – Design Calculations - Pallets types and definitions - Cushioning specification calculator - Carton box specification calculator - Optimized final packaging solution calculator - Manufacturing methods in detail.

MODULE IV COMPONENT AND PRODUCT TESTING OF SHIPMENT PACKAGING L:10

Part level testing requirements - Introduction to different standards related to shipment packaging - International standards ISTA 3A and ASTM D4728 - Drop testing -Vibration testing -Shock testing.

MODULE V RECENT TRENDS IN SHIPMENT AND PACKAGING L:8

Recent trends in shipment packaging - Automation - Case study on Amazon packaging - Problem statement: Design & Optimize packaging for any of the e-retailer.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

3. S.Natarajan, M.Govindarajan, B. Kumar, "Fundamentals of Packaging Technology",Prentice Hall India Learning Private Limited,2nd Edition, 2014.
4. Anne Emblem and Henry Emblem, "Packaging Technology",Woodhead Publishing, 2012.

REFERENCES:

1. KarliVerghese, Helen Lewis, Leanne Fitzpatrick "Packaging for Sustainability" Springer, London, 2012.
2. Eiri, "Hand Book of Packaging Technology", Engineers India Research Institute, 2008.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the elements of shipment packaging

CO2: Apply packaging strategies related to fragility.

CO3: Design the cushioning and packaging box

CO4: Select the suitable testing methods for shipment packaging

CO5: Describe the recent trends in shipment packaging

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

The packaging technology helps to optimize the manufacturing and processing methods for packaging materials in terms of environmental, economic and social aspects.

MEDX 13	**DESIGN OF PRESSURE VESSELS AND PIPING ENGINEERING**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**2**	**3**

Use of ASME PRESSURE VESSEL and PIPING CODES are permitted for semester end exam.

COURSE OBJECTIVES:

COB1: To learn the fundamentals in pipe and pressure vessel design

COB2: To gain knowledge on the stresses in pressure vessel and piping

COB3: To familiarize with pressure vessel and piping

COB4: To acquire knowledge on dynamic behaviour of pipe structures

MODULE I INTRODUCTION L:7 P:7

Rationale behind development of codes and standards -Highlights of national and international codes -Theoretical background of pressure vessel and piping design as per ASME codes and RCC-MR codes - Engineering aspects in pressure vessel design: Failure criteria, material selection, geometrical considerations and weld inspection.

MODULE II STRESSES IN PRESSURE VESSEL AND PIPING L:7 P:7

General theory of membrane stresses in vessel under internal pressure and its application to shells: Cylindrical, conical and spherical and end closures, stress concentration, thermal stresses, pressure vessel fatigue, stresses in pipes.

MODULE III DESIGN OF PRESSURE VESSEL AND PIPING L:8 P:8

Pressure vessel and piping design considering excessive elastic deformation, plastic instability, buckling, ratcheting, rupture and creep - High temperature design - Problems and case studies.

MODULE IV DYNAMIC ANALYSIS OF PIPE STRUCTURES L:8 P:8

Wind and Seismic analysis - Damping - Lumped Mass - Steady state vibration and harmonic analysis.

PRACTICALS

List of Experiments

1. Exposure to Element Basic data, Additional data using PV Elite
2. 2D and 3D modelling using PV Elite
3. Stress analysis using PV Elite
4. Preparing Isometric drawing of Pipelines and supports using CEASER II
5. Editing model, Modeling Trunnion or Dummy Support in Caesar II
6. Modeling of Horizontal Vessel for Stress Analysis
7. Wind and Seismic Analysis in Caesar II
8. Flange Leakage Analysis using Pressure Equivalent, NC, and ASME Sec VIII method
9. Slug and Surge Flow Analysis
10. WRC 537 and WRC 297 in Caesar II

L – 30; P-30; TOTAL HOURS – 60

TEXT BOOKS:

1. John F. Harvey, "Theory and Design of Pressure Vessels", 1st Edition, CBS Publishers, New Delhi, 2001.
2. Peter Smith, "The Fundamentals of Piping Design", 1st Edition, Gulf Publishing Company,USA, 2007

REFERENCES:

1. ASME - BPVC, "Pressure Vessel and Boiler code",ASME, USA, 2019.
2. Henry H Bednar, "Pressure Vessel Design Handbook", 2nd Edition, Krieger Publishing Company, USA, 1990.
3. ASME - BPVC, "Pressure Vessel and Boiler code" ,ASME, USA, 2019.
4. ASME SEC VIII DIV-1 Boiler and Pressure Vessel Code: Rules for Constructing Pressure Vessels, ASME, 2013.
5. Dennis Moss, “Pressure Vessel Design Manual” Gulf professional Publishing, Third Edition 2012.
6. ASME Boiler and pressure vessel code Section VIII 8. ASME Boiler and pressure vessel code Section II.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the fundamentals used in design of Pressure vessel and

Pipes

CO2: Design pressure vessels and pipes under internal and external stresses

CO3: Design pressure vessels and pipes against elastic and plastic deformations

CO4: Design pipe structures against dynamic conditions

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

The design of pressure vessel and piping ensures the safe storage of enormous energy stored inside of pressure vessels with gases and volatile liquids.

MEDX 14	**GEOMTRIC MODELLING**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To gain knowledge on the basics of computer graphics.

COB2: To familiarise the mathematics of curve representations.

COB3: To learn the surface and solid modelling techniques.

COB4: To study the applications of geometric models.

MODULE I INTRODUCTION TO COMPUTER GRAPHICS L:8

Role of Geometric Models in product development – Interactive computer graphics: Raster scan graphics, Line Drawing Algorithm - 2D and 3D transformation - Viewing transformation - Modeling schemes: Wire frame, surface, solid modeling.

MODULE II CURVE REPRESENTATION L:8

Implicit, explicit and parametric representation of curves - Continuity conditions - Spline representation: Cubic, Bézier and B-Spline curves - Curve manipulations - NURBS.

MODULE III SURFACE AND SOLID MODELLING L:8

Surfaces: Implicit and explicit function of surfaces, Surface Representation - Analytic and synthetic surfaces - Coons surface patch - Solid Modelling: Solid Representation, Topology, Entities, Set operations, Half Spaces - Boundary representation - Constructive Solid Geometry - Sweep representation.

MODULE IV MODELLING FEATURES AND DATA EXCHANGE L:6

Parametric Modelling: Relations, constraints - Assembly Modelling - Overview of Product Data Exchange: Need for Translators, IGES, STEP and DXF standards - Collaborative Design.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Ibrahim Zeid, “Mastering CAD / CAM” McGraw-Hill Education, 2006.
2. P.N. Rao, “CAD / CAM Principles and Applications”, 3rd Edition, McGraw Hill Education, 2017.

REFERENCES:

1. M Mortenson, “Geometric Modelling”, McGraw-Hill Education, 2013.
2. Chris McMohan and Jimmi Browne, “CAD/CAM Principles, Practice and Manufacturing Management”, Pearson Education, 2000.
3. Donald Hearn and Pauline Baker “Computer Graphics: C Version” Pearson Education India, 2002.
4. Anupam Saxena and Birendra Sahay, Computer Aided Engineering Design, Springer, 2005.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the basics principles of computer graphics.

CO2: Demonstrate the curve generation techniques.

CO3: Explain the surface and solid modelling techniques.

CO4: Implement geometric models for necessary applications.

Board of Studies (BoS):
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Academic Council:
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M		H					L		L	H	M
CO2	H	M	M		H					L		L	H	M
CO3	H	M	M		H					L		L	H	M
CO4	H	M	M		H					L		L	H	M

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

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

The expertise in geometric modelling shall be utilized to visualize, analyse and present innovative design solution that leads to the development of sustainable product and resilient infrastructure by the industry.

MEDX 15	**RELIABILITY ENGINEERING**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To learn the reliability concepts

COB2: To study the role of probability in engineering problems

COB3: Toacquire skills on maintenance of a system

COB4: To be conversant with the repairable systems

MODULE I BASICSOF PROBABILITYAND RELIABILITY L:12

Probability concepts -Elements of probability and binomial distribution – Role of distribution curves in probability and reliability - Definitions of reliability, availability, and serviceability-Failure data analysis: Mean time to failure and Mean time between failure, Failure distribution, Constant failure rate model, Time dependent failure rate model- Bathtub curve and Hazard Model: Constant Hazard and linearly Increasing Hazard- System reliability: Series configuration, parallel configuration and mixed configurations.

MODULE II PROGRESS IN RELIABILITY AND FAULT TREE ANALYSIS L:8

Improvements of components – Redundancy: Element redundancy, unit redundancy, Standby redundancy, Partially redundant system - Reliability cost trade off- - Fault tree construction –System state analysis - Determination of reliability from fault tree analysis.

MODULE III MAINTAINABILTY/AVAILABILITY L:5

Maintainability approach – Strategic maintenance and outsourcing – Preventive maintenance - Availability aspect - System down time - Availability types: Inherent Availability, Achieved availability and operational availability- Reliability and Maintainability trade off.

MODULE IV REPAIRABLE SYSTEMS L:5

Instantaneous repair rate - Mean time to repair – Logical and sequential fault location – Equipment records – Role of computers in job orders and maintenance.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Charles E. Ebeling, An introduction to reliability and maintainability

engineering, Tata McGraw Hill, 2009.
2. Dhillon, Engineering maintainability, PHI, 2008.

REFERENCES:

1. L. S. Srinath, Reliability engineering, Affiliated east west (Pvt) ltd.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Deal the problems through reliability concepts

CO2: Apply the probability statistics to a problem to determine the solution

CO3: Incorporate the maintenance skills at appropriate places.

CO4: Explain the repairable systems

Board of Studies (BoS):
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Academic Council:
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L		M					L			L	M	L
CO2	M	L		M					L			L	M	L
CO3	M	L		M					L			L	M	L
CO4	M	L		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 holistic understanding of reliability engineering helps to prevent certain failure modes and reduce the likelihood and frequency of failures.

MEDX 16 SDG: 9	MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

COB 1: To learn the basic concepts of micro sensors and actuators used in MEMS.

COB 2: To acquire knowledge about circuit and system design in MEMS.

COB 3: To familiarize with MEMS materials and its fabrication techniques.

COB 4: To be conversant about advanced MEMS for sensing and actuation purposes.

MODULE I MICRO SENSORS AND MICRO ACTUATORS L:8

Introduction to MEMS – Miniaturization - Typical products – Micro sensors - Micro accelerometers - Micro actuators -Micro fluidics - Biochemical micro system - Static bending of thin plates - Configurations of accelerometers – Thermo mechanics - Fracture mechanics - Thin film mechanics.

Pressure sensors - Thermal sensors - Electrostatics: basic theory, Gap and finger pull up, Electro static actuators, Comb generators, Inchworms, Electromagnetic actuators, Bistable actuators, Micro motors.

MODULE II CIRCUIT AND SYSTEM DESIGN L:6

System types- Basic modelling elements in system - Feedback systems - Noise, Modelling of MEMS systems - CAD for MEMS - Capacitive accelerometers.

MODULE III MEMS MATERIALS AND FABRICATION TECHNOLOGIES L:8

MEMS materials - Substrates and wafers - Micro system fabrication: Photolithography, Etching techniques, CVD process, Oxidation, Diffusion - Micro machining process: Bulk micro machining, Surface micro machining, and LIGA process.

MODULE IV ADVANCED MEMS FOR SENSING AND ACTUATION L:8

Electromechanical effects: Piezo resistance, Piezoelectricity, Shape memory alloy-Thermal effects: Temperature coefficient of resistance, Thermo-electricity, Thermocouples – Micro fluidics - Squeeze film damping - Surface tension and bubbles -Devices: Pumps, valves, mixers -Integrated fluidic systems - BioMEMS.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Stephen Santeria," Microsystems Design", Kluwer publishers, 2000.

REFERENCES:

1. NadimMaluf," An introduction to Micro electro mechanical system design", Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, "The MEMS Handbook", CRC press Baco Raton, 2000.
3. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.
4. NitaigourPremchandMahalik "MEMS" McGraw hill education (India) private limited, 2007.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explainthe basic concepts of micro sensors and actuators used in MEMS.

CO2: Describethe circuit and system design in MEMS.

CO3: Elucidatevarious MEMS materials and its fabrication techniques.

CO4: Illuminate on advanced MEMS for sensing and actuation purposes.

Board of Studies (BoS): **Academic Council:**

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

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

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

The use of Micro-electromechanical systems (MEMS) considerably increases the tiny integrated devices or systems that combine mechanical and electrical components, which fosters the industrialization.

MEDX 17	**INSTRUMENTATION AND CONTROL**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To learn the basics of measurement systems

COB2: To acquire knowledge on force, torque and speed measurements

COB3: To familiarize the temperature, pressure and flow measurement techniques

COB4: To study the control system components and to provide knowledge of advanced control theory.

MODULE I INTRODUCTION TO MEASUREMENT SYSTEMS L:6

Units -General instrumentation system - Static characteristics: Sensitivity, accuracy, precision, and calibration - Dynamics characteristics: Speed of response and Response time, Measuring Lag, Fidelity, Dynamic errors.

MODULE II MEASUREMENT OF FORCE, TORQUE AND SPEED L:8

Force measurement: Electric balance, Hydraulic and Pneumatic load cells, strain gauge-Magneto elastic and Piezoelectric load cells -Different methods of Torque measurement: Strain gauge, Relative angular twist - Speed measurement - Capacitive tacho-Drag cup type, D.C and A.C tacho-Generators - Stroboscope

MODULE III MEASUREMENT OF TEMPERATURE, PRESSURE AND FLOW L:7

Temperature measurement: Thermistors, RTD, Thermocouple and semiconductors - Pressure measurement: pressure gauge, manometers, bellows, diaphragm, and differential pressure transmitter - Flow measurement: venturi-tubes, rotameters and anemometers.

MODULE IV SIGNALS AND CONTROL SYSTEMS L:9

Data acquisition systems - Basic signal conditioning - Basic elements in control systems: Open and closed loop systems - Design and effect of P, PI, PD and PID feedback controllers - Stability analysis of system: Root locus, Routh Hurwitz criterion - Concept of state variables – State models for linear systems

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. W. Bolton, Instrumentation and Control Systems, Newnes-Elsevier publication, 2nd edition, 2015.
2. M. Gopal, ‘Control Systems, Principles and Design’, 4th Edition, Tata McGraw Hill, New Delhi, 2012.

REFERENCES:

1. Ernest O. Doeblin, Measurement Systems: Application and Design, 5th Edition, TataMcGraw- Hill, 2012.
2. Katsuhiko Ogata, Modern Control Engineering 5th Edition, Prentice Hall of India Pvt. Ltd, 2010.
3. Patranabis D, Instrumentation and Control, PHI Learning Pvt. Ltd, 2011.
4. D.S Kumar, Mechanical Measurements & Control Engineering, Metropolitan Book Co. (P) Ltd, 2015.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe thebasics of measurement systems

CO2: Use various instruments for force, torque and speed measurement

CO3: Demonstrate the method of temperature, pressure and flow measurements

CO4: Explain the methods of acquiring signals from various sensors and apply control theory

Board of Studies (BoS):
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	M	M
CO2	M	L					M					L	M	M
CO3	M	L					H				H	L	M	M
CO4	M	L										L	H	M

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

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

The understanding of industrial instruments and control theory leads to automation in industries.

MEDX 18 **ADVANCED SYSTEM SIMULATION (1D MODELING)**
SDG: 9

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

COB1: To familiarize different types of system and system modelling

COB2: To learn simulation of various mechanical systems

MODULE I INTRODUCTION TO SYSTEMS AND SYSTEM MODELLING L:8

System definition – System boundary – System components and their interactions - System environment – Classification of systems: linear and non-linear systems, lumped and distributed parameter systems, continuous and discrete systems, deterministic and stochastic systems - Analysis of systems - Synthesis of systems, principle of superposition

Need for system modeling - Fundamental axiom - Component postulate - model evaluation - Mathematical modeling of mechanical systems – Spring, mass, dashpot – Transfer function - State space approach.

MODULE II SYSTEM SIMULATION L:7

Simulation: Meaning, types and methods - Simulation of spring-mass-damper systems: Single and multi-degree of freedom, solving differential equation using Laplace transform, Solving the state space equations- Stability criterion through the state transition matrix –Simulation of robotic arm.

L – 15; TOTAL HOURS – 15

TEXT BOOKS:

1. Devendra K. Chaturvedi, Modeling and Simulation of Systems Using MATLAB and Simulink, CRC Press, 2010.
2. DingyuXue, YangQuan Chen, System Simulation Techniques withMatlab and Simulink, John Wiley & Sons, 2014.
3. Philip D. Cha, James J. Rosenberg, and Clive L. Dym, “Fundamentals of Modellingand Analysis of Engineering Systems”, Cambridge University Press, 2000.
4. Woods Robert L. and Lawrence Kent L., “Modelling and Simulation of DynamicSystems”, Prentice Hall, 1997.

REFERENCES:

6. Frank L. Severance, System modeling and simulation: an introduction, J. Wiley, 2001
7. NCOSE. Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities. 4th ed. Wiley, p. 304, 2015.(ISBN: 9781118999400)
8. NASA Systems Engineering Handbook,NASA Headquarters. NASA/SP-2007–6105 Rev 1. Military Bookshop, 2007. (ISBN: 9781780391380)
9. Alexander Kosiakoff, William N. Sweet,Samual J. Seymour, Steven M.Biemer, Systems Engineering Principles and practice,2nd Edition, Wiley,2011.
10.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Classify the various types of system and identify suitable modelling

CO2: Explain the simulation of mechanical systems

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

Holistic understanding of system modelling principle and simulations leads to design innovation.

MEDX 19	**PRODUCT DESIGN USING VALUE ENGINEERING**	**L T P C**
SDG: 9		**1 0 0 1**

COURSE OBJECTIVES:

COB1: To learn the concepts of product design and development

COB2: To acquire knowledge about value engineering approach

MODULE I PRODUCT DESIGN AND DEVELOPMENT L:8

Introduction to product design and development- Design and development of products - Types of design and redesigns - Engineering designs - Duration and cost of product development - The challenges of Product development.

MODULE II VALUE ENGINEERING L:7

Value Engineering (VE) History - Concept and definitions - Value Engineering function - Approach of function - Evaluation of function - Determining function - Classifying function - Evaluation of costs -Value engineering vs Cost cutting - VE applications in product design and success stories.

L – 15; TOTAL HOURS – 15

TEXT BOOKS:

1. Product Design, by Kevin Otto, Kristin wood, Pearson Education Inc., 2001.
2. Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill., 2004.
3. Techniques of Value Analysis and Engineering: 3rd Edition eBook: Miles, Lawrence D., 2015.

REFERENCES:

1. The Guide to Cost-to-Value Analysis - David J. Birnbaum, Emma Birnbaum 2020 OCS Publisher.
2. Kumar S, Singh R K and Jha J K (Ed), “Value Engineering”, Narosa Publishing House, 2005.
3. Product Design Techniques In Reverse Engineering And New Prodct Development Kevin N Otto, Kristin L Wood (Author), Pearson Education Limited (Publisher), 2017.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the new product design and development

CO2: Describe value engineering for developing new products.

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th AC held on 29 .09.2022

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

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

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

The knowledge of Product design with Value Engineering concept upgrades the technological capabilities of industrial sectors and encourages innovation in releasing new customer centric products.

THERMAL STREAM

MEDX 31	**REFRIGERATION AND AIR CONDITIONING**	**L T P C**
SDG: 9		**3 0 0 3**

COURSE OBJECTIVES:

COB1: To study the principles of refrigeration system

COB2: To acquire knowledge on various components of air conditioning

COB3: To learn the principles of psychrometry

COB4: To acquire knowledge on cooling and heating loads

COB5: To gain knowledge on components of refrigeration and various control equipment

MODULE I REFRIGERATION SYSTEMS L:9

Review of thermodynamic principles of refrigeration – Concept of air craft refrigeration system – Vapour compression refrigeration system – Use of PH charts – Cascade system – Coefficient of performance (COP) comparison- Vapour absorption system – Ammonia - water and Lithium Bromide - Water systems – Steam jet refrigeration system.

MODULE II REFRIGERANTS AND COMPONENT SELECTION L:9

Refrigerants – Properties – Selection of refrigerants - Alternate refrigerants – Basic principle, working, construction and types: Reciprocating and rotary compressors, condensers, evaporators, expansion device – Cooling towers – Testing and charging of refrigeration units - Balancing of system components – Application to refrigeration systems – Ice plant – Food storage plants – Milk chilling plants – Refrigerated cargo ships.

MODULE III PSYCHROMETRY L:9

Importance of psychrometric properties - Psychrometric chart - Psychrometric processes: Sensible cooling and heating, Humidification and dehumidification, Cooling and dehumidification, Heating and humidification, Cooling and humidification (evaporative cooling), Adiabatic mixing, Spray washers and cooling towers - Combined heat and mass transfer processes - Coil bypass factor and Apparatus Dew Point (ADP) - Psychrometric calculations for simple air-conditioning system and return air systems with bypass factor - RSHF, GSHF and ESH

Thermal comfort - Heat transfer from human body by sensible and latent heat transfer- Metabolic heat generation - Effect of clothing and definition of effective temperatures - ASHRAE comfort chart - Inside and Outside design conditions - Summer air conditioning systems - Winter air conditioning systems - All year air conditioning systems

MODULE IV COOLING LOAD CALCULATION L:9

Types of load – Design of space cooling load – Heat transmission through building – Solar radiation – Infiltration – Indoor Air Quality (IAQ) – Internal heat sources (sensible and latent heat) – Outside air and fresh air load – Estimation of total load – Domestic and industrial systems – Central air conditioning systems – Heating load calculations

MODULE V AIR CONDITIONING SYSTEM DESIGN AND CONTROLS L:9

Air conditioning equipment – All air systems: Air cleaning and filters, humidifiers, dehumidifiers, air washers - Unitary systems: Window air conditioners – Fan and duct systems - Elementary treatment of duct design – Air distribution system – Types of control action - Controllers – Temperature, pressure and humidity sensors, actuators – Thermal insulation of air conditioning system – Applications: Car, industry, stores and public buildings.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Manohar Prasad, Refrigeration and air conditioning. New Age International, 2011.
2. Arora, C. P., Refrigeration and air conditioning. Tata McGraw-Hill Education, 2021.
3. Roy.J.Dosaat, Principles of Refrigeration, Pearson Education, 2001.

REFERENCES:

1. Stoecker N.F. and Jones, Refrigeration and Air conditioning, 2e Tata McGraw Hill, 2014.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the principle of refrigeration

CO2: Describe the various components of air conditioning

CO3: Explain the principles of psychrometry

CO4: Perform cooling and heating loads

CO5: Elucidate the control equipment used in refrigeration system

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 refrigeration principles enables to utilize their technical skills, design and operate refrigerating equipment's safe and eco–friendly.

MEDX 32	**ADVANCED I.C. ENGINES**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn various fuel supply systems used in I.C. engine

COB2: To gain knowledge on combustion process in I.C. engine

COB3: To study various components of I.C. engine and its sub systems

COB4: To acquire knowledge on automobile emissions and control measures

COB5: To familiarize on recent advancements in I.C. engine

MODULE I FUEL SUPPLY SYSTEM FOR IC ENGINE L:9

Carburetion: Theory of carburetion, mixture requirements for components in S.I Engines, simple carburetor, tuning of carburetor – Requirements of ignition system: Types of ignition system, Direct and indirect, mono point, multipoint injection – Types of nozzles.

MODULE II COMBUSTION IN I.C. ENGINES L:9

Combustion phenomena S.I Engine: Normal and abnormal combustion, factors affecting combustion in S.I. engines, Combustion chamber for S.I engines, octane rating of fuels, knocking in S.I and C.I Engine – Combustion phenomena C.I Engine: Normal and abnormal combustion, factor affecting combustion in C.I. Engines, Combustion chamber for C.I engines – Cetane rating.

MODULE III ENGINE SYSTEM AND COMPONENTS L:9

Ignition system – Lubrication system – Engine starting system – Engine cooling system – Governing system – Testing of IC engines.

MODULE IV AIR POLLUTION FROM IC ENGINE AND ITS REMEDIES L:9

Pollutants: Sources, formation of carbon monoxide, unburnt hydrocarbon, NOx, smoke and particulate matter – Method of controlling Emissions: Catalytic converters and particulate traps – Engine modifications to reduce emissions, EGR, SCR, Method of measurement – Emissions norms.

MODULE V ALTERNATIVE FUELS & RECENT TRENDS L:9

Alternate fuels: Alcohol, Hydrogen, Compressed Natural Gas, LPG, Bio

Diesel, properties, Suitability – Merits and Demerits – HCCI engines – Comparison of Electric vehicle and IC engine – Challenges in Retrofit of IC engine.

L – 45; TOTAL HOURS – 45

TEXT BOOK:

1. V. Ganesan, Internal Combustion Engines, 4th Edition, Tata Mc-Graw Hill Publishing Co. Ltd. 2017. Advanced Vehicle Technology, Heinz Heisler, Elsevier Ltd, (Second Edition)

REFERENCES:

7. Heywood, J.B., Internal Combustion Engine Fundamentals, Tata McGraw-Hill, 9th edition, 2017.
8. K.K. Ramalingam, Internal Combustion Engines Fundamentals, Scitech Publications (India) Pvt Ltd,2018.
9. Dr. V.M. Domkundar, A Course In Internal Combustion Engines, DhanapatRai&Co, Delhi 5. R.Yadav, I.C. Engines, Central book Depot, Allahabad, 2018.
10. Willard w. Pulkrabek, Internal Combustion Engines, Pearson Education, 2nd edition, 2003

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Analyse and compare different fuel supply system of an I.C. Engine

CO2: Explain the stages of combustion and factors involved in it

CO3: Describe the various sub systems of I.C engine

CO4: Explain automobile emissions and their control measures.

CO5: Elucidate the recent trends and developments in I.C. engine.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 fundamentals and recent trends in IC engines enables to contribute in the development automobile industries

MEDX 33	NUCLEAR ENGINEERING	L	T	P	C
SDG:7&9		3	0	0	3

COURSE OBJECTIVES:

COB1: To study the basics of nuclear physics.

COB2: To learn about nuclear reactions and reaction materials.

COB3: To gain knowledge on various nuclear reactors and fuel reprocessing

COB4: To familiarize about the separation of reactor products.

COB5: To acquire knowledge on safe disposal of nuclear waste

MODULE I NUCLEAR PHYSICS L:8

Nuclear model of an atom-Equivalence of mass and energy-binding-Radioactive Decay: Modes, Energetics, and Trends-Half life-Neutron interactions-Cross sections.

MODULE II NUCLEAR REACTIONS AND REACTION MATERIALS L:8

Mechanism of nuclear fission and fusion- Radio activity- Chain reactions-Critical mass and composition-Nuclear fuel cycles and its characteristics-Uranium production and purification-Zirconium, thorium, beryllium.

MODULE III NUCLEAR REACTOR AND NUCLEAR FUEL REPROCESSING L:12

Nuclear reactors: Types of fast breeding reactors, design and construction of fast breeding reactors- Heat transfer techniques in nuclear reactors- Reactor shielding- Fusion reactors– Reprocessing -Nuclear fuel cycles - Spent fuel characteristics - Role of solvent extraction in reprocessing - Solvent extraction equipment.

MODULE IV SEPARATION OF REACTOR PRODUCTS L:8

Separation processes - Fuel element dissolution - Precipitation process– Ion exchange - Redox – Purex – ThenoylTrifluoro Acetone (TTA) - Chelation - U235 - Hexone - Tributyl phosphate (TBP) and thorax Processes - Oxidative slagging and electro refining - Isotopes – Principles of Isotope separation.

MODULE V SAFETY AND DISPOSAL L:9

Safety and disposal - Nuclear plant safety-Safety systems-Changes and consequences of accident-Criteria for safety-Nuclear waste-Types of waste and its disposal-Food irradiation and safety- Radiation hazards and their prevention-Weapons proliferation- Case study

L – 45; TOTAL HOURS – 45

TEXT BOOK:

1. Brent J. Lewis, E,NihanOnder and Andrew A. Prudil, "Fundamentals of nuclear Engineering", John Wiley, 2017.

REFERENCES:

1. Collier J.G., and Hewitt G.F, "Introduction to Nuclear power", Hemisphere publishing, New York, 2000.
2. Yassin A. Hassan, Robin A. Chaplin "Nuclear energy materials and reactors" Vol, 1, EOLSS Publications, oxford,UK, 2010.
3. S. Glasstone and A. Sesonske, "Nuclear Reactor Engineering: Reactor Design Basics", Vol. 1, Ed. 4, Chapman and Hall, London, 2013.
4. 4. S. Glasstone and A. Sesonske, "Nuclear Reactor Engineering: Reactor Systems Engineering", Vol. 2, Ed. 4, Chapman and Hall, New York, 2013.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: describe the basic concepts of nuclear physics

CO2: explain about nuclear reactions and materials

CO3: elucidate nuclear reactors and reprocessing techniques of nuclear fuel

CO4: discuss about separation of nuclear products

CO5: recognise various methods of nuclear waste disposal

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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

SDG7: Provide Affordable and Clean Energy.
SDG9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The understanding of nuclear engineering supports the design and fabrication of components that ensures safety, enhances efficiency and sustainability of nuclear power plants.

MEDX 34 GAS DYNAMICS AND JET PROPULSION L T P C

SDG: 9 3 0 0 3

COURSE OBJECTIVES:

COB1: To learn fundamentals of compressible flow and variation of flow properties in variable area duct

COB2: To study the variation of flow properties in constant area duct

COB3: To familiarize with shock waves and its effect on flow properties

COB4: To acquire knowledge on elements of jet engines

COB5: To gain knowledge on space vehicles and their applications

MODULE I FUNDAMENTALS OF COMPRESSIBLE FLOW AND FLOW THROUGH VARIABLE AREA DUCTS L:12

Energy and momentum equations for compressible fluid flows - Reference velocities – Stagnation state – Velocity of sound – Critical states – Mach number –Critical Mach number – Types of waves - Mach cone and Mach angle – Effect of Mach number on compressibility – Isentropic flow through variable area ducts - Comparison of isentropic and adiabatic processes - T–s and H–s diagrams for nozzle and diffuser flows – Mach number variation – Impulse function and Area ratio as a function of Mach number.

MODULE II FLOW THROUGH CONSTANT AREA DUCT L:10

Fluid flow with friction (Fanno flow)– Fanno curve - Variation of flow properties - Variation of Mach number with duct length - Isothermal flow with friction – Fluid flow with heat transfer (Rayleigh flow) - Rayleigh curve - Variation of flow properties - Maximum heat transfer – Application of Fanno flow and Rayleigh flow.

MODULE III NORMAL SHOCK WAVES L:8

Governing equations – Variation of flow parameters: Static pressure, static temperature, density, stagnation pressure and entropy across the normal shock –Prandtl – Meyer equation – Impossibility of shock in subsonic flows – Application of shock wave in variable and constant area ducts - Flow with oblique shock (elementary treatment only).

MODULE IV JET PROPULSION L:8

Aircraft propulsion thrust - Modes of propulsion - Operation of Ramjet engine and turbo Ramjet engine - Scramjet engines - Thermodynamics of jet engines– Thrust equation for a turbojet and turbofan Engine - T–s diagram of a turbojet Engine - Performance calculations –Turbojet and turbofan engines

MODULE V SPACE VEHICLES L:7

Rocket propulsion – Types of rocket engines – Constructional details and working principle – Thrust equation – Effective jet velocity - Specific impulse – Rocket engine performance - Solid and liquid propellants - Comparison of different propulsion systems - Space vehicle applications.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Yahya, S. M. "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion"New Age International Publisher, New Delhi, 2018.
2. Oosthuizen, Patrick H., and William E. Carscallen.“Introduction to compressible fluid flow”. CRC press, 2013.

REFERENCES:

1. Philip Graham Hill, Carl R. Peterson, "Mechanics and Thermodynamics of Propulsion", Addison-Wesley Longman, 2010.
2. Ganesan, V.Gas Turbines 3E. Tata McGraw-Hill Education, 2010.
3. J. D. Mattingly, “Elements of Gas Turbine Propulsion”, McGraw–Hill Series in Aeronautical and Aerospace Engineering, 2017.
4. G. C. Oates, “Aerothermodynamics of Gas Turbine and Rocket Propulsion”, AIAA Education Series, 2016.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the fundamentals of compressible flow andanalyse the flow in variable area duct

CO2: Analyse the flow properties in constant area duct

CO3: Evaluate flow properties associated with shock waves

CO4: Explain the elements of jet engines

CO5: Describe space vehicles and their applications

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 fundamentals of gas dynamics leads to design and development of energy conversion devices employing compressible fluids.

MEDX 35	**ENERGY CONVERSION SYSTEMS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To gain knowledge on power generation from thermal power plant.

COB2: To learn about nuclear, hydro and gas turbine power plants and methods to improve efficiency

COB3: To acquire knowledge on renewable energy sources and its utilization

COB4: To familiarize about Diesel, Magneto Hydro Dynamic(MHD) and Waste heat recovery plants

COB5: To learn about energy economics and environmental pollution.

MODULE I COAL BASED THERMALPOWERPLANTS L:9

High pressure, Super critical and ultra-super critical boilers - Coal and ash handling - Burning-stoker firing – Burners - Fluidized bed combustion -Dust collection: Scrubbers, ESP- Boiler calculations –Layout of thermal plant–Components.

MODULE II NUCLEAR, HYDRO AND GAS TURBINE POWER PLANTS L:9

Development of nuclear plant in India, nuclear energy -Fission chain reaction –Reactor components -Types of reactors and plants- Waste disposal and safety -Hydel plant -Layout and system components – Hydraulic turbines –Types of hydel plants –Safety- Gas turbines - Working - Types - Methods to improve power output and efficiency - Layout with inter-cooling, reheating and regeneration.

MODULE III RENEWABLE ENERGY BASED POWER PLANTS L:9

Power from wind-Wind turbine working and types –Solar thermal power plants: solar concentrators for low , medium and high power generation, solar PV power plants -Stand alone and Grid connected - Power from wave, tidal and geothermal sources - Ocean thermal energy conversion system-Energy from biomass.

MODULE IV DIESEL, MHD ANDWASTEHEAT RECOVERY POWER PLANTS L:9

Diesel engine power plant layout – Components - Various operating systems – Merits and demerits- Applications – MHD power plants – Working principle -Types: open cycle and closed cycle systems - Seeded inert gas system - Liquid metal system - Merits and demerits - Future prospects - Energy from wastes - Waste heat recovery: waste heat recovery technologies, importance and types of cogeneration and combined cycle power plants.

MODULE V ENERGY ECONOMICS AND ENVIRONMENTAL POLLUTION L:9

Facts in environmental and energy economics - Models and practices - Cost of energy generation – Load curves– Economics of load sharing - Comparison of economics of various power plants - Environmental degradation- Emissions from fossil-based power plants and their implications – Remedial measures.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Arora S.C and Domkundwar S, “A course in Power Plant Engineering”,Dhanpatrai, 2016.

REFERENCES:

1. EI-WakilM.M, “Power Plant Technology”, McGraw-Hill, 2017.
2. G.R.Nagpal,“PowerPlantEngineering”,HannaPublishers,2012.
3. G.D.Rai, “Introduction to Power Plant Technology”, Khanna Publishers,2020.
4. Nag P.K, “Power plant Engineering”, Tata McGraw-Hill, 2015.
5. R.K.Rajput, “Power Plant Engineering”, Laxmi Publications,2016.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the construction and working of thermal power plant.

CO2: Explain the construction and working of nuclear, hydro and gas turbine power plants

CO3: Describe renewable energy sources and their utilization

CO4: Elucidate the construction and working of Diesel, MHD and waste heat recovery plants.

CO5: Explain energy economics and environmental pollution.

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	M	M		L		L						L	H	H
CO2	M	M		L		L						L	H	H
CO3	M	M	H	L		L						L	H	H
CO4	M	M	H	L		L	M					L	H	H
CO5	M	M	H	L		L	M					L	H	H

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

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

The knowledge on energy conversion system can be applied in the areas of design and manufacturing of heat transfer equipment for power plants.

MEDX 36	**COMPUTATIONAL FLOW AND HEAT TRANSFER**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the basic concepts of fluid dynamics

COB2: To acquire knowledge on Finite element and difference methods applicable to fluid flow and heat transfer

COB3: To gain knowledge on modeling of fluid flow and heat transfer using FVM

COB4: To familiarize with turbulence modelling in fluid flow

COB5: To study the different grid generation techniques

MODULE I EQUATIONS OF FLUID DYNAMICS L:7

Basic concepts : Eulerarian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, vorticity - Laws governing fluid motion, continuity, Navier – stokes and energy equations - Boundary layer equation - Euler equations -Potential flow equations - Bernoulli’s equation and vorticity transport equation - Initial and boundary conditions - Classification of equation of motions :Hyperbolic, parabolic, elliptic.

MODULE II FINITE ELEMENT AND DIFFERENCE METHOD L:12

FEM: Introduction, Weighted residual and variational formulations, Interpolation in one-dimensional and two-dimensional cases, Application of FEM to ID and 2D problems in fluid flow and heat transfer - FDM: Basic aspects of finite difference equations, Consistency, explicit and implicit methods, errors and stability analysis - Stability of elliptic and hyperbolic equations - Fundamentals of fluid flow modelling: Conservative property, upwind scheme, transporting property, higher order up winding - Finite difference applications in heat transfer :Conduction, convection.

MODULE III FINITE VOLUME METHOD L:10

Introduction - Application of FVM in diffusion and convection problems - NS equations – Staggered grid - Collocated grid - SIMPLE algorithm - Solution of discretised equations using TDMA - Finite volume methods for unsteady problems – Explicit schemes, implicit schemes.

MODULE IV TURBULENCE MODELS L:8

Turbulent flows - Boundary layer theory - Introduction to turbulent flows and

Reynolds average Navier-Stokes equations (RANS) - Turbulent modeling: k-epsilon, k-omega, k-omega SST models based on RANS, LES and DES calculation for internal and external flows.

MODULE V GRID GENERATION L:8

Basic concepts of grid generation – Structured grids - algebraic grid generation - Differential equations-based grid generation - General coordinate transformation – Conformal mapping methods - Unstructured grids: Grid refinement, Adaptive grids, Moving grids – Algorithms - CAD interfaces to grid generation.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. H. Aref,S. Balachandar "A First Course in Computational Fluid Dynamics", Cambridge University Press, 2017.
2. JiyuanTu,GuanHengYeoh,Chaoqun Liu , "Computational Fluid Dynamics: A Practical Approach", Butterworth-Heinemann, 2012.
3. H. Versteeg, W. Malalasekera, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Published by Pearson, 2nd Edition, 2007.
4. Sundararajan, T., "Computations Fluid Flow and Heat Transfer", Alpha Science International, 2003.

REFERENCES:

1. Pradip Majumdar, "Computational Fluid Dynamics and Heat Transfer", Taylor & Francis Group, 2021.
2. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", CRC Press, 2018.
3. BengtSundén, Ryoichi Amano, "Computational Fluid Dynamics and Heat Transfer", WIT, 2011.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basic concepts of fluid dynamics

CO2: Analyze fluid flow and heat transfer problems with Finite element and difference methods

CO3: Solve flow and heat transfer problems using FVM

CO4: Analyze problems which involves turbulence in fluid flow

CO5: Generate grid with stability and convergence

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

CFD as a nascent technology in the digital era, provides a virtual digital environment for simulating, analyzing and predicting flow behaviour thereby inspiring sustainable rapid design and development of new flow handling solutions for industry.

MEDX 37	**RENEWABLE SOURCES OF ENERGY**	**L**	**T**	**P**	**C**
SDG: 7		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To acquire knowledge on energy resources and harnessing of energy from solar

COB2: To learn about harnessing energy from wind and geothermal energy sources

COB3: To gain knowledge on harnessing energy from ocean, tides and hydro power plants

COB4: To study about harnessing energy from bio mass, municipal and industrial wastes

COB5: To familiarize with direct energy conversion system

MODULE I ENERGY RESOURCES AND SOLAR ENERGY L:12

Primary energy sources - World energy resources - Indian energy scenario - Energy cycle of the earth-Principles of solar energy collection - Solar radiation: measurements , instruments , data and estimation – Types of collectors - Characteristics and design principles of different types of collectors - Performance of collectors - Testing of collectors - Solar thermal applications - Water and air heaters - Performance and applications - Simple calculations - Solar cooling - Solar drying - Solar ponds- Solar tower concept.

MODULE II WIND AND GEOTHERMAL ENERGY L:8

Wind potential in India - Energy from the wind - General theory of wind mills -Types of windmills - Design aspects of horizontal axis wind mills - Applications - Potential Sites - Potential impacts of harnessing wind energy - Estimation of geothermal power - Nature of geothermal sites - Hot-dry rocks – Resources- Magma resources - Systems for energy generation - Applications of geothermal energy- Environmental issues.

MODULE III OCEAN, TIDAL AND HYDRO ENERGY L:8

Basic theory of OTEC (Ocean Thermal Energy Conversion) - Potential and application of technologies - Energy from tides and waves - Working principle of tidal plants - Classification of small hydro power stations - Mini and micro hydel projects - Turbines and generators for small scale hydro plants - Advantages and limitations- Potential impacts of harnessing ocean, tidal and hydro energies.

MODULE IV BIO ENERGY L:9

Energy from bio mass and bio gas plants - Types - Design principle of biogas plants - Applications- Energy from wastes - Waste collection - Reduction and transfer- Waste burning power plants - Utilization of industrial and municipal wastes - Potential impacts of harnessing bio energy.

MODULE V OTHER RENEWABLE ENERGY SOURCES L:8

Direct energy conversion (description, principle of working and basic design aspects only) – Magneto hydrodynamic systems (MHD) – Thermoelectric generators – Thermionic generators- Fuel cells – Solar cells - Types - Emf generated - Power output – losses - efficiency and applications - Hydrogen conversion and storage systems.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Kanoglu, M., Çengel, Y. A., and Cimbala, J. M. (2020).Fundamentals and applications of renewable energy. McGraw-Hill Education.
2. Bhatia, S. C., and Gupta, R. K. (2019).Textbook of renewable energy. Wood head Publishing India Pvt. Limited.

REFERENCES:

1. Sukhatme, S. P., and Nayak, J. K. Solar energy. McGraw-Hill Education, 2017.
2. Mitofsky, A. M. Direct Energy Conversion, 2018.
3. Duffie J. A., Beckman, W. A., and Blair, N. Solar engineering of thermal processes, photovoltaics and wind. John Wiley & Sons, 2020.
4. Garg H. P.Solar energy: fundamentals and applications. Tata McGraw-Hill Education, 2000.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the significance of energy resources and harnessing energy from solar

CO2: Elucidate about harnessing energy from wind and geothermal energy sources.

CO3: Describe harnessing energy from ocean, tidal and hydro power plants

CO4: Explain the power generation using biomass, municipal and industrial wastes

CO5: Describe the direct energy conversion systems

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

SDG 7: Affordable and Clean Energy.

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

The understanding of renewable energy sources and their utilization leads to clean energy and contribution of industrial growth and economic development of country.

MEDX 38 SOLAR ENGINEERING L T P C

SDG: 9 3 0 0 3

COURSE OBJECTIVES:

COB1: Tolearn about basics of solar radiation, its measurement and data estimation

COB2: Toacquire knowledge on performance characteristics of non-concentrating collectors

COB3: To study the performance characteristics of concentrating collectors

COB4: Tolearn the principle and application of photo voltaic cells

COB5: To familiarize on application and economics of solar energy

MODULE I SOLAR RADIATION AND MEASUREMENT L:9

The Solar energy option- An overview of thermal applications - Solar Radiation analysis – Solar constant - Electromagnetic energy spectrum - Determination of sun angles, solar time, solar angles, sunset, sunrise and day length - Solar radiation: Measurements and data estimation.

MODULE II NON- CONCENTRATING COLLECTORS L:9

Physical principle and general characteristics of non-concentrating (flat plate) collectors –Performance and thermal analysis of liquid flat plate collector –Coatings and selection of materials - Effect of dust and shade - High temperature non concentrating collectors - Solar stills - Design and performance studies on solar dryers and water heaters.

MODULE III CONCENTRATING COLLECTORS L:10

Type of concentrating collectors: line focusing, point focusing and tower collectors, Compound Parabolic Collectors (CPC), Evacuated Tube Collectors (ETC) -Thermal performance of concentrating collectors -Solar thermal power generation – Solar energy storage types: Solar ponds, sensible heat storage, latent heat storage and thermochemical storage systems

MODULE IV SOLAR CELLS L:9

Fundamentals of Photovoltaic (PV) cells – PV principle - Materials for solar cells - Design and fabrication of PV cells - PV modules and arrays – Performance analysis of PV cells: Efficiency, effect of temperature intensity and spectrum - Comparative discussion on different state of the art solar conversion technologies and future directions - Design and performance analysis of standalone and grid connected PV systems

MODULE V APPLICATIONS AND ECONOMICANALYSIS L:9

Applications of non-concentrating and concentrating collectors: Solar heating, solar cooling, heat pump, solar distillation, solar cooking, solar pumping and solar thermal power generation.
Cost analysis and payback calculations for different types of solar collectors and PV panels (standalone & grid connected) –Installation and operating costs –Environmental and safety issues – Protection systems and performance monitoring.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. S.P. Sukhatme, “Solar Energy”, Tata McGrew Hill Company Ltd., New Delhi Fourth edition, 2017.

REFERENCES:

1. G.D.Rai, “Solar energy utilisation, Khanna Publishers”, New Delhi. 1993.
2. S.P. Sukhatme, “Solar Energy”, Tata McGrew Hill Company Ltd., NewDelhi. Third edition, 12th reprint, 2013.
3. H.P. Garg, “Advanced in Solar Energy Technology”, D. Reidel Publishing Co., Drdricht, 2000.
4. Mathur and Metha – “Solar Energy”.D. Reidel Publishing Co., 2018.
5. Duffle and Beckman, “Solar Thermal Engineering Process’, John Wiley&Sons, New York Fifth Edition, 2013.
6. J.S. Hsieh, “Solar Energy”, Prentice Hall Inc. New Jerssey, 2004.
7. A.B. Meinel and M.B. Meinel, “Applied Solar Energy”, Addison – Wiley Pub. Co.,1997.
8. G.N. Tiwari and S. Suneja, “Solar Thermal Engineering Systems”, Narosa Publishing House,1997.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of solar radiation, its measurement and data estimation

CO2: Analyze the performance characteristics of non-concentrating collector

CO3: Analyze the performance characteristics of concentrating collector

CO4: Describe solar photovoltaic principle and its applications

CO5: Explain the applications and economics of solar energy

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The knowledge on solar engineering enables the design of components for solar energy conversion for small, medium and large scale power plants

MEDX 39	**DESIGN OF HEAT TRANSFER EQUIPMENTS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To familiarize on the basics of heat transfer equipment

COB2: To learn the design of double pipe and shell and tube heat exchangers

COB3: To acquire knowledge on design of compact heat exchanger

COB4: To study the performance of condenser and evaporator

COB5: To gain knowledge on performance of cooling tower

MODULE I INTRODUCTION TO HEAT EXCHANGER AND HEAT PIPES L:8

Introduction - Applications of heat exchangers - Classifications of heat exchangers - Fouling in heat exchangers - Design and simulation of heat exchangers - Heat pipes: Structures, applications, basic relations, performance characteristics, effects of working fluid and operating temperature, wick material selection and pore size

MODULE II DOUBLEPIPE, SHELLANDTUBEHEATEXCHANGERS L:10

Thermal and hydraulic design: Inner pipe, annulus - Hairpin heat exchangers: Base inner tube, finned inner multi tubes, parallel and series arrangements, pressure drop and constructional features – Shell and tube heat exchanger: Basic components, types and geometry , design procedure , preliminary estimation of size ,pressure drop and heat transfer calculations on shell and tube sides – Calculation methods: Kenn, Bell Delaware method.

MODULE III COMPACTANDPHASE CHANGEHEATEXCHANEGRS L:9

Compact heat exchangers - Types: finned plate and tube heat exchangers, micro scale heat exchangers, direct contact heat exchangers - Constructional features - heat transfer and pressure drop calculation - Performance analysis - Phase change heat exchangers: Constructional features, flow arrangement, heat exchanger network, heat transfer and pressure drop calculation –Performance analysis and comparison with other type of heat exchangers.

MODULE IV CONDENSERS AND EVAPORATORS L:10

Shell and tube condenser- Horizontal and vertical types- Temperature distribution and heat flow in a condenser - Pressure drop in a condenser - Extended surfaces - Design and operational consideration - Plate heat condenser - Air cooled and direct contact types - Condensers for refrigeration - Evaporative condenser.

Temperature distribution and heat flow in an evaporator - Evaporator for refrigeration and air conditioning- Chillers - Air coolers - Thermal analysis - Shah, Kandhar, Gungor and Winterton correlations.

MODULE V COOLING TOWERS L:8

Cooling tower - Types - Basic relation- Heat balance and heat transfer characteristics - Effects of packing, geometry, spray design - Selection of pumps and fans – Testing – Maintenance - Environmental effects - Wind loads - Typical Installations.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1 M.N. Ozisik, Basic Heat Transfer, McGraw-Hill, 10th International edition, 2009.

REFERENCES:

1. J.P. Holman, Heat Transfer, McGraw Hill, 10th edition, 2010.
2. SadicKakac and HongtanLin, Heat Exchangers—CRC Press, London,1998.
3. Kenn.D. Process Heat Transfer–TataMcGrawHill, 1980.
4. Walker, Industrial Heat Exchangers-TataMcgrawHill,1997.
5. Holger Martin, Heat Exchangers- Hemisphere Publishing Corporation,London, 1992.
6. Arthu rP. Fraas, Heat Exchanger design–JohnWiley&Sons,1997.
7. Arora,Domkundwar, A course in Heat and mass Transfer–Dhanpat Rai& Co pvt ltd, 2003.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of heat transfer equipment

CO2: Design double pipe and shell and tube heat exchangers

CO3: Design compact heat exchanger for specific application

CO4: Analyze the performance of condenser and evaporator

CO5: Analyze the performance of cooling tower

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.
The understanding of design principles can be applied in the areas of design of heat transfer systems in power plants and process industries.

MEDX 40	**ELECTRIC AND HYBRID VEHICLES**	**L**	**T**	**P**	**C**
SDG: 7		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To study the basics of electric and hybrid electric vehicles and their architecture

COB2: To learn the fundamentals of electric drives for electric vehicles and hybrid electric vehicles

COB3: To familiarize with different energy storage techniques suitable for hybrid electric vehicles

COB4: To gain knowledge on energy management strategies

MODULE I INTRODUCTION TO ELECTRIC AND HYBRID VEHICLES L:7 P:7

History of hybrid and electric vehicles - Vehicle power source characterization - Transmission characterization- Traction motor characteristics - Concept of hybrid electric drive trains-Architecture of hybrid electric drive trains - Social and environmental importance of hybrid and electric vehicles.

MODULE II ELECTRIC AND HYBRID ELECTRIC DRIVE TRAINS L:9 P:8

Basic concept of electric traction - Introduction to various electric drive - Trains - Power flow control in electric drive-train topologies - Electric propulsion unit - Introduction to electric components used in hybrid and electric vehicles- Configuration and control: Direct current (DC) motor drives, induction motor drives, permanent magnet motor drives, switch reluctance motor drives.

Basic concept of hybrid traction - Introduction to various hybrid drive train topologies- Power flow control in hybrid drive train topologies.

MODULE III ENERGY STORAGE L:7 P:8

Introduction to energy storage requirements in hybrid and electric vehicles- Battery based energy storage and its analysis - Energy efficiency in Lead-Acid Batteries - Nickel based batteries- Lithium based batteries- Fuel cell-based energy storage and its analysis- Super capacitor-based energy storage and its analysis- Hybridization of different energy storage devices-Selection of energy storage technology.

MODULE IV ENERGY MANAGEMENT STRATEGIES L:7
P:7

Introduction to energy management strategies used in hybrid and electric vehicles - Classification of different energy management strategies - Comparison of different energy management strategies - Implementation issues of energy management strategies.

L – 30; P – 30; TOTAL HOURS – 60

PRACTICALS

List of Experiments:

1. Dismantling, Assembling and Study of Electric Scooter
2. Demonstration of Wiring layout of Electric Vehicle
3. VI Characteristics of SCR (Silicon Controlled Rectifier), IGBT (Insulated Gate Bipolar Transistor) and MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor)
4. MOSFET based Step-up and Step-down Chopper
5. Speed Control of BLDC (Brushless Direct Current) Motor
6. Speed control of induction Motor
7. Study of CAN (Controller Area Network) Bus protocol for Electric Vehicles

TEXT BOOKS:

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2017.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.

REFERENCES:

1. Ehsani, Mehrdad, YiminGao, Stefano Longo, and Kambiz M. Ebrahimi.Modern electric, hybrid electric, and fuel cell vehicles. CRC press, 2018.
2. Denton, Tom. Electric and hybrid vehicles. Routledge, 2020.
3. Husain, Iqbal. Electric and hybrid vehicles: design fundamentals. CRC press, 2021, ISBN 9780367693930, Published February 22, 2021.
4. Larminie, James, and John Lowry.Electric vehicle technology explained. John Wiley & Sons, 2012.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of electric and hybrid vehicles and their architecture

CO2: Describe the fundamentals of electric drive for the electric vehicles and hybrid electric vehicles

CO3: Identify the different energy storage techniques suitable for hybrid electric vehicles

CO4: Explain various energy management strategies for electric vehicles

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th AC held on 29 .09.2022

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

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

SDG 7: Clean Energy

The understanding of fundamentals of electric and hybrid vehicles enable to develop an eco-friendly automobile.

MEDX 41	**ENERGY CONSERVATION AND MANAGEMENT**	**L T P C**
SDG: 9		**2 0 0 2**

COURSE OBJECTIVES:

COB1: To study the concept and fundamentals of energy conservation

COB2: To learn about the energy conservation opportunities in thermal energy system.

COB3: To gain knowledge on energy conservation opportunities in residential and industrial sectors.

COB4: To familiarise on energy economics and management

MODULE I ENERGY CONSERVATION CONCEPTS AND FUNDAMENTALS L:6

Concept of energy conservation – Need for energy conservation in domestic, transportation, agricultural and industrial sectors – Lighting and HVAC systems – Simple case studies.

MODULE II THERMAL ENERGY CONSERVATION L:7

Thermal energy conservation -Combustion systems and processes – Combustion efficiency – Boiler efficiency – Steam turbine and distribution systems - Energy conservation in turbines – Necessity for maintenance of correct pressure, temperature and quality of steam – Condensate recovery – Recovery of flash steam – Air and gas removal – Thermal insulation.

MODULE III ENERGY CONSERVATION IN RESIDENTIAL AND INDUSTRIAL SECTORS L:9

Indian energy current scenario, Energy conservation opportunities in Industries: Energy savings in compressed air systems, energy savings in refrigeration & air conditioning systems, emergency DG sets, illumination and electrical motors – Energy efficient fans and motors - Energy conservation in resident, commercial and transport sectors: Residential house, office, educational institutions and commercial shops – Energy efficient lighting - Movement sensors - Tiny switches - Ventilation – Sustainable construction - Fuel economy : Additives, preventive and periodic maintenance.

MODULE IV ENERGY ECONOMICS AND MANAGEMENT L:8

Energy economics - Environmental energy economics-Supply and demand in energy market-Energy derivatives- Energy markets-Energy forecasting-

Risk analysis and securities of supply - Energy policy - Concept of energy management – Energy auditing: definition, necessity and types - Understanding energy costs – Bench marking – Energy performance – Matching energy usage to requirement – Maximizing system efficiencies – Optimizing the input energy requirements.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Archie, W Culp, “Principles of Energy Conservation”, McGraw Hill, 2003.
2. D Patrick and S W Fardo, “Energy Management and Conservation”, PHI,1992.

REFERENCES:

1. S.S. Rao and Parulekar, “Energy Technology”, Khanna Publishers Ltd, 2014.
2. P. O’Callaghan: “Energy Management”, McGraw - Hill Book Company, 2003.
3. Wayne C Turner, “Energy Management Handbook”, The Fairmount Press, 2000.
4. Kenney, W. F., “Energy Conservation in Process Industries”, Academic Press,2012.
5. Tyagi A. K, “Handbook of energy audits and management”, Tata Energy Research Institute, 2000.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the concept and fundamentals of energy conservation

CO2: Describe the energy conservation opportunities in thermal energy system

CO3: Elucidate energy conservation opportunities in residential and industrial sectors

CO4: Apply the fundamentals of energy economics and management

Board of Studies (BoS):	**Academic Council:**
20^{th} BOS held on 08.08.2022	19^{th} AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M									L	L	
CO2	M		M									L	L	M
CO3	M		M		M					M		L	L	M
CO4	M		M	M		M					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 understanding of energy conservation and management techniques enables to adopt energy conservation measures in residential and industrial sectors leading to sustainable development.

MEDX 42 SDG: 9,13	AUTOMOTIVE POLLUTION AND CONTROL	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

COB1: To acquire knowledge on emissions and standards

COB2: To gain knowledge on emissions from SI and CI Engines

COB3: To familiarize on pollution control techniques for SI and CI engines.

COB4: To learn automotive emission measuring techniques.

MODULE I EMISSIONS AND STANDARDS L:7

Sources of air pollution - Vehicle population assessment in metropolitan cities and contribution to pollution - Effects on human health and environment - Global warming - Types of emission - Transient operational effects on pollution - Emission standards – BS6 - Driving cycles: USA, Japan, Euro and India - Sources of noise and its reduction in automobiles.

MODULE II EMISSION FORMATION IN SI AND CI ENGINES L:8

Pollutant formation in SI & CI engines - Mechanism of NOx, HC and CO formation in four stroke SI and CI engines - Effects of design and operating variables on emission formation - Smoke and particulate emissions in CI engines.

MODULE III CONTROL OF EMISSIONS FROM SI AND CI ENGINES L:8

Exhaust gas recirculation - Selective catalytic reduction - Thermal reactors - Secondary air injection - Water injection - After treatment: Catalytic converters, charcoal canister, positive crank case ventilation system, Diesel particulate filter - NOx versus smoke –Trade off - Fuel modifications.

MODULE IV EMISSION MEASUREMENTS L:7

Methods of measurements – Carbon monoxide and carbon dioxide measurement by Non-Dispersive Infrared (NDIR) - Flame Ionization Detector (FID) for HC measurement – NOx measurement by Chemiluminescent detector – Smoke measurement –Types - Soot measurement – Constant volume sampling procedure – Gas chromatography - Sound level meters

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Ganesan V, *"Internal combustion engines"*., 4th edition, Tata McGraw Hill Education, 2017.
2. John B Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill Education, 2nd edition, 2019.

REFERENCES:

1. Patterson D.J. and Henein N.A, "Emissions from combustion engines and their control," AnnArbor Science publishers Inc, USA, 1978.
2. Klingenberg H, "Automobile Exhaust Emission Testing", Springer, 2012.
3. James D Halderman, "Automotive Fuel and Emissions Control Systems", Prentice Hall, 4thEdition, 2016.
4. L. Lberanek, 'Noise Reduction', Mcgrawhill Company., Newyork 1993.
5. C. Duerson, 'Noise Abatment', Butterworths ltd., London, 1990.
6. A. Alexander, J.P.Barde, C.lomure and F.J. Langdan, 'Road traffic noise', Applied science publisher ltd., London,1987.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain various emissions and standards

CO2: Describe different types of pollution from engine.

CO3: Apply suitable emission control techniques for SI and CI engines.

CO4: Explain automotive emission measuring techniques.

Board of Studies (BoS): **Academic Council:**

20th BOS held on 08.08.2022

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

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

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

SDG 13: Climate Action

The understanding of pollution control techniques enables to develop systems which reduces the greenhouse gas emissions and provide sustainable environment.

MEDX 45 **DESIGN OF COMPACT AND MICRO HEAT EXCHANGERS**
SDG: 9

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

COB1: To gain knowledge on design of compact heat exchangers

COB2: To learn design and applications of micro heat exchangers.

MODULE I COMPACT HEAT EXCHANGERS L:8

Compact heat exchangers -Types – Plate heat exchangers – Finned tube heat exchanger – Printed circuit heat exchanger – Spiral heat exchanger – Constructional features - Flow arrangement - Applications – Thermal design - Heat transfer and pressure drop calculations.

MODULE II MICRO HEAT EXCHANGERS L:7

Micro heat exchangers – Types- heat transfer and fluid flow through narrow conduits - Design considerations for heat transfer enhancement – Micro heat exchanger for electronics cooling, gas turbines and air conditioning applications.

L – 15; TOTAL HOURS – 15

TEXT BOOKS:

1. R. K. Shah, Dusan P. Sekulic Fundamentals of Heat Exchanger Design, John Wiley & Sons, 2006.
2. Hesse greaves J E Compact heat exchangers- Selection, Design and operation, Pergamon Press, Oxford, UK, 2008.

REFERENCES:

1. Jovan Mitrovic Heat Exchangers- Basics Design Applications, Intech open Ltd. UK, 2012.
2. Heat Exchanger Design Handbook by Kuppan Thulukkanam, Taylor & Francis, 2000.
3. Heat Exchangers: Selection, Rating, and Thermal Design, Third Edition by SadikKakac, Hongtan Liu, CRC-Press, 2004.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Design compact heat exchangers

CO2: Design and explain the applications of micro heat exchanger

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.
The understanding of heat exchanger principles enables to design and develop heat transfer devices for micro scale cooling applications.

MEDX 43	**COMBUSTION OF FUELS**	**L**	**T**	**P**	**C**
SDG:9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To learn about the types and characteristics of solid fuels

COB2: To study about the types and characteristics of liquid fuels

COB3: To acquire knowledge on the various types and properties of gaseous fuels

COB4: To familiarize with the thermodynamics associated with combustion and kinetics fuels.

MODULE I SOLID FUELS L:8

Fuels :Introduction, Types and Characteristics of Fuels – Production - Present scenario and consumption pattern of fuels -Determination of properties of fuels- Solid fuel types - Coal family - Properties - Calorific value - Coal tar distillation - Coal liquefaction- Bulk and apparent density - Storage - Washability - Coking and Caking Coals - Renewable solid fuels - Biomass - Wood waste -Agro fuels – Manufactured solid fuels

MODULE II LIQUID FUELS L:7

Liquid fuel types - Sources - Petroleum fractions - Classification –Refining – Atmospheric and vacuum refining - Refinery equipment's - Properties of liquid fuels: Calorific value, specific gravity, flash and fire point, Octane number, Cetane number - Alcohols - Tar sand oil

MODULE III GASEOUS FUELS L:7

Classification - Composition and properties - Estimation of calorific value – Gas calorimeter- Rich and lean gas - Wobbe Index - Natural gas - Dry and wet natural gas - Stripped NG - Foul and sweet NG - LPG - LNG - CNG – Methane- Producer gas - Gasifiers - Water gas - Town gas - Coal gasification -Gasification efficiency - Non - thermal route - Biogas - Digesters – Reactions- Viability - Economics.

MODULE IV COMBUSTION THERMODYNAMICS & KINETICS L:8

Stoichiometry - Mass Basis and volume basis - Excess air calculation - Fuel and flue gas - Compositions - Calculations - Rapid methods – Combustion processes – Stationary flame - Surface or flameless combustion -Submerged combustion - Pulsating and slow combustion - Explosive combustion.

Premixed flame – Burning velocity measurement methods - Ignition and Ignition Energy - Spontaneous combustion - Flame propagation – Environment and combustion - Chemical and atmosphere emission from combustion- Emission control techniques

L – 30; TOTAL HOURS – 30

TEXT BOOKS

1. Sharma SP, Mohan Chander, "Fuels and Combustion", Tata Mcgraw Hill, 1987.

REFERENCES:

1. Bhatt, "Vora Stoichiometry", 2nd Edition, Tata Mcgraw Hill, 2004.
2. Samir Sarkar, Orient Black Swan,"Fuels and Combustion", 3rd Edition, 2009.
3. Civil Davies, "Calculations in Furnace Technology, Pergamon Press", Oxford, 1970.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: explain the types and characteristics of solid fuels

CO2: describe the types and characteristics of liquid fuels

CO3: elucidate the various types and properties of gaseous fuels

CO4: apply and analyse the thermodynamics and kinetics of combustion

Board of Studies (BoS):

19th BOS held on 21.12.2021

Academic Council:

18th AC held on 24.02.2022

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

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

SDG9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The understanding of fundamentals of combustion enables to adopt control measures for emission and to enhance the combustion efficiency of fuels

MEDX 44 **ALTERNATE FUELS** **L T P C**

SDG:7&9 **1 0 0 1**

COURSE OBJECTIVES:

COB1: To study the different kinds of alternative fuels and their emission characteristics

COB2: To gain the knowledge on properties of alternate fuel

MODULE I INTRODUCTION TO ALTERNATE FUELS L:8

Introduction to alternative fuels – Need for alternative fuels – Availability of different alternative fuels- Need of alcohol as fuel - Production methods of alcohols- Properties of alcohols as fuels - Methods of using alcohols in CI and SI engines - Emission characteristics - Di-Methyl Ether (DME) - Di-Ethyl Ether (DEE) performance analysis.

MODULE II PROPERTIES OF ALTERNATE FUELS L:7

Bio diesel - Oxidation stability - Performance in Engines - Properties of bio-fuels and their importance in the context of IC Engines –Various vegetable oils and their important properties - Different methods of using vegetable oil in engines :Blending, preheating, trans-esterification and emulsification of Vegetable oils – Performance in engines.

L – 15; TOTAL HOURS – 15

TEXT BOOKS:

1. Thipse S. S., “Alternative Fuels”, Jaico Publishing House, 2010.

REFERENCES:

1. AyhanDemirbas, “Biodiesel A Realistic Fuel Alternative for Diesel
2. Engines”, Springer,Verlag London Limited, 2008.
3. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, “The Biodiesel Handbook”, AOCS Press Champaign, Illinois, 2005.
4. Richard L Bechtold P.E., “Alternative Fuels Guide book”, Society of Automotive Engineers, 1997. ISBN 0-76-80-0052-1.
5. 4. Devaradjane G, Kumaresan M., “Automobile Engineering”, AMK Publishers, 2013.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: describe the various types of alternate fuels and their emission characteristics
CO2: explain the various properties of alternate fuel.

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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

SDG7: provide Affordable and Clean Energy.
SDG9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The knowledge on alternate fuel leads to harness energy from alternate fuel sources, which reduces the need for fossil fuels there by providing eco-friendly environment.

MANUFACTURING STREAM

MEDX 51	**PROCESS PLANNING AND COST ESTIMATION**	**L**	**T**	**P**	**C**
SDG 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the fundamental concepts of process planning

COB2: To gain knowledge on various process planning activities

COB3: To familiarize with estimation and costing

COB4: To acquire knowledge on cost estimation in forming, casting and fabrication process.

COB5: To be conversant with the time and cost estimation in manufacturing units

MODULE I INTRODUCTION TO PROCESS PLANNING L:8

Introduction- Aims and objectives of Process planning – Steps involved in manual process planning-Types of production - Job type, Batch type and Continuous - Drawing interpretation - Material evaluation – Steps in process selection - Production equipment and tooling selection.

MODULE II PROCESS PLANNING ACTIVITIES L:8

Product Analysis - Production aspects: Standardization, Simplification, Marketing aspects - Economical aspects - Break-even analysis- Bill of Materials- Computer aided process planning: Retrieval, generative - Selection of process analysis - Method study and Time study basic procedures.

MODULE III ESTIMATION AND COSTING L:10

Importance and aims of cost estimation –Functions of estimation –Costing- Difference between costing and estimation -Importance of realistic estimates- Estimation procedure- -Material cost- Determination of material cost - Labour cost - Expenses- Cost of Product (Ladder of cost) - Illustrative examples - Analysis of overhead expenses - Factory expenses - Administrative expenses- Selling and distributing expenses- Allocation of overhead expenses - Depreciation- Physical and functional causes of depreciation- Method of Depreciation.

MODULE IV COST ESTIMATION IN FORMING, CASTING ANDWELDING SHOP L:10

Product cost Estimation - Estimation in forging shop-Losses in forging-

Forging cost- Illustrative examples - Estimation in foundry shop-Estimation of pattern and casting cost- Illustrative examples - Estimation in welding shop-Gas cutting-Electric welding- Illustrative examples

MODULE V ESTIMATION OF MACHINE TIME AND COST L:9

Estimation of machining time for machining operations involved in the lathe, drilling, milling and grinding – Estimation of machining cost.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 1995.
2. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002.

REFERENCES:

1. Nanusa Singh, "System approach to Computer Integrated Designand Manufacturing" John Wiley & Sons, Inc., 1996.
2. G.B.S. Narang and V. Kumar, "Production and costing ", Khanna Publishers, 2001.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain about the concept of process planning

CO2: Describe the process planning activities.

CO3: Calculate various cost components with proper estimation.

CO4: Determine the cost for different manufacturing units.

CO5: Evaluate the machining time and cost for metal cutting operations

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The knowledge of various process planning and cost estimation techniques will cut down the processing cost of the manufacturing sector.

MEDX 52	**PRODUCTION PLANNING AND CONTROL**	**L**	**T**	**P**	**C**
SDG 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the basics of production planning

COB2: To gain knowledge about forecasting techniques

COB3: To acquire knowledge on inventory management

COB4: To familiarize with production scheduling and routing

COB5: To be conversant with dispatching

MODULE I INTRODUCTION TO PRODUCTION PLANNING L:8

Production planning and control: Definition, Objectives, functions and control elements - Types of production- Organization of production planning and control – Internal organization department.

MODULE II FORECASTING L:8

Importance of forecasting – Types of forecasting - General principles of forecasting techniques - Qualitative methods and quantitative methods.

MODULE III INVENTORY MANAGEMENT L:9

Functions of inventory- Relevant inventory cost- ABC analysis- VED Analysis- EOQ model – Inventory control systems – P and Q Systems - Introduction to MRP and ERP - LOB (Line of Balance) - JIT inventory - Japanese concepts.

MODULE IV PRODUCTION SCHEDULING AND ROUTING L:10

Definition – Routing procedure- Route sheets – Bill of material - Factors affecting routing procedure - Schedule – Difference with loading - Scheduling polices– Techniques - Standard scheduling methods: Job shop, flow shop - Line balancing- Aggregate planning- Methods for aggregate planning- Chase planning -Expediting - Control aspects.

MODULE V DISPATCHING L:10

Introduction - Activities of dispatcher- Dispatching procedure - Follow up – Reasons for the existence of functions – Types of follow up - Applications of computer in production planning and control.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. S.K. Mukhopadhyay, "Production Planning and control: Text and cases", Prentice-Hall of India Pvt. Ltd, 3rd Revised edition, 2015.
2. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990.

REFERENCES:

1. MartandTelsang, "Industrial Engineering and Production Management", First edition, S.Chand and Company, 2000.
2. Stephen N. Chapman, "The Fundamentals of Production Planning and Control", Pearson, 2005.
3. Samuel Eilon, "Elements of Production Planning and Control", 1st Edition, Universal Publishing Corp., 1999.
4. Baffa & Rakesh Sarin, "Modern Production / Operations Management", 8th Edition, John Wiley & Sons, 2002.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the fundamentals of production planning.

CO2: Describe the forecasting techniques

CO3: Elucidate different inventory control techniques

CO4: Determine the production scheduling and routing

CO5: Describe the dispatching procedures

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The knowledge of production planning and control helps inventory management and optimizes the resources and production process.

MEDX 53 STATISTICS AND QUALITY CONTROL L T P C

SDG: 9 3 0 0 3

COURSE OBJECTIVES:

COB1: To gain knowledge on the basics of quality control.

COB2: To familiarize with the Statistical process control.

COB3: To learn about the Control Charts for Variables and attributes

COB4: To acquire knowledge on the concept of sampling methods.

COB5: To be conversant with the six sigma and quality management concepts.

MODULE I INTRODUCTION TO QUALITY CONTROL L:8

Concepts of quality– Quality characteristics– Quality standards– Quality cost– Concept of quality control– Quality assurance –Inspection planning – Manufacturing planning for quality – Planning for process control–Tools of Quality.

MODULE II STATISTICAL PROCESS CONTROL L:8

Introduction to Statistics –Concept of variation – Variable and attribute data –Population and sample – Frequency distribution – Normal curves – Binomial distribution–Concept of process capability –Measures of process capability –Potential process capability –Actual process capability –Process capability analysis –Case studies.

MODULE III CONTROL CHARTS FOR VARIABLES AND ATTRIBUTES L:12

Control Charts for X and R : Statistical basis, Development and use, Estimating process capability, Interpretation, The effect of non-normality on the chart, Operating characteristics (OC) function, Average run length – Control Charts for X and S – Control Chart for Individual Measurements – Control Chart for Fraction Nonconforming – Control Charts for Nonconformities or Defects- Choices between Attribute and Variable control charts–Moving average control chart - Cumulative sum control chart(CUSUM) – Exponentially weighted moving average control chart (EWMA).

MODULE IV ACCEPTANCE SAMPLING L:9

Introduction – Sampling methods – OC curve– Producer and consumer risk – Quality indices – Average outgoing quality limit – Steps in the design of acceptance plan – Sampling plans – Average total inspection curve – Dodge Romig sampling plans – Acceptance sampling plan by variables.

MODULE V SIX SIGMA AND QUALITY MANAGEMENT L:8

Concept of six sigma – Methods of six sigma – DMAIC methodology – DFSS methodology – Six sigma control chart – Case studies – Reliability – Quality control and reliability–Taguchi loss function – Failure Mode Effective Analysis (FMEA) and Failure Mode effects and criticality Analysis (FMECA) – Quality circles –Quality systems – Quality Audit.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Douglas C Montgomery, Introduction to Statistical Quality Control, John Wiley, Eighth Edition, 2019.

REFERENCES:

1. M.Mahajan,"Statistical quality control" Dhanpatrai and co pvt Ltd., 2016.
2. Dale H. Besterfield, C. B. Michna, G. H. Besterfield, M. B. Sacre,Hemant U., Rashmi U. Total Quality Management, Fifth Edition, Pearson Education, 2018.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the concepts of quality control.

CO2: Describe the concepts of statistical process control.

CO3: Analyze the process using variable and attribute control charts.

CO4: Select suitable acceptance sampling techniques.

CO5: Elucidate six sigma and quality management concepts to improve quality in an organisation.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 statistical quality control and its components leads to assure quality processes and products which supports economic development.

MEDX 54	**PROJECT MANAGEMENT**	**L**	**T**	**P**	**C**
SDG: 17		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the fundamentals of project management.

COB2: To familiarize with sources of risk and risk analysis.

COB3: To gain knowledge on project planning and implementation.

COB4: To be conversant with various project tools and communication methods.

COB5: To acquire knowledge on project procurement and resource management techniques.

MODULE I INTRODUCTION TO PROJECT MANAGMENT L:9

Introduction to Project and Project Management - Project Management as a Career- Project Management Skill Sets - The project life cycle - Project initiation - Project evaluation methods and techniques - Project selection criteria - Project profile.

MODULE II PROJECT RISK ANALYSIS L:9

Sources of risk: Project specific, Competitive, Industry specific, Market and international risk – Perspectives of risk – Risk analysis: Sensitivity analysis, scenario analysis, breakeven analysis, simulation analysis, decision tree analysis – Managing/mitigating risk – Project selection under risk.

MODULE III PROJECT PLANNING AND IMPLEMENTATION L:9

Project planning – Importance – Functions - Areas of planning - Project objectives and policies - Steps in planning process – Work breakdown structure (WBS) – Capital requirements - Budgeting and cost estimation - Feasibility analysis - Creation of project plan – Project implementation - Pre-requisites - Forms of project organization.

MODULE IV PROJECT TOOLS AND PROJECT COMMUNICATION L:9

Triple constraints of project: Quality, cost, and schedule - Quality planning - Quality assurance and quality control - Process control - Cost of quality - Seven tools of quality control - Project time management - Duration estimation method - Project communication management - Formal vs. Informal communications: written, verbal and non-verbal communications.

MODULE V PROJECT PROCURMENT AND RESOURCE MANAGEMENT TECHNIQUES L:9

Introduction to Project Procure Management - Soliciting RFQ/RFP Contract - Project scheduling - Network construction – Estimation of project completion time – Identification of critical path - PERT & CPM – Crashing of project network - Complexity of project scheduling with limited resources - Resource: allocation, levelling and smoothing.

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. Projects: Planning, Analysis, Financing, Implementation and Review, Prasanna Chandra, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
2. Jack. R. Meredith, Samuel. J. Mantel & Scott. M. Shafer, Project Management in Practice, Fifth Edition, Bangalore: Wiley, 2015.

REFERENCES:

1. Project Management and Control, Narendra Singh, Himalaya Publishing, New Delhi, 2015.
2. Bob Hughes, Mike Cotterrel "Software Project Management", Tata McGraw-Hill, 2009.
3. A Guide to the Project Management Body of Knowledge (PMBOK® Guide)–Sixth Edition Author & publisher: Project Management Institute, 2017.
4. Lean Project Management: Philip Small, Arkham Publishing Limited, March 2020.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1. Describe the fundamentals of project management

CO2: Elucidate various sources of risk and risk analysis.

CO3: Develop and implement a project plan.

CO4: Explain various project tools and communication methods.

CO5: Apply project management techniques for maximizing resource utilization.

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H										M	L	H	L
CO2	L										L	L	L	L
CO3	L			M							M	L	M	L
CO4	L			M	M		M			H	L	L	H	L
CO5	L			M	M			M		M	M	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 holistic understanding of project management gives various strategies to improve productivity by optimally utilizing projects resources.

MEDX 55	ADVANCED MACHINING PROCESSES	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge on the basics of advanced machining processes

COB2: To familiarize with various advanced machining processes

COB3: To acquire knowledge on advanced abrasive machining processes

COB4: To be conversant with the advanced electric machining processes

COB5: To learn about advanced chemical machining processes

MODULE I INTRODUCTION L:12

Advanced machining theory and practices - Mechanisms of chip formation - Shear angle relations and theoretical determination of cutting forces in orthogonal cutting - Analysis of turning, drilling, and milling operations - Mechanics of grinding – Dynamometry - Thermal aspects of machining - Tool wear - Economics of machining - Processing of polymers, ceramics, and composites.

MODULE II ADVANCED MACHINING PROCESSES L:9

Working principle and applications of processes: Water jet machining (WJM), Laser beam machining (LBM), Plasma arc machining (PAM), Electron Beam Machining (EBM).

MODULE III ADVANCED ABRASIVE MACHINING PROCESSES L:8

Abrasive flow finishing (AFF) - Abrasive jet machining (AJM) - Abrasive water jet machining (AWJM)- Magnetorheological finishing (MRF) - Magnetorheological abrasive flow finishing (MRAFF) - Modelling and analysis.

MODULE IV ADVANCED ELECTRIC MACHINING PROCESSES L:8

Principle, applications, process parameters, and Modelling: Electric discharge machining (EDM), Electric Discharge Grinding (EDG), Electric Discharge Diamond Grinding (EDDG), and Wire Electric Discharge Machining (WEDM).

MODULE V ADVANCED CHEMICAL MACHINING PROCESSES L:8

Principle, applications, process parameters, and Modelling: Electrochemical machining (ECM), Electrochemical Grinding (ECG), Electro stream Drilling (ESD), Shaped Tube Electrolytic Machining (STEM), Chemical machining (ChM).

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Pandey P.S. and Shah N. “Modern Manufacturing Processes ", 1980.
2. Battacharya," Theory of metal cutting ", NCB Agency, 1984.
3. HMT Manual, “Non-traditional machining methods ", 1975.

REFERENCES:

1. "Materials and Processes in Manufacturing" (8th Edition), E.P. DeGarmo, J. T Black, R.A.Kohser,Prentice Hall of India, New Delhi (ISBN 0-02-978760).
2. "Manufacturing Science" A. Ghosh, and A.K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.
3. "Non-traditional Manufacturing Processes", G.F.Benedict, Marcel Dekker, Inc. New York (ISBN 0-8247-7352-7).

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basic concepts involved in advanced machining processes

CO2: Describe various advanced machining processes

CO3: Illustrate the advanced abrasive machining processes.

CO4: Elucidate the advanced electric machining processes.

CO5: Illuminate on advanced chemical machining processes

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The knowledge on advanced machining processes helps industries towards innovation by ease in manufacturing complex parts.

MEDX 56	**SURFACE MOUNTING TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the concepts of SMT and PCB fabrication.

COB2: To acquire knowledge on Surface mount components and substrates for surface mounting.

COB3: To familiarize with the adhesive and solder paste used in SMT applications.

COB4: To gain knowledge in various component placement techniques and soldering of surface mounted components.

COB5: To be conversant with the inspection, testing, repair, and rework of SMT assemblies.

MODULE I INTRODUCTION TO SURFACE MOUNT TECHNOLOGY (SMT) AND PCB MANUFACTURING L:9

Introduction – Types – Benefits about surface mounting technology - SMT Equipment requirement - Technical issues in Surface Mounting - Trends in Surface Mounting – Future scope -Wafer preparation by various methods - Printed Circuit Boards- Types: Single sided, Double sided, Multi-Layer and Flexible printed circuit board.

MODULE II SURFACE MOUNT COMPONENTS AND SUBSTRATES FOR SURFACE MOUNTING L:9

Surface Mount component characteristics – Passive and Active surface mount components - Ball grid arrays - Chip scale packaging - Major issues in components – Introduction to substrates - Glass transition temperature - Selection of substrate material – Ceramic - Glass Epoxy substrates - Plating processes - Solder mask selection.

MODULE III ADHESIVE & SOLDER PASTE AND ITS APPLICATIONS L:8

Ideal adhesive for surface mounting - General classification - Conductive adhesives for surface mounting - Adhesive application methods - Curing of adhesives - Solder paste properties - Solder paste printing - Equipment and process –Defects - Printing for different types of components.

MODULE IV COMPONENT PLACEMENT AND SOLDERING OF SURFACE MOUNTED COMPONENTS L:10

Manual & Automated placement of parts - Selection criteria for placement equipment - Selection of feeders for placement equipment - Introduction to soldering - Wave soldering- Types of Wave soldering in inert environment – Single step soldering of mixed assemblies and double-sided SMT assemblies – Vapour phase soldering – Various types of reflow soldering.

MODULE V INSPECTION, TESTING, REPAIRS, AND REWORKABILITY OF SOLDER JOINTS IN SMT L:9

Inspection techniques - Equipment and principle – X-Ray, Defects and Corrective action –Testing process: Stencil printing process, Component placement process, Reflow soldering process, Under fill and Encapsulation process, Electrical testing of PCB assemblies.

Quality Control - Defects related to materials and process - Solder joint quality requirements - Solder joint inspection - Repair equipment and processes - Assembly testing - ISO 9000 Quality standards and certification.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Ray Prasad, “Surface Mount Technology: Principles and Practice”, Second Edition, Chapman and Hall, New York, 1997.(ISBN 0-41-12921-3)
2. Ning-Cheng Lee, “Reflow Soldering Process and Trouble Shooting SMT, BGA, CSP And Flip Chip Technologies”, Elsevier Science.(ISBN 0-7506-7218-8)

REFERENCES:

1. Rao. R.Tummala, “Fundamentals of Microsystem Packaging”, McGraw Hill, 2001.(ISBN 00- 71-37169-9)
2. PuligandlaViswanadham and Pratap Singh, “Failure Modes and Mechanisms in Electronic Packages”, Chapman and Hall, New York.(ISBN 0-412-105591-8 4)
3. Paul Totta and Karl Puttlitz, and Kathleen Stalter, “Area Array Interconnection Handbook”, Kluwer Academic Publishers, Norwell, MA, USA, 2001. (ISBN 0-7923 7919-5)
4. Phil Zarrow, “Surface Mount Technology Terms and Concepts”, Elsevier Science and Technology,1997.(ISBN 0750698756)
5. C. A. Harper, “Electronic Packaging and Interconnection Handbook”, Second Edition, McGraw Hill Inc., New York,

1997.(ISBN 0-07-026694-8)

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the concepts of SMT and PCB fabrications.

CO2: Elucidate various Surface mount components and substrates for SMT.

CO3: Describe the use of adhesives and solder paste for SMT components.

CO4: Illustrate the method of placing the components and soldering of surface mounted components.

CO5: Illuminate about the inspection, testing, and repair of the SMT assemblies.

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th AC held on 29 .09.2022

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

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

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

The understanding and usage of surface mounting technology for the manufacture of miniature printed circuit boards significantly increase access to information and communications technology.

MEDX 57	**OPERATION RESEARCH TECHNIQUES**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To gain knowledge on linear programming problems (LPP)

COB2: To learn the concepts of transportation and assignment problems

COB3: To familiarize with sequencing and network analysis techniques

COB4: To acquire knowledge on inventory, queuing and replacement models

COB5: To be conversant with non-linear optimization techniques

MODULE I LINEAR PROGRAMMING PROBLEMS L:9

Scope and phases of Operations research (OR) –Advantages and applications of OR – Formulation of the problem -Types: Simplex method, Graphical method, Big M method, and Two phase Method.

MODULE II TRANSPORTATION AND ASSIGNMENT PROBLEMS L:9

Transportation Problems: Initial basic feasible solution by North west corner method, Least cost method, and Vogel's approximation method- Optimum solution by MODI method –Degeneracy and Non degeneracy type.

Assignment Problems: Minimization and maximization types of problems by Hungarian method.

MODULE III SEQUENCING AND NETWORK ANALYSIS L:9

Sequencing - Objectives – Types: N Jobs to be processed on two machines, N Jobs to be processed on three machines, N jobs M machines.

Network Analysis - Network diagram – Fulkerson's rule - Difference between PERT and CPM – Determination of project duration -Critical path duration and slack time.

MODULE IV INVENTORY MODELS, QUEUING AND REPLACEMENT MODEL L:9

Types of inventory cost- Economic order quantity (EOQ) – Deterministic method - Queuing model -Single channel - Replacement of items that deteriorate with time – Money value changing with time – Money value not changing with time- Individual and group replacement policy.

MODULE V NON LINEAR OPTIMIZATION TECHNIQUES L:9

Overview of Genetic algorithms, Simulated Annealing and neural network based optimization- Basic concepts of Fuzzy sets- Introduction to Multi Attribute Decision Making (MADM).

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. HamdyA.Taha, "Operations Research an introduction", 8th edition, Pearson publisher, 2016.
2. Dr. D.S. Hira and PremkumarGupta,"Operations Research", S. Chand Publisher, 2014.

REFERENCES:

1. R.Pannerselvam, "Operations Research", Prentice Hall of India, 2016.
2. Kalymanoy Deb, "Optimization for Engineering Design",PHI,2003.
3. Singiresu S. Rao, "Engineering optimization – Theory and practices", John Wiley and Sons, 3rd Edition, 2009.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Apply LPP techniques for solving Engineering problems

CO2: Analyze problems in transportation and assignment models

CO3: Describe the concept of sequences and network analysis techniques

CO4: Explain the concepts of Inventory, Queuing and Replacement problems

CO5: Analyze problems in non-linear optimization techniques

Board of Studies (BoS):
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19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M		H	M							L	M	L
CO2	M	M		H	M							L	M	L
CO3	M	M		H	M							L	M	L
CO4	M	M		H	M							L	M	L
CO5	M	M		H	M							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 knowledge of Operations research helps us to formulate industrial problems into mathematical models that can be solved.

MEDX 58	**TOTAL PRODUCTIVE MAINTENANCE**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the fundamentals of TPM.

COB2: To gain knowledge on various types of maintenance.

COB3: To acquire knowledge on the pillars of TPM.

COB4: To be conversant with the implementation of TPM.

COB5: To familiarize with the future of TPM.

MODULE I TPM OVERVIEW L:9

Origin and development of Total Productive Maintenance (TPM) – Objectives and functions– TQM vs TPM– Benefits– Four phase approach to PM– TPM and Lean - Six sigma – Tero Technology –Maintenance costs – Maintenance organization.

MODULE II TYPES OF MAINTENANCE L:9

Types of Maintenance involved with TPM: Breakdown, Preventive, Predictive, Corrective - Maintenance Prevention – Six big losses – Overall Equipment Effectiveness (OEE) –Planned versus Total Maintenance – Maintainability – Reliability – Five Zero concept – Reliability Centred Maintenance (RCM).

MODULE III TPM PILLARS L:9

Housekeeping 5S –Autonomous Maintenance – Kobetsu Kaizen –Planned Maintenance – Quality Maintenance – Training – Office TPM – Safety, Health, and Environment – Common Targets for Lean, Six Sigma, and TPM– HoshinKanri– Equipment Failure Mode Effective Analysis (FMEA).

MODULE IV TPM IMPLEMENTATION L:9

Stages of TPM: Preparation, Implementation, Institutionalisation – Twelve steps of TPM development – Small group activities – Structures to Keep TPM – Performance Indicators for TPM – Condition Monitoring Techniques.

MODULE V FUTURE OF TPM AND CASE STUDIES L:9

Computerized Maintenance Management System – Overall Factory Efficiency (OFE) – Automation in TPM Implementation – Visual Factory – TPM Concepts in Design and Development Life Cycle – TPM in Service and Healthcare – TPM in Industry 4.0 – Case Studies.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Tina KantiAgustiady, Elizabeth A. Cudney, ‘Total Productive Maintenance: Strategies andImplementation Guide’, CRC Press, 2016.

REFERENCES:

1. Venkatraman K., ‘Maintenance Engineering and Management’, PHI Learning Private Limited, 2010.
2. Joel Levitt “TPM Reloaded Total Productive Maintenance”. Industrial Press, Inc, 2010.
3. Steven Borris, “Total Productive Maintenance”, McGraw-Hill, 2006.
4. Terry Wireman, “Total Productive Maintenance”, 2nd Edition, Industrial Press, 2004.
5. David J. Sumanth, “Total Productivity Management: A Systematic and Quantitative Approach to Compete in Quality, Price and Time”, Productivity Press, 1997.
6. Seiichi Nakajima, “Total Productive Maintenance”, Productivity Press, 11th edition, 1988.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the concepts of TPM used in Industry

CO2: Elucidate various types and maintenance.

CO3: Describe the pillars of TPM in an industry.

CO4: Illustrate the steps involved in implementing the TPM for effective utilization of the machinery.

CO5: Apply the futuristic concepts of TPM for the manufacturing and service industries.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The understanding of total productive maintenance and its components leads to infrastructure upgradation and retrofit industries to make them sustainable with increased efficiency.

MEDX 59	**AGILE MANUFACTURING**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the concepts of Agile Manufacturing.

COB2: To acquire knowledge on the frame work of Agile Manufacturing and its drivers.

COB3: To be conversant with computer control of Agile Manufacturing.

COB4: To familiarize with advanced concepts of Agile Manufacturing.

COB5: To gain knowledge in Agile supply chain management.

MODULE I INTRODUCTION L:9

Definition – Business need – Lean, Flexible, and Agile Manufacturing – Basic elements – Enablers.

MODULE II AGILE MANUFACTURING BASICS L:9

Core Concepts – Framework – Conceptual model of Agile Manufacturing– Drivers – Management –Technology – Manufacturing Strategy – Competitive strategy.

MODULE III COMPUTER CONTROL OF AGILE MANUFACTURING L:8

Cellular manufacturing – Concepts - Examples – CAPP for Agile Manufacturing – Aggregate capacity planning- Production line design / redesign in Agile manufacturing.

MODULE IV ADVANCED CONCEPTS L:10

A strategic approach to develop Agile Manufacturing – Product development strategies for Agility – Information technology/systems and multimedia in agile manufacturing – Managing people in Agile organizations – Measurement of agility.

MODULE V SUPPLY CHAIN MANAGEMENT IN AGILE MANUFACTURING L:9

Agile supply chain management – Engineering the Agile supply chain - Enterprise integration and management in Agile organizations – Case studies on Agile Manufacturing.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Gunasekaran A, Agile Manufacturing, 21st Strategy Competitiveness Strategy", Elsevier Publications, 2001.
2. S. R. Devadasan, V. Sivakumar, R. Murugesh, P. R. Shalij, Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities", PHI, Delhi, 2012.

REFERENCES:

1. Poul T Kidd, Amagow Co "Agile Manufacturing- Forging Mew Frontiers". UK, 1994.
2. Montgomery, J.C and Levine, L. O., "The transition to agile manufacturing – Staying flexible for competitive advantage", ASQC Quality Press, Wisconsin, 1996.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the concepts of agile manufacturing.

CO2: Describe the frame work of Agile Manufacturing and its drivers.

CO3: Select suitable computer aided tools for Agile manufacturing.

CO4: Describe advanced concepts of agile manufacturing.

CO5: Explain Supply Chain in Agile Organizations.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The understanding of agile manufacturing and its components promotes inclusive and sustainable industrialization and hence significant raise in the employment and gross domestic product.

MEDX 60	**COMPOSITE MATERIALS FOR MANUFACTURE**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To study various fiber and matrix materials used in composites.

COB2: To learn various PMC manufacturing processes

COB3: To gain knowledge on processing of MMC.

COB4: To familiarize the basics of CMC and its fabrication.

MODULE I INTRODUCTION L:9 P:10

Fundamentals of composites: Properties, Applications - Reinforcement types: Fiber, Particulate and whisker - Forms of fiber reinforcement: continuous, chopped, mat, prepreg - Properties and processing of synthetic fibers, Natural fibers, particles - Introduction to Matrix materials - Wettability - Interfacial bonding - Rule of mixture - Volume fraction.

MODULE II POLYMER MATRIX COMPOSITES (PMC) L:8 P:10

Characteristics of polymer matrix resins - PMC fabrication processes: Hand layup, spray processes, Compression moulding, Resin transfer moulding, Pultrusion, Filament winding, Injection moulding, Autoclave Molding - Manufacturing Defects -Voids –Non-destructive testing of composites.

MODULE III METAL MATRIX COMPOSITES (MMC) L:7 P:6

Characteristics of metal matrix materials - Reinforcement materials for MMC -Alloy vs. MMCs - Applications - Processing of MMC - Solid state: Sinter forging, spray forming, diffusion bonding -Liquid state processing: Stir casting, Squeeze Casting, Pressure infiltration, deposition and in-situ fabrication.

MODULE IV CERAMIC MATRIX COMPOSITES (CMC) L:6 P:4

Characteristics of ceramic matrix materials -Reinforcement materials for CMC - Properties of CMC - Applications - Processing of CMC: Hot pressing, liquid infiltration technique, in-situ chemical reaction techniques – CVD – CVI - Solgel process.

PRACTICALS

LIST OF EXPERIMENTS:

13. Processing of Natural fibers
14. Preparation of particles
15. Volume fraction of flat plates fabricated by compression molding
16. Fabrication of curved shapes using hand lay-up technique
17. Filament winding of pipes
18. Injection Molding
19. Stir casting of MMC
20. Sintering of MMC
21. Liquid infiltration of CMC

L – 30; P-30; TOTAL HOURS – 60

TEXT BOOKS:

1. Krishnan K Chawla, "Composite materials: Science and Engineering", Springer, 2006.
2. Mallick P.K.,Fiber-Reinforced Composites: Materials, Manufacturing, and Design, CRC Press, 2007.

REFERENCES:

1. Brent Strong A, "Fundamentals of composite Manufacturing", Society of Mechanical Engineers, 2nd Edition, 2008.
2. Derek Hull, "Introduction to Composite Materials", Cambridge University Press, 3rd Edition, 2019.
3. Yoshinori Nishida, "Introduction to Metal Matrix Composites: Fabrication and Recycling", Springer, 2013.
4. John Wanberg, Composite Materials Fabrication Handbook, Wolfgang Publications, 2009.
5. Sharma S.C., "Composite Materials", Narosa Publications, 2000.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Select suitable fiber and matrix materials for composites.

CO2: Describe various PMC manufacturing processes.

CO3: Explain various fabrication processes for metal matrix composites.

CO4: Demonstrate various processing of ceramic matrix composites.

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th AC held on 29 .09.2022

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

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

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

Holistic understanding of composite materials and its manufacturing methods leads to sustainable fabrication of industrial products.

MEDX61	**ADVANCED WELDING PROCESSES**	**L**	**T**	**P**	**C**
SDG:9		**2**	**0**	**2**	**3**

COURSE OBJECTIVES:

COB1: To study the fundamental concepts of welding processes

COB2: To acquire knowledge on advanced joining techniques

COB3: To learn about various friction related and non-metal welding

COB4: To familiarize with weld characteristics and inspection methods

MODULE I INTRODUCTION **L:8 P:15**

Overview of basic & advanced welding processes and their classifications - Types of weld joints - Edge preparation – Etching of weldments – Weld bead geometry and Nomenclature - Heat sources: Gaussian distribution of heat flux – Power density - Arc and Current characteristics – Voltage - Types of welding manipulators and their applications.

MODULE II ADVANCED WELDING TECHNIQUES I **L:6**

Plasma Arc welding - Laser beam welding -Electron beam welding - Ultrasonic welding - Magnetic Arc welding - Explosive welding - Principle and working – Applications.

MODULE III ADVANCED WELDING TECHNIQUES II **L:6**

Friction welding- Friction stir welding - Linear friction welding process - Welding of non-metals - Principle and working – Applications.

MODULE IV WELD CHARACTERISTICS & INSPECTION METHODS **L:10 P:15**

Weldability – Groove and fillet welds - Weld design: Requirements, Essential factors, Variables, Effective weld length, Effective area, Partial and complete joint penetration, Effective throat, minimum and maximum fillet weld size – Fracture and fatigue of weld joints – Welding symbols – NDT Techniques: Visual penetrant test, Liquid penetrant test, Magnetic particle test, Radiographic testing, Ultrasonic inspection, Eddy current and Acoustic inspection methods.

PRACTICALS

LIST OF EXPERIMENTS:

1. Butt joint fabrication – TIG welding process
2. T- joint fabrication – TIG welding process
3. Butt joint fabrication – MIG welding process
4. T- joint fabrication – MIG welding process
5. Butt joint fabrication – MMAW welding process
6. T- joint fabrication – MMAW welding process
7. Lap joint fabrication – MMAW welding process
8. Detection of weld defects – Liquid penetrant, Eddy current & Ultrasonic testing.
9. Weld cladding process (Demo)

L – 30; P – 30; TOTAL HOURS – 60

TEXT BOOKS:

1. Khanna O. P, “A text book on welding technology”,Dhanpat rai and sons, New Delhi, 2013.
2. Parmar R S, “Welding process and technology”, Khanna publishers, 3rd Edition, 2003.

REFERENCES:

1. Kou S, “Welding metallurgy”, John wiley publication, New York, 2003.
2. John Norrish, “Advanced welding processes”, Woodhead publishing, 2006.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: explain the fundamental concepts of different welding processes

CO2: describe the advanced joining techniques

CO3: elucidate various friction related and non-metal welding process

CO4: analyze and apply weld characteristics and various inspection techniques

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

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

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 modern and sophisticated welding technology helps in achieving sustainable production.

MEDX62 SDG:9	ADVANCED CASTING AND FORMING PROCESS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

COB1: To familiarize about special casting processes

COB2: To learn about automation and other aspects of advanced casting

COB3: To gain knowledge on high velocity forming

COB4: To study about high speed extrusion, blanking and bar cropping

COB5: To acquire knowledge on advanced forming techniques

MODULE I SPECIAL CASTING PROCESSES L:9

Expendable pattern casting -Plaster mould casting-Ceramic mould casting – Vacuum casting-Permanent mould casting-Slush casting-Squeeze casting-Application: Casting for ferrous and non-ferrous alloys.

MODULE II ADVANCED ASPECTS IN CASTING PROCESS L:9

Mechanization and automation in casting- Use of robot – Near net shape casting – Pollution control - Energy and waste Management - Casting defects - Inspection, diagnosis and rectification - Economics of casting.

MODULE III HIGH VELOCITY FORMING L:9

High velocity forging machine-Energy distribution and velocity variation-Pressure distribution during flattening- Dynapak High-speed forming machine -Petro forge high-speed forming machine – Effects of high speed on metal deformation – Factors affecting high velocity forming process – Applications

MODULE IV HIGH SPEED EXTRUSION, BLANKING AND BAR CROPPING L:9

Types of high-speed extrusion system- Tool materials- Flow of metal-Theories of high-speed extrusion- High speed blanking and Bar cropping - Two pillar die set - Effects of high speed on blanked components – Effect of high speed on load and energy.

MODULE V ADVANCED FORMING TECHNIQUES L:9

Explosive forming: Methods, Types of explosives, Pressure time curve, Energy Transfer medium, Spring back phenomenon – Forming process variables – Applications - Electro Magnetic forming(EMF): EMF machine , Production of parts, Characteristics and Applications – Super plastic forming process: Construction and working Principle, Super plasticity materials, Process and Applications.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. SeropeKalpakjian and Steven R, “Manufacturing Engineering and Technology”, 7th Edition,Pearson Publisher, 2018.
2. Nagpal G. R., “Metal Forming Processes”, Khanna Publishers, 2011.

REFERENCES:

1. P.C Sharma, “A Text book of Production Technology”,S.Chand Publisher, 2016.
2. R.K. Rajput, “A Text book of Manufacturing Technology”,Laxmi Publications (P) Ltd, 2013.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe about features of special casting processes

CO2: Explain the automation and other aspects of advanced casting

CO3: Discuss different types of high velocity forming process

CO4: Explain about high-speed extrusion, blanking and bar cropping

CO5: Elucidate about advanced forming techniques

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			M										M	L
CO2			M										M	M
CO3			M										L	L
CO4			M										L	L
CO5					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 understanding of advanced casting and forming processes enables to manufacture complicated high-quality parts which creates value for the industries and inclusive path to economic growth.

MEDX 63 INDUSTRIAL ENGINEERING L T P C
SDG 9 3 0 0 3

COURSE OBJECTIVES:

COB1: To learn the basics of Industrial engineering to improve productivity

COB2: To acquire knowledge on method design and ergonomics

COB3: To familiarize with work measurement concepts and techniques

COB4: To gain knowledge of facility planning and plant layouts.

COB5: To be conversant with engineering economics concepts on demand and forecast

MODULE I INTRODUCTION TO INDUSTRIAL ENGINEERING L:9

Definition, History and Development of Industrial Engineering - Industrial Engineering approach - Objectives of Industrial Engineering - Functions of Industrial Engineer - Tools and techniques of industrial engineering - Contribution of F.W.Taylor, Gilberth, Gantt and Maynard to the field of Industrial Engineering - Productivity: Definition, factors of productivity, productivity cycle, total productivity, labor Productivity, measurement of productivity, improvement techniques of productivity- Japanese techniques responsible for higher productivity.

MODULE II METHOD DESIGN AND ERGONOMICS L:9

Objectives of work-study - Scope of method study - Steps involved in method study- Selection of job for method study -Recording techniques - Micro and memo motion study- Development and selection of new method - Principles of motion economy- Installation of the proposed method - Ergonomics related to workplace design.

MODULE III WORK MEASUREMENT L:9

Time Study: Objectives, Use of stopwatch procedure in making time study - Time study forms - Performance rating - Allowances and its types - Calculation of standard time - Work Sampling: Definition, Confidence level, Sample Size, Determination of Standard time using work sampling, Other application of work sampling - Synthetic and Standard data method for standard time measurement : Pre-determined Motion Time standards (PMTS), Methods Time measurement (MTM), Maynard operation sequence technique (MOST).

MODULE IV FACILITY PLANNING L:9

Facility location - Important factors affecting location decision- Cost and non cost factors- Location theories- Basic layouts- Layout planning and designing for job, batch, mass production layout - Hybrid layouts-Computerized layout planning - Systematic layout planning procedure - Computerized relative allocation facility techniques (CRAFT) and Automated layout design planning (ALDEF) - Design of operation line-Line balancing - Material handling systems - Principle - Types of material handling equipment.

MODULE V ENGINEERING ECONOMICS L:9

Economics: Definition, Scope, basic terms, Classification-Importance of Economics in Engineering. Demand- Law of Demand – Demand curve-Factors affecting demand- Demand Elasticity-Estimation of Demand Elasticity- Methods of Demand Forecasting- Trend, Projection, Correlation and Regression Methods – Problems in Demand Forecasting - Break Even Point- Applications of BEP - Problems- Limitations.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. MartandTelsang, Industrial Engineering and Production Management, S.Chand& Company Ltd. S. Chand & Co., 1998.
2. Khanna. O.P., Industrial Engineering – Khanna Publishers, 2018.

REFERENCES:

1. P K.C Jain, L.N.Aggarwal production planning control and Industrial management, Khanna publishers, 2015.
2. Prasad L.M, “Principles of Management”. Sultan Chand & Sons, 2005.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explore the overall aspects of Industrial engineering to improve productivity

CO2: Illustrate the method design and ergonomic concept.

CO3: Describe different work measurement techniques.

CO4: Explain the concepts facility planning and plant layout

CO5: Elucidate about engineering economics and correlate demand with forecast.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

SDG 9: Promote inclusive and sustainable industrialization and foster innovation.

The knowledge of Industrial Engineering helps to increase the productivity by eliminating waste and non-value added activities and the effective utilization of resources.

MEDX 64	**GREEN MANUFACTURING DESIGN AND PRACTICES**	**L**	**T**	**P**	**C**
SDG: 13		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the basics of Green Manufacturing

COB2: To gain knowledge about Environmental life cycle assessment.

COB3: To familiarize with design for environment

COB4: To acquire knowledge on green factory through green unit processes.

COB5: To be conversant with the value engineering green plan

MODULE I INTRODUCTION TO GREEN MANUFACTURING L:8

Need for Green Manufacturing - Definition of green – Is green sustainable – Green Manufacturing: Motivations, Barriers, Strategies, Five principles - Environmental impact of Manufacturing.

MODULE II ENVIRONMENTAL LIFE CYCLE ASSESSMENT L:9

Metrics for Green Manufacturing: Financial, Ecology, Society – Life cycle Assessment Methodologies - Economy level: One way economy, Resource efficient economy, closed loop economy - Impact Assessment - Risk Assessment – Economic input output Life cycle assessment (EIO-LCA) – Types: Process based and economy based.

MODULE III DESIGN FOR ENVIRONMENT L:10

Importance of Design for environment (DFE): Customer demand, Government pressure, ISO requirements – Environmental factors – Scope of Environmental impact – Global issues, Regional and local issues – Waste Management – Sources of waste – Level of design for Environment: Design for Manufacturability, disassembly, Energy and Efficiency, Zero toxicity, Recycling, Remanufacturing, Compostability, Energy recovery – Implementation of DFE process.

MODULE IV GREEN FACTORY THROUGH GREEN UNIT PROCESSES L:9

Roadmap to create a green factory – Green unit manufacturing process – Machining for greenness – Case study with green drilling – Process optimization – Artificial Bee colony (ABC) algorithm – Green factory simulation

MODULE V VALUE ENGINEERING GREEN PLAN L:9

Introduction – Value – Types of value - Value Engineering – Need for value engineering – Cost cutting vs Value engineering – Value engineering green plan – methodology.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009.
2. Dornfield David, Green Manufacturing, Springer, 2012.

REFERENCES:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010.
2. Hans Berns, World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press, 2005.
3. Davim.J.Pauls, Green Manufacturing Processes and Systems, Springer, 2013.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the fundamentals of green manufacturing.

CO2: Describe the environmental life cycle assessment methods

CO3: Elucidate about the design for environment

CO4: Illustrate about green factory through green unit processes

CO5: Describe the value engineering green plan

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

SDG 13: Build resilient Infrastructure, promote green manufacturing design and practices to improve climate action.

The holistic understanding of green manufacturing gives various strategies necessary to promote the ecology focus to improve climate action.

MEDX 65 **RUBBER PRODUCT MANUFACTURING TECHNOLOGY** **L T P C**

SDG:9 **3 0 0 3**

COURSE OBJECTIVES:

COB1: To learn about the rubber compound mixing and processing

COB2: To impart the knowledge of latex product manufacturing

COB3: To acquaint with the belt manufacturing technology

COB4: To be conversant with the cable and hose manufacturing process

COB5: To gain knowledge on footwear and sport goods manufacturing processes

MODULE I COMPOUND MIXING AND PROCESSING L:9

Mixing machinery for rubber: Two-roll mills, internal batch mixers, continuous mixers - Processing: Calendaring, extrusion – Molding: Compression molding, transfer molding, injection molding.

MODULE II LATEX PRODUCT MANUFACTURING L:9

Latex compounding ingredients - Preparation of aqueous dispersions and emulsions - Dispersion of water insoluble solids - Dipping and casting - Types of dipping processes - Glove production - Batch dipping process - Continuous dipping process - Defects and remedies - Latex casting - Latex casting using plaster and metal mould - Latex foam rubber - Dunlop process -Talalay process - Testing of latex foam - Latex rubber thread - Latex adhesives.

MODULE III BELT MANUFACTURING TECHNOLOGY L:9

Conveyor belt: Raw materials, belt construction, different grades of belts with their properties and applications, belt selection, manufacturing, vulcanization.

V-Belt – Raw materials – Processing of various components: Rubber, cord, canvas – Method of processing of various v-belts.

MODULE IV HOSE AND CABLE MANUFACTURING L:9

Hose manufacturing - High Pressure Hydraulic Hose - Wire Braid Hoses - Spiral Hoses, -Automotive Hose - Coolant Hoses - Power Steering Hoses - Fuel Hoses - Industrial Hose - Air, Water, and Welding Hose - Steam Hose - Cable Technology - Constructional Elements of Polymer-Insulated Cables - Polymeric Materials for Cable Insulation- Compound Design -

Manufacturing Techniques – Extrusion - Curing Processes - Special purpose cables.

MODULE V FOOT WEAR & SPORTS GOODS MANUFACTURING L:9

Types of foot wear – Build up shoes – All rubber shoes – DVP shoes – Dip shoes – Plastic foot wear manufacturing by slush molding – Injection molded PVC shoes - Injection molding of sole and heel units – Expanded micro cellular soling – Methods of manufacturing microcellular soling – Trouble shooting - Golf ball and tennis ball manufacturing.

L –45; TOTAL HOURS – 45

TEXT BOOKS:

1. Richard F. Grossman, "The Mixing of Rubber", Chapman & Hall, 1997.
2. Rani Joseph, "Practical Guide to Latex Technology", SmithersRapra Technology Ltd, 2013.
3. A.K. Bhowmick, M.M. Hall and H.A. Benaney, "Rubber Products Manufacturing Technology", Marcel Dekker Inc, New York, 1994.

REFERENCES:

1. Blow. C.M. and Hepburn C, "Rubber Technology and Manufacture", Butterworths, 1982.
2. C.W. Evans, "Hose Technology", Elsevier Applied Science Publishers, 1979.

COURSE OUTCOMES:

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

CO1: Explain rubber compound mixing and processing

CO2: Describe latex product manufacturing

CO3: Demonstrate the belt manufacturing process

CO4: Elucidate cable and hose manufacturing methods

CO5: Discuss the footwear and sport goods manufacturing processes

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	M			L							L	L	L
CO2	L	L										L	L	L
CO3	L		L		M							L	L	L
CO4	L		L		M							L	L	L
CO5	L		L		M							L	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 knowledge on rubber product manufacturing and technology leads to increased efficiency and productivity with sustainable natural rubber practices.

MEDX 66	**TYRE MANUFACTURE AND TESTING**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To introduce the concept of tyre compounding

COB2: To acquaint with the tyre components and structure

COB3: To focus on tyre cord reinforcements

COB4: To be conversant with the tyre and tube manufacturing

COB5: To gain knowledge on tyre testing and evaluation procedures

MODULE I TYRE COMPOUNDING L:9

Introduction to tyre technology – Tyre compound and fundamental properties – Compound development – Raw materials for compounding – Designing the compound matrix for the reinforced composite.

MODULE II TYRE COMPONENTS AND STRUCTURE L:9

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

MODULE III TYRE CORD REINFORCEMENTS L:9

Tyre cords – Physical Properties of tyre-cords – Types: 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 IV TYRE AND TUBE MANUFACTURING L:9

Tyre manufacturing – Tyre building – Green tyre – Curing methods – Post curing inflation – Finishing - Tyre mould design - Different types - Their feature and operation of tyre building machines - Bead winding machine - wire/glass processing machines - Bias cutters - Curing presses - Retreading – Criteria – Methods of retreading.

Tubes: Principles of tube design – Manufacturing of tubes: Extrusion, curing, tube testing.

MODULE V TYRE TESTING AND FIELD EVALUATION L:9

Tyre Testing – Destructive and Non-destructive Testing of Tyres - Plunger Tests (Breaking energy) - Pulley wheel test - Field Tract Testing – Braking – Acceleration – Mileage - Regulations – BIS standards for tyres, tubes and flaps, 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. 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, BurakErman "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: At the end of the course, the students will be able to

CO1: Explain the concept of tyre compounding

CO2: Elucidate tyre components and structure

CO3: Describe the tyre reinforcements with respect to tyre cords

CO4: Illustrate the tyre and tube manufacturing processes

CO5: Select suitable tyre testing and evaluation procedures

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M										L	L	L
CO2	L		L									L	L	L
CO3	M		L									L	L	L
CO4	L	L	L									L	L	L
CO5	L	L	L		M	M						L	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 knowledge of tyre manufacture and testing leads to various product applications which contribute to the sustainability journey of the global natural economy.

MEDX 67	**PLANT LAYOUT AND MATERIAL HANDLING**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To learn about product and process layouts

COB2: To gain knowledge on different layout requirements

COB3: To familiarize with various material handling equipment

COB4: To be conversant with the heavy-duty material handling equipment

MODULE I PRODUCTAND PROCESS LAYOUTS L:7

Selection of plant locations:Territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal- Safe layout: Process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, nuclear power stations, thermal power stations, metal powders manufacturing and match works , Equipment layout, safety system, fire hydrant locations, fire service rooms -Equipment required for operation of the plant – Capacity -Service and flexibility -Space requirements - Man power requirements

MODULE II LAYOUT REQUIREMENTS L:8

Principles of good ventilation –Purpose -Physiological and comfort level types -Local and exhaust ventilation -Hood and duct design -Air conditioning -Ventilation standards -Applications –Lighting -Types, advantages of good illumination, glare and its effect, lighting requirements for various works, standards- Housekeeping -Principles of 5S – Layout planning procedure – Improvisation of existing layout

MODULE III MATERIAL HANDLING EQUIPMENT L:7

Ropes :Fiber rope, types, lubrication, overloading, rope fitting, inspection and replacement – Slings: Types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection - Hoisting apparatus: Cranes, types, design and construction, guards and limit devices, – Conveyors-Precautions-Types -Applications.

MODULE IV HEAVY DUTY MATERIAL HANDLING EQUIPMENT L:8

Powered industrial trucks: Requirements, operating principles, operators selection and training and performance test, inspection and maintenance, electric trucks, gasoline operated trucks, LPG trucks – Power elevators -

Types of drives, hoist way and machine room emergency procedure, requirements for the handicapped – Escalator-Safety devices and brakes - Moving walks – Man lifts-Construction -Brakes -Inspection

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1. Spivakosky, "Conveyors and related Equipment", Vol.I and II Peace Pub. Moscow, 1982.
2. S. C. sharma, Plant layout and material handling, Khanna Publishers, Edition 3, 2000.

REFERENCES:

1. APPLE M. JAMES "Plant layout and material handling", 3rd edition, John Wiley and sons,1987.
2. Reymond, A.Kulwice, "Material Handling Hand Book - II", John Wiley and Sons, New York, 1985.
3. Safety and good housekeeping", N.P.C. New Delhi, 1985.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe various product and process layouts

CO2: Explain different layout requirements

CO3: Discuss various material handling equipment

CO4: Elucidate the heavy duty material handling equipment.

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th AC held on 29 .09.2022

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

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

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

The understanding of material handling systems and its components supports domestic technology development, research and innovation in developing countries

MEDX 68 **PRODUCTION MANAGEMENT** **L T P C**

SDG: 9 **2 0 0 2**

COURSE OBJECTIVES:

COB1: To learn the basics of production management

COB2: To familiarize with product design and its analysis

COB3: To gain knowledge about planning and investment decisions

COB4: To be conversant with the modern concepts in production management

MODULE I BASICS OF PRODUCTION MANAGEMENT L:7

Functional Subsystems of Organizations-Systems Concept of Production-Productivity-Strategic Management-Gross Domestic Product (GDP) and Its Impact-World Class Manufacturing

MODULE II PRODUCT DESIGN AND ANALYSIS L:8

Product Design and Analysis-New Product Development - Concepts-Process Planning and Design-Process Design-Value Analysis/Value Engineering – Standardization – Simplification-Ergonomic Considerations in Product design-Concurrent Engineering

MODULE III PLANNING AND INVESTMENT DECISIONS L:7

Capacity Planning- Determination of Plant Capacity - Capacity Planning Strategies - Equipment Selection - Investment Decisions - Interest Formulas - Bases for Comparison of Alternatives

MODULE IV MODERN CONCEPTS L:8

Modern concepts: Management by Objectives (MBO), Management by Exception (MBE), Strategic Management - Planning for Future direction - SWOT Analysis - Information technology in management - Decisions support system - Business Process Re-engineering (BPR) - Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (ABM)-Just-in-Time

L - 30; TOTAL HOURS – 30

TEXT BOOKS:

1. T.R.Banga& S C Sharma Industrial Organization and Engineering Economics Khanna. Publishers, 2006.
2. Pannerselvam R- Production and Operations Management-2012 by PHI Learning Private Limited, New Delhi.

3. Buffa E.S - Modern Production/Operations Management - A Wiley/Hamilton Publication

REFERENCES:

1. Ahuja, K. K. Industrial Management and Organizational Behaviour. Khanna Publishers, 2001.
2. Operations Management by William J. Stevenson. Eighth Edition, Irwin / McGraw-Hill, 2005.
3. Tripathi. P.C. & P.N. Reddy, "Principles of Management", Tata McGraw Hill, 2006.
4.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of production management

CO2: Discuss the concept of product design and its analysis

CO3: Describetheplanning and investment decisions in production management

CO4: Elucidate the modern concepts in production management

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

Understanding the concept of production management helps in sustainable development in manufacturing industries.

MEDX 69	**INTERNET OF THINGS FOR MANUFACTURING**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To learn the importance of IOT and IIOT

COB2: To study various storage management techniques

COB3: To gain knowledge on IOT analytics and applications

COB4: To study the applications of IOT in manufacturing industries.

MODULE I INTERNET OF THINGS L:7

The Internet of Things: An overview - IOT Vs. IIOT- Components of IIOT: Sensors, Interface, Networks, People &Process, Hype cycle - IOT Market, Trends &future, Real life examples, Key terms – IOT Platform, Interfaces, API, clouds, Data Management Analytics, Mining &Manipulation - Role of IIOT in Manufacturing Processes - Use of IIOT in plant maintenance practices.

MODULE II AUTOMATIC STORAGE MANAGEMENT L:8

Techniques for Writing Embedded Code: Memory Management, Performance and Battery Life, Libraries and debugging - Automatic Storage Management in a Cloud World – Introduction to Cloud, Relational Databases in the Cloud, Automatic Storage Management in the Cloud - Smart Connected System Design - Case Study.

MODULE III IOT ANALYTICS AND ITS SMART APPLICATION L:7

IOT Analytics: Role of Analytics in IOT, Data visualization Techniques - Online Predictive Modelling - Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes - Smart Energy Management of manufacturing processes and facilities.

MODULE IV APPLICATIONS IN MANUFACTURING L:8

Applications of IoT: Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy- Smart factories - Future research challenges

L –30; TOTAL HOURS – 30

TEXT BOOKS:

1. Ovidiu & Peter,Internet of Things- From Research and Innovation to Market Deployment; By; River Publishers Series,2014.
2. N. Vengurlekar and P. Bagal, Database Cloud Storage: The Essential Guide to Oracle Automatic Storage Management, 1st edition, McGraw-Hill Education, 2013. (ISBN-10: 0071790152)
3. De Lacalle, Luis Norberto López, and Jorge Posada, eds. New industry 4.0 advances in Industrial IoT and visual computing for manufacturing processes. MDPI, 2020.

REFERENCES:

1. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013.(ISBN-10: 111843062X)
2. M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010. (ISBN-10: 0123748992)

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain about IOT and IIOT

CO2: Describe the storage management

CO3: Discuss the IOT analytics and its smart application

CO4: Elucidate applications of IOT in manufacturing industries

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The understanding of IOT, IIOT and their major applications helps the manufacturing industries to improve its productivity.

MEDX 70 **DIGITAL MANUFACTURING** **L T P C**

SDG: 9 **1 0 0 1**

COURSE OBJECTIVES:

COB1: To study about principles of digital manufacturing process and geometric modelling used for different materials

COB2: To gain knowledge about algorithmic design for digital manufacturing and future development

MODULE I OVERVIEW OF DIGITAL MANUFACTURINGPROCESS L:9

Digitalization of manufacturing process – The ten disruptive principles of digital manufacturing processes – Basic concept and Connotation of digital manufacturing science – Research method of digital manufacturing science – Digital Twins and Applications - Digital Process Twins in Manufacturing - Digital Transformation Concepts and Technologies- Empirical and data driven models.

MODULE II ALGORITHMIC DESIGN FOR DIGITAL MANUFACTURING AND FUTURE DEVELOPMENT L:6

Parametric models – Vibrational Geometry – Generative models – Topology optimization - Precision of digital manufacturing – Extreme of digital manufacturing - Environmental protection of digital manufacturing - Safety, Liability and intellectual property – Environmental impact – On-demand fabrication models and mass customization -IIOT.

L – 15; TOTAL HOURS – 15

TEXT BOOKS:

1. Zhou, Xie, S.Chen,D, “Fundamentals of Digital Manufacturing Science”, Springer Publications, 2012.
2. Ian Gibson, David W Rosen, & Brent Stucker, “Additive Manufacturing Technologies “, Springer Publication, 2014.

REFERENCES:

1. Christoph Haag, TorstenNiechoj, “Digital Manufacturing: Prospects and Challenges”, Metropolis Verlag, 2016.
2. LihuiWang, Andrew YehChing Nee, “Collaborative Design and Planning for Digital Manufacturing”, Springer; 2009 edition.
3. Philip M. Parker, “The 2018-2023 World Outlook for Digital Manufacturing (DM)“ICON Group International, Inc., 2017.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Demonstrate the principles of digital manufacturing process and geometric modelling used for different materials

CO2: Create an algorithmic design for digital manufacturing

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L					M							M	L
CO2	L								M		M		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 digitalization of manufacturing process provides solutions to key industrial problems.

MEDX 71	GEOMETRIC DIMENSIONING AND TOLERANCING	L	T	P	C
SDG: 9		1	0	0	1

COURSE OBJECTIVES:

COB1: To study the basic principles of geometric dimensioning and tolerancing

COB2: To acquire knowledge on geometric characteristics

MODULE I BASICS OF GEOMETRIC DIMENSIONING AND TOLERANCING L:7

Principles of dimensional and form measurements - Standards - Measurement errors - Uncertainty in measurements - Examples of linear and angular measurements –Definitions and importance of dimensioning and tolerancing – Datum reference frame – Feature control frame - Maximum material condition (MMC) - Least material condition (LMC) – General Rules – Datum System.

MODULE II PRINCIPLES OF MEASUREMENT FOR GEOMETRIC CHARACTERISTICS L:8

Geometric characteristic symbols and meanings – Profile of a surface –- Profile of a Line – Form tolerances- Location tolerances – Run out tolerances – Orientation tolerances –True position theory – Dimensional and tolerance schemes – Case studies.

L – 15; TOTAL HOURS – 15

TEXT BOOKS

1. Krulikowski. A, “Fundamentals of Geomtric Dimensioning and Tolerancing”, Delmar Cengage Learning, International edition, 2012.

REFERENCES:

1. Oliver R Wade, “Tolerance Control in Design and Manufacturing”, Industrial Press Inc., New York, 2008.
2. Geometric Dimensioning and Tolerancing: Applications and Techniques for use in Design, Manufacturing and Inspection, James D. Meadows CRC Press, First edition, 1995.
3. Rao Ming, Harry Peck, “Designing for Manufacture”, Pitman Publications, London, 1983.
4. Spotts. M.F, “Dimensioning and Tolerance for Quality Production”, Prentice Hall Inc., New Jersey, 1983.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basic principles for geometric dimensioning and tolerancing

CO2: Apply different types of tolerances for a given component

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

The understanding of the principles of measurement of geometric characteristics leads to manufacture of parts with close dimensional tolerances.

MEDX 72	TOOL AND DIE DESIGN	L	T	P	C
SDG: 9		**1**	**0**	**0**	**1**

COURSE OBJECTIVES:

COB1: To gain the knowledge on the design of various cutting tools

COB2: To study the design of various dies

MODULE I DESIGN OF CUTTING TOOLS L:7

Introduction to tool design – Requirements of a tool designer - General tool design procedure – Single Point Cutting Tools: Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, and planers – Chip breakers and their design – Multipoint Cutting Tools: Classification and specification, nomenclature – Design of drills, milling cutters, broaches, and taps – Design of form tools: Flat and circular form tools.

MODULE II DESIGN OF DIES L:8

Types of Dies: Single cavity, multi-cavity dies, combination dies, unit dies – Advantages and disadvantages – Wire drawing, Extrusion, Forging and Rolling – Design of dies for sheet metal – Blanking and piercing, Bending and Deep-drawing – Die casting alloys – Finishing – Trimming - Powder metallurgy die design.

L – 15; TOTAL HOURS – 15

TEXT BOOKS

1. Donaldson, C., "Tool Design", Tata Mc-Graw Hill, 2006.

REFERENCES:

1. Grant, H.E., "Jigs and Fixtures, Tata Mc-Graw Hill, 2006
2. Joshi, P.H., "Jigs and Fixtures, Tata Mc-Graw Hill, 2003.
3. Kempster, M.H.A., "Principles of Jig and Tool Design", English University Press Ltd., 1968.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Design various cutting tools

CO2: Design various dies

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th AC held on 29 .09.2022

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

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

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

The understanding of tool and die design leads to the innovative production of various tools and dies.

MATERIALS STREAM

MEDX 76	**AEROSPACE MATERIALS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To familiarize with the selection of aerospace materials.

COB2: To learn about aluminum and its alloys.

COB3: To study about titanium and its alloys.

COB4: To gain knowledge on high temperature materials.

COB5: To acquire knowledge about applications of polymers and composites.

MODULE I SELECTION OF MATERIALS L:9

Introduction – Classification of aircraft materials: Ferrous materials, Nonferrous materials and alloys, Ceramic materials, Composites of polymer, metal and ceramic.

MODULE II ALUMINIUM AND ITS ALLOYS L:9

Introduction – Aluminium alloys – Alloy designation and tempering - Al-Cu alloys - Al-Li alloys - Al-Mg alloys - Nano crystalline aluminium alloys - Properties and its applications- Principles of age hardening.

MODULE III TITANIUM AND ITS ALLOYS L:9

Introduction – Titanium alloys – Alloy designation and tempering - α-β titanium alloys - Structural titanium alloys – Super plasticity – Intermetallics - Properties and its applications.

MODULE IV HIGH TEMPERATURE MATERIALS L:9

Introduction – Classification – Production processes– Nickel alloys - Tantalum alloys - Tungsten alloys - Zirconium alloys - Niobium alloys - Properties and its applications.

MODULE V POLYMERS AND COMPOSITES L:9

Introduction – Polymers – Classification of engineering and high-performance polymers : Polyetheretherketone (PEEK), Polytetrafluoroethylene (PTFE), Polyamide(PA), Polyimides (*PI*) - Composites: Fibre-reinforced composites (Natural and Synthetic), Bio-Composites.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Adrian P. Mouritz, "Introduction to aerospace materials" Woodhead Publishing Limited, 1st Edition, 2012.
2. K. K. Chawla, Composite Materials, Springer, USA, 2nd edition, 2010.
3. V. C. H. Cahn, Material Science and Technology, Wiley WCH, West Germany, 3rd edition, 2007.

REFERENCES:

1. Polmear, I. J., Light Alloys: From Traditional Alloys to Nanocrystals, 4th ed., Elsevier, 2005.
2. Titterton.G., “Aircraft Materials and Processes”, V Edition, Pitman Publishing Co., 2010.
3. Reed, R. C., The Superalloys: Fundamentals and Applications, Cambridge Univ. Press, 3rd Edition, 2006.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basic concepts of different types of aerospace materials and their uses.

CO2: Elaborate the classification, structure, properties and applications of various aluminium alloys.

CO3: Elucidate about titanium materials.

CO4: Describe the classification, structure, properties and applications of various high temperature alloys.

CO5: Illustrate the properties and uses of various polymer composite materials.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 various aerospace materials leads to development of robust engineering systems.

MEDX 77	**THIN FILMS, COATINGS AND APPLICATIONS**	**L T P C**
SDG: 9		**3 0 0 3**

COURSE OBJECTIVES:

COB1: To gain knowledge on various surface coating techniques.

COB2: To learn about the preparation of thin films.

COB3: To familiarize the characterization techniques of thin films.

COB4: To acquire knowledge on properties of thin films.

COB5: To study the various applications of thin films.

MODULE I BASICS OF THIN FILMS AND COATINGS L:9

Introduction - Classification of coating techniques – Thin films – Thick film - Methods and working principles: Galvanizing, Electrochemical coatings, Electro-depositions, Electroless depositions, Vapour deposition, Conversion Coatings, Thermal Spraying, Plasma electrolytic oxidation.

MODULE II FABRICATION OF THIN FILMS AND COATINGS L:12

Gas phase fabrication methods: Magnetron sputtering, Pulsed laser deposition, Atomic layer deposition and Vapour deposition - Liquid phase fabrication methods: Electrospray deposition, Electrochemical deposition and Sol-gel method – Process parameters of Coating Techniques: Anodizing, Galvanizing, Electrochemical Coatings, Conversion Coatings, Thermal Spraying and Powder Coating.

MODULE III CHARACTERIZATION TECHNIQUES L:9

Scanning Electron Microscopes (SEM) - Transmission Electron Microscopes (TEM) -Auger Electron spectroscope- X-ray spectrometers- Electron Microprobe -Electron spectrometers- Atomic Force Microscope (AFM)-Nano indentation.

MODULE IV PROPERTIES OF THIN FILMS AND COATINGS L:8

Thin films: Microstructure and morphology, Mechanical properties, Chemical properties, Electrical properties, Optical properties, Electronic properties and Magnetic properties – Coatings: Mechanical properties, Chemical properties, Wear and corrosion properties, Microstructure and morphology and Surface roughness.

MODULE V APPLICATIONS OF THIN FLIMS AND COATINGS L:7

Applications of thin film- Reflection and anti-reflection coatings - Interference filters - Thin film solar cells – Electrophotography - Thin film resistors- Strain gauges and Gas sensors- Super conducting thin films – Architectural and constructional applications.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Goswami, Thin Film Fundamentals, New Age international (P) Ltd. Publishers, New Delhi, 2006.
2. Sarfraj Ahmed, Vinayak S. Dakre, Tribology and Characterization of Surface Coatings, John Wiley & Sons, Singapore Pte. Ltd, 2022.

REFERENCES:

1. Inamuddin, RajenderBoddula, Mohd Imran Ahamed and Abdullah M. Asiri, Polymer Coatings Technology and Applications, John Wiley & Sons, Inc., 2020.
2. Shizhu Wen, Ping Huang, Principles of Tribology, John Wiley & Sons Singapore Pte. Ltd, 2018.
3. Donald L Smith, Thin-Film Deposition: Principles and Practice, McGraw-Hill Professional Pub, 2005.
4.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the various surface coating techniques.

CO2: Describe the preparation of thin films.

CO3: Illustrate the characterization techniques of thin Films.

CO4: Elucidate the properties of thin films.

CO5: Identify the suitable thin film coating process for different applications.

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th AC held on 29 .09.2022

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

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 thin film coating processes and its fabrication techniques helps to solve challenges in real time engineering materials processing.

MEDX 78	**ADVANCED ENGINEERING MATERIALS**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To acquire knowledge about ceramic and carbon materials

COB2: To study about composite building materials

COB3: To gain knowledge about the nuclear materials.

COB4: To familiarize with hydrogen storage materials

COB5: To gain knowledge about different functional materials

MODULE I CERAMIC AND CARBON MATERIALS L:9

Introduction - Crystal chemistry - Structure and bonding in materials-Ceramic powder production: Chemical and physical means-Powder consolidation- Ceramic processing: Cold and hot Isostatic pressing, Sintering- Nano carbon materials - Carbon fiber- Precursors and production, properties-Carbon-carbon composites: Production, Properties and applications.

MODULE II COMPOSITE BUILDING MATERIALS L:8

Introduction - Components of cement based matrices: Preparation, Properties - Polymer impregnated concrete (PIC) -Polymer Cement Concrete (PCC)- Cement based smoothing and concrete repair-Macro defect free cements- Reinforcement of cement based composites

MODULE III NUCLEAR MATERIALS L:10

Introduction-Structure of nucleus- Radioactivity - Binding energy - Nuclear interaction -Radiation effects on fissile and non-fissile materials - Radiation damage and radiation growth - Types of reactors and classification - Materials for nuclear reactors: Selection of common materials used as fuels- Canning materials - Coolants - Control rods - Reflectors and shielding materials-Physical and Chemical properties.

MODULE IV HYDROGEN STORAGE MATERIALS L:10

Introduction - Fabrication of CNT and CNF- Fuel cell materials - Hydrogen storage methods - Metal hydrides - Hydrogen storage capacity - Hydrogen reaction kinetics

MODULE V FUNCTIONAL MATERIALS L:8

Introduction-Dielectric, Ferroelectric, Super conductors and Magnetic materials - Smart materials- Piezoelectric, Pyroelectric and Electro-Optic materials - Shape memory alloys: Ni-Ti, Cu-Zn-Al-Ferromagnetic Shape Memory Alloy- MEMS materials.

L – 45; TOTAL HOURS – 45

TEXT BOOKS

1. D. Askeland, P. Fulay, W. J. Wright and K. Balani, “The Science and Engineering of Materials”, Sixth Edition, Cengage, 2012.
2. YuryGogotsi, Volker Presser, “Carbon Nanomaterials”, 2nd edition, CRC Press, 2013.

REFERENCES:

1. Shigeyuki Somiya “Handbook of Advanced Ceramics, Materials, Processing and Their Applications”, II Edition, Elsevier Academic press,2013.
2. Richerson D. W., “Modern Ceramic Engineering - Properties Processing and Use in Design”, 3rd Edition, CRC Press, 2006
3. XianguoLi “Principles of Fuel Cells” Taylor and Francis, 2005.
4. K. VijayamohananPillai and MeeraParthasarathi,“Functional Materials: A Chemist’s Perspective”, Orient Blackswan publisher, 2013

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the ceramic and carbon materials

CO2: Explain about composite building materials

CO3: Elucidate about the nuclear materials

CO4:Illustrate about hydrogen storage materials

CO5: Discuss about different functional materials

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

Understanding of advanced engineering materials is used for developing various components to meet the societal needs.

MEDX 79	**FRACTURE OF ENGINEERING MATERIALS**	**L T P C**
SDG: 9		**3 0 0 3**

COURSE OBJECTIVES:

COB1: To learn about mechanical testing methods

COB2: To gain knowledge about yield and plasticity of engineering materials

COB3: To acquire knowledge about different fracture and its mechanisms

COB4: To familiarize with various fracture mechanics concepts

COB5: Tobe conversant with analysis of different engineering failures.

MODULE I MECHANICAL TESTING L:9

Definitions of Stress and Strain – Stress - Strain curves for uniaxial loading – Analysis: Tensile test curves, Young's Modulus, Compression test curves, Failure by elastic buckling, Resilience and Strain Energy Density - Non-axial Testing - Multiaxial loading - Elastic anisotropy- Stiffness and Compliance matrices- Thermal stresses and thermal shock induced failure - Composite materials: Iso-stress analysis, Iso-strain analysis, Strength of composites.

MODULE II YIELD AND PLASTICITY L:9

Dislocations in metals and ceramics – Slip - Yield criteria for metals and ceramics - Post-yield plastic Deformation - Slip in single crystals and textured Materials - Deformation twinning - Plasticity in polymers.

MODULE III FRACTURE L:9

Introduction - Theoretical cohesive Strength - Defect population in solids – Stress Concentration factor - Notch strengthening - External variables affecting fracture - Characterizing the fracture process: Fractures of metals, Macroscopic fracture mechanisms, Fractures of polymers, Fractures of glasses and ceramics, Fractures of engineering composites - Microscopic fracture mechanisms

MODULE IV FRACTURE MECHANICS L:10

Griffith crack theory - Charpy impact fracture testing - Polymer fracture test methods - Limitations of the transition temperature philosophy - Stress analysis of cracks -Relation between energy rate and stress field approaches - Crack-tip plastic-zone size estimation - Fracture-mode transition: Plane stress versus plane strain, Plane-strain fracture - Toughness testing of metals and ceramics - Fracture toughness of engineering alloys - Plane-stress fracture-Toughness testing - Toughness determination from crack-opening displacement measurement.

MODULE V ANALYSIS OF ENGINEERING FAILURES L:8

Typical defects - Macroscopic fracture surface examination - Metallographic and fractographic examination: Fracture surface preservation, Fracture surface cleaning, Replica preparation and image interpretation, Component failure analysis data - Case studies: Shotgun barrel failures, Stress corrosion cracking failure of the point pleasant bridge, Failure analysis of 175-mm gun tube, Hydrotest failure of a 660-cm-diameter rocket motor casing, Premature fracture of powder-pressing die, Laboratory analysis of a lavatory failure.

L - 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Richard W. Hertzberg, Richard P. Vinci, Jason L. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, Fifth Edition, John Wiley & Sons, Inc, 2012.
2. G E Dieter, Mechanical Metallurgy, McGraw - Hill Publication, Third edition, 2017.

REFERENCES:

1. Anderson T.L., Fracture Mechanics Fundamentals and Applications, CRC Press, Second edition, 1994.
2. Kumar Prashant, Elements of Fracture Mechanics, Wheelers Publishing Co. Ltd India, Second edition, 2010.
3. Sanford R.J., Principles of Fracture Mechanics, Printice Hall, Printice Hall USA, 2003.
4. Gdoutos E.E., Rodopoulos C.A. and Yates J.R., Problems in Fracture Mechanics A Solution Guide, Kluwer Academic Publishers The Netherlands, 2003.
5. Lawn, B. R. Fracture of Brittle Solids. Cambridge University Press, 1993.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the different mechanical testing methods

CO2: Describe the yield and plasticity of engineering materials

CO3: Illustrate different fracture and its mechanisms

CO4: Elucidate the various fracture mechanics concepts

CO5: Analyze the different engineering failures

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

Understanding of different testing and failure modes helps to prevent the damages occurred in components which leads to build resilient Infrastructure.

MEDX 80	**DESIGN AND APPLICATIONS OF BIOMATERIALS**	**L T P C**
SDG: 9		**3 0 0 3**

COURSE OBJECTIVES:

COB1: To learn about the basics of biomaterials

COB2: To gain knowledge about various metallic biomaterials and its applications

COB3: To familiarize with the various ceramic biomaterials and its applications.

COB4: To acquire knowledge on polymeric biomaterials and its applications.

COB5: To study the composite biomaterials and its applications.

MODULE I BASICS OF BIOMATERIALS L:9

Introduction - Definition of biomaterials - Classification of biomaterials : Structure, Physical and Mechanical properties - Chemical bonding - Crystalline and Amorphous: Melting, Solidification, Nucleation.

MODULE II METALLIC BIOMATERIALS L:9

Introduction - Definition of materials - Classification of biomaterials: Stainless Steels, CoCrAlloys,Ti Alloys, TiNi Alloys, Dental Metals – Bio-corrosion of metallic implants – Applications.

MODULE III CERAMIC BIOMATERIALS L:9

Introduction – Bio- inert Ceramics – Biodegradable Ceramics - Bioactive Ceramics - Deterioration of Ceramics - Bio-ceramic manufacturing processes - Applications.

MODULE IV POLYMERIC BIOMATERIALS L:9

Introduction – Basic Structure and Polymerization – Polymers used as Biomaterials –Sterilization – Surface Modifications for Improving Bio-compatibility - Chemo gradient Surfaces for Cell and Protein Interaction - Applications.

MODULE V COMPOSITE BIO MATERIALS L:9

Introduction – Structure and properties – Anisotropy of composites – Particulate Composites – Fibrous Composites – Porous Materials – Biocompatibility - Applications.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Ratner, Hoffman, Schoen, Lemons, “Biomaterials Science”, Academic Press, Massachusetts, 1st Edition, 2012.
2. Joyce Y. Wong, Joseph. D.Bronzino, “Biomaterials”, Taylor & Francis Group, 3rd Edition, 2006.
3. J.B. Park and J.D. Bronzino, “Biomaterials: Principles and Applications”, 1st Edition, CRC Press, 2002.

REFERENCES:

1. Wong, “Biomaterials”, 10th Edition, Routledge Taylor and Francis group, 2012.
2. Buddy RatnerAllan Hoffman Frederick Schoen Jack Lemons, “Biomaterials Science”, 3rd Edition, Academic Press, 2012.
3. Steven M. Kurtz, “Peek Biomaterials Handbook”, Elsevier, Atlanta, 1st Edition, 2011.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of biomaterials.

CO2: Elucidate various metallic biomaterials and their applications

CO3: Illustrate the uses of various ceramic bio-materials.

CO4: Describe the polymeric biomaterials and their uses.

CO5: Explain about various composite biomaterials and their applications.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 various biomaterials helps to develop artificial body parts for the improvement of human life index.

MEDX 81	**POWDER METALLURGY**	**L**	**T**	**P**	**C**
SDG:9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To gain knowledge about the basics of powder metallurgy

COB2: To learn about powder conditioning and compaction

COB3: To familiarize sintering process and its various stages.

COB4: To study about various secondary operations used in Powder Metallurgy

COB5: To acquire knowledge on various materials for Powder Metallurgy

MODULE I BASICS OF POWDER METALLURGY L:9

Introduction– Characteristics and testing of metal powders-Chemical composition and purity-Particle size and its distribution-Apparent density-Tap density- Flow rate –General process parameters in powder metallurgy – Applications.

MODULE II POWDER CONDITIONING AND COMPACTION L:9

Synthesis of metal powder: Sol-gel method, Atomization, High energy planetary ball milling method– Blending/mixing process –Compaction - Presses – Tool construction - Various powder compaction Techniques: Cold isostatic pressing, Hot isostatic pressing, Uniaxial pressing and Biaxial pressing technique.

MODULE III SINTERING L:9

Sintering process – Sintering furnace - Classification – Sintering atmosphere - Stages of sintering – Mechanisms of sintering – Types of sintering.

MODULE IV SECONDARY OPERATIONS L:9

Heat treatment of sintered parts – Surface treatments – Impregnation treatments – Electroplating – Machining of sintered compacts.

MODULE V MATERIALS FOR POWDER METALLURGY L:9

Bearing materials - Copper-lead bearings, Oil Impregnated Porous bearings-Dry Lubricated bearings-Polytetrafluoroethylene (PTFE) bearing- Sintered Friction Materials-Dry Clutch-Dry Brake-Aircraft Brakes-Oil clutches and brakes-.Cemented Carbides – Ferrites – Cermets - Electrical contact materials - Compositions-Properties-Applications.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Sydney H Avner, “Introduction to Physical Metallurgy”, Tata McGraw Hill Edition, 10th Edition, 2017.
2. Randall M. German., “Sintering Theory and Practice”, Wiley-VCH Publications, 4th Edition, 1996.
3. KatsuyoshiKondoh, “Powder Metallurgy”, Published by InTech, 1st Edition, 2012.

REFERENCES:

1. A.K.Sinha, “Powder Metallurgy”, 4th Edition, Dhanpoat rai publications, 2013.
2. Ohio, “ASM Metal hand book”, ASM Metal park, USA, Vol. 7, 2015.
3. Randall M. German,Gary L. Messing, Robert G. Cornwall., “Sintering Technology”, Taylor & Francs Group Publishing, 1st Edition, 2020.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:explain the basic concepts of Powder Metallurgy

CO2:describe the concepts of powder conditioning and compaction

CO3: elucidate the sintering process and its various stages.

CO4:identify various secondary operations for powder metallurgy

CO5:select the suitable materialsfor powder metallurgy applications

Board of Studies (BoS):

19th BOS held on 21.12.2021

Academic Council:

18th AC held on 24.02.2022

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

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

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

Holistic understanding of powder metallurgy concepts enhances the industries to develop superior products.

		L	T	P	C
MEDX 82	**FRICTION MATERIALS: FORMULATION AND CHARACTERIZATION**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the fundamentals of friction and wear

COB2: To gain knowledge on various types of friction materials used for different applications

COB3: To familiarize with the production process of friction materials

COB4: To be conversant with various characterizations of friction materials.

COB5: To acquire knowledge on various brake systems

MODULE I INTRODUCTION TO FRICTION AND WEAR L:7

Introduction – Laws of friction - Types of friction – Wear - Types of wear - mechanism involved in wear of friction material.

MODULE II TYPES OF FRICTION MATERIALS AND APPLICATIONS L:9

Friction Materials -Definition and nature overview of types - Organic Friction Materials – Semi-metallic friction materials - Ceramic Friction Materials - Sintered Friction Materials – Frictionless Magneto Rheological (MR) Fluid Brakes - Applications of friction materials in different sectors.

MODULE III PRODUCTION OF FRICTION MATERIALS L:9

Raw Materials - Classification of raw materials - Properties of raw materials – Materials performing multi tasks - Sample formulations – Manufacturing of brake pad – Mixing – Preforming – Backplate treatment – curing and post curing – Scorching - Secondary operations.

MODULE IV CHARACTERIZATION OF FRICTION MATERIALS L:12

Types of Characterizations: Physical, Chemical, Mechanical, Thermal, Tribological and Micro structural characterization as per industrial standards – NVH issues -Environmental concerns –Non exhaust emissions – $PM_{2.5}$, PM_{10} - Measurement of particulate matter – Emission reduction methods - Case studies.

MODULE V BRAKE SYSTEM L:8

Basic requirements and functions of braking system - Types of brake system: Hydraulic brake system, compressed air brake system, parking brakes, dual power brake system, regenerative brake system, electronic brake for distribution, anti-skid braking system - Brake efficiency and testing - Weight transfer - Braking ratio – Brake shims.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Sundarkrishna K.L, Friction Material Composites, Materials Perspective, Springer-Verlag Berlin Heidelberg, 2012, First edition.
2. Geoffrey Nicholson, Facts about Friction: A Friction Material Manual Almost All You Need to Know about Manufacturing, Croydon, Pa. P & W Price Enterprises, Inc, 1995.

REFERENCES:

1. Automotive Brake Systems, Robert Bosh GmbH, 1995, First edition, USA.
2. Peter J. Blau, Friction Science and Technology- From Concepts to Applications, Second Edition, 2009, CRC Press, USA.
3. ASM Handbook, Friction, Lubrication, and Wear Technology, Volume 18, 1992, USA.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the concepts of friction and wear.

CO2: Select suitable friction materials for different applications.

CO3: Describe the production process of friction materials.

CO4: Illustrate the various characterizations of friction materials.

CO5: Elucidate the working principles of different braking systems.

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th AC held on 29 .09.2022

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

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

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

The innovation in newer materials and process will help in the development of friction materials with minimum NVH issues and controlled wear emissions.

MEDX 83	**RUBBER RECYCLING AND WASTE MANAGEMENT**	**L**	**T**	**P**	**C**
SDG: 09		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To gain knowledge on the methods of rubber recovery and grinding it for further use.

COB2: To acquire knowledge on devulcanization techniques to recover rubbers

COB3: To be conversant with the characterisation techniques for the devulcanized rubbers

COB4: To familiarize with the tire recycling methods

COB5: To learn about the applications of crumb rubber

MODULE I RUBBER RECOVERY AND GRINDING L:9

Sources of Waste Rubbers – Waste Rubber Grinding Routes – Different Grinding Conditions: Ambient Grinding, Cryogenic Grinding, Solution Grinding, Grinding by Ozone Cracking, Elastic Deformation Grinding

MODULE II DEVULCANIZATION TECHNIQUES L:9

Generic categories of devulcanization technology - Structure of Sulfur Vulcanized Rubber and the Properties of Sulfur Crosslinks - Devulcanization Processes: Thermal, Mechanical, Mechanochemical, Ultrasonic, Microwave, Microbiological and Miscellaneous Devulcanization Processes.

MODULE III DEVULCANISED RUBBER CHARACTERISATION TECHNIQUES L:9

Characterization of devulcanized rubber: Chemical analysis tests, tests to assess the quality, processability, physical properties of vulcanizates of devulcanized rubber – Surface treatment of rubber waste.

MODULE IV RECYCLING OF TIRE RUBBERS L:9

Life cycle and reusability of tire rubbers - Tire composition - Tire parts and end-of-life tires –Reason to recycle tire rubbers - Recycling of waste/used tire rubbers - Reusability and application of tire rubbers - Advantages of reclaimed/de-vulcanized rubber - Disadvantages of reclaimed/de-vulcanized rubber.

MODULE V APPLICATIONS OF RUBBER CRUMB L:9

Filler for plastics and rubber compounds: Construction products, Bitumen and Asphalt Products, Gypsum and Screed Products, Roofing Products, Sound and Vibration Insulation Products, Sports and other Recreational Surfaces.

L –45; TOTAL HOURS – 45

TEXT BOOKS:

1. Martin Forrest, "Recycling and Re-use of Waste Rubber", Smithers Information Ltd., 2014.
2. Carlson, Melody, Kim, Jin Kuk "Rubber Recycling Challenges and Developments", Royal Society of Chemistry, 2019.

REFERENCES:

1. Sadhan K. De, AvraamIsayev, KlementinaKhait, "Rubber recycling", Taylor & Francis, CRC Press, 2005.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the methods of rubber recovery and grinding it for further use.

CO2: Explain the devulcanization techniques to recover rubbers

CO3: Illustrate the characterisation techniques for the devulcanized rubbers

CO4: Elucidate the tire recycling methods

CO5: Identify the applications of crumb rubber

Board of Studies (BoS): 20th BOS held on 08.08.2022

Academic Council: 19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L		H			L	L					L	L	M
CO2	L		H			L	L					L	L	
CO3	L		H			L	L					L	L	M
CO4	L		H			L	L					L	L	
CO5	L		H			L	L					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 rubber recycling and waste management helps to achieve the global goals as waste management is a powerful driver of sustainable development.

MEDX 84	**POLYMER RHEOLOGY**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To gain knowledge on the viscoelastic behaviour of polymeric materials

COB2: To familiarize with various models depicting viscoelastic behaviour

COB3: To be conversant with the parameters influencing the viscosity of polymers

COB4: To familiarize with the flow properties of polymer melt

COB5: To acquire knowledge on measurement of rheological properties and its application to processing.

MODULE I VISCOELASTIC BEHAVIOUR OF POLYMERIC MATERIALS L:9

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

MODULE II VARIOUS MODELS DEPICTING VISCOELASTIC BEHAVIOUR L:9

Mechanical models – Stress strain response of spring and dashpot – Viscoelastic models – Maxwell element – Voight kelvin element – Response to creep and stress relaxation – Four-parameter model – Dynamic mechanical properties – Behavior of Maxwell element and relaxation spectra.

MODULE III PARAMETERS INFLUENCING POLYMER VISCOSITY L:9

Effect of pressure on viscosity - Effect of temperature - Activation energy- Effect of molecular weight and molecular weight distribution on viscosity - Molecular at dependence of zero shear viscosity - Effect of crosslinking - Crystallinity branching – Copolymerization - Effect of: fillers, fiber filled polymer melts, plasticizers - Shear rate dependence of viscosity.

MODULE IV FLOW PROPERTIES OF POLYMER MELT L:9

Fluid flow – Types of fluid flow – Time dependent fluids - Shear rate dependent fluids - Newtonian and Non-Newtonian fluids – Laminar flow of Newtonian fluids - Viscosity of polymer melts – Shear thinning and shear thickening – Zero-shear rate viscosity – Laminar flow of Newtonian fluids-Power law – General treatment of isothermal viscous flow in tubes – Entrance and exit effects - Elastic effects in polymer melt flow - Die-swell and melt fracture – Weissenberg effect – Normal stress difference – Elongational viscosity.

MODULE V MEASUREMENT OF RHEOLOGICAL PROPERTIES AND ITS APPLICATIONS TO PROCESSING L:9

Measurements of rheological properties – Capillary rheometers – Melt flow index – Cone and plate viscometer– Torque rheometers – Mooney viscometer – cure meters– Optical methods – Birefringence - Applications of rheology to polymer processing (injection moulding, extrusion and blow moulding).

L –45; TOTAL HOURS – 45

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the viscoelastic properties of polymer materials

CO2: Describe the models depicting viscoelastic behavior of polymer materials

CO3: Elucidate the parameters influencing the polymer viscosity

CO4: Analyze the flow properties of polymer melts

CO5: Illustrate the function of various rheological instruments

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 polymer rheology helps process industries to optimize the process parameters to get defect free products.

MEDX 85	**RUBBER TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn the fundamentals of elastomers

COB2: To gain knowledge on various compounding and mixing process

COB3: To be conversant with the general-purpose elastomers

COB4: To familiarize with the special purpose rubbers

COB5: To acquire knowledge on the thermoplastic elastomers

MODULE I FUNDAMENTALS OF ELASTOMERS L:6

Rubber elasticity – Thermodynamics of rubber – Classification of rubbers – Effect of structure on: Tg, chemical structure on the performance properties of rubbers, processing properties of elastomers.

MODULE II COMPOUNDING AND MIXING L:9

Principles of rubber compounding – Compounding ingredients and their classifications: carbon blacks, non-black fillers, 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 L:9

Natural rubber: Tapping latex, conversion to dry rubber, properties, grading and specifications, chemical modification – SBR: Preparation, types, properties and applications– BR: Polymerization, properties and applications – IR: Manufacture, properties and applications – poly alkenamers, and polynorbornenes.

MODULE IV SPECIAL PURPOSE RUBBERS L:12

Manufacture, properties and application: Butyl rubbers – EPRs– Nitrile rubbers and blends – Polychloroprene – ACM– EVA – CSM– CM– Silicone elastomers– Fluorocarbon rubbers – Polyurethane rubbers – Epichlorohydrin rubbers – Polysulphide rubbers.

MODULE V THERMOPLASTIC ELASTOMERS L:9

Definition – Categories of TPEs- Methods of preparation –Styrenic block copolymers – Thermoplastic elastomeric olefins- Thermoplastic vulcanizates – Thermoplastic polyurethanes - Copolyesters - Polyamides.

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 HanserVerlag 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, Burak Erman, 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: Describe various rubber compounding and mixing process

CO3: Select suitable elastomers for commodity applications

CO4: Illustrate about the special purpose rubbers

CO5: Elucidate thermoplastic elastomers

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											L	M	L
CO2	M	H										L	M	M
CO3	L		M									L	M	L
CO4	L		L									L	M	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 understanding of rubber and its processing techniques help the industry sector move towards sustainable development, “from evolution to revolution”.

MEDX 86	**CHARACTERIZATION OF MATERIALS**	**L T P C**
SDG: 9		**3 0 0 3**

COURSE OBJECTIVES:

COB1: To gain knowledge about various mechanical testing methods

COB2: To learn about micro and crystal structure analysis of materials

COB3: To study the various microscopic techniques used for image analysis

COB4: To acquire knowledge about various chemical analysis techniques

COB5: To familiarize with different types of thermal analysis techniques used for the materials

MODULE I MECHANICAL TESTING L:9

Hardness: Brinell, Rockwell and Vickers Tests -Tensile Test – Stress - Strain curve - Proof Stress – Compression test - Torsion Test - Impact Test: Charpy and Izod - Drop Weight Tear Test (DWTT) - Fracture Toughness Test - Standards for testing metallic and composite materials.

MODULE II MICRO AND CRYSTAL STRUCTURE ANALYSIS L:9

Principles of Optical Microscopy - Specimen Preparation Techniques - Polishing and Etching - Polarization Techniques - Quantitative Metallography - Estimation of grain size - ASTM grain size numbers - Microstructure of Engineering Materials - Elements of Crystallography - X-ray Diffraction - Bragg‘s law -Techniques of X-ray Crystallography - Debye - Scherer formula - Geiger Diffractometer - Analysis of Diffraction patterns - Inter planer spacing - Identification of Crystal Structure - Elements of Electron Diffraction.

MODULE III ELECTRON MICROSCOPIC TECHNIQUES L:9

Interaction of Electron Beam with Materials - Scanning Electron Microscope (SEM): Construction and working, Various Imaging Techniques, Applications - Transmission Electron Microscope (TEM): Specimen Preparation, Imaging Techniques: BF, DF, and SAD - Electron Probe Micro Analysis - Energy Dispersive X-ray micro analysis (EDX): Construction and working, Applications - Atomic Force Microscope(AFM): Construction and working, Applications.

MODULE IV CHEMICAL ANALYSIS TECHNIQUES L:9

X-Ray Spectroscopy: Wavelength Dispersive Spectroscopy - Energy Dispersive Spectroscopy: Basic Principles, Applications - Electron Spectroscopy -Auger Electron Spectroscopy: Basic Principle, Instrumentation and Applications - Secondary Ion Mass Spectroscopy: Basic Principle, Instrumentation and Applications - Fourier Transform Infra-Red Spectroscopy (FTIR):Working Principle and Applications

MODULE V THERMAL ANALYSIS TECHNIQUES L:9

Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC): Working principle, Experimental Aspects, Measurement of Temperature and Enthalpy Change and Applications - Thermo Gravimetric Analysis (TGA): Instrumentations, Experimental Aspects - Interpretation of Thermogravimetric Curves and Applications - Dynamic Mechanical Analysis (DMA).

L –45; TOTAL HOURS – 45

TEXT BOOKS:

1. Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Wiley and Sons, 2008.
2. Elton N. Kaufmann, Characterization of Materials, Volumes 1& 2, Wiley and Sons, 2003.

REFERENCE BOOKS:

1. Culity B.D and Stock S.R., Elements of X ray Diffraction, (3rd Edition).Pearson New international Edition, 2014.
2. ASM Handbook: Materials Characterization, ASM International, 2008.
3. KyriakosKomvopoulos, Mechanical Testing of Engineering Materials (2nd Edition), Cognella Academic Publishing, 2017.
4. Suryanarayana A. V. K., Testing of metallic materials, (2nd Edition), BS publications, 2007.
5. Joseph I Goldstein, Dale E. Newbury, Patrick Echlin, David C. Joy, Charles E. Lyman, Eric Lifshin, Linda Sawyer and Joseph R. Michael, Scanning Electron Microscopy and X-Ray Microanalysis (3rd Edition), Plenum Publishing Corp., 2003.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the various mechanical testing methods

CO2: Describe the micro and crystal structure of the materials

CO3: Elucidate various microscopic techniques used for image analysis

CO4: Discuss the chemical analysis techniques used for various materials

CO5: Illustrate various thermal analysis techniques

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

The knowledge on characterization of materials used to identify the structural information of materials to build resilient industrial components.

MEDX 87	**SCIENCE AND TECHNOLOGY OF NANO MATERIALS**	**L**	**T**	**P**	**C**
SDG:9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To study the basics of nano-material and its properties

COB2: To learn about the production techniques of nano-material

COB3: To gain knowledge on the top down techniques for nano materials

COB4: To acquire knowledge on characterization and applications of nanomaterials

MODULE I NANO MATERIAL AND PROPERTIES L:8

Classification of Nano materials– Size effects-Surface to volume ratio-Surface curvature-Strain confinement – Quantum effects - Kinetics in nanostructured materials- Multilayer thin films and super lattice clusters of metals - Semiconductors and nanocomposites- Properties: Mechanical, Thermal, Electrical, Electronics, Optical and acoustic properties.

MODULE II PRODUCTION TECHNIQUES I L:8

Characteristics of Zero, One and Two dimensional nanostructures - Methods of production: Electro deposition-Inert gas condensation-Arc plasma-Laser ablation-Micro emulsion polymerization and Pulsed electrochemical deposition.

MODULE III PRODUCTION TECHNIQUES II L:6

High energy ball milling-Photolithography-Optical lithography-Beam lithography-Scanning probe lithography.

MODULE IV CHARACTERIZATION AND APPLICATIONS L:8

Electron Microscopy - Scanning Probe Microscopy - Atomic Force Microscopy - Scanning Tunnel Microscopy- Nano Indentation - Applications: Mechanical, Electronics, Biological, Environmental, and Polymer based applications.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. W. R. Fahrner, Introduction to Nanotechnology & Nano electronics: Materials, Devices and Measurement Techniques, Springer, 2005.
2. M. D. Ventra, S. Evoy and J. R. Heflin, “Introduction to Nanoscale Science and Technology”, Kluwer Academic Publishers, 2004.

REFERENCES:

1. Pulikel M. Ajayan “Nanocomposite science and technology”, Wiley-VCH, 2015.
2. Michel F.Ashby, Paulo J Ferreira and Daniel L Schodek “Nanomaterials, Nanotechnologies and design” Elsevier, 2009.
3. T.Pradeep “Nano: The essentials”, Tata McGraw Hill Education pvt. Ltd, New Delhi, 2007.
4. Guozong Cao “Nano structures and Nanomaterials” Imperial college press, London, 2006.
5. B. D. Cullity, “Elements of X-ray Diffraction”, 4th Edition, Addison Wiley, 2015.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics nano material and its properties

CO2: Describe the production techniques of nanomaterial

CO3: Elucidate the top down techniques of nano materials

CO4: Illustrate the characterization and applications of nanomaterials

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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

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

The knowledge on nano materials helps to produce various components to meet the societal needs.

MEDX 88	**MATERIALS FOR MODERN DEVICE TECHNOLOGY**	**L T P C**
SDG: 9		**2 0 0 2**

COURSE OBJECTIVES:

COB1: To study about electric and di-electric materials.

COB2: To gain knowledge about the materials used for optical devices

COB3: To be conversant with magnetic materials.

COB4: To familiarize with semiconductor devices and their materials

MODULE I ELECTRIC AND DIELECTRIC MATERIALS L:8

Electrical conduction in metals and alloys: Conductivity, Superconductivity and Thermo electric phenomena – Conducting polymers and metal-organic polygon (MOP) – Dielectric properties –-Dielectric constants and Dielectric loss – Capacitor Dielectric materials – Ferro Electric materials – Piezo electric materials – Pyro electric materials - Electronic polarization – Polarization mechanisms

MODULE II MATERIALS FOR OPTICAL DEVICES L:7

Optical Properties: Refractive Index, Damping constant, Absorbance, Reflectivity and transmittance – Optical wave guide materials – Optical Modulators and switches – Optical storage devices – Liquid crystal displays – Emissive flat panel displays

MODULE III MAGNETIC MATERIALS L:8

Magnetic properties: Magnetization, Flux Density, Magnetic Susceptibility, Magnetic Permeability, and Relative magnetic permeability – Classification of magnetic materials: Di magnetic materials, Paramagnetic materials, Super paramagnetic materials, and Anti Ferro magnetic materials – Hard and Soft Magnetic Materials – Magnetic data storage materials.

MODULE IV SEMICONDUCTOR DEVICES L:7

Fundamental of Semiconductors: P-type and N-type semiconductors, P-N junction – Semiconductor materials: Solar Cells, Light emitting diodes, Transistors, Digital Circuits and memory devices

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. S.O. Kasap, Principles of Electronic Materials and Devices, McGraw Hill Publications, Fourth edition, 2020.

2. S.M,M.K.Lee, Semiconductor Devices Physics and Technology, John Wiley and Sons, Third Edition, 2015.

REFERENCES:

1. P.K.Palanisamy, Engineering Physics-II, Scitech Publishers,Second Edition, 2015.
2. V.Rajendran, Material Science, McGraw Hill Education India, 2017.
3. Rolf E.Hummel, Electronic Properties of Materials, Springer, Third Edition, 2001.
4. PradeepFulay,Electronic, Magnetic and Optical Materials, CRC Press, 2010.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain about electric and di-electric materials

CO2: Elucidate about the materials used for optical devices

CO3: Describe the magnetic materials

CO4: Discuss the various semiconductor devices and their materials

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 electric, di-electric, optical, magnetic and semiconductor materials helps to develop the modern devices

MEDX 89 SDG:9	MATERIALS FOR ENERGY TECHNOLOGIES	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

COB1: To learn the importance of different energy technologies
COB2: To study the materials used in energy generation
COB3: To acquire the knowledge on energy storage materials
COB4: To familiarise about the energy conversion materials

MODULE I TECHNOLOGIES FOR ENERGY SYSTEMS L:9

Energy generation technologies: Wind Energy, Fossil Fuel, Photovoltaics, Biomass, Renewable Energy Source - Energy storage technologies: Batteries, Thermal, Mechanical and Hydrogen storage - Energy Conservation Technologies: Heat Storage Tank (Ice Heat Storage) System, Outside Air Cooling, Large–TemperatureDifference Air Conditioning, Inverter Control, SolarHeating, Geo Thermal Energyand Cogeneration System.

MODULE II MATERIALS FOR ENERGY GENERATION L:7

Traditional materials used for energy generation: Lignite, coal, gas, uranium, water - Renewable Energy from Biomass: Introduction, Resources, Heat and Electricity Generation, Liquid biofuels, and Solid biofuels.

MODULE III MATERIALS FOR ENERGY STORAGE L:7

Basic principles of energy storage – Carbon-based nanomaterial for energy storage - Polymeric nanomaterials for fuel cell application – Low-cost materials for solar cells - Materials used for hydrogen generation – Materials used for super capacitors.

MODULE IV MATERIALS FOR ENERGY CONVERSION L:7

Materials used for photovoltaic and photocatalytic applications – Thermoelectric materials- Dielectric materials- Magnetic Materials- Phase change materials.

L – 30; TOTAL HOURS -30

TEXT BOOKS:

1. Martin Kaltschmitt, Editor, “Energy from Organic Materials (Biomass) A Volume in the Encyclopedia of Sustainability Science and Technology”, Second Edition, Springer, 2019.
2. AlagarsamyPandikumar, PerumalRameshkumar Editor,

"Nanostructured, Functional, and Flexible Materials for Energy Conversion and Storage Systems", Elsevier, 2020.

REFERENCES:

1. Mesfin A. Kebede and Fabian I. Ezema Editors, "Electrode Materials for Energy Storage and Conversion", CRC Press, 2021.
2. M. Shaheer Akhtar, Sadia Ameen and Hyung-Shik Shin Editors, "Emerging Materials for Environment Protection and Renewable Energy", Nova Science Publishers, 2018.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:describe the different energy technologies

CO2:elucidate various materials used in energy generation techniques

CO3:explain the different energy storage materials

CO4:explain the energy conversion materials for various applications

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1							L						M	H
CO2			L										M	L
CO3	M												M	L
CO4			M				M						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 holistic understanding of materials for energy technologies helps in energy conversion and energy storage in different forms for sustainable industrial growth

MEDX 90 SDG: 9	MATERIALS FOR EXTREME ENVIRONMENT	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

COB1: To acquire knowledge on radiation resistant materials

COB2: To gain knowledge about spacecraft materials.

COB3: To familiarize with materials under thermo-mechanical environment.

COB4: To study about the materials under bio-chemical environment.

MODULE I RADIATION RESISTANT MATERIALS L:8

Fundamentals of high temperature deformation - Super plasticity - Structural materials at high temperatures - Radiation-resistant materials - Radiation effects of materials for fusion reactors - Radiation properties of metals and structural Materials - Radiation defects and damage – Properties and applications.

MODULE II SPACECRAFT MATERIALS L:8

Super alloys for high temperature applications - Cryogenic insulation materials - Atomic oxygen resistant materials - Space suit materials and materials for life support systems - Evaluation of materials for space environment and space worthiness - Behaviour of materials in space - Spacecraft materials - Reusable space vehicles - Carbon-Carbon Composites (CCC)– Properties and applications

MODULE III MATERIALS UNDER THERMO-MECHANICAL ENVIRONMENT L:7

Materials under thermo-mechanical extremes: Static and Dynamic behaviour-High pressure phases- Shock to Detonation-Cavitation-Super cooled liquids and glasses-High strain rate deformation - Elastic wave propagation- Shock resistant materials -Armor grade materials – Properties and applications.

MODULE IV MATERIALS UNDER BIO-CHEMICAL ENVIRONMENT L:7

Materials under chemical extremes - Interfaces in fuel cell - Protective coating-Novel synthesis - Nanomaterials in bone substitutes and dentistry – Tissue Engineering - Neuroscience - Neuro-electronic Interfaces - Nano robotics - Protein Engineering – Nano sensors in diagnosis - Drug delivery - Cancer therapy and other therapeutic applications.

L – 30; TOTAL HOURS – 30

TEXT BOOKS

1. RusselHemley, “Material in extreme environment: Physics Today, Vol.62, 2009.

REFERENCES:

1. William G.Fahren Holtz, William E.Lee “Ultra-High Temperature ceramic materials under extreme conditions” Wiley press, 2014.
2. 2. Vincenzo Schettino and Roberto Bini, Materials Under Extreme Conditions, Imperial College Press, 2012.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe about various radiation resistant materials and their properties

CO2: Explain about various spacecraft materials and their properties

CO3: Elucidate about various thermo-mechanical environment materials and their properties

CO4:Illustrate about various bio-chemical environment materials and their properties

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M			H							L	L	M	H
CO2	M			H							L	L	M	H
CO3	M			H							L	L	M	H
CO4	M			H							L	L	M	H

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

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

The knowledge on materials for extreme environment conditions helps to produce various components to meet the societal needs.

MEDX 91 DYNAMIC BEHAVIOR OF MATERIALS

SDG: 9

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

COB1: To gain knowledge about the basics of dynamic behaviour of materials

COB2: To study about mechanical behaviour of materials.

COB3: To familiarize with dynamic deformation of materials

COB 4: To learn about experimental techniques for dynamic deformation and applications of dynamic behaviour of materials.

MODULE I BASICS OF DYNAMIC BEHAVIOR L:8

Introduction- Dynamic deformation and failure – Introduction to waves – Elastic waves - Types of elastic waves – Reflection, refraction and interaction of waves - Plastic waves and shock waves – Plastic waves of uniaxial stress, uniaxial strain and combined stress - Taylor's experiments - Shock waves - Shock wave induced phase transformation - Explosive-material interaction and detonation

MODULE II MECHANICAL BEHAVIOUR OF MATERIALS L:8

Elastic and plastic deformation of metals – Dislocation mechanics – Plastic deformation of metals at high strain rates – Empirical constitutive equations - Relationship between dislocation velocity and applied stress – Physically based constitute equations.

MODULE III DYNAMIC DEFORMATION L:9

Plastic deformation in shock waves: Strengthening due to shock wave propagation, Dislocation generation, Point defect generation and deformation twinning - Strain localization/shear bands: Constitutive models, Metallurgical aspects - Dynamic Fracture: Fundamentals of fracture mechanics, Limiting crack speed, Crack branching and dynamic fracture toughness, Spalling and fragmentation - Dynamic deformation of Polymers, ceramics and composites.

MODULE IV EXPERIMENTAL TECHNIQUES AND APPLICATIONS L:5

Experimental techniques for dynamic deformation: Intermediate strain rate tests - Split Hopkinson pressure bar - Expanding ring test - Gun systems – Applications – Armor, Explosive welding and forming.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Marc A. Meyers, Dynamic Behavior of Materials, John Wiley & Sons, New York, 1994
2. G.E. Dieter, Mechanical Metallurgy, Mc Graw Hill, 1986.

REFERENCES:

1. Shock Wave Compression of Condensed Matter: A Primer (Shock Wave and High Pressure Phenomena), Springer; 12th edition, 2013.
2. Elements of Fracture Mechanics, Prof Prashant Kumar, Tata McGraw Hill Education Private Limited, 2009.
3. Fracture Mechanics: Fundamentals and Applications, T. L. Anderson, Third Edition, CRC Press; 3rd edition, 2005.
4. L.B. Freund, Dynamic Fracture Mechanics, Cambridge, 1990.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of dynamic behaviour of materials

CO2: Elucidate the mechanical behaviour of materials.

CO3: Describe about dynamic deformation of materials

CO4: Discuss the experimental techniques for dynamic deformation and applications of dynamic behaviour of materials.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 mechanical behaviour of materials leads to the construction of robust engineering systems.

MEDX 92	**PHYSICAL METALLURGY**	**L**	**T**	**P**	**C**
SDG:9		**1**	**0**	**0**	**1**

COURSE OBJECTIVES:

COB1: To explore the fundamental concepts of the phase diagram.

COB2 : To learn about the metallurgical thermodynamics of materials.

MODULE I PHASE DIAGRAM L:7

Constitution of alloys – Classification of alloys, Pure metals, Solid solutions – Binary Phase diagram - Physical metallurgy of non-ferrous alloys: Cu-Al, Bronze and Brass - Invariant Reactions – Peritectic, Eutectic - Transformation in solids - Eutectoid, Peritectoid - Ternary Phase diagrams.

MODULE II METALLURGICAL THERMODYNAMICS L:8

Thermodynamics – Definition and Importance - First law of thermodynamics - Phase diagram of a single component system - Internal energy, heat capacity, enthalpy - Second law of thermodynamics, entropy, and entropy changes - Free energy and its significance - Free energy change as a function of temperature - Free energy–composition diagrams for binary alloy systems-Determination of liquidus, solidus and solvus lines - Introduction of metallurgical kinetics -Heterogeneous reaction kinetics: gas-solid, solid-liquid, liquid-liquid and solid-solid systems.

L – 15; TOTAL HOURS – 15

TEXT BOOKS:

1. Avner, Sidney H., "Introduction to Physical Metallurgy", Second Edition, Tata McGraw-hill Education, 2017.
2. David G. Rethwisch, William D. Callister Jr., "Fundamentals of Materials Science and Engineering: An Integrated Approach", Wiley, 4th edition, 2011.

REFERENCES:

1. David R. Gaskell, "Introduction to the Thermodynamics of Materials", CRC Press, 5th edition, 2008.

2. Ghosh, Ahindra, “Textbook of Materials and Metallurgical Thermodynamics”, Prentice Hall India Learning Private Limited, 2002.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:explain the phase diagram of different materials.

CO2: describe the thermodynamics of material systems.

Board of Studies (BoS):
19th BOS held on 21.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M											M	L
CO2	M	M											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 understanding of physical metallurgy of materials helps to utilize the materials for sustainable industry growth and economy

MEDX 93	**CORROSION ENGINEERING**	**L**	**T**	**P**	**C**
SDG: 9		**1**	**0**	**0**	**1**

COURSE OBJECTIVES:

COB1: To learn the fundamentals of corrosion.

COB2: To gain knowledge about corrosion of engineering materials and its prevention techniques

MODULE I FUNDAMENTALS OF CORROSION L:7

Introduction - Definitions of Corrosion - Overall classification of types of corrosion: Galvanic corrosion, crevice corrosion, fitting corrosion erosion corrosion, stress corrosion – Principles and corrosion rate expressions – Polarization techniques to measure corrosion rates.

MODULE II CORROSION OF MATERIALS AND ITS PREVENTION L:8

Corrosion of Cast iron, steel, Al, Mg, Ti and its Metallurgical properties influencing corrosion - Non-metallics: Thermosetters, Laminates and Reinforced plastics, Rubbers, Wood, Ceramics, Carbon and Graphite - Methods of corrosion prevention and control – Principles and classification of Cathodic and Anodic protection.

L – 15; TOTAL HOURS – 15

TEXT BOOKS:

1. Pierre R Roberge, “Corrosion Engineering – Principles and Practice, MCGraw - Hill, 2008.

REFERENCES:

1. M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company (NY), 2017.
2. H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY), 2008.
3. Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice Hall, N. J.,1996.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the fundamentals of corrosion behaviours.

CO2: Describe the corrosion of engineering materials and its prevention.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th AC held on 29 .09.2022

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

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 the mechanism of corrosion and its preventions helps to solve challenges in industrial material handling.

PHYSICS ELECTIVE

PHDX 01	**NON DESTRUCTIVE TESTING OF MATERIALS**	**L**	**T**	**P**	**C**
SDG: 4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To understand the importance, principle, concept and inspection methods of various surface NDT methods and develop the skills of interpretation of results effectively.

COB2: To study the working and instrumentation of thermography and eddy current testing methods and apply to interpret the results and investigate the possible defects.

COB3: To get full exposure about principle, instrumentation and standards of various radiographic NDT methods and improve the skill to identify the defects suitably.

COB4: To get deep insight into the principle, types of waves, instrumentation, standards, calibration methods of ultrasonic NDT methods.

COB5: To understand the importance, principle, concept and inspection methods of various surface NDT methods and develop the skills of interpretation of results effectively.

MODULE I SURFACE NDT METHODS 7

Liquid Penetrant Inspection – Principles, Types of dye and methods of application,developers, advantages and limitations of various methods, Interpretation of results. Magnetic Particle Inspection- Magnetic particle testing, Basic theory of magnetism, Magnetization methods, Interpretation of field indicators, Particle application, Inspection,Residual magnetism Principles and methods of demagnetization.

MODULE II THERMOGRAPHY AND EDDY CURRENT TESTING 7

Thermography- Principles, Contact and non contact inspection methods, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Applications, advantages, Limitations, Interpretation/Evaluation.

MODULE III RADIOGRAPHY 8

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square law, characteristics of films -graininess, density, speed, contrast, characteristic curves. Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Digital Radiography.

MODULE IV ULTRASONIC TESTING 8

Ultrasonic Testing: Basic principles of sound propagation, types of sound waves, Principle of UT, methods of UT, their advantages and limitations, Piezoelectric Material, Various types of transducers/probe, Calibration methods, use of standard blocks, technique for normal beam inspection.

L – 30; Total Hours–30

TEXT BOOKS:

1. ASM Metals Handbook,Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, 2018.
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.

REFERENCES:

1. Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age International Publishers, 2010.
2. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition New Jersey, 2005.
3. Charles, J. Hellier, Handbook of Nondestructive evaluation, McGraw Hill, New York 2001.
4. B.P.C. Rao, Practical Eddy Current Testing, Alpha Science International Limited (2006).

COURSE OUTCOMES:

CO1: Demonstrate the importance, principle, concept and inspection methods of various surface NDT methods and apply the same to interpret the results effectively.

CO2: Comprehend the ideas behind working of thermography and eddy current testing methods and apply them to interpret the results of testing and analyse the defects and problem.

CO3: Grasp the fundamental principles, and standards of various radiographic NDT methods and utilise them to identify the defects and defect location suitably.

CO4: Assimilate the ideas concerning the principle, types of waves, instrumentation, standards, calibration methods of ultrasonic NDT methods and identify the areas for their application.

Board of Studies (BoS) :
BOS of Physics was held on 21.6.21

Academic Council:
17th AC held on 15.07.2021

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

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

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

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

PHDX 02	**MATERIALS SCIENCE FOR ENGINEERING**	**L**	**T**	**P**	**C**
SDG: 4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To impart knowledge on the fundamentals of materials science and engineering.

COB2: To provide a basis for understanding properties and applications of dielectric materials.

COB3: To expose the students to different classes of materials, their properties, structures and imperfections

COB4: To aid the teaching learning process through relevant illustrations, animations, web content and practical examples

MODULE I CLASSIFICATION OF MATERIALS 6

Concept of amorphous, single crystals and polycrystalline materials, crystallinity and its effect on physical properties, metal, ceramic, polymers, classification of polymers, structure and properties, additives for polymer products, effect of environment on materials, composites

MODULE II PROPERTIES OF MATERIALS 10

Mechanical Properties: Stress-strain response of metallic, ceramic and polymer materials, yield strength, tensile strength and modulus of elasticity, toughness, plastic deformation, fatigue, creep and fracture- Electronic Properties:Free electron theory, Fermi energy, density of states, band theory of solids, semiconductors, Hall effect, dielectric behaviour, piezo, ferro, pyroelectric materials - Magnetic Properties: Origin of magnetism in metallic and ceramic materials, para-magnetism, diamagnetism, ferro and ferrimagnetism- Thermal Properties: Specific heat, thermal conductivity and thermal expansion, thermoelectricity- Optical Properties: Refractive index, absorption and transmission of electromagnetic radiation in solids, electro-optic and magneto-optic materials.

MODULE III CRYSTALLOGRAPHIC STRUCTURES AND IMPERFECTIONS 7

Crystal symmetry, point groups, space groups, indices of planes, close packing in solids, bonding in materials, coordination and radius ratio concepts, point defects, dislocations, grain boundaries, surface energy and equilibrium shapes of crystals.

MODULE IV THERMODYNAMICS AND KINETICS 7

Phase rule, phase diagrams, solid solutions, invariant reactions, lever rule, basic heat treatment of metals, solidification and phase transformations, Fick's laws of diffusion, mechanisms of diffusion, temperature dependence of diffusivity.

L – 30; Total Hours–30

TEXT BOOKS:

1. Nanotechnology: An introduction to nanostructuring techniques by Michael Köhler and Wolfgang Fritzsche, Wiley-VCH; 2Rev Ed edition, 2007.

REFERENCES:

1. William D. Callister, Jr., David G. Rethwisch, Materials Science and Engineering, Edition 9, Wiley, 2014.
2. Michael F. Ashby, David R.H. Jones , Engineering Materials 1 An Introduction to Properties, Applications and Design · Volume 1, Elsevier Science, 2012
3. Michael F. Ashby, David R.H. Jones , Engineering Materials 2: An Introduction to Microstructures, Processing and Design · Volume 2, Elsevier Science, 2013
4. Reza Abbaschian, Robert E. Reed-Hill, Physical Metallurgy Principles - SI Version, Cengage Learning, NY, 2009
5. "Encyclopedia of Polymer Science and Technology" 3rd Edition, Vol.1-12, Wiley Interscience , 2003

COURSE OUTCOMES

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

CO1:select suitable material for specific application.

CO2: analyse crystallographic structure of metals and their imperfections.

CO3: develop metal alloys with varying properties by selecting suitable heat treatment

CO4: correlate the various properties of material with their structure.

Board of Studies (BoS) :	**Academic Council:**
BOS of Physics was held on 21.6.21	17th AC held on 15.07.2021

	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 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**
SDG: 4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1:To facilitate the knowledge about optical fibres and its transmission characteristics.

COB2:To make the students to learn about LED and laser diodes.

COB3:To make the students understand the various types of optical Receiversand sensors.

COB4: To enrich the knowledge on optical amplifiers and networks.

MODULE I INTRODUCTION TO OPTICAL FIBRES 7

Optical fibre – Principle and propagation of light in optical fibre – Numerical aperture and acceptance angle – Types of optical fibres – Attenuation – Absorption, Scattering losses, Bending losses and Dispersion in Optical fibres – Fiber Connectors and Couplers.

MODULE II FIBER OPTICAL SOURCES 7

Light Emitting Diodes (LED) – power and efficiency - double hetero LED – LED structure - LED characteristics – Semiconductor Lasers diode, Homojunction and Heterojunction laser diodes - Optical processes in semiconductor lasers - applications.

MODULE III FIBER OPTICAL RECEIVERS AND SENSORS 8

Photo detectors - photodiodes - phototransistors - noise characteristics - PIN diode Avalanche Photodiode (APD) characteristics - APD design of detector arrays – Charged Couple Device - Solar cells - Materials and design considerations, Thin film solar cells, amorphous silicon solar cells - Fiber optic sensors: Intrinsic and Extrinsic sensors, amplitude, phase, wavelength and polarization modulation.

MODULE IV OPTICAL AMPLIFIERS AND NETWORKS 8

Optical amplifiers, Semiconductor optical amplifiers, Erbium-doped fiber amplifiers - Optical Networks: Basic networks, SONET/SDH, WDM Networks, Nonlinear effects on network performance, Performance of WDM + EDFA systems, Solitons, Optical CDMA, Ultrahigh capacity networks.

L – 30; Total Hours–30

TEXT BOOKS:

1. Gerd Keiser, Optical Fiber Communication, 3rd Edition, McGraw-Hill International, Singapore, 2013.

REFERENCES:

1 Govind P. Agrawal, Fiber-Optic Communication Systems (Wiley Series in Microwave and Optical Engineering) , Wiley 4th Edition, 2010.
2 J. Senior, Optical Communication, Principles and Practice, Prentice Hall of India, 3rd Edition, 2010.
3 D. C. Agrawal, Fiber Optic Communication, S.Chand& Co Ltd., 2005.
4 Rajiv Ramaswami, KumarSivarajan, Galen Sasaki, Optical Networks: A Practical Perspective, 3rd Edition, Morgan Kaufmann, 2009.
5 B. Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd, 2014.

COURSE OUTCOMES:

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

CO1: realize basics of optical fiber and differentiate various modes and configurations.

CO2: understand and assimilate the working principle of LED and Diode Laser.

CO3: select suitable photodetectors/sensorsfor different types of applications.

CO4: analyze the mechanism of optical amplifiers and analyze optical networks.

Board of Studies (BoS) :

BOS of Physics was held on 21.6.21

Academic Council:

17th AC held on 15.07.2021

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

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

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

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

PHDX 05	**SEMICONDUCTOR PHYSICS FOR INFORMATION TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 4		**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

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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 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.

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

PHDX 07	**FUNDAMENTALS OF NANOTECHNOLOGY AND ITS APPLICATIONS**	**L**	**T**	**P**	**C**
SDG: 4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1:To introduce the basic concepts of Nanoscience through quantum mechanical theories and solid state physics.

COB2: To provide knowledge about the various synthesis methods applicable to different nano materials

COB3:To enrich the knowledge of students in various characterisation techniques.

COB4:To provide knowledge on applications of poymer based nano materials in various fields.

MODULE I BASICS OF NANO SCIENCE 7

Introduction to Nanoscience & Nanotechnology : Review of classical mechanics – overview Quantum Mechanics. Background to nanoscience and nanotechnology - scientific revolutions - nanosized effects – surface to volume ratio – atomic structure – molecular and atomic size - quantum effects - formation of nano sized particles – energy at the nanoscale.

MODULE II SYNTHESIS OF NANOMATERIALS 8

Nanomaterial Fabrication: Bottom-up vs. top-down - Preparations of Nanomaterials by mechanical and physical methods : – High energy ball milling – melt quenching and annealing – vapour deposition – Pulsed laser deposition – Magnetron sputtering - Microwave plasma evaporation. Chemical Methods of Preparation : Sol-gel method –Electrodeposition – Electrospinning. Arc method for carbon nanotubes – nanofibres and rods – synthesis of Graphene- Handling of nano particles - Health hazards – Precautions.

MODULE III CHARACTERIZATION OF NANOMATERIALS 8

Characterisation of Nanomaterials: XRD – particle size determination - SEM - FESEM - TEM – AFM – Nanoindentor – UV-VIS spectroscopy – FTIR, FT-Raman, Photoluminescence, NMR, ESR - Dielectric characterization – Magnetic characterization

.

MODULE IV APPLICATION OF NANO MATERIALS 7

Applications of Carbon based nanomaterials (CNT, CNF, Graphene) -

Biosensor (principle, component, types, applications) - agriculture (nano-fertilizers, herbicides, nano-seed science, nano-pesticides) and food Systems (encapsulation of functional foods, nano-packaging) – Nano - electronics, Nano-optics.

L – 30; Total Hours–30

TEXT BOOKS:

1. Nanotechnology: An introduction to nanostructuring techniques by Michael Köhler and Wolfgang Fritzsche, Wiley-VCH; 2Rev Ed edition, 2007.

REFERENCES:

1 Nanotechnology: basic science and emerging technologies by Mick Wilson, Kamali Kannangara, Geoff Smith, and Michelle Simmons, Chapman & Hall/CRC; I edition, 2002.
2 Handbook of NanoScience, Engineering and Technology by Gaddand. W., Brenner. D., Lysherski. S. and Infrate. G.J., CRC Press, 2012.
3 Nanocomposite Science and Technology by P. M. Ajayan, L. S. Schadler, P. V. Braun, WILEY-VCH Verlag GmbH, 2003.
4 Nanotechnology Applications in Agriculture – C.R. Chinnamuthu, B.Chandrasekaran and C. Ramasamy – 2008.

COURSE OUTCOMES:

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

CO1: understand basic principles of nanomaterials and apply them to differentiate the significance of nanomaterials compared to bulk materials.

CO2: familiarize the various synthesis methods of nanomaterials and compare them with the preparation of materials in bulk form.

CO3: get useful ideas about characterization techniques and differentiate different techniques.

CO4: understand the various applications of nanomaterilas and realize the role of nanomaterials in various fields

Board of Studies (BoS) :

BOS of Physics was held on 21.6.21

Academic Council:

17th AC held on 15.07.2021

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

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

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

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

CHEMISTRY ELECTIVE

CHDX01	CHEMISTRY OF CONSTRUCTION MATERIALS	L	T	P	C
		2	0	0	2

SDG: 9

COURSE OBJECTIVES:

To impart knowledge on

COB1: The chemistry of cement and concrete

COB2: The properties of steel and mechanism of corrosion

COB3: The quality of water and its impact on concrete

COB4: The analytical techniques for concrete research

MODULE I CHEMISTRY OF CEMENT AND CONCRETE 8

Cement - chemical composition - Bogue's compounds - hydration of cement - hydrated products - influence of hydrated products on properties of cement - types of cement - microstructure of aggregate phase and hydrated cement paste - Interfacial transition zone in concrete : significance and microstructure

MODULE II CHEMISTRY OF STEEL AND CORROSION 8

Steel for construction - chemical composition - types of steels - influence of chemical composition on properties. Corrosion of steel - mechanism of corrosion of steel in water and concrete medium - types of corrosion of steel associated to civil engineering. Corrosion prevention and control : coatings & inhibitors - working mechanism. Cathodic protection to steel : Concept - working mechanism - sacrificial anodes

MODULE III WATER CHEMISTRY FOR CONCRETE 7

Water quality parameters – pH, solids, hardness, alkalinity, chloride and sulphates in water and their determination- Water quality for building construction – Effect of water impurities on concrete strength and durability- Carbonate and Sulphate attack-Chloride attack –Alkali-Silica reactions in concrete-Case studies

MODULE IV ANALYTICAL TECHNIQUES FOR CONCRETE RESEARCH 7

Analytical techniques for cement concrete research - FITR spectroscopy - SEM - XRD - Cyclic voltammetry (CV) - Thermo-gravimetric analysis (TGA) and Differential thermal analysis (DTA) - Advanced chloride and water analysis techniques.

L – 30; Total Hours– 30

TEXT BOOKS:

1. Wieslaw Kurdowski, Cement and Concrete Chemistry, Springer Netherlands, 2014.

REFERENCES:

1. P.C Jain and Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd.,New Delhi , 2013.
2. S SUmare and S S Dara, A text Book of Engineering Chemistry, S. Chand and Company Ltd, New Delhi, 2014.
3. M.G. Fontana and N.G. Green, Corrosion Engineering, McGraw Hill Book Company,NewYork, 1984.
4. B. Sivasnakar, Engineering Chemistry, Tata McGrow - Hill Publication Limited, New Delhi,second reprint 2008.
5. P. Kumar Mehta and Paulo J.M. Moteiro, "Concrete : Microstructure, Properties and Materials", McGraw Hill Education (India) Pvt. Ltd., 4th Edition, New Delhi, 2014
6. APHA Standard Methods for the Examination of Water & Wastewater, American Public Health Association, USA, 2005.

COURSE OUTCOMES:

CO1: Explain the properties of cement and concrete

CO2: Describe the properties of steel, mechanism of corrosion and its prevention

CO3: Enumerate the impact of water quality on the concrete

CO4: Elaborate the principle, instrumentation and applications of various analytical techniques for concrete research

Board of Studies (BoS) :
11thBoS of Chemistry held on 17.06.2021

Academic Council:
17th AC held on 15.07.2021

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

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

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

CHDX 02	**CHEMISTRY OF MATERIALS AND**	**L**	**T**	**P**	**C**
SDG: 9	**ELECTROCHEMICAL DEVICES**	**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

The students will be conversant with

COB1: concepts of corrosion, types and various methods to control corrosion.

COB2: the chemicals, chemical reactions, construction and working of different batteries and fuels cells.

COB3: the types, properties and manufacture of refractories and abrasives.

COB4: types, functions of lubricants and mechanism of lubrication.

MODULE I CORROSION AND ITS CONTROL 8

Types of corrosion - chemical corrosion – electrochemical corrosion – galvanic corrosion – differential aeration corrosion - factors influencing rate of corrosion.

Corrosion control – selection of materials - cathodic protection: sacrificial anode - corrosion inhibitors – paints: constituents & functions – treatment of metal surface for inorganic coatings - metallic coatings: hot dipping: galvanizing and tinning – electroplating — electroless plating.

MODULE II ELECTROCHEMICAL DEVICES 8

Electrochemical cell, electrolytic cell - introduction to batteries – classification – primary: dry alkaline – secondary: lead–acid, nickel–cadmium and lithium batteries, Fuel cells – classification based on temperature and electrolyte - hydrogen–oxygen fuel cell, applications – solar cells: construction and working – dye sensitised solar cells.

MODULE III REFRACTORIES AND ABRASIVES 7

Refractories: Introduction - refractory - classification – based on chemical nature - characteristic and selection of good refractory - properties of refractories: refractoriness - refractoriness under load - thermal spalling - porosity and dimensional stability – general manufacture of refractory – components, properties and uses of: silica, magnesite, zirconia refractories - super refractories - application of refractories.

Abrasives: classification - Moh’s scale – properties - natural abrasives: diamond, corundum, emery, garnet, quartz - synthetic abrasives: preparation, properties and uses: carborundum, alundum, boron carbide (norbide), tungsten carbide, zirconium silicate – grinding wheel – abrasive paper and cloth - Rockwell scale test - knoop hardness test.

MODULE IV LUBRICANTS 7

Introduction – functions of lubricant- mechanism of lubrication - classification of lubricant – selection of lubricants - lubricating oils - properties of lubricant: viscosity index - flash point and fire point - cloud point and pour point – oiliness - aniline point - carbon residue - semisolid: grease (sodium, calcium, lithium, aluminium) - solid lubricant: graphite, graphene, molybdenum disulphide – lubricating emulsions - cutting fluids – synthetic and semi-synthetic lubricants.

L – 30; Total Hours– 30

TEXT BOOKS:

1. Jain P.C and Monika Jain, Engineering Chemistry, Dhanpat Rai Publishing Co., New Delhi. 2016.

REFERENCES:

1. E. McCafferty, "*Introduction to Corrosion Science*" Springer, May 2010.
2. Tulika Sharma "*Electrochemical devices*" LAP Lambert Academic Publishing, 2011.
3. Jeffry S Gaffney, Nancy A Marley *General chemistry for engineers*, Elsevier, 2018.
4. Don M Pirro, Martin Webster, Ekkehard Daschner "*Lubrication Fundamentals*", Taylor & Francis Gp,LLC, 2016.
5. Theo Mang, Wilfred Dresel "*Lubricants and Lubrication*" Wiley-VCH, 2017

COURSE OUTCOMES:

The students will be able to

CO1: apply specific methods to control corrosion of different materials.

CO2: illustrate the construction and working of different types of cells, batteries and fuel cells.

CO3: compare the properties and devise a method of manufacture of refractories and abrasives.

CO4: analyze and choose the right type of lubrication based on the type of machines.

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

Academic Council:
17th AC held on 15.07.2021

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

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

SDG 9: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

CHDX 03 SDG: 9	CHEMISTRY AND INSTRUMENTATION FOR ELECTRICAL AND ELECTRONIC APPLICATIONS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

COB1: Synthesis, properties and applications of electrical and electronic devices.

COB2: Classification and types of fuel cells.

COB3: Types of sensors and their applications.

COB4: Principle, instrumentation and applications of analytical techniques.

MODULE I ELECTRICAL AND ELECTRONIC DEVICES 7

Solar Cell- Si solar cell, quantum dot solar cell, LCD : components, liquid crystals and their composition, electrodes – OLEDS: components, synthesis and modification of small molecules, polymers, phosphors - FRP-synthesis, properties and electrical applications - Solders : composition and uses – Capacitors : synthesis and modification of capacitor materials, fabrication.

MODULE II FUEL CELLS 7

Difference between batteries and fuel cells - classification of fuel cell (based on temperature and electrolyte) – principle, characteristic features, advantages, disadvantages and applications of polymer electrolyte membrane or proton exchange membrane fuel cell (PEMFC), direct methanol fuel cell (DMFC), alkaline fuel cell (AFC), phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC), and solid oxide fuel cells (SOFC) microbial fuel cell, - hydrogen storage materials, challenges in using hydrogen as a fuel.

MODULE III SENSORS 7

Definition, receptor, transducer, classification of chemical sensors based on operating principle of transducer, Ion-selective electrodes, Conductometric gas sensors (chemoresistors), Electrochemical sensors, Potentiometric MOSFET gas sensor, Touch sensors (oximeter, glucometer), Chemocapacitors, Biochips and microarray.

MODULE IV ANALYTICAL TECHNIQUES 9

Voltammetry: cyclic voltammetry, electrogravimetry - principle, instrumentation and applications of: UV-Vis spectrophotometry, Atomic emission spectroscopy- Photoluminescence spectrophotometry, atomic absorption spectrophotometry –- FT-IR spectroscopy, Raman spectroscopy, TGA-DTA analyzer, TEM.

L – 30 ; Total Hours – 30

TEXT BOOKS:

1. P.C. Jain & Monica Jain, Engineering Chemistry, Dhanpatrai Publishing Company (P) Ltd., New Delhi (2016).

REFERENCES:

1. K.M. Gupta & Nishu Gupta, Advanced electrical and electronic materials: process and applications, Wiley-Scrivener (2015).
2. S. Vairam, P. Kalyani and Suba Ramesh, Engineering Chemistry, Wiley India Ltd., New Delhi (2011).
3. B. Viswanathan & M. Aulice Scibioh, Fuel Cells: Principles and Applications, University Press (2008).

COURSE OUTCOMES:

CO1: Illustrate the construction and applications of electrical and electronic devices.

CO2: Classify the fuel cells and elaborate the different types of fuel cells.

CO3: Explain the different types of sensors and their applications.

CO4: State the principle and illustrate the instrumentation of various analytical techniques.

Board of Studies (BoS) :
11thBoS of Chemistry held on 17.06.2021

Academic Council:
17th AC held on 15.07.2021

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

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

CHDX 04	**FUNCTIONAL MATERIALS AND APPLICATIONS**	**L**	**T**	**P**	**C**
SDG: 11 & 12		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

To make the students conversant with

COB1: specific materials for hardware components fabrication, datastorage and their related properties

COB2: selection of advanced materials for various current applications

COB3: materials for the fabrication of sensors

COB4: essential characterization techniques and software tools with chemistry background

MODULE I MATERIALS FOR HARDWARE AND DATA STORAGE 7

Specific materials for electrical and electronic gadgets-computers, instruments (Semiconductors-N, S doped Silicon, CdX QDs, metal nano and other applications). Networking of networks and connecting devices - materials used in robotic construction (metal alloys, kevlor, biodegradable smart materials). Data storage and magnetic hard disk and devices-pendrive (flash memory-ferro magnetic and super paramagnetic materials, optical dics). Nanomaterials to enhance the lifetime and storage of CD, DVD and BD (Nano incorporated Polycarbonate, Al and lacquer) - Nanomaterials and small molecules for data storage.

MODULE II ADVANCED MATERIALS AND APPLICATIONS 8

Materials for 3D printing (Nylon, ABS, PLA, Ti, Au and Ag). Solar panels function monitoring-IOT enabled (crystalline Si, organometallics) – Displays and LCD, LEDs and its types-OLEDs (Group III-V materials). RGB analysis -sensing and TV/system screen (QDs and anthocyanins). Semiconductor chemistry for VLSI processing technology (metalloid staircase, Si, Ge, GaAs)-materials for inkjet printable circuit board (nanocarbon based) - Right material for signal speed and right thermal coefficient of expansion - Remote sensing (photodectectors and radiometers). Solder:-Lead based solder - issues and alternative for lead free solder (Conductive inks).

MODULE III MATERIALS FOR FABRICATION OF SENSORS 8

Wireless Sensors – Introduction to sensors (chemo/bio/gas sensors)-

Wearable/touch sensors-Components - selection of materials - Device fabrication and function monitoring - wireless, Smartphone based and IOT enabled-Properties of materials, anti-corrosive, water proof, insulation and lamination. Robotics in surgery, gene coding and molecular modelling. Biochips and DNA microarray chips (fluorescent dyes, glass/nylon).

MODULE IV ANALYTICAL TECHNIQUES AND SOFTWARE SOLUTIONS 7

Characterization tools – UV-Visible (DRS), FT-IR, SEM, TEM, AFM, TG-DTA and XRD (Principle and applications only). Introduction to softwares- ChemOffice, Image J, Origin - Molecular modelling, comparison of old drug structures with new, drug designing-drug for COVID-19 and drug delivery. Molecular docking (drug interaction in a human body).

L – 30; Total Hours – 30

TEXT BOOKS:

1. P. Roy, S.K. Srivastava, Nanomaterials for Electrochemical Energy Storage Devices (Book), John Wiley & Sons, 2019.
2. K. Brun, T. Allison, R. Dennis, Thermal, Mechanical, and Hybrid Chemical Energy Storage Systems (Book), Elsevier, 2000.

REFERENCES:

1. B.J. Cafferty, A.S. Ten, M.J. Fink, S. Morey, D.J. Preston, M. Mrksich, G.M. Whitesides, Storage of Information Using Small Organic Molecules, ACS Central Science, 2019, 5, 911−916.
2. Nabeel Ahmad P. Gopinath and Rajiv Dutta, 3D Printing Technology in Nanomedicine (Book), Elsevier, 2019.
3. Aaftaab Sethi, Khusbhoo Joshi, K. Sasikala and Mallika Alvala, Molecular Docking in Modern Drug Discovery: Principles and Recent Applications, IntechOpen, (2019), DOII: 10.5772/intechopen.85991.
4. W-L. Xing, J. Cheng, Frontiers in Biochip Technology, Springer, 2006.
5. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, 3rd Edition, Springer, 2015.

COURSE OUTCOMES:

CO1: Identification of suitable materials in electronic gadgets and data storage systems.

CO2: Application of specific functionalized materials for advanced applications

CO3: Choose appropriate materials for fabricating the different types of sensors
CO4: Hands on experience of software and exposure to material properties

Board of Studies (BoS) :
15th BoS of Department of Chemistry held on 15.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12	PSO1	PSO2	PSO3
CO1	-	L	-	H	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	H	-	-	-	-	-	-	-	-
CO3	-	-	-	L	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	H	-	-	-	-	-	-	-	-	-	-	-	-

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

SDG: 11 & 12

Statement : Identification of suitable materials towards the manufacturing of electronic gadgets and data storage systems without much affecting the natural resources and application of the fabricated devices to the sustainable cites and communities.

CHDX 05	**CHEMISTRY OF FUELS,**	**L**	**T**	**P**	**C**
SDG: 9	**COMBUSTION AND LUBRICANTS**	**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

The students will be conversant with

COB1:types, composition and process of manufacture of solid, liquid and gaseous fuels.

COB2:determination of calorific value and calculation of GCV and NCV.

COB3:types, concepts of corrosion and different methods for control of corrosion.

COB4:types, functions of lubricants and mechanism of lubrication.

MODULE I FUELS 8

Introduction – classification of fuels – calorific value – characteristics of a good fuel – comparison of solid, liquid and gaseous fuel – solid fuels – coal – ranking of coal – proximate analysis of coal – pulverised coal – metallurgical coke – manufacture of coke (Otto Hoffman) – Liquid fuel – petroleum – refining of petroleum – cracking – fixed bed catalytic cracking - synthetic petrol – Fischer-Tropsch process – biodiesel - Gaseous fuel – CNG – LPG – Biogas – producer gas – water gas

MODULE II COMBUSTION 8

Introduction – calorific value - Calorific value: Gross and net calorific value - Bomb Calorimeter - Gas calorimeter - Definition of combustion – theoretical calculation of calorific values (Dulong’s formula) - Gross and net calorific values (problems) - air-fuel ratio - minimum requirement of air for complete combustion of fuels (problems) –– Analysis of flue gas - Orsat’s gas analysis method

MODULE III CHEMISTRY OF CORROSION 7

Types of corrosion - chemical corrosion – electrochemical corrosion – galvanic corrosion – differential aeration corrosion - factors influencing rate of corrosion.

Corrosion control – selection of materials - cathodic protection: sacrificial anode - corrosion inhibitors – paints: constituents & functions – treatment of metal surface for inorganic coatings - metallic coatings: hot dipping: galvanizing and tinning – electroplating –– electroless plating.

MODULE IV LUBRICANTS 7

Introduction – functions of lubricant- mechanism of lubrication - classification of lubricant – selection of lubricants - lubricating oils- properties of lubricant: viscosity index - flash point and fire point - cloud point and pour point – oiliness - aniline point - carbon residue - semisolid: grease (sodium, calcium, lithium, aluminium) - solid lubricant: graphite, graphene, molybdenum disulphide – lubricating emulsions - cutting fluids – synthetic and semi-synthetic lubricants.

L – 30; Total Hours– 30

TEXT BOOKS:

1. Jain P.C and Monika Jain, “Engineering Chemistry”, Dhanpat Rai Publishing Co., New Delhi. 2016.

REFERENCES:

1. Stephen R Turns, “An Introduction to Combustion: Concepts and Applications”, McGraw Hill Education, July 2017,
2. Samir Sarkar, “Fuels and Combustion”, University Press, 2009
3. Dipak K Sarkar “Thermal power plant: Design and operations – Chapter-3”, Elsevier, 2015.
4. E. McCafferty, “Introduction to Corrosion Science” Springer, May 2010.
5. Don M Pirro, Martin Webster, Ekkehard Daschner “Lubrication Fundamentals”, Taylor & Francis Gp,LLC, 2016.
6. Theo Mang, Wilfred Dresel “Lubricants and Lubrication” Wiley-VCH, 20172nd Edition, India, 2012. (ISBN 13: 9788131704370)

COURSE OUTCOMES:

The students will be able to

CO1: compare and interpret the different purpose of application, composition, and calorific value of different fuels.

CO2: calculate the minimum amount of air required, GCV and NCV for the combustion of the fuels.

CO3: apply specific methods to control corrosion of different materials.

CO4: analyze and choose the right type of lubrication based on the type of machines.

Board of Studies (BoS) :	**Academic Council:**
11^{th}BoS of Chemistry held on 17.06.2021	!7^{th} AC held on 15.07.2021

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

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

SDG 9: Industry, Innovation & Infrastructure

The holistic understanding of the materials used as fuels and lubricants and devices towards sustainable solutions for the advances in mechanical systems.

		L	T	P	C
CHDX06	**INSTRUMENTAL METHODS OF POLYMER ANALYSIS**	**L**	**T**	**P**	**C**
SDG4		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

To impart knowledge on

COB1: To impart knowledge on spectroscopic analysis of polymers.

COB2: To equip with the knowledge of optical methods and X-ray diffraction methods for understanding the morphology and orientation of molecules

COB3: To develop an understanding on separation of various mixtures by different chromatographic techniques.

COB4: To understand the chemical elemental structure of polymers by NMR and mass spectroscopic technique.

MODULE I ULTRAVIOLET, VISIBLE AND IR SPECTROSCOPY 9

Principle- Instrumentation-Double beam spectrophotometers – single beam spectrophotometers -sources of radiation – Detectors – I operational procedure – qualitative and quantitative analysis – applications in polymer analysis.

Fourier Transform Infrared Spectroscopy -principle- instrumentation – optical materials – sources- detectors – typical spectrophotometers — calibration and standardization – sample preparation - analysis – interpretation of FTIR spectra-principle of identification and characterization of polymers using IR

MODULE II NMR SPECTROSCOPY 7

Fundamental concepts – chemical shift – spin –spin- coupling. Instrumentation - data acquisition and spectral interpretation. Solid state NMR (magic angle), Applications of NMR and FT NMR in the characterization of polymers

MODULE III CHROMATOGRAPHY AND THERMAL ANALYSIS 7

Thermal analysis: DSC, TG/DTA, TMA, DMA, DETA with examples. gel permeation chromatography (GPC) – High pressure liquid chromatography (HPLC) – Thin layer chromatography (TLC - Gas chromatography (GC) – sample preparation. Chromatographic process and instrumentation – compositional separation and detectors – various types – Analyses. The uses and applications of various chromatographic techniques – pyrolysis gas chromatography.

MODULE IV X-RAY DIFFRACTION & NEWTON SCATTERING 7

Principle & basic concept of absorption of X-rays- monochromatic X-ray sources – X-ray detectors - Instrumentation – Experimental technique -Analysis by X-ray absorption. Absorption apparatus – X-ray diffraction – Diffraction apparatus. Application to polymer analysis.

L – 30; Total Hours – 30

TEXT BOOKS

1. Douglas A. Skoog, F. James Holler, Stanley R. Crouch "Principles of Instrumental Analysis" 7th edition, Publisher Cengage Learning ,2016
2. Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, "Introduction to Spectroscopy" 5th edition, Publisher Cengage Learning ,2015
3. Yang, Rui "Analytical methods for polymer characterization" CRC Press, 2018.
4. Joseph D. Menczel, R. Bruce Prime "Thermal analysis of polymers: fundamentals and applications" John Wiley, 2019.

REFERENCES:

1. Galen W. Euring, "Instrumental methods of chemical analysis", McGraw Hill International editions, New York, 1985.
2. B.J. Hunt & MI Jones Blackie, "Polymer Characterisation", Academic professional, London, 1997.
3. Hubert Lobo, Jose V.B.Bonilla, "Handbook of Plastic analysis" , Marcel Dekker inc, New York, 2003.
4. RA pethrick & JV Daukins, "Modern techniques for polymer characterization" , John Wiley & sons Chichester, UK, 1999.
5. D. Campbell and R. White, "Polymer characterization", Chapman & Hall, London 1989.
6. Arza Seidel, "Characterization and Analysis of Polymers", John wiley and sons, New jersey, 2008.
7. Nicholas P. Cheremisinoff, "Polymer Characterization: Laboratory Techniques and Analysis", Noyes publications, New jersey, 1996.
8. John M Chalmers, Robert J Meier, "Molecular characterization and analysis of polymers" Elsevier, 2008

COURSE OUTCOMES

CO1: Gaining knowledge on principles of various instruments

CO2: Understand about various characterization techniques

CO3: Interpretation the polymer by different techniques

Board of Studies (BoS) :	**Academic Council:**
11thBoS of Chemistry held on	!7th AC held on 15.07.2021

17.06.2021

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12	PSO1	PSO2	PSO3
CO1	-	-	-	L	-	-	-	-	-	-	-	-	M	-	-
CO2	-	-	-	M	-	-	-	-	-	-	-	-	M	-	-
CO3	-	-	-	-	-	-	M	-	-	-	-	-	L	-	-
CO4	-	-	-	M	-	-	-	-	-	-	-	-	L	-	-

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

SDG 4: Aims at ensuring inclusive and equitable quality education and promote lifelong learning opportunities for all.

This course will provide deep knowledge on analysis of polymers using different instrumental methods.

CHDX 07	**MEDICINAL CHEMISTRY**	**L**	**T**	**P**	**C**
SDG: 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

To impart knowledge on

COB1: The basic factors governing drug design.

COB2: The software tools for molecular docking.

COB3: The synthetic pathway of antinfective, antineoplastic, cardiovascular and steroidal drugs.

COB4: The mode of action and side effects of synthetic drugs.

MODULE I INTRODUCTION TO DRUG DESIGN 7

Development of new drugs: Procedure followed in drug design – Literature survey - Search for Active Pharmaceutical Ingredient(s) - Molecular modification – Types of pharmaceutical form / mode of administration, Chemical Characterization of Medicinal Drugs - Molecular docking.

MODULE II ANTIINFECTIVE DRUGS 8

Synthesis, mode of action and side effect of Dapsone and Clofazimine (antileprotic) – Isoniazid, Rifampicin, Pyrazinamide and Ethambutol (antitubercular) – Fluconazole and griseofulvin (antifungal) – Chloroquine and Primaquine (antimalarial) - Semisytheticpencillin, Streptomycin, Ciprofloxacin (Antibiotics) - Nevirapine and Zidovudine (Antiviral)

MODULE III ANTINEOPLASTIC AND CARDIOVASCULAR DRUGS 8

Synthesis, mode of action and side effect of Mechlorethamine, Cyclophosphamide, Melphalan, Fluorouracil, 6-Mercaptopurine (Antineoplastic) – Sorbitrate, methylprednisolone, Methyldopa, quinidine (Cardiovascular).

MODULE IV STEROIDS AND RELATED DRUGS 7

Synthesis, uses and mode of action - (A) Androgens -testosterone (B) Estrogens and progestational agents – progesterone, (C) Adrenocorticoids – prednisolone, dexamethasone, Remdesivir (D) Glucocorticoids – Cortisol (E)Anabolicsteroids - nandrolone, oxandrolone (F) Neurosteroids – allopregnanolone.

L – 30; Total Hours–30

TEXT BOOKS:

1. An Introduction to Drug Design, S. N. Pandeya and J. R.Dimmock, New Age International, 1997.
2. Burgers's Medicinal Chemistry and Drug Discovery, Fifth Edition; M. E. Wolff, John Wiley and Sons, 1996.
3. The organic chemistry of drug design and drug action, R. B. Silverman and M. W. Holladay, Academic Press, 3rd Edition, 2014.
4. Introduction to medicinal chemistry**:** How Drugs Act and Why, A. Gringuage, Wiley-VCH, 1996.
5. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry; Eleventh Edition; Lippincott Williams & Wilkins, 2004.

REFERENCES:

1. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley, 2nd Edition 2008.

COURSE OUTCOMES:

CO1: Carry out searches to retrieve information relevant to the development of a new drug.

CO2: Describe and justify the role and importance of the various disciplines involved in the different phases of drug discovery and development.

CO3: Explain how synthetic methods are used to make early decisions in the drug discovery and development.

CO4: Elaborate the mode of action and side effect of the drugs.

Board of Studies (BoS) :
11thBoS of Chemistry held on 17.06.2021

Academic Council:
17th AC held on 15.07.2021

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

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

SDG 9:Industry, Innovation & Infrastructure

Understanding of drugs preparation and usage in sustainable method reduces unwanted side effects and help to environments.

MATHEMATICS ELECTIVE
(SEMESTER III)

MADX01	**TRANSFORMS AND PARTIAL**	**L**	**T**	**P**	**C**
SDG: 4	**DIFFERENTIAL EQUATIONS**	**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

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

COB2: To introduce basics and engineering applications of Fourier series

COB3: To develop Fourier transform techniques

COB4: To introduce analytic solutions of PDEs by using Fourier series

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

MODULE I PARTIAL DIFFERENTIAL EQUATIONS 9+3

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

MODULE II FOURIER SERIES 9+3

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

MODULE III FOURIER TRANSFORMS 9+3

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

MODULE IV APPLICATIONS OF FOURIER SERIES 9+3

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

MODULE V Z – TRANSFORM 9+3

Introduction and Definition of Z-transform - Properties of Z- Transform -

Convolution Theorem of Z-Transform - Inverse Z–transform - Convolution Theorem of Inverse Z-Transform - Formation of difference equations - Solving Difference Equations using Z-Transform

L – 45 ; T - 15; TOTAL HOURS – 60

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

At the end of the course students will be able to

CO1:form and solve the partial differential equations using different methods

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

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

CO4:solve partial differential equations by using Fourier series

CO5:solve difference equations using Z-transform

Board of Studies (BoS) :

12th BOS of Mathematics & AS held on 23.06.2021

Academic Council:

17th AC held on 15.07.2021

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

CO2	M														
CO3	H														
CO4	M														
CO5	M														

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

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

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

MADX02	**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

MADX03	**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.

MADX05	**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

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HUMANITIES ELECTIVE – (SEMESTER III)

SSDX 01	**ENGINEERING ECONOMICS AND MANAGEMENT**	**L**	**T**	**P**	**C**
SDG: 4, 8, 9,12		**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) :

5th BoS of SSSH held on 29.12.2021

Academic Council:

18th Academic council held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1			H			H	H	M	L	H	L	
CO2			M			H	H	M	H	H	M	L
CO3			H	M	H	H	M		M	H	H	M
CO4			M			H	H	L	L	M	H	H
CO5			M			H				M		L

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

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

To inculcate knowledge and socialize youth in building participation, institutions and partnership for inclusive development for the implementation of sustainable development goals.

SSDX 03	**INDUSTRIAL ECONOMICS AND MANAGEMENT**	**L**	**T**	**P**	**C**
SDG: 8 and 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To provide a wholesome idea about the concept of industrial economics and identify the classifications of firms based on ownership and control.

COB2: To impart theoretical and analytical knowledge on the different market structures, pricing practices and government policies.

COB3: To equip the students with the framework that will be useful for applying economic models in business strategy, competition policy and regulations.

COB4: To understand the importance of Industrial Policy in the development of Industries in India.

COB5: To elucidate industrial growth in India by examining its performance and problems in industrial sector.

MODULE I INTRODUCTION TO INDUSTRIAL ECONOMICS 9

Definition and scope of industrial economics - Concept and importance of industry; Concept and organization of a firm - Classification of firms based on ownership - sector (industries, formal vs. Informal) - size and use - based classification - Separation of ownership and control - Localization of industries .

MODULE II MARKET STRUCTURE 9

Perfect Competition – Imperfect Competition: Monopoly – Monopolistic – Oligopolistic Strategy, Cartels, Cournot Kinked Demand and Price Leadership – Measurement of economic concentration – Policy against monopoly and restrictive trade practices – Competition Law – Pricing Practices: Objectives – Determinants – Pricing Methods – Government Policies and Pricing.

MODULE III PRODUCTION ECONOMICS AND THEORY OF FIRM 9

Production and Production function – Types, Factor Inputs – Input-Output Analysis, Undifferentiated Products - Cournot, Stackelberg, Dominant firm model, Bertrand-Heterogeneous products - Chamberlin’s small and large number case - Kinked demand curve theory - Bain’s limit pricing – Production Possibility Frontier.

9

MODULE IV INDUSTRIAL POLICY

Industrial Policy: Industrial Policy in India -1948, 1956, 1977, 1980, 1990, 1991 - Industrial Performance after Independence.

MODULE V INDUSTRIAL GROWTH IN INDIA 9

Trends and prospects - Public enterprises; efficiency - Productivity and performance constrain - Small scale industries: definition, role - Policy issues and performance - Capacity utilization - Industrial sickness and Exit - Technology transfer - Privatization.

L – 45 ; Total Hours – 45

TEXT BOOKS:

1. Barthwal R R "Industrial Economics: An Introductory Textbook", New Age International Pvt. Ltd Publishers, 2017
2. P.J. Devine, N. Lee, R.M. Jones, W.J. Tyson, "An Introduction to Industrial Economics", Routledge.2019.

REFERENCES:

1. Ferguson, Paul R. and Glenys J. Ferguson, "Industrial Economics - Issues and Perspectives", Macmillan, London. 1994
2. Gregory Mankiw "Principles of Microeconomics", Havcourt Asia Publishers, 2001.
3. Mohanty Binode Ed. "Economic Development Perspectives", Vol. 3, Public Enterprises and Performance, Common Wealth Publishers, New Delhi, 1991
4. Mote and Paul "Managerial Economics, Tata McGraw Hill, 2001
5. Peterson and Lewis "Managerial Economics", 4th Ed., Prentice Hall, 2004

COURSE OUTCOMES:

CO1: Develop knowledge on the concept and organization of firms and the implications of the separation of ownership and control.

CO2: Acquire familiarity with various market structures and formulate appropriate pricing strategies.

CO3: Think analytically using various economic models concerning market structures and apply them to the real world of industry.

CO4: To compare the various Industrial Policies introduced in India and recognize the role of these policies in making required industrial development in India.

CO5: Clearly diagnose and illustrate the challenges in industrial economy in India and develop effective and comprehensive solution on them.

Board of Studies (BoS) :

Mention details of BoS

5thBoS of SSSH held on 29.12.2021

Academic Council:

18th Academic council held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	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 IIISOCIAL STRATIFICATION IN INDIA 9

Social stratification - Concept of hierarchy - inequality, meaning and characteristics - Social Stratification and Social Mobility - Functions of Social Stratification - Caste, definition, principles, contemporary changes, dominant caste - Caste - class interface - Religious minorities.

MODULE IV SOCIAL PATHOLOGY 9

Social Problem - nature, social disorganization - Population explosion- causes, effects, relationship with development - Child Labour- causes, magnitude and consequences – Unemployment - nature, types, causes and effects - Gender issues - social status of women, violence against women and women in work place - Contemporary issues - communalism, terrorism and corruption.

MODULE V SOCIAL CHANGE IN INDIA 9

Socio-cultural change - Sanskritization – Westernization - Secularization, Modernization - Processes of Social change - Industrialization – Urbanization – Globalization - Social movement - concept, characteristics, functions - New social movement-Women and Environment movement.

L – 45; Total Hours –45

TEXT BOOKS:

1. Sharma,K.L., “Indian Social Structure and Change”, Jaipur: Rawat Publications, 2008.
2. Ahuja Ram., “Social Problems in India”, Rawat Publication: New Delhi, 2014.
3. Ahuja Ram., “Society in India”, Rawat Publication: New Delhi, 2014.

REFERENCES:

1. Atal Yogesh, “Changing Indian Society” Rawat Publications, Jaipur, 2006.
2. Dube S.C., “India's Changing Villages: Human Factors in Community Development”, London, Routledge and Kegan Paul, 2003.
3. Hasnain N., “Indian Society: Themes and Social Issues”, Mc Graw Hill, 2019.
4. Jayapalan, N., “Indian Society and Social Institutions” Atlantic Publishers, 2001.
5. Pandey Vinita., “Indian Society and Culture”, Rawat Publications, New Delhi, 2016
6. Rao Sankar., “Sociology of Indian Society”, S. Chand Publisher, New Delhi, 2004.

COURSE OUTCOMES:

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

CO1: explain about the social structure and social institutions that constitute society in India.

CO2: differentiate the various categories of inequalities and their challenges.

CO3: describe the social stratification and its impact in society.

CO4: analyze the social problems encountered in contemporary India.

CO5: correlate the various forms and trends of the social change in Indian society and realize the relevance of their role in bringing about development.

Board of Studies (BoS) :
5th BoS of SSSH held on 29.12.2021

Academic Council:
18th Academic council held on 24.02.2022

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1			H			H	M			M		
CO2			M			M	H	L				H
CO3			M			M	H	L				H
CO4			H			H	H		M			M
CO5			H		H	M	H	M		H		H

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

SDG 10: Reduce inequality within and among countries.
SDG16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

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.

HUMANITES ELECTIVES – VI SEMESTER

		L	T	P	C
SSDX 11	**ECONOMICS OF SUSTAINABLE DEVELOPMENT**				
SDG: 1-17		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To inculcate the knowledge base on sustainable development with a view to balance our economic, environmental and social needs, allowing prosperity for now and future generations.

COB2: To develop a capacity to undertake a theoretically grounded analysis of environment issues and identify and describe what the United Nations and other governing bodies are doing to assist in a more sustainable world.

COB3: To have an insight of the emerging debate about reconciling ecological sustainability with poverty alleviation in the context of globalization and development.

COB4: To establish a clear understanding of the policy instruments of sustainable development.

MODULE I CONCEPT OF SUSTAINABLE DEVELOPMENT 8

Evolution of the Concept – Rio Summit and sustainable development - various definitions of sustainable development - Components of sustainable development: Social, environmental and economic components – Sustainable Development Goals – Quality education, Gender equality, innovation and infrastructure, peace and justice - Sustainable engineering practices.

MODULE II NEED FOR SUSTAINABLE DEVELOPMENT 6

Need for sustainability – Global environmental challenges: population growth, resource depletion, pollution, energy use, climate change, pollution, growing water scarcity, other urban problems, loss of biodiversity, hazardous wastes disposal.

International responses to environmental challenges - Global policy such as Kyoto Protocol, Paris Agreement, Montreal Protocol, Basel Convention.

Community Participation in Sustainable Development, Common Property Resource Management, Innovation, Industry and Sustainable Development.

MODULE III GLOBALIZATION AND ENVIRONMENT SUSTAINABILITY 7

Impact of Globalization on sustainable development, Co - existence of globalization and Environment sustainability - Globalization and Global Governance.

Green economy - Renewable energy, sustainable transport, sustainable construction, land and water management, waste management.

MODULE IV POLICIES FOR ACHIEVING SUSTAINABLE DEVELOPMENT 9

Principles of environmental policy for achieving sustainable development: precautionary principle and polluter pays principle – Business Charter for Sustainable Development.

Policy instruments for sustainable development: direct regulation – market based pollution control instruments such as pollution tax, subsidy, pollution permits.

L –30 ; TOTAL HOURS – 30

TEXT BOOKS:

1. Peter P. Rogers, Kazi F. Jalal, John A. Boyd, "An Introduction to Sustainable Development", Glen Educational Foundation, 1st Edition, England, UK, 2008.

2. Sayer, J. and Campbell, B, "The Science of Sustainable Development: Local Livelihoods and the Global Environment" (Biological Conservation, Restoration &Sustainability), Cambridge University Press, London, 2003.

REFERENCES:

1. Anderson, David A, "Environmental Economics and Natural Resource Management", Routledge, 3rd edition, England, UK, 2010.
2. Berck, P., "The Economics of the Environment", New Delhi: Pearson India, 2015.
3. Karpagam M, "Environmental Economics: A Textbook.pdf", Sterling Publishers Pvt. Ltd, New Delhi, 2021.
4. Kumar, Pushpam, "Economics of the Environment and Development",Ane Book Publication, New Delhi, India, 2009.
5. Karpagam M and Jaikumar Geetha, "Green Management Theory and Applications", Ane Books Pvt. Ltd, New Delhi, India, 2010.
6. Sengupta Ramprasad, "Ecology and Economics: An Approach to Sustainable Development", Oxford University Press, New Delhi, 2004.
7. Muthukrishna, S, "Economics of Environment", PHI Learning Pvt. Ltd., New Delhi, India, 2010.

COURSE OUTCOMES:

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

CO1: Develop awareness of the ethical, economic, social and political dimensions that influence sustainable development.

CO2: Clearly articulate their views and beliefs with regards to environmental issues.

CO3: Identify and describe the major economic forces that shape our approach to the environment issues and demonstrate responsible globalization through global governance.

CO4: Account for strategies, international agreements and major policy instruments for a sustainable use of resources and ecosystem services.

Board of Studies (BoS) :
4th BoS of SSSH held on 28.06.2021

Academic Council:
17th AC held on 15.07.2021

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

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

SDG 1: End poverty in all forms and everywhere.

SDG 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.

SDG 3: Ensure healthy lives and promote well-being for all at all ages

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

SDG 5: Achieve gender equality and empower all women and girls

SDG 6: Ensure availability and sustainable management of water and sanitation for all.

SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all.

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

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

SDG 10: Reduce income inequality within and among countries

SDG 11: Make cities and human settlements inclusive, safe, resilient, and sustainable.

SDG 12: Ensure sustainable consumption and production patterns

SDG 13: Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy.
SDG 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

The holistic understanding of all the 17 SDGs aims to end poverty, ensure prosperity, and protect the planet.

SSDX 12	**SOCIOLOGY OF INDUSTRIAL RELATION**	**L**	**T**	**P**	**C**
SDG: 8, 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To familiarize sociological approaches and perspectives to understand the social relationship in manufacturing industries and corporate sector.
COB2: To highlight the structure and functions of industrial organizations
COB3: To explicate the dynamics of organizational behavior, leadership and communication.
COB4: To provide an overview in labour legislation and labour welfare

MODULE I INTRODUCTION 7

Sociology of Industrial relation - definition, scope and importance - Theoretical approaches- scientific management, human relations approach, theory of bureaucracy- Fordism and post-fordism - Production system- concept and characteristics of factory system - automation and rationalization -The Industrial Employment (Standing Orders) Act, 1946 Industrial conflict-strike, lockout and trade unions- Emerging role of trade unions in India.

MODULE II INDUSTRIAL ORGANIZATION 7

Formal organization- definition, features, utility - Informal organization- definition, characteristics, types and relevance - Structure of industrial organization- features and functions of line organization, characteristics and roles of staff organization, distinction- Industrial hierarchy-white collar, blue collar, supervisors and managers.

MODULE III DYNAMICS OF INDUSTRIAL RELATIONS 7

Group dynamics- Definition, Group behaviour model - Group decision making process, group cohesiveness - Leadership- definitions, style and effective supervision- Communication- concepts, types, model barriers - Job satisfaction- nature, employee compensation and job satisfaction. Grievance Handling and Disciplinary Action, Code of Conduct, Industrial Relations in changing scenario, Employers' organisations.

MODULE IV LABOUR LEGISLATION AND LABOUR 9

WELFARE

Labour Legislation-Objectives, Principles, Classification and Evolution. International Labour Organisation. Social Justice and Labour Legislation, Indian Constitution and Labour Laws- The Factories Act, 1948, The Inter-state Migrant Workmen Act, 1979, The Contract Labour (Regulation and Abolition) Act, 1970, The Child Labour (Prohibition and Regulation) Act, 1986. Labour welfare-Concept, Scope, Types, and Principles, Industrial Health and Hygiene, Industrial Accidents and safety, Occupational Diseases. Social Security-Concept and Scope, Social Assistance and Social assurance.

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1. Mamoria ,Gankar., “Dynamics of Industrial relations”, Himalaya Publishing House,Mumbai, 2007.
2. Narender Singh ., “Industrial Sociology”, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.
   Kumar., “Industrial Sociology”, Lakshmi Narain Agrawal Publishers, Agra, 2019.
3. SharmisthaBhattacharjee, “Industrial Sociology”, Aavishkar Publishers, Jaipur, 2016.

REFERENCES:

1. Bhatnagar M., “Industrial Sociology”,S. Chand Publications, New Delhi, 2012.
2. MisraRajan., “Industrial Sociology”, University Science Press (An Imprint of Laxmi Publications Pvt. Ltd.), New Delhi, 2013.
3. Newstorm W John, “Organizational Behavior”, Mc. Graw Hill Publishing Co., New Delhi, 2006.
4. Nina, Bandlej (ed)., “Economic Sociology of Work”, Bingley: Emerald Group Publishing Ltd, 2009.
5. Richard Brown, John Child, S.R. Parker, “The Sociology of Industry”, Routledge Publisher, 2015.
6. Sushil Kumar Saxena, Satish Mittal, “Industrial Sociology”,Common Wealth Publishers, 2012.
7. Watson, Tony, “Sociology, Work and Industry (5th edition), Oxon: Routledge, 2008.

COURSE OUTCOMES:

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

CO1: Understand the sociological perspectives for dealing with social relationships in production and service organizations.

CO2: Have deeper knowledge in structure of authority, roles and responsibility in organizational settings.
CO3: Assess the role of leadership, communication and behavioral acumen to govern the organization.
CO4: Describe the importance of labour legislation and labour welfare

Board of Studies (BoS) :
4th BoS of SSSH held on 28.06.2021

Academic Council:
17th AC held on 15.07.2021

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

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

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

The holistic understanding of industrial relations leads to equal access to opportunity, and equal pay for work of equal value for male and female contributions is necessary for gender equality as well as for inclusive economic growth. Explore work opportunities, understand career processes and appreciate the meaning and purpose of work in people's lives which leads to decent work and safe working practices.

SSDX 13	**PROFESSIONAL ETHICS AND HUMAN VALUES**	**L**	**T**	**P**	**C**
SDG: 8		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To render basic insights and inputs to the students to inculcate human values to grow as responsible human beings with a proper personality.

COB2: To create awareness on senses of engineering ethics.

COB3: To inculcate knowledge and exposure on safety and risk, risks benefit analysis and professional rights.

COB4: To instill social values and loyalty and to appreciate the rights of others

.

MODULE I HUMAN VALUES 7

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

MODULE II ENGINEERING ETHICS 7

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - Theories about right action - Self-interest - Customs and Religion - Uses of ethical theories - Valuing Time – Co-operation – Commitment.

MODULE III SAFETY, RESPONSIBILITIES AND RIGHTS 8

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

MODULE IV CONTEMPORARY ISSUES 8

Globalisation-Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Ethics-Ethics and codes of business conduct in MNC.

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1. Govindarajan M, Natarajan S, Senthil Kumar V. S., “Engineering Ethics”, Prentice Hall of India, New Delhi, 2019.
2. Kiran. D R, “Professional Ethics and Human Values”, Mc Graw Hill Publishers,New Delhi, 2013.
3. Naagarazan R.S., “Professional Ethics and Human Values”, New Age International Publishers, New Delhi, 2006.
4. R Sangal, RR Gaur and G P Bagaria, “Foundational Course in Human Values & Professional Ethics”, Excel Books, India, 2010.

REFERENCES:

1. Charles D. Fleddermann , “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004.
2. Charles E Harris, Michael S.Protchard and Michael J Rabins., “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000.
3. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
5. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.
6. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York, 2010.
7. Subramanian. R,“Professional Ethics - Includes Human Values”, Oxford HED Publishers, 2017.\

COURSE OUTCOMES:

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

CO1: Apply moral and ethical values scrupulously that ought to guide the engineering profession.

CO2: Understand the ethical issues related to engineering aspects.

CO3: Assess safety and risk and execute risk benefit analysis.

CO4: Become responsible engineers, experimenters, researchers or businessmen

Board of Studies (BoS) :

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

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

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

Holistic understanding of professional ethics explores work opportunities, understand career processes and appreciate the meaning and purpose of work in people's lives leading to a decent work and safe working practices and environments.

SSDX 14	**GENDER, TECHNOLOGY AND DEVELOPMENT**	**L**	**T**	**P**	**C**
SDG: 8		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To conceptualize what is gender and sex and draw a line of distinction between the two.
COB2: To develop students' sensibility to the difference in gender roles, responsibilities, rights and injustice.
COB3: To reflect critically on the ways in which new technologies have sharpened and/or blurred gender difference.
COB4: To develop an insight to the gender and development with the paradigm shift from time to time.

MODULE I UNDERSTANDING GENDER 7

Basic Concepts: Sex/Gender, Gender roles, Gender socialization, - Construction of Gender- Making Women, Making Men Gender stereotyping, Femininity and Masculinity, Patriarchy, Heteronormativity, LGBTIQ - Theoretical Background to gender and feminist thinking: Liberal, Radical, Marxist, Socialist, Post-modern Feminism.

MODULE II GENDER ROLES AND GENDER INJUSTICE 7

Gender Roles and Relations-Types of Gender Roles Gender Roles and Relationships Matrix. Health conditions, Sex Ratio, Education: Literacy & Gender Bias - Work Related Issues: Existing Prejudices, gender Related Violence, Gender Discrimination - Political participation: Lack of women's representation - Economic Conditions- Social Conditions: divorce, rape, domestic violence.

MODULE III GENDER, TECHNOLOGY AND CHANGE 8

A historical perspective – Technology as masculine culture – Household technology – medical technology: New Reproductive technologies – Impact of Technological Change on Women. The Digital Divide: Unequal Access, Unequal Effects – Outcome and impact of ICT's Policies and projects for women. How gender influences technologies and the social organization of scientific and technical workspaces.

MODULE IV GENDER AND DEVELOPMENT 8

Gender, Governance and Sustainable Development - Women's role in Development - Women in Development (WID), Women and

Development (WAD) - Gender and Development (GAD); Gender Mainstreaming and Gender Budgeting - Gender and Human Rights

L – 30; TOTAL HOURS –30

TEXT BOOKS:

1. Bhasin, Kamala., "Understanding Gender", New Delhi: Kali for Women, 2000.
2. John, Mary E., "Gender and Development in India, 1970-90's: Some reflections on the constitutive role of context' Chaudhuri, Maitrayee. (ed.) Feminism in India", New Delhi: Kali for women. pp. 246-258, 2004.
3. Menon, Nivedita, "Embodying the Self: Feminism, Sexual Violence and the Law" in Partha Chatterjee and Pradeep Jeganathan (ed)- Subaltern Studies XI: Community, Gender and Violence", Permanent Black and Ravi Dayal, 2000.
4. Gender and Technology: A reader ., Edited by Nina E. Lerman, Ruth Oldenziel, and Arwen P. Mohun, John Hopkins University Press, Baltimore , 2003.

REFERENCES:

1. Lourdes Beneria , GünseliBerik , Maria Floro .,"Gender, Development and Globalization: Economics as if All People Mattered", 2nd edition , Routledge, 2015.
2. Moser, Caroline, "Gender Planning and Development: Theory, Practice and Training", Routledge, 1993.
3. Rege, Sharmila., "Sociology of Gender: The Challenge of Feminist Sociological Knowledge", Sage publications: New Delhi, 2003.
4. Jain S.C., Women and Technology, Rawat Publication, Jaipur Begh, 1985.

COURSE OUTCOMES:

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

CO1: Distinguish important concepts related to gender in contemporary society.

CO2: Interpret the gender discrimination works in our society and how to counter it.

CO3: Illustrate how the intersection of gender and technology involves gender shaping technology and technology shaping gender.

CO4: Apply gender sensitive perspective on development and human rights.

Board of Studies (BoS) :
4th BoS of SSSH held on 28.06.2021

Academic Council:
17th AC held on 15.07.2021

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

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

SDG 5: Achieve gender equality and empower all women and girls

To imbibe gender concern and gender perspective in the invention, and application of technology, planning and designing production and innovating strategies for engendering gender equality.