B.S. Abdur Rahman

# Crescent
Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

*Regulations 2021*
*Curriculum and*
*Syllabi (I - IV Semesters)*
*(Amendments updated upto February 2022)*

*B.Tech. (Mechanical Engineering)*

**REGULATIONS 2021**

**CURRICULUM AND SYLLABI (I - IV Semesters)**

**(Amendments updated upto February 2022)**

**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)*

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

### 4.1.4 Value Added Courses

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

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

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

### 4.1.5 Industry Internship

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

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

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

### 4.1.6 Industrial Visit

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

**4.2** Each course is normally assigned certain number of credits:

- one credit per lecture period per week
- one credit per tutorial period per week
- one credit for two to three periods and two credits for four periods of laboratory or practical 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 3$^{rd}$ to 8$^{th}$ 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

**14.1** A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% to become eligible to appear for the semester end examination in that course, failing which the student shall be awarded "I" grade in that course.

**14.2** The faculty member of each course shall cumulate the attendance

details for the semester and furnish the names of the students who have not earned the required attendance in the concerned course to the class advisor. The class advisor shall consolidate and furnish the list of students who have earned less than 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end examination in each course.

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

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

**14.5** The student awarded "I" grade, shall enroll and repeat the course when it is offered next. In case of "I" grade in an elective course either the same elective course may be repeated or a new elective course may be taken with the approval of the Head of the Department / Dean of the School.

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

the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of arrear examination.

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

## 15.0 REDO COURSES

**15.1** A student can register for a maximum of three redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the 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,

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

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<br>Aeronautical Engineering |
| 2. | Block Chain | Polymer Engineering |
| 3. | Cyber Security | Automobile Engineering |
| 4. | Data Science | Civil Engineering |
| 5. | Internet of Things (IoT) | Biotechnology<br>Electrical and Electronics Engineering<br>Electronics and Instrumentation Engineering |
| 6. | Virtual and Augmented Reality | Mechanical Engineering<br>Aeronautical Engineering<br>Polymer Engineering<br>Automobile Engineering<br>Civil Engineering<br>Biotechnology<br>Electrical and Electronics Engineering<br>Electronics and Instrumentation Engineering<br>Electronics and Communication Engineering |

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

| SI. 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

| SI. 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

| SI. 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.

**CHD1181**

**SDG: 9**

**ENGINEERING MATERIALS AND APPLICATIONS**

| L | T | P | C |
|---|---|---|---|
| 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) :**
11th BoS of Chemistry held on 17.06.2021

**Academic Council:**
17th AC held on 15.07.2021

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

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

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

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

**MAD  1181**

**SDG: 4**

**ALGEBRA AND DIFFERENTIAL**
**CALCULUS**

| L | T | P | C |
|---|---|---|---|
| 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     9+3**
**                        VARIABLES**

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

**MODULE V       ORDINARY DIFFERENTIAL EQUATIONS      9+3**

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

**L – 45 ; T - 15; Total Hours – 60**

**TEXT BOOKS:**

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

**REFERENCES:**

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

**COURSE OUTCOMES:**

At the end of the course students will be able to

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

**CO2:** solve equations using the relations between roots and coefficients

**CO3:** apply differential calculus in various engineering problems

**CO4:** use differential calculus on several variable functions

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

**Board of Studies (BoS) :**       **Academic Council:**

12th BOS of Mathematics & AS held on    17th AC held on 15.07.2021

23.06.2021

|  | PO 1 | PO 2 | P O3 | 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):**                 **Academic Council:**

18[th]BoS of MECH held on 21.06.2021       17th AC held on 15.07.2021

|  | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | 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):**
18<sup>th</sup>BoS of MECH held on 21.06.2021

**Academic Council:**
17<sup>th</sup> AC held on 15.07.2021

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

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

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

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

**GED 1103**

**SDG: 9**

**MANUFACTURING PRACTICES LABORATORY**

| L | T | P | C |
|---|---|---|---|
| 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):**              **Academic Council:**
18th BoS of MECH held on 21.06.2021      17th AC held on 15.07.2021

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

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

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

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

**GED 1104**

**SDG: 8**

**PROGRAMMING FOR PROBLEM SOLVING**

| L | T | P | C |
|---|---|---|---|
| 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) :**
13[th]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**

**SDG: 4**

**PARTIAL DIFFERENTIAL**
**EQUATIONS AND TRANSFORMS**

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

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

**COB2:** To introduce basics and engineering applications of Fourier series

**COB3:** To develop Fourier transform techniques

**COB4:** To introduce techniques and engineering applications of Laplace Transforms

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

**MODULE  I        PARTIAL DIFFERENTIAL EQUATIONS        9+3**

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

**MODULE  II        FOURIER SERIES        9+3**

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

**MODULE  III        FOURIER TRANSFORMS        9+3**

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

**MODULE  IV        LAPLACE TRANSFORM        9+3**

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

**MODULE  V        Z – TRANSFORM        9+3**

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

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

**L – 45; T - 15; Total Hours – 60**

**TEXT BOOKS:**

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

**REFERENCES:**

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

**COURSE OUTCOMES:**

At the end of the course students will be able to

**CO1:**form and solve the partial differential equations

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

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

**CO4:**solve ordinary differential equations using Laplace transforms

**CO5:** solve difference equations using Z-transform

**Board of Studies (BoS) :**          **Academic Council:**

12th BOS of Mathematics & AS held on          17th AC held on 15.07.2021
23.06.2021

|  | 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　L: 11**
　　　　　　　**PARTICLE**　　　　　　　　　　　　　　　**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):**　　　　　　**Academic Council:**

18<sup>th</sup> BOS held on 21.06.2021　　　　17<sup>th</sup> AC held on 15.07.2021

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

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

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

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

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

## COURSE OBJECTIVES:

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

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

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

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

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

## MODULE I        DC CIRCUITS & MEASUREMENTS        12

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

## MODULE II        AC CIRCUITS & MEASUREMENTS        17

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

## MODULE III        ELECTRICAL MACHINES        18

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

## MODULE IV        SEMICONDUCTOR DEVICES AND        14
        APPLICATIONS

Introduction to semiconductors - Characteristics of PN Junction Diode –

Zener Diode and its characteristics – SCR and its characteristics –– Bipolar Junction Transistorand its characteristics – JFET & MOSFET – their characteristics.

Applications: Half wave and full wave rectifiers - Voltage Regulation – Regulator ICs.

**MODULE V        INTRODUCTION TO DIGITAL CIRCUITS        14**
Logic gates- Boolean algebra theorems– K Map-Introduction to combinational circuits– Flip-Flops – Registers– A/D and D/AConversion – Data acquisition systems

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

**L – 45; P – 30; Total Hours– 75**

**REFERENCES:**
1. Edward Hughes, "Electrical and Electronics Technology", Pearson India, 12th Edition, 2016.
2. D P Kothari and I J Nagrath, "Basic Electrical Engineering", McGraw Hill Education, First Edition, 2017.
3. Cotton H, "Electrical Technology", CBS Publishers, 7th Edition, 2007.
4. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2015.
5. Jacob Millman & Christos C. Halkias, Satyaprataba Jit "Electronic Devices and Circuits" McGraw Hill Education, 4th Edition, 2021.
6. Floyd, "Electronic Devices: Conventional Current Version" Pearson Education India, 7th Edition, 2008.
7. S. Salivahanan, N. Sureshkumar and A. Vallavaraj, "Electronic Devices and Circuits", McGraw Hill Education (India) Pvt. Ltd., 2018.
8. Thomas L. Floyd, "Digital Fundamentals", 10th Edition Pearson Education Inc., New Delhi, 2008.

**COURSE OUTCOMES:**

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

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

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

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

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

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

**Board of Studies (BoS) :**

15th meeting of  BoS of EEE held on 25.06.2021

**Academic Council:**

17th AC held on 15.07.2021

|  | 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 | L | T | P | C |
|---|---|---|---|---|---|
| SDG: 9 | LABORATORY | 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):**          **Academic Council:**

18[th]BoS of MECH held on 21.06.2021          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   8
### MANAGEMENT

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   6
### ISSUES

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

.

**Board of Studies (BoS) :**          **Academic Council:**

11th BoS of Chem held on              17th AC held on 15.07.2021

17.06.2021

|  | 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):**          **Academic Council:**

19th BOS held on 21.12.2021          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           L:6**
**                 STEAM POWER CYCLES                         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** **L:6**
**RELATIONS** **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):**          **Academic Council:**

19th BOS held on 21.12.2021          18th AC held on 24.02.2022

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | H | M | | | | | | | | | | | M | M |
| CO 2 | H | M | | | | | | | | | | | M | M |
| CO 3 | H | M | | | | | | | | | | | M | M |
| CO 4 | H | M | | | | | | | | | | | M | M |
| CO 5 | 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 | L:7 |
|---|---|---|
| | MECHANISMS | 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):**      **Academic Council:**

19<sup>th</sup> BOS held on 21.12.2021      18<sup>th</sup> 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 | L | T | P | C |
|---|---|---|---|---|---|
| SDG:9 | PROCESSES | 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 DRAFTINGEXERCICE:**

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):**
19[th]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):**
19thBoS 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 | L | T | P | C |
|---|---|---|---|---|---|
| SDG: 17 | FOR ENGINEERS | 0 | 0 | 2 | 1 |

## COURSE OBJECTIVES:

**COB1**:To enable them to make effective business presentations

**COB2**:To train them to participate in group discussions

**COB3:**To enhance the problem-solving skills

**COB4:**To train students in solving analytical problems

## MODULE I    ORAL DISCOURSE                                     07

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

## MODULE II    VERBAL COMMUNICATION                         08

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

## MODULE III    BASIC NUMERACY                                08

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

## MODULE IV    ANALYTICAL COMPETENCY                     07

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

**L – 30; TOTAL HOURS- 30**

## REFERENCES:

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

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

**COURSE OUTCOMES:**
**CO1:**Make effective business presentations
**CO2:**Speak English intelligibly, fluently and accurately in group discussions
**CO3:**To apply the various problem-solving techniques
**CO4:**Understand and solve aptitude problem

**Board of Studies (BoS) :**
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    L:9**
**                  PERFORMANCE                           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  L:9**
**SYSTEMS  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** | L | T | P | C |
|----------|--------------------------|---|---|---|---|
| SDG:9 | **MACHINERY** | 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          L:9
                ANALYSIS                              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, 9th edition, 2018.

3. Streeter V. Land Wylie, E.B "Fluid Mechanics",McGrath-Hill, 9th edition, 2017.

4. White, F.M., Fluid Mechanics", Tata McGraw-Hill, 8th 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", 10th 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):**
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 | 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:** To gain knowledge on design of shafts, keys and couplings

**COB3:** To familiarize on design of springs

**COB4:** To study the design process of bolted, riveted and welded joints

**COB5:** To acquire 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

|  | 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 SDG:9 | MATERIALS ENGINEERING AND TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 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**   **L:12**
              **OF FRACTURE**                          **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 |
|---|---|---|---|---|---|
| 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 | L:9 |
|---|---|---|
| | AND CALIBRATION | 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", 4<sup>th</sup>Edition, Vol. 2, McGraw-Hill Education, USA, 2018.
2. S.K. Hajra Choudhury, Nirjhar Roy, "Elements of Workshop technology" 15<sup>th</sup> 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 - 21<sup>st</sup> Edition, Khanna Publishers, 2004.

**REFERENCES:**
1. Serope Kalpakjian and Stephen Schmid, "Manufacturing, Engineering and Technology", 7<sup>th</sup>Edition, Pearson Education,USA, 2018.
2. Mikell P Groover, "Principles of Modern Manufacturing", 5<sup>th</sup>Edition, Wiley& Sons Pvt. Ltd, India, 2013.
3. Radhakrishanan P, "Computer Numerical Control Machining and Computer Aided Manufacturing", 1<sup>st</sup>Edition, 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):**
19<sup>th</sup> BOS held on 21.12.2021

**Academic Council:**
18<sup>th</sup> 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**   L    T    P    C

**SDG: 8**                    **FOR ENGINEERS**        0    0    2    1

## COURSE OBJECTIVES:

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

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

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

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

## MODULE  I       EXTENSIVE READING & WRITING                    07

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

## MODULE  II      INTENSIVE READING & WRITING                    08

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

## MODULE  III     QUANTITATIVE APTITUDE                    08

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

## MODULE  IV     LOGICAL COMPETENCY                    07

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

**L – 30; TOTAL HOURS - 30**

## REFERENCES:

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

Reasoning , S. Chand Limited, 2010

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

**COURSE OUTCOMES:**

**CO1:**Demonstrate reading skills with reference to business related texts

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

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

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

**Board of Studies (BoS) :**
13[th]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** | L | T | P | C |
|---|---|---|---|---|---|
| SDG: 16 | **HUMAN RIGHTS** | 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    8
ABOUT INDIAN CONSTITUTION**

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    7
DIRECTIVE PRINCIPLES**

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) :**
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 |  |  | M |  |  | H | M | L | M |  | M |  |
| CO2 |  |  | H |  |  | M | H | M |  |  | H |  |
| CO3 |  |  | M |  |  | H | M | L |  |  | L |  |
| CO4 |  |  | H |  |  | H | H | M | M |  |  | H |

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

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

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

**PROFESSIONAL ELECTIVE COURSES**
**DESIGN STREAM**

| MEDX 02 | DESIGN OF HYDRAULICS AND | L | T | P | C |
|---------|--------------------------|---|---|---|---|
| SDG:9 | PNEUMATICS | 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          L:9**
**                PUMPS**

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          L:9**
**                COMPONENTS**

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          L:9
##                       SYSTEMS

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 andPneumatic logic circuits

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

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", TataMcGraw 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):**              **Academic Council:**
19[th]BoS of MECH held on 21.12.2021     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 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", 5$^{th}$ edition, CRC Press, 2018.
2. Singiresu S Rao. "Mechanical Vibrations", 6$^{th}$ 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):**                    **Academic Council:**
19th BOS held on 21.12.2021            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.

**THERMAL STREAM**

| 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              L:8**
**                MATERIALS**

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         L:12**
**                REPROCESSING**

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 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 liquidfuels

**CO3:** elucidate the various types and properties of gaseous fuels

**CO4:** apply and analysethe thermodynamics and kinetics of combustion

| | | |
|---|---|---|
| **Board of Studies (BoS):** | **Academic Council:** | |
| 19th BOS held on 21.12.2021 | 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**

**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**     **L:10**
                     **METHODS**                                 **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 | ADVANCED CASTING AND FORMING | L | T | P | C |
|---|---|---|---|---|---|
| SDG:9 | PROCESS | 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     L:9
                CROPPING**

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.

**MATERIALS STREAM**

**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):** | **Academic Council:** |
|---|---|
| 19th BOS held on 21.12.2021 | 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.

| MEDX 89 | MATERIALS FOR ENERGY | L | T | P | C |
|---------|----------------------|---|---|---|---|
| SDG:9 | TECHNOLOGIES | 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 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):**          **Academic Council:**

19<sup>th</sup> BOS held on 21.12.2021          18<sup>th</sup> 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

## PHYSICS ELECTIVE

**PHDX 01**

**SDG: 4**

| | NON DESTRUCTIVE TESTING OF MATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 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**

**SDG: 4**

| | MATERIALS SCIENCE FOR ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 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      7**
**IMPERFECTIONS**

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     6
SCREENING OF BIOMATERIALS**

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) :**     **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 | M | L | L | M | L | M | M | M | L | L | L | M | - | - | - |
| CO2 | M | L | M | L | L | M | M | M | L | L | L | M | - | - | - |
| CO3 | M | L | H | H | L | H | M | M | L | H | L | M | - | - | - |
| CO4 | M | L | H | M | L | M | M | M | L | M | L | M | - | - | - |

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

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

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**PHDX 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) :**            **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 05**
**SDG: 4**

SEMICONDUCTOR PHYSICS FOR
INFORMATION TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**COURSE OBJECTIVES:**

**COB**1: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) :**

**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 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

SDG: 4

**FUNDAMENTALS OF NANOTECHNOLOGY AND ITS APPLICATIONS**

| L | T | P | C |
|---|---|---|---|
| 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) :**          **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.

**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) :**
11$^{th}$BoS of Chemistry held on 17.06.2021

**Academic Council:**
17$^{th}$ 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 | - | - | - | L | - | - | - | - | - | - | - | - | M | - | - |
| CO2 | - | - | - | M | - | - | - | - | - | - | - | - | M | - | - |
| CO3 | - | - | - | - | - | - | M | - | - | - | - | - | L | - | - |
| CO4 | - | - | - | M | - | - | - | - | - | - | - | - | L | - | - |

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

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

| CHDX 02 | CHEMISTRY OF MATERIALS AND | L | T | P | C |
|---------|---------------------------|---|---|---|---|
| SDG: 9  | ELECTROCHEMICAL DEVICES   | 2 | 0 | 0 | 2 |

**COURSE OBJECTIVES:**

The students will be conversant with

**COB1:** concepts of corrosion, types and various methods to control corrosion.

**COB2:** the chemicals, chemical reactions, construction and working of different batteries and fuels cells.

**COB3:** the types, properties and manufacture of refractories and abrasives.

**COB4:** types, functions of lubricants and mechanism of lubrication.

**MODULE  I          CORROSION AND ITS CONTROL          8**

Types of corrosion - chemical corrosion – electrochemical corrosion – galvanic corrosion – differential aeration corrosion - factors influencing rate of corrosion.

Corrosion control – selection of materials - cathodic protection: sacrificial anode - corrosion inhibitors – paints: constituents & functions – treatment of metal surface for inorganic coatings - metallic coatings: hot dipping: galvanizing and tinning – electroplating — electroless plating.

**MODULE  II          ELECTROCHEMICAL DEVICES          8**

Electrochemical cell, electrolytic cell - introduction to batteries – classification – primary: dry alkaline – secondary: lead–acid, nickel–cadmium and lithium batteries, Fuel cells – classification based on temperature and electrolyte - hydrogen–oxygen fuel cell, applications – solar cells: construction and working – dye sensitised solar cells.

**MODULE  III          REFRACTORIES AND ABRASIVES          7**

Refractories: Introduction - refractory - classification – based on chemical nature - characteristic and selection of good refractory - properties of refractories: refractoriness - refractoriness under load - thermal spalling - porosity and dimensional stability – general manufacture of refractory – components, properties and uses of: silica, magnesite, zirconia refractories - super refractories - application of refractories.

Abrasives: classification - Moh's scale – properties - natural abrasives: diamond, corundum, emery, garnet, quartz - synthetic abrasives: preparation,

properties and uses: carborundum, alundum, boron carbide (norbide), tungsten carbide, zirconium silicate – grinding wheel – abrasive paper and cloth - Rockwell scale test - knoop hardness test.

## MODULE IV       LUBRICANTS                                7

Introduction – functions of lubricant- mechanism of lubrication - classification of lubricant – selection of lubricants - lubricating oils - properties of lubricant: viscosity index - flash point and fire point - cloud point and pour point – oiliness - aniline point - carbon residue - semisolid: grease (sodium, calcium, lithium, aluminium) - solid lubricant: graphite, graphene, molybdenum disulphide – lubricating emulsions - cutting fluids – synthetic and semi-synthetic lubricants.

**L – 30; Total Hours– 30**

**TEXT BOOKS:**
1. Jain P.C and Monika Jain, Engineering Chemistry, Dhanpat Rai Publishing Co., New Delhi. 2016.

**REFERENCES:**
1. E. McCafferty, "*Introduction to Corrosion Science*" Springer, May 2010.
2. Tulika Sharma "*Electrochemical devices*" LAP Lambert Academic Publishing, 2011.
3. Jeffry S Gaffney, Nancy A Marley *General chemistry for engineers*, Elsevier, 2018.
4. Don M Pirro, Martin Webster, Ekkehard Daschner "*Lubrication Fundamentals*", Taylor & Francis Gp,LLC, 2016.
5. Theo Mang, Wilfred Dresel "*Lubricants and Lubrication*" Wiley-VCH, 2017

**COURSE OUTCOMES:**
The students will be able to
**CO1:** apply specific methods to control corrosion of different materials.
**CO2:** illustrate the construction and working of different types of cells, batteries and fuel cells.
**CO3:** compare the properties and devise a method of manufacture of refractories and abrasives.
**CO4:** analyze and choose the right type of lubrication based on the type of machines.

**Board of Studies (BoS) :**          **Academic Council:**
11<sup>th</sup>BoS of Chemistry held on 17.06.2021          17<sup>th</sup> 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 | L | T | P | C |
|---|---|---|---|---|---|
| | FOR ELECTRICAL AND ELECTRONIC | 2 | 0 | 0 | 2 |
| | APPLICATIONS | | | | |

**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

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      7 SOLUTIONS**

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**

**SDG: 9**

**CHEMISTRY OF FUELS, COMBUSTION AND LUBRICANTS**

| L | T | P | C |
|---|---|---|---|
| 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:**

11ᵗʰBoS of Chemistry held on    !7ᵗʰ AC held on 15.07.2021

17.06.2021

|      | 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.

| 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) :**
11[th]BoS of Chemistry held on

**Academic Council:**
!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**    **8**                                **DRUGS**

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) :**          **Academic Council:**

11thBoS of Chemistry held on 17.06.2021    17th AC held on 15.07.2021

|  | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | M | - | - | - | - | - | - | - | 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)

| | | L | T | P | C |
|---|---|---|---|---|---|
| **MADX01** | **TRANSFORMS AND PARTIAL** | | | | |
| **SDG: 4** | **DIFFERENTIAL EQUATIONS** | 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

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

**COB2:** To introduce basics and engineering applications of Fourier series

**COB3:** To develop Fourier transform techniques

**COB4:** To introduce analytic solutions of PDEs by using  Fourier series

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

## MODULE  I    PARTIAL DIFFERENTIAL EQUATIONS                    9+3

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

## MODULE  II    FOURIER SERIES                    9+3

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

## MODULE  III    FOURIER TRANSFORMS                    9+3

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

## MODULE  IV   APPLICATIONS OF FOURIER SERIES                    9+3

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

## MODULE V   Z – TRANSFORM                                              9+3

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

**L – 45 ; T - 15; TOTAL HOURS – 60**

### TEXT BOOKS:

1   Kreyszig .E., "Advanced Engineering Mathematics", 10$^{th}$ edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2011.

2.  Grewal B.S., "Higher Engineering Mathematics", 44$^{th}$ 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", 5$^{th}$ edition, Tata Mc Graw Hill Publishing Co. New Delhi, 2012.

2.  Peter V. O'Neil, "Advanced Engineering Mathematics", 7$^{th}$ edition, Cengage Learning, 2011.

3.  Dennis G. Zill, Warren S. Wright, "Advanced Engineering Mathematics", 4$^{th}$ 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) :**               **Academic Council:**

12$^{th}$ BOS of Mathematics & AS held on      17$^{th}$ AC held on 15.07.2021

23.06.2021

| | 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  9+3**
**                       FUNCTIONS**

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

**MADX04**
**SDG: 4**

**RANDOM PROCESSES**

L   T   P   C

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  9+3**
**                DISTRIBUTIONS**

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) :**
12$^{th}$ BOS of Mathematics & AS held on 23.06.2021

**Academic Council:**
17$^{th}$ 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    | 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**    **9+3**
                        **INTEGRATION**

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**    **9+3**
                        **ORDER ORDINARY DIFFERENTIAL**
                        **EQUATIONS**

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) :** | **Academic Council:** |
|---|---|
| 12th BOS of Mathematics and AS department held 23.06.2021 | 17th AC held on 15.07.2021 |

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | 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 | L | T | P | C |
| --- | --- | --- | --- | --- | --- |
| SDG: 4, 8, 9,12 | AND MANAGEMENT | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

**COB1:** To present the major concepts and techniques of engineering economic analysis that is needed in the decision making process by providing insights to the basic microeconomic concepts of demand, supply and equilibrium.

**COB2:** To generate theoretical knowledge and understanding of macroeconomic aggregates such as national income and inflation and the major challenges associated with the measurement of these aggregates.

**COB3:** To develop analytical and critical thinking skills on money, banking and public finance and use them to judge the appropriateness of economic development and policy options.

**COB 4:** To introduce the basic concepts of management and planning and highlight the contribution of planning to the attainment of organization's objectives.

**COB 5:** To apprise the students about important management concepts and create awareness about the corporate social responsibilities and ethical aspects.

**MODULE  I               DEMAND AND SUPPLY ANALYSIS               9**

Introduction to Engineering Economics – Engineering efficiency – Economic efficiency - Scope of Engineering Economics, Engineers' contributions to economic growth- Problem solving and decision making - Laws of Demand and Supply - Difference between Microeconomics and Macroeconomics - Equilibrium between Demand and Supply, Elasticity of Demand - Pricing strategies.

**MODULE  II               NATIONAL INCOME AND INFLATION               8**

Concepts of National Income and measurement – GDP Growth Rate - Importance and difficulties of estimating National Income in India - Aggregate demand and aggregate supply, Macroeconomic equilibrium – Meaning of Inflation, its types causes and preventive measures.

**MODULE  III               MONEY, BANKING AND PUBLIC FINANCE      10**

Money – Meaning, types, functions, importance - Commercial Banks -

Central Bank - Monetary Policy – meaning, objectives, Methods of Credit Control By RBI, Government Budget – Government revenue and expenditures – Fiscal policy - Its objectives, instruments and limitations - Deficit Financing - The Fiscal Responsibility and Budget Management Act, 2003 (FRBMA) – Economic Reforms in India – LPG Policy.

**MODULE IV          PRINCIPLES OF MANAGEMENT AND          8
                     PLANNING**

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    9
##               AND CHANGE

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) :**

5<sup>th</sup>BoS of SSSH held on 29.12.2021

**Academic Council:**

18<sup>th</sup> 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** | L | T | P | C |
| SDG: 8 and 9 | **MANAGEMENT** | 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) :**         **Academic Council:**

Mention details of BoS         18th Academic council held on

5thBoS of SSSH held on 29.12.2021       24.02.2022

|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | 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**　　L　T　P　C

**SDG: 10, 16**　　　　　　　　　　**STRUCTURE**　　　　　3　0　0　3

## COURSE OBJECTIVES:

**COB1:** To provide knowledge on the components of the Indian social structure.

**COB2:** To learn the nature and contemporary structure of Indian social institutions.

**COB3:** To sensitize students about social stratification in Indian Society.

**COB4:** To create awareness about the social problems occurring in contemporary India.

**COB5:** To explicate the changing institutions, the processes, the agents and the interventions that brings about change in the Indian society.

**MODULE  I**　　　　　**INDIAN SOCIAL STRUCTURE**　　　　　　9

Demographic composition - Racial, religious, ethnic and linguistic -Types of communities - rural, urban, agrarian and tribal - Social backwardness - OBC, SC, ST and  EWS - Indian minorities- religious, ethnic, linguistic and LGBT.

**MODULE  II**　　　　　**INDIAN SOCIAL INSTITUTIONS**　　　　　9

Family - types, characteristics, functions of family - Joint Family- definition features, functions of joint family , dysfunctions of joint family, disintegration of joint family – Marriage - definition, characteristics, marriage as sacrament or contract.

**MODULE III** **SOCIAL STRATIFICATION IN INDIA**　　　9

Social stratification - Concept of hierarchy - inequality, meaning and characteristics - Social Stratification and Social Mobility - Functions of Social Stratification - Caste, definition, principles, contemporary changes, dominant caste - Caste - class interface - Religious minorities.

**MODULE  IV**　　　　　**SOCIAL PATHOLOGY**　　　　　　　9

Social Problem - nature, social disorganization - Population explosion- causes, effects, relationship with development - Child Labour- causes, magnitude and consequences – Unemployment - nature, types, causes and effects -  Gender issues - social status of women, violence against women and women in work place - Contemporary issues - communalism, terrorism and corruption.

## MODULE V      SOCIAL CHANGE IN INDIA      9

Socio-cultural change - Sanskritization – Westernization - Secularization, Modernization - Processes of Social change - Industrialization – Urbanization – Globalization - Social movement - concept, characteristics, functions - New social movement-Women and Environment movement.

**L – 45; Total Hours –45**

### TEXT BOOKS:

1. Sharma,K.L., "Indian Social Structure and Change", Jaipur: Rawat Publications, 2008.
2. Ahuja Ram., "Social Problems in India", Rawat Publication: New Delhi, 2014.
3. Ahuja Ram., "Society in India", Rawat Publication: New Delhi, 2014.

### REFERENCES:

1. Atal Yogesh, "Changing Indian Society" Rawat Publications, Jaipur, 2006.
2. Dube S.C., "India's Changing Villages: Human Factors in Community Development", London, Routledge and Kegan Paul, 2003.
3. Hasnain N., "Indian Society: Themes and Social Issues", Mc Graw Hill, 2019.
4. Jayapalan, N., "Indian Society and Social Institutions" Atlantic Publishers, 2001.
5. Pandey Vinita., "Indian Society and Culture", Rawat Publications, New Delhi, 2016
6. Rao Sankar., "Sociology of Indian Society", S. Chand Publisher, New Delhi, 2004.

### COURSE OUTCOMES:

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

**CO1:** explain about the social structure and social institutions that constitute society in India.

**CO2:** differentiate the various categories of inequalities and their challenges.

**CO3:** describe the social stratification and its impact in society.

**CO4:** analyze the social problems encountered in contemporary India.

**CO5:** correlate the various forms and trends of the social change in Indian society and realize the relevance of their role in bringing about development.

**Board of Studies (BoS) :**
5<sup>th</sup>BoS of SSSH held on 29.12.2021

**Academic Council:**
18<sup>th</sup> 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.