NARASARAOPETA ENGINEERING COLLEGE (AUTONOMOUS)

Course Structure and Syllabus

(R23 Regulations)

Mechanical Engineering

B.Tech – I, II & III Year
(Applicable for the Batches admitted from 2023-2024)

NEC NARASARAOPETA ENGINEERING COLLEGE (AUTONOMOUS)

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Kotappakonda Road, Yellamanda (P.O), Narasaraopet – 522601, Palnadu District, AP
(Sponsored by Gayatri Educational Development Society), Narasaraopet.
Approved by AICTE, New Delhi & Permanently Affiliated to JNTUK, Kakinada, Code: 47.
Accredited by NBA (Tier 1), NAAC "A+" Grade. NIRF: 2022 (251-300 Band),
RTA Approved Pollution test Centre, & ISO 9001: 2015 Certified Institution.
Phone: 08647-239923 **Website: www.nrtec.in**

Academic Regulations (R23) for B.Tech. (Regular)

(Effective for the students admitted into I year from the Academic Year 2023-2024 onwards)

1. Award of the Degree

(a) Award of the B.Tech. Degree / B.Tech. Degree with a Minor if he/she fulfilsthe following:

(i) Pursues a course of study for not less than four academic years and not more than eight academic years. However, for the students availing Gapyear facility this period shall be extended by two years at the most and these two years would in addition to the maximum period permitted forgraduation (Eight years).

(ii) Registers for 160 credits and secures all 160 credits.

(b) Award of B.Tech. Degree with Honors

A student will be declared eligible for the award of the B.Tech with Honors ifhe/she fulfils the following:

(i) Student secures additional 15 credits fulfilling all the requisites of aB.Tech. Program i.e., 160 credits.

(ii) Registering for Honors is optional.

(iii) Honors is to be completed simultaneously with B.Tech. programme.

2. Students, who fail to fulfil all the academic requirements for the award of the degree within eight academic years from the year of their admission, shall forfeit their seat inB.Tech. Course and their admission stands cancelled. This clause shall be read along with clause 1 a) i).

3. Admissions

Admission to the B.Tech Program shall be made subject to the eligibility, qualificationsand specialization prescribed by the A.P. State Government/University from time to time. Admissions shall be made either based on the merit rank obtained by the studentin the common entrance examination conducted by the A.P. Government/University or any other order of merit approved by the A.P. Government/University, subject to reservations as prescribed by the Government/University from time to time.

4. Program related terms

Credit: A unit by which the course work is measured. It determines the number of hoursof instruction required per week. One credit is equivalent to one hour of teaching (Lecture/Tutorial) or two hours of practical work/field work per week.

Credit definition:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credit
2 Hrs. Practical (Lab) per week	1 credit

a) Academic Year: Two consecutive (one odd + one even) semesters constitute one academic year.

b) Choice Based Credit System (CBCS): The CBCS provides a choice for studentsto select from the prescribed courses.

5. Semester/Credits:

i) A semester comprises 90 working days and an academic year is divided into two semesters.

ii) The summer term is for eight weeks during summer vacation. Internship/ apprenticeship / work-based vocational education and training can be carried out during the summer term, especially by students who wish to exit after two semesters or four semesters of study.

iii) Regular courses may also be completed well in advance through MOOCs satisfying prerequisites.

6. Structure of the Undergraduate Programme

All courses offered for the undergraduate program (B.Tech.) are broadly classified as follows:

S. No.	Category	Breakup of Credits (Total 160)	Percentage of total credits	AICTE Recommendation (%)
1.	Humanities and Social Science including Management (HM)	13	8 %	8 – 9%
2.	Basic Sciences (BS)	20	13 %	12 - 16%
3.	Engineering Sciences (ES)	23.5	14%	10 – 18%
4.	Professional Core (PC)	54.5	34 %	30 – 36%
5.	Electives – Professional (PE) & Open (OE); Domain Specific Skill Enhancement Courses(SEC)	33	21 %	19 - 23%
6.	Internships & Project work (PR)	16	10 %	8 – 11%
7.	Mandatory Courses (MC)	Non-credit	Non-credit	-

7. Course Classification:

All subjects/ courses offered for the undergraduate programme in Engineering & Technology (B.Tech. degree programmes) are broadly classified as follows:

S.No.	Broad Course Classification	Course Category	Description
1.	Foundation Core Courses	Foundation courses	Includes Mathematics, Physics and Chemistry; fundamental engineering courses; humanities, socialsciences and management courses
2.	Core Courses	Professional Core Courses (PC)	Includes subjects related to the discipline/department/branch of parent Engineering
3.	Elective Courses	Professional ElectiveCourses (PE)	Includes elective subjects related to the parent discipline/department/ branch of Engineering
		Open Elective Courses (OE)	Elective subjects which include interdisciplinary subjects or subjects in an area outside the parent discipline/ department/ branch of Engineering
		Domain specific skillenhancement courses (SEC)	Interdisciplinary/job-oriented/domain courses whichare relevant to the industry
4.	Project & Internships	Project	B.Tech. Project or Major Project
		Internships	Summer Internships – Community based and Industry Internships; Industry oriented Full Semester Internship
5.	Audit Courses	Mandatory non-credit courses	Covering subjects of developing desired attitude among the learners

8. Programme Pattern

i. Total duration of the B.Tech (Regular) Programme is four academic years.
ii. Each academic year of study is divided into two semesters.
iii. Minimum number of instruction days in each semester is 90 days.
iv. There shall be mandatory student induction program for freshers, with a three- week duration before the commencement of first semester. Physical activity, Creative Arts, Universal Human Values, Literary, Proficiency Modules, Lectures by Eminent People, Visits to local Areas, Familiarization to Dept./Branch & Innovations etc., are included as per the guidelines issued by AICTE.
v. Health/wellness/yoga/sports and NCC /NSS /Scouts & Guides / Community service activities are made mandatory as credit courses for all the undergraduatestudents.
vi. Courses like Environmental Sciences, Indian Constitution, and Technical Paper Writing & IPR are offered as non-credit mandatory courses for all the undergraduate students.
vii. Design Thinking for Innovation & Tinkering Labs are made mandatory as creditcourses for all the undergraduate students.
viii. Increased flexibility for students through an increase in the elective component of the curriculum, with 05 Professional Elective courses and 04 Open Elective courses.
ix. Professional Elective Courses, include the elective courses relevant to the chosen specialization/branch. Proper choice of professional elective courses can lead to students specializing in emerging areas within the chosen field of study.
x. A total of 04 Open Electives are offered in the curriculum. A student can complete the requirement for B.Tech. Degree with a Minor within the 160 credits by opting for the courses offered through various verticals/tracks under Open Electives.
xi. While choosing the electives, students shall ensure that they do not opt for the courses with syllabus contents similar to courses already pursued.
xii. A pool of interdisciplinary/job-oriented/domain skill courses which are relevant to the industry are integrated into the curriculum of all disciplines. There shall be 05 skill-oriented courses offered during III to VII semesters. Among the fiveskill courses, four courses shall focus on the basic and advanced skills related to the domain/interdisciplinary courses and the other shall be a soft skills course.
xiii. Students shall undergo mandatory summer internships, for a minimum of eight weeks duration at the end of second and third year of the programme. The internship at the end of second year shall be community oriented and industry internship at the end of third year.
xiv. There shall also be mandatory full internship in the final semester of the programme along with the project work.
xv. Undergraduate degree with Honors is introduced by the College for the students having good academic record.
xvi. College will plan to implement Virtual Labs (https://www.vlab.co.in) which provide remote access to labs in various disciplines of Engineering and will help student in learning basic and advancedconcept through remote experimentation. Student shall be made to work on virtual lab experiments during the regular labs.
xvii. College will assign a faculty advisor/mentor after admission to a group of students from same department to provide guidance in courses registration/career growth/placements/opportunities for higher studies/GATE/other competitive exams etc.
xviii. Preferably 25% of course work for the theory courses in every semester shallbe conducted in the blended mode of learning.

9. Evaluation Process

The performance of a student in each semester shall be evaluated subject wise with a maximum of 100 marks for theory and 100 marks for practical subject. Summer Internships shall be evaluated for 50 marks, Full Internship & Project work in final semester shall be evaluated for 200 marks, and mandatory courses with no credits shall be evaluated for 30 mid semester marks. A student has to secure not less than 35% of marks in the end examination and a minimum of 40% of marks in the sum total of the mid semester and end examination marks taken together for the theory, practical, design, drawing subject or project etc. Incase of a mandatory course, he/she should secure 40% of the total marks.

THEORY COURSES

Assessment Method	Marks
Continuous Internal Assessment	30
Semester End Examination	70
Total	100

i) For theory subject, the distribution shall be 30 marks for Internal Evaluation and 70marks for the End-Examination.

ii) For practical subject, the distribution shall be 30 marks for Internal Evaluation and70 marks for the End- Examination.

iii) If any course contains two different branch subjects, the syllabus shall be written intwo parts with 3 units each (Part-A and Part-B) and external examination question paper shall be set with two parts each for 35 marks.

iv) If any subject is having both theory and practical components, they will be evaluated separately as theory subject and practical subject. However, they will be given the same subject code with an extension of "T" for theory subject and "P" for practical subject.

a) Continuous Internal Evaluation

i) For theory subjects, during the semester, there shall be two midterm examinations.Each midterm examination shall be evaluated for 30 marks of which 10 marks for objective paper (20 minutes duration), 15 marks for subjective paper (90 minutes duration) and 5 marks for assignment.

ii) Objective paper shall contain 05 short answer questions with 2 marks each or maximum of 20 bits for 10 marks. Subjective paper shall contain 3 either or type questions (totally six questions from 1 to 6) of which student has to answer one from each either-or type of questions. Each question carries 10 marks. The marks obtained in the subjective paper are condensed to 15 marks.

Note:

- The objective paper shall be prepared in line with the quality of competitive examinations questions.
- The subjective paper shall contain 3 either or type questions of equal weightageof 10 marks. Any fraction shall be rounded off to the next higher mark.
- The objective paper shall be conducted either online or offline by the respectivedepartment on the day of subjective paper test.
- If conducted offline, the midterm examination shall be conducted first by distribution of the Objective paper, simultaneously marking the attendance, after 20 minutes the answered objective paper shall be collected back. The student is not allowed to leave the examination hall. Then the descriptive question paper and the answer booklet shall be distributed.After 90 minutes the answered booklets are collected back.

- Assignments shall be in the form of problems, mini projects, design problems, slip tests, quizzes etc., depending on the course content. It should be continuousassessment throughout the semester and the average marks shall be considered.
- Assignment Test if conducted like slip tests, the following procedure may be followed: Two assignment tests may be conducted before first and second mid examinations for 5 marks. First assignment test may be conducted after the 1st Unit of syllabus. 5 or 6 questions may be announced in advance. On the day of test, 2 questions will be given to each student randomly. The test may be conducted in the first hour for 30 minutes. Second assignment test may be conducted in the similar way after the completion of 3rd Unit of syllabus.

iii) If the student is absent for the mid semester examination, no re-exam shall be conducted and mid semester marks for that examination shall be considered as zero.

iv) First midterm examination shall be conducted for I, II units of syllabus with one either or type question from each unit and third either or type question from both the units. The second midterm examination shall be conducted for III, IV and V units with one either or type question from each unit.

v) Final mid semester marks shall be arrived at by considering the marks secured by the student in both the mid examinations with 80% weightage given to the better mid exam and 20% to the other.

For Example:
Marks obtained in first mid: 25 Marks obtained in second mid: 20
Final mid semester Marks: (25x0.8) + (20x0.2) = 24
If the student is absent for any one midterm examination, the final mid semester marks shall be arrived at by considering 80% weightage to the marks secured by the student in the appeared examination and zero to the other. For Example:
Marks obtained in first mid: AbsentMarks obtained in second mid: 25
Final mid semester Marks: (25x0.8) + (0x0.2) =20

b) End Examination Evaluation:

End examination of theory subjects shall have the following pattern:

i) There shall be 6 questions and all questions are compulsory.

ii) Question I shall contain 10 compulsory short answer questions for a total of20 marks such that each question carries 2 marks.

iii) There shall be 2 short answer questions from each unit.

iv) In each of the questions from 2 to 6, there shall be either/or type questions of 10 marks each. Student shall answer any one of them.

v) The questions from 2 to 6 shall be set by covering one unit of the syllabus for eachquestion.

End examination of theory subjects consisting of two parts of different subjects, for Example: Basic Electrical &Electronics Engineering shall have the following pattern:

i) Question paper shall be in two parts viz., Part A and Part B with equal weightage of 35marks each.

ii) In each part, question 1 shall contain 5 compulsory short answer questions for a totalof 5 marks such that each question carries 1mark.

iii) In each part, questions from 2 to 4, there shall be either/or type questions of 10 markseach. Student shall answer any one of them.

iv) The questions from 2 to 4 shall be set by covering one unit of the syllabus for each question.

PRACTICAL COURSES

Assessment Method	Marks
Continuous Internal Assessment	30
Semester End Examination	70
Total	100

a) For practical courses, there shall be a continuous evaluation during the semester for 30 sessional marks and end examination shall be for 70 marks.

b) Day-to-day work in the laboratory shall be evaluated for 15 marks by the concernedlaboratory teacher based on the regularity/record/viva and 15 marks for the internaltest.

c) The end examination shall be evaluated for 70 marks, conducted by the concernedlaboratory teacher and External examiner from the other reputed Institutions.

- Procedure: 20 marks
- Experimental work & Results: 30 marks
- Viva voce: 20 marks.

In a practical subject consisting of two parts (Eg: Basic Electrical &Electronics Engineering Lab), the end examination shall be conducted for 70 marks as a singlelaboratory in 3 hours. Mid semester examination shall be evaluated as above for 30 marks in each part and final mid semester marks shall be arrived by considering the average of marks obtained in two parts.

d) For the subject having design and/or drawing, such as Engineering Drawing, the distribution of marks shall be 30 for mid semester evaluation and 70 for end examination.

Assessment Method	Marks
Continuous Internal Assessment	30
Semester End Examination	70
Total	100

Day-to-day work shall be evaluated for 15 marks by the concerned subject teacherbased on the reports/submissions prepared in the class. And there shall be two midterm examinations in a semester for duration of 2 hours each for 15 marks withweightage of 80% to better mid marks and 20% for the other. The subjective papershall contain 3 either or type questions of equal weightage of 5 marks. There shallbe no objective paper in mid semester examination. The sum of day-to-dayevaluation and the mid semester marks will be the final sessional marks for the subject.

The end examination pattern for Engineering Graphics, shall consists of 5 questions, either/or type, of 14 marks each. There shall be no objective type questions in the end examination. However, the end examination pattern for other subjects related to design/drawing, multiple branches, etc is mentioned along withthe syllabus.

10. There shall be no external examination for mandatory courses with zero credits. However, attendance shall be considered while calculating aggregate attendance and student shall be declared to have passed the mandatory course only when he/she secures 40% or more in the internal examinations. In case, the student fails,a re-examination shall be conducted for failed candidates for 30 marks satisfying the conditions mentioned in item 1 & 2 of the regulations. Skill oriented Courses.

i) There shall be five skill-oriented courses offered during III to VII semesters.
ii) Out of the five skill courses two shall be skill-oriented courses from the same domain of the remaining three skill courses, one shall be a soft skill course and theremaining two shall be skill-advanced courses from the same domain/Interdisciplinary/Job oriented.
iii) The course shall carry 100 marks and shall be evaluated through continuous assessments during the semester for 30 sessional marks and end examination shallbe for 70 marks. Day-to-day work in the class / laboratory shall be evaluated for 30 marks by the concerned teacher based on the regularity/assignments/viva/mid semester test. The end examination similar to practical examination pattern shall be conducted by the concerned teacher and an expert in the subject nominated by the Principal.
iv) The Head of the Department shall identify a faculty member as coordinator for thecourse. A committee consisting of the Head of the Department, coordinator and a senior Faculty member nominated by the Head of the Department shall monitor theevaluation process. The marks/grades shall be assigned to the students by the above committee based on their performance.
v) The student shall be given an option to choose either the skill courses being offeredby the college or to choose a certificate course being offered by industries/Professional bodies or any other accredited bodies. If a student chooses to take a Certificate Course offered by external agencies, the credits shall be awarded to the student upon producing the Course Completion Certificate from theagency. A committee shall be formed at the level of the college to evaluate the grades/marks given for a course by external agencies and convert to the equivalentmarks/grades.
vi) The recommended courses offered by external agencies, conversions and appropriate grades/marks are to be approved by the concerted department's HOD at the beginning of the semester.
vii) If a student prefers to take a certificate course offered by external agency, the department shall mark attendance of the student for the remaining courses in that semester excluding the skill course in all the calculations of mandatory attendance requirements upon producing a valid certificate as approved by the Principal.

11. Massive Open Online Courses (MOOCs):

A Student has to pursue and complete one course compulsorily through MOOCs approved by the HOD. A student can pursue courses other than core through MOOCs and it is mandatory to complete one course successfully through MOOCs for awarding the degree. A student is not permitted to register and pursue core courses through MOOCs.

A student shall register for the course (Minimum of either 8 weeks or 12 weeks) offeredthrough MOOCs with the approval of Head of the Department. The Head of the Department shall appoint one mentor to monitor the student's progression. The studentneeds to earn a certificate by passing the exam. The student shall be awarded the creditsassigned in the curriculum only by submission of the certificate. Examination fee, if any, will be borne by the student.

Students who have qualified in the proctored examinations conducted through MOOCsplatform can apply for credit transfer as specified and are exempted from appearing internal as well as external examination (for the specified equivalent credit course only)conducted by the College.

Necessary amendments in rules and regulations regarding adoption of MOOC courseswould be proposed from time to time.

12. Credit Transfer Policy

Adoption of MOOCs is mandatory, to enable Blended model of teaching-learning as also envisaged in the NEP 2020. As per University Grants Commission (Credit Framework for Online Learning Courses through SWAYAM) Regulation, 2016, the College shall allow up to a maximum of 20% of the total courses being offered in a particular programme i.e., maximum of 32 credits through MOOCs platform.

i) The College shall offer credit mobility for MOOCs and give the equivalent credit weightage to the students for the credits earned through online learningcourses.
ii) Student registration for the MOOCs shall be only through the respective department, it is mandatory for the student to share necessary information with the department.
iii) Credit transfer policy will be applicable to the Professional & Open Elective courses only.
iv) The concerned department shall identify the courses permitted for credit transfer.
v) The concerned department shall notify at the beginning of semester the list of the online learning courses eligible for credit transfer.
vi) The department's HOD will designate a faculty member as a Mentor for each course to guide the students from registration till completion of the credit course.
vii) The College will ensure no overlap of MOOC exams with that of the End Semester examination schedule.
viii) Student pursuing courses under MOOCs shall acquire the required credits only after successful completion of the course and submitting a certificate issued bythe competent authority along with the percentage of marks and grades.
ix) The Department shall submit the following to the examination section:
    a) List of students who have passed MOOC courses in the current semester along with the certificate of completion.
    b) Undertaking form filled by the students for credit transfer.
x) The College shall resolve any issues that may arise in the implementation of this policy from time to time and shall review its credit transfer policy in the light of periodic changes brought by UGC, SWAYAM, NPTEL and State Government.

Note: Students shall be permitted to register for MOOCs offered through online platforms approved by the respective Department from time to time.

13. Academic Bank of Credits (ABC)

The College has implemented Academic Bank of Credits (ABC) to promote flexibility in curriculum as per NEP 2020 to

i. provide option of mobility for learners across the universities of their choice
ii. Provide option to gain the credits through MOOCs from approved digitalplatforms.
iii. facilitate award of certificate/diploma/degree in line with the accumulatedcredits in ABC
iv. Execute Multiple Entry and Exit system with credit count, credit transfer andcredit acceptance from student's account.

14. Mandatory Internships

Summer Internships

Two summer internships either onsite or virtual each with a minimum of 08 weeks duration, done at the end of second and third years, respectively are mandatory. It shallbe completed in collaboration with local industries, Govt. Organizations, construction agencies, Power projects, software MNCs or any industries in the areas of concerned specialization of the Undergraduate program. One of the two summer internships at theend of second year (Community Service Project) shall be society oriented and shall becompleted in collaboration with government organizations/NGOs & others.

The other internship at the end of third year is Industry Internship and shall be completed in collaboration with Industries. The student shall register for the internship as per course structure after commencement of academic year. The guidelines issued by the APSCHE / University shall be followed for carrying out and evaluation of Community Service Project and Industry Internship.

Evaluation of the summer internships shall be through the departmental committee. A student will be required to submit a summer internship report to the concerned department and appear for an oral presentation before the departmental committee comprising of Head of the Department, supervisor of the internship and a senior facultymember of the department. A certificate of successful completion from industry shall be included in the report. The report and the oral presentation shall carry 50% weightageeach. It shall be evaluated for 50 external marks. There shall be no internal marks for Summer Internship. A student shall secure minimum 40% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the College.

Full Semester Internship and Project work:

In the final semester, the student should mandatorily register and undergo internship (onsite/virtual) and in parallel he/she should work on a project with well-defined objectives. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship.

The project report shall be evaluated with an external examiner. The total marks for project work is 200 marks and distribution shall be 60 marks for internal and 140 marks for external evaluation. The supervisor assesses the student for 30 marks (Report: 15 marks, Seminar: 15 marks). At the end of the semester, all projects shall be showcasedat the department for the benefit of all students and staff and the same is to be evaluatedby the departmental Project Review Committee consisting of supervisor, a senior faculty and HOD for 30 marks. The external evaluation of Project Work is a Viva-VoceExamination conducted in the presence of internal examiner and external examiner appointed by the Principal and is evaluated for 140 marks.

The HOD shall facilitate and monitor the student internship programs. Completion ofinternships is mandatory, if any student fails to complete internship, he/she will not beeligible for the award of degree. In such cases, the student shall repeat and complete the internship.

15. Guidelines for offering a Minor

To promote interdisciplinary knowledge among the students, the students admitted into B.Tech. in a major stream/branch are eligible to obtain degree in Minor in another stream.

i) The Minor program requires the completion of 12 credits in Minor stream chosen.
ii) Two courses for 06 credits related to a Minor are to be pursued compulsorily for the minor degree, but may be waived for students who have done similar/equivalentcourses. If waived for a student, then the student must take an extra elective course in its place. It is recommended that students should complete the compulsory courses (or equivalents) before registering for the electives.
iii) Electives (minimum of 2 courses) to complete a total of 12 credits.

Note: A total of 04 Open Electives are offered in the curriculum. A student can complete the requirement for Minor within the 160 credits by opting for the courses offered through various verticals/tracks under Open Electives.

16. Guidelines for offering Honors

The objective of introducing B.Tech. (Hons.) is to facilitate the students to choose additionally the specialized courses of their choice and build their competence in a specialized area in the UG level. The programme is a best choice for academically excellent students having good academic record and interest towards higher studies andresearch.

i) Honors is introduced in the curriculum of all B.Tech. Programs offering a major degree and is applicable to all B.Tech (Regular and Lateral Entry) students admitted in Engineering & Technology.

ii) A student shall earn additional 15 credits (4 theory courses of 3 credits each and One MOOC course of 3 credits) for award of B.Tech. (Honors) degree from same branch/department/discipline registered for major degree. This is in addition to the credits essential for obtaining the Undergraduate degree in Major Discipline (i.e., 160 credits).

iii) A student is permitted to register for Honors in IV semester after the results of III Semester are declared and students may be allowed to take maximum one subject per semester pertaining to the Honors from IV Semester onwards.

iv) The college will arrange separate class work and timetable of the courses offered under Honors program.

v) Courses that are used to fulfil the student's primary major may not be double counted towards the Honors. Courses with content substantially equivalent to courses in the student's primary Major may not be counted towards the Honors.

vi) Students can complete the MOOC course in online platforms like SWAYAM with a minimum duration of 12 weeks for 3-credits satisfying the criteria for credit mobility. Student can register for online MOOC course in any semester starting from the 4th Semester. Should submit the MOOC certificate before the commencement of 7th Semester End Examinations. For the 4 theory courses offered by the college, the teaching and evaluation procedure shall be similar to regular B.Tech courses.

vii) The attendance for the registered courses under Honors and regular courses offered for Major degree in a semester are to be considered separately.

viii) A student shall maintain an attendance of 75% in all registered courses under Honors to be eligible for attending semester end examinations.

ix) A student registered for Honors shall pass in all subjects that constitute the requirement for the Honors degree program. No class/division (i.e., second class, first class and distinction, etc.) shall be awarded for Honors degree programme. Honors courses should be completed in a single attempt otherwise the registration for honors stands cancelled.

x) If a student drops or is terminated from the Honors program, the additional credits so far earned cannot be converted into open or core electives; they will remain extra. However, such students will receive a separate grade sheetmentioning the additional courses completed by them.

xi) The Honors will be mentioned in the degree certificate as Bachelor of Technology (Honors) in XYZ. For example, B.Tech. (Honors) in Mechanical Engineering.

xii) Student who registered for Honors should pass all subsequent regular semester courses in a single attempt with a minimum of 7 SGPA.

Enrolment into Honors:

i) Students of a Department/Discipline are eligible to opt for Honors program offered by the same Department/Discipline

ii) The enrolment of student into Honors is based on the SGPA obtained in each semester in the major degree program. 7 SGPA shall be maintained in all semesters up to III semester in case of regularentry students and only III semester in case of lateral entry students. Students having 7 SGPA (in all semesters) without any backlog subjects will be permitted to register

for Honors.

iii) If a student is detained due to lack of attendance either in Major or in Honors, registration shall be cancelled.

iv) Transfer of credits from Honors to regular B.Tech degree and vice-versa shall not be permitted.

v) Honors is to be completed simultaneously with a Major degree program.

Registration for Honors:

i) The eligible and interested students shall apply through the HOD of his/her parent department. Selected students shall be permitted to register the courses under Honors.

ii) The selected students shall submit their willingness to the principal through his/her parent department offering Honors. The parent department shall maintain the record of student pursuing the Honors.

iii) The students enrolled in the Honors courses will be monitored continuously. An advisor/mentor from parent department shall be assigned to a group of studentsto monitor the progress.

iv) There is no fee for registration of subjects for Honors program offered in offlinemode.

17. Attendance Requirements:

i) A student shall be eligible to appear for the University external examinations if he/she acquires a minimum of 40% attendance in each subject and 75% of attendance in aggregate of all the subjects. b) Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.

ii) Shortage of Attendance below 65% in aggregate shall in NO CASE be condoned.

iii) A stipulated fee shall be payable towards condonation of shortage of attendance to the College.

iv) Students whose shortage of attendance is not condoned in any semester are noteligible to take their end examination of that class and their registration shall stand cancelled.

v) A student will not be promoted to the next semester unless he satisfies the attendance requirements of the present semester. They may seek readmission for that semester from the date of commencement of class work.

vi) If any candidate fulfils the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

vii) If the learning is carried out in blended mode (both offline & online), then the total attendance of the student shall be calculated considering the offline and online attendance of the student.

viii) For induction programme attendance shall be maintained as per AICTEnorms.

18. Promotion Rules:

The following academic requirements must be satisfied in addition to the attendance requirements mentioned in section 16.

i) A student shall be promoted from first year to second year if he/she fulfils the minimum attendance requirement as per College norms.

ii) A student will be promoted from II to III year if he/she fulfils the academic requirement of securing 40% of the credits (any ***decimal*** fraction should be ***rounded off*** to ***lower*** digit) up to in the subjects that have been studied up to III semester.

iii) A student shall be promoted from III year to IV year if he/she fulfils the academic requirements of securing 40% of the credits (any ***decimal*** fraction should be ***rounded off*** to ***lower*** digit) in the subjects that have been studied up to V semester. And in case a student is detained for want of credits for a particular academic year by ii) & iii) above, the student

may make up the credits through supplementary examinations and only after securing the required credits he/she shall be permitted to join in the V semester or VII semester respectively as the case may be.

iv) When a student is detained due to lack of credits/shortage of attendance he/she maybe re-admitted when the semester is offered after fulfilment of academic regulations. In such case, he/she shall be in the academic regulations into which he/she is readmitted.

19. Grading:

As a measure of the student's performance, a 10-point Absolute Grading System usingthe following Letter Grades and corresponding percentage of marks shall be followed:

After each course is evaluated for 100 marks, the marks obtained in each course will beconverted to a corresponding letter grade as given below, depending on the range in which the marks obtained by the student fall.

Structure of Grading of Academic Performance

Range in which the marksin the subject fall	Grade	Grade points Assigned
90 & above	S (Superior)	10
80 - 89	A (Excellent)	9
70 - 79	B (Very Good)	8
60 - 69	C (Good)	7
50 - 59	D (Average)	6
40 - 49	E (Pass)	5
< 40	F (Fail)	0
Absent	Ab (Absent)	0

i) A student obtaining Grade 'F' or Grade 'Ab' in a subject shall be considered failed andwill be required to reappear for that subject when it is offered in the next supplementary examination.

ii) For non-credit audit courses, "Satisfactory" or "Unsatisfactory" shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA/Percentage.

Computation of Semester Grade Point Average (SGPA) and Cumulative GradePoint Average (CGPA):

The Semester Grade Point Average (SGPA) is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.,

$$SGPA = \Sigma (Ci \times Gi)/\Sigma Ci$$

Where, Ci is the number of credits of the ith subject and Gi is the grade point scored by the student in the ith course.

The Cumulative Grade Point Average (CGPA) will be computed in the same manner considering all the courses undergone by a student over all the semesters of a program, i.e.,

$$CGPA = \Sigma (Ci \times Si)/ \Sigma Ci$$

Where "Si" is the SGPA of the ith semester and Ci is the total numberof credits up to that semester.

Both SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Semester Grade Point Average (SGPA) for a semster will be computed only for those students, who have successfully passed all the courses of that semester. Similarly Cumulative Grade Point Average (CGPA) will be computed for the current semester only for those candidates who successfully completed all the courses starting from the 1st Semester to the Current Semester.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale. Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by the letters S, A, B, C, D, E and F.

Award of Class:

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B.Tech. Degree, he/she shall be placed in oneof the following four classes:

Class Awarded	CGPA Secured
First Class with Distinction	≥ 7.5 (Without any supplementaryappearance)
First Class	≥ 6.5 < 7.5
Second Class	≥ 5.5 < 6.5
Pass Class	≥ 5.0 < 5.5

- **Note:** Students who have written supplementary examinations to fulfil the credit requirement will not be awarded First Class with Distinction. For such students thehighest degree that is awarded will be First Class Only.

CGPA to Percentage conversion Formula – (CGPA – 0.5) x 10

20. With–holding of Results

If the candidate has any dues not paid to the College or if any case of indiscipline or malpractice is pending against him/her, the result of the candidate shall be withheld in suchcases.

21. Multiple Entry / Exit Option

(a)Exit Policy:

The students can choose to exit the four-year programme at the end of first/second/thirdyear.

i) **UG Certificate in (Field of study/discipline)** - Programme duration: First year (first two semesters) of the undergraduate programme, 40 credits followed by an additional exit 10-credit bridge course(s) lasting two months, including at least 6- credit job-specific internship/ apprenticeship that would help the candidates acquirejob-ready competencies required to enter the workforce.

ii) **UG Diploma (in Field of study/discipline)** - Programme duration: First two years(first four semesters) of the undergraduate programme, 80 credits followed by an additional exit 10-credit bridge course(s) lasting two months, including at least 6- credit job-specific internship/ apprenticeship that would help the candidates acquirejob-ready competencies required to enter the workforce.

iii) **Bachelor of Science (in Field of study/discipline)** i.e., **B.Sc. Engineering in (Field of study/discipline)** - Programme duration: First three years (first six semesters) of the undergraduate programme, 120 credits.

(b) Entry Policy:

Modalities on multiple entry by the student into the B.Tech. programme will be provided in due course of time.

Note: The Universities shall resolve any issues that may arise in the implementation of Multiple Entry and Exit policies from time to time and shall review the policies in the light of periodic changes brought by UGC, AICTE and State government.

22. Gap Year Concept:

Gap year concept for Student Entrepreneur in Residence is introduced and outstandingstudents who wish to pursue entrepreneurship / become entrepreneur are allowed to take a break of one year at any time after II year to pursue full-time entrepreneurship programme/to establish startups. This period may be extended to two years at the mostand these two years would not be counted for the time for the maximum time for graduation. The HOD of the respective department shall forward such proposals submitted by the students to the Principal. An evaluation committee constituted by the Principal shall evaluate the proposal submitted by the student and the committee shall decide whether to permit the student(s) to avail the Gap Year or not

23. Transitory Regulations

Discontinued, detained, or failed candidates are eligible for readmission as and when the semester is offered after fulfilment of academic regulations. Candidates who havebeen detained for want of attendance or not fulfilled academic requirements or whohave failed after having undergone the course in earlier regulations or have discontinued and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same orequivalent subjects as and when subjects are offered, subject to Section 2 and they will follow the academic regulations into which they are readmitted.

Candidates who are permitted to avail Gap Year shall be eligible for re-joining into the succeeding year of their B.Tech from the date of commencement of class work, subject to Section **2** and they will follow the academic regulations into which they arereadmitted.

24. Minimum Instruction Days for a Semester:

The minimum instruction days including exams for each semester shall be 90 days.

25. Medium of Instruction:

The medium of instruction of the entire B.Tech undergraduate programme in Engineering &Technology (including examinations and project reports) will be in English only.

26. Student Transfers:

Student transfers shall be as per the guidelines issued by the Government of Andhra Pradesh and the Universities from time to time.

27. General Instructions:

a. The academic regulations should be read as a whole for purpose of any interpretation.
b. Malpractices rules-nature and punishments are appended.
c. Where the words “he”, “him”, “his”, occur in the regulations, they also include“she”, “her”, “hers”, respectively.
d. In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.
e. The Universities may change or amend the academic regulations or syllabi at any timeand the changes or amendments shall be made applicable to all the students on rolls with effect from the dates notified by the Universities.
f. In the case of any doubt or ambiguity in the interpretation of the guidelines given, the decision of the Vice-Chancellor / Head of the institution is final.

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ACADEMIC REGULATIONS (R23) FOR B.TECH. (LATERAL ENTRY SCHEME)

*(Effective for the students getting admitted into II year through Lateral Entry Scheme from the Academic Year **2024-2025** onwards)*

1. Award of the Degree

(a) Award of the B.Tech. Degree / B.Tech. Degree with a Minor if he/she fulfils the following:

(i) Pursues a course of study for not less than three academic years and notmore than six academic years. However, for the students availing Gap year facility this period shall be extended by two years at the most and these two years would in addition to the maximum period permitted forgraduation (Six years).

(ii) Registers for 120 credits and secures all 120 credits.

(b) Award of B.Tech. Degree with Honors

A student will be declared eligible for the award of the B.Tech with Honors ifhe/she fulfils the following:

(i) Student secures additional 15 credits fulfilling all the requisites of aB.Tech. Program i.e., 120 credits.

(ii) Registering for Honors is optional.

(iii) Honors is to be completed simultaneously with B.Tech. programme.

2. Students, who fail to fulfil the requirement for the award of the degree within sixconsecutive academic years from the year of admission, shall forfeit their seat.

3. Minimum Academic Requirements

The following academic requirements have to be satisfied in addition to the requirements mentioned in item no.**2**

i. A student shall be deemed to have satisfied the minimum academic requirements and earned the credits allotted to each theory, practical, design, drawing subject or project if he secures not less than 35% of marks in the end examination and a minimum of 40% of marks in the sum total of the mid semester evaluation and endexamination taken together.

ii. A student shall be promoted from III year to IV year if he/she fulfils the academic requirements of securing 40% of the credits (any decimal fraction should be rounded off to lower digit) in the subjects that have been studied up to V semester.

And in case if student is already detained for want of credits for particular academicyear, the student may make up the credits through supplementary exams of the above exams before the commencement of IV year I semester class work of next year.

4. Course Pattern

i) The entire course of study is three academic years on semester pattern.

ii) A student eligible to appear for the end examination in a subject but absent at it or has failed in the end examination may appear for that subject at the next supplementary examination offered.

iii) When a student is detained due to lack of credits/shortage of attendance the studentmay be re-admitted when the semester is offered after fulfilment of academic regulations, the student shall be in the academic regulations into which he/she is readmitted.

5. All other regulations as applicable for B.Tech. Four-year degree course (Regular) will hold good for B.Tech. (Lateral Entry Scheme).

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

- The Principal shall refer the cases of Malpractices in Internal Assessment Test and Semester end examinations to a malpractice prevention committee constituted by him for the purpose. Such committee shall follow the approved levels of punishment. The Principal shall take necessary action against the students based on the recommendations of the committee.
- Any action by the candidate trying to get undue advantage in the performance or trying to help another, or derive the same through unfair means is punishable according to the provisions contained here under.

	Nature of Malpractices/ Improper conduct	**Punishment**
	If the candidate:	
1(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination).	Expulsion from the examination hall and cancellation of the performance in that subject only.
1(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the college.

3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and to be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all college examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all college examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant– Superintendent /any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation,	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the Police and a police case is registered against them.

	assaults the officer-in- charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all college examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the college expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.

11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the college for further action to award suitable punishment.	

OTHER MATTERS:

1. Physically challenged candidates who have availed additional examination time and a scribe during their intermediate / EAPCET examinations will be given similar concessions on production of relevant proof / documents.
2. The Principal shall deal in an appropriate manner with any academic problem which is not covered under these rules and regulations, in consultation with the Controller of Examinations and Heads of the departments and subsequently such actions shall be placed before the Academic Council for ratification. Any emergency modification of regulation, approved in the meetings of the Heads of the departments shall be reported to the Academic Council for ratification.

GENERAL:

1. The academic council may, from time to time, revise, amend or change the regulations, schemes of examinations and / or syllabi.
2. Where ever the words "he'', "him'', "his'' occur in the regulations, they include "she'', "her'', "hers''.
3. The academic regulation should be read as a whole for the purpose of any interpretation.
4. In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.
5. Malpractice cases will be indicated in the grade card with letters 'MP'.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA-533003, Andhra Pradesh (India)

For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

Prohibition of ragging in educational institutions Act 26 of 1997

Salient Features

- Ragging within or outside any educational institution is prohibited.
- Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student

	Imprisonment upto		Fine Upto
Teasing, Embarrassing & Humiliation	6 Months	+	Rs. 1,000/-
Assaulting or Using Criminal force or Criminal intimidation	1 Year	+	Rs. 2,000/-
Wrongfully restraining or confining or causing hurt	2 Years	+	Rs. 5,000/-
Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence	5 Years	+	Rs. 10,000/-
Causing death or abetting suicide	10 Months	+	Rs. 50,000/-

In Case of Emergency CALL TOLL FREE No. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

ANNEXURE-I

COMMUNITY SERVICE PROJECT

Experiential learning through community engagement

As per the decision of the concerned department BOS

Introduction

- Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development
- Community Service Project involves students in community development and service activities and applies the experience to personal and academic development.
- Community Service Project is meant to link the community with the college for mutual benefit. The community will be benefited with the focused contribution of the college students for the village/ local development. The college finds an opportunity to develop social sensibility and responsibility among students and also emerge as a socially responsible institution.

Objective

Community Service Project should be an integral part of the curriculum, as an alternative to the 2 months of Summer Internships / Apprenticeships / On the Job Training, whenever there is an exigency when students cannot pursue their summer internships. The specific objectives are;

- To sensitize the students to the living conditions of the people who are around them,
- To help students to realize the stark realities of the society.
- To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
- To make students aware of their inner strength and help them to find new /out of box solutions to the social problems.
- To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
- To help students to initiate developmental activities in the community in coordination with public and government authorities.
- To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.
- Implementation of Community Service Project
- Every student should put in a minimum of **180 hours** for the Community Service Project during the summer vacation.
- Each class/section should be assigned with a mentor.
- Specific Departments could concentrate on their major areas of concern. For example, Dept. of Computer Science can take up activities related to Computer Literacy to different sections of people like - youth, women, house-wives, etc
- A log book has to be maintained by each of the student, where the activities undertaken/involved to be recorded.
- The log book has to be countersigned by the concerned mentor/faculty incharge.
- Evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.
- The final evaluation to be reflected in the grade memo of the student.

- The Community Service Project should be different from the regular programmes of NSS/NCC/Green Corps/Red Ribbon Club, etc.
- Minor project report should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.
- Award of marks shall be made as per the guidelines of Internship/apprentice/ on the job training

Procedure

- A group of students or even a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, so as to enable them to commute from their residence and return back by evening or so.
- The Community Service Project is a twofold one –
- First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area. Or it can even be a general survey, incorporating all the different areas. A common survey format could be designed. This should not be viewed as a duplication of work by the Village or Ward volunteers, rather, it could be another primary source of data.
- Secondly, the student/s could take up a social activity, concerning their domain or subject area. The different areas, could be like –

- Agriculture
- Health
- Marketing and Cooperation
- Animal Husbandry
- Horticulture
- Fisheries
- Sericulture
- Revenue and Survey
- Natural Disaster Management
- Irrigation
- Law & Order
- Excise and Prohibition
- Mines and Geology
- Energy
- Internet
- Free Electricity
- Drinking Water

EXPECTED OUTCOMES

BENEFITS OF COMMUNITY SERVICE PROJECT TO STUDENTS

Learning Outcomes

- Positive impact on students' academic learning
- Improves students' ability to apply what they have learned in "the real world"
- Positive impact on academic outcomes such as demonstrated complexity of understanding, problem analysis, problem-solving, critical thinking, and cognitive development
- Improved ability to understand complexity and ambiguity

Personal Outcomes

- Greater sense of personal efficacy, personal identity, spiritual growth, and moral development
- Greater interpersonal development, particularly the ability to work well with others, and build leadership and communication skills

Social Outcomes

- Reduced stereotypes and greater inter-cultural understanding
- Improved social responsibility and citizenship skills
- Greater involvement in community service after graduation

Career Development

- Connections with professionals and community members for learning and career opportunities
- Greater academic learning, leadership skills, and personal efficacy can lead to greater opportunity

Relationship with the Institution

- Stronger relationships with faculty
- Greater satisfaction with college
- Improved graduation rates

BENEFITS OF COMMUNITY SERVICE PROJECT TO FACULTY MEMBERS

- Satisfaction with the quality of student learning
- New avenues for research and publication via new relationships between faculty and community
- Providing networking opportunities with engaged faculty in other disciplines or institutions
- A stronger commitment to one's research

BENEFITS OF COMMUNITY SERVICE PROJECT TO COLLEGES AND UNIVERSITIES

- Improved institutional commitment
- Improved student retention
- Enhanced community relations

BENEFITS OF COMMUNITY SERVICE PROJECT TO COMMUNITY

- Satisfaction with student participation
- Valuable human resources needed to achieve community goals
- New energy, enthusiasm and perspectives applied to community work
- Enhanced community-university relations.

SUGGESTIVE LIST OF PROGRAMMES UNDER COMMUNITY SERVICE PROJECT

The following is the recommended list of projects for engineering students. The lists are not exhaustive and open for additions, deletions and modifications. Colleges are expected to focus on specific local issues for this kind of projects. The students are expected to carry out these projects with involvement, commitment, responsibility and accountability. The mentors of a group of students should take the responsibility of motivating, facilitating, and guiding the students. They have to interact with local leadership and people and appraise the objectives and benefits of this kind of projects. The project reports shall be placed in the college website for reference. Systematic, Factual, methodical and honest reporting shall be ensured.

For Engineering Students

1. Water facilities and drinking water availability
2. Health and hygiene
3. Stress levels and coping mechanisms
4. Health intervention programmes
5. Horticulture
6. Herbal plants
7. Botanical survey
8. Zoological survey
9. Marine products
10. Aqua culture
11. Inland fisheries

***

INDUCTION PROGRAMME

S. No	Course Name	Category	L-T-P-C
1	Physical Activities -- Sports, Yoga and Meditation ,Plantation	MC	0-0-6-0
2	Career Counselling	MC	2-0-2-0
3	Orientation to all branches -- career options, tools, etc.	MC	3-0-0-0
4	Orientation on admitted Branch – corresponding labs, tools and platforms	EC	2-0-3-0
5	Proficiency Modules & Productivity Tools	ES	2-1-2-0
6	Assessment on basic aptitude and mathematical skills	MC	2-0-3-0
7	Remedial Training in Foundation Courses	MC	2-1-2-0
8	Human Values & Professional Ethics	MC	3-0-0-0
9	Communication Skills -- focus on Listening, Speaking, Reading, Writing skills	BS	2-1-2-0
10	Concepts of Programming	ES	2-0-2-0

I B.Tech I SEMESTER

S. No	Subject	Course Code	Cat. Code	Internal Marks	External Marks	Total Marks	L	T	P	Credits
1	LINEAR ALGEBRA & CALCULUS	R23CC1101	BS&H	30	70	100	3	0	0	3
2	INTRODUCTION TO PROGRAMMING	R23CC1102	ES	30	70	100	3	0	0	3
3	ENGINEERING PHYSICS	R23CC1106	BS&H	30	70	100	3	0	0	3
4	BASIC ELECTRICAL & ELECTRONICS ENGINEERING	R23CC1107	ES	30	70	100	3	0	0	3
5	ENGINEERING GRAPHICS	R23CC1108	BS&H	30	70	100	3	0	0	3
6	COMPUTER PROGRAMMING LAB	R23CC11L1	ES	30	70	100	0	0	3	1.5
7	IT WORKSHOP	R23CC11L5	BS&H	30	70	100	0	0	2	1
8	ENGINEERING PHYSICS LAB	R23CC11L6	ES	30	70	100	0	0	3	1.5
9	EEE WORKSHOP	R23CC11L7	BS&H	30	70	100	0	0	2	1
10	NSS/NCC/SCOUTS & GUIDES/COMMUNITY SERVICE	R23CC11MC2	BS&H	100	-	100	-	-	1	0.5
TOTAL										**20.5**

I B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
CODE: R23CC1101	LINEAR ALGEBRA & CALCULUS						

COURSE OBJECTIVES:

- Grasping fundamental principles in linear algebra, including linear transformations, solving systems of linear equations, and applying matrix calculus.
- To become proficiency in solving computational problems of linear algebra.
- To acquire knowledge on mean value theorems in calculus.
- Familiarization about the techniques in calculus and multivariate analysis.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Solve** the system of linear equations and transformations.

CO2: **Analyze** the applications of matrices in various fields and obtain Eigen values and Eigenvectors.

CO3: **Analyze** mean value theorems to real life problems

CO4: **Apply** the functions of several variables to evaluate the rates of change with respect to time and space variables in engineering

CO5: **Identify** the area and volume by interlinking them to appropriate double and triple integrals.

UNIT-I:

MATRICES

Introduction to Linear Transformation-Rank of a matrix by Echelon form and normal form - Cauchy- Binet formulae (without proof) - Inverse of non-singular matrices by Gauss-Jordan method - System of linear equations: Solving system of homogeneous and non-homogeneous equations - Gauss elimination method, Jacobi and Gauss-Seidel iteration methods.

Applications: L-C-R Circuits

UNIT-II:

EIGENVALUES, EIGENVECTORS AND ORTHOGONAL TRANSFORMATION

Eigenvalues, Eigenvectors and their properties - Diagonalization of a matrix - Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem - Quadratic form and nature of a quadratic form - Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT-III:

CALCULUS

Mean Value Theorems (without proofs): Rolle's Theorem, Lagrange's mean value theorem with their geometrical interpretation - Cauchy's mean value theorem - Taylor's and Maclaurin's theorems with remainders - Problems and applications on the above theorems.

UNIT-IV:
PARTIAL DIFFERENTIATION AND APPLICATIONS
(MULTI VARIABLE CALCULUS)

Functions of several variables: Continuity and Differentiability - Partial derivatives – Homogeneous function-Euler's Theorem on homogeneous functions-Total derivatives - Chain rule - Taylor's and Maclaurin's series expansion of functions of two variables - Jacobians - Functional dependence - Maxima and minima of functions of two variables - Method of Lagrange's multipliers.

UNIT-V:
MULTIPLE INTEGRALS (MULTI VARIABLE CALCULUS)

Double integrals - Triple integrals - Change of order of integration - Change of variables to polar, cylindrical and spherical coordinates - Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

TEXTBOOKS:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2017, 44th Edition.
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, 2018, 10th Edition.

REFERENCE BOOKS:

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 2021 5th Edition (9th reprint).
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, Micheael Greenberg, Pearson publishers, 9th edition.
5. Higher Engineering Mathematics, H. K. Das, Er. Rajnish Verma, S. Chand Publications, 2014, Third Edition (Reprint 2021).

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
CODE :R23CC1102	INTRODUCTION TO PROGRAMMING						

COURSE OBJECTIVES:

- To introduce students to the fundamentals of computer programming.
- To provide hands-on experience with coding and debugging.
- To foster logical thinking and problem-solving skills using programming.
- To familiarize students with programming concepts such as data types, controlstructures, functions, and arrays.
- To encourage collaborative learning and teamwork in coding projects.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Infer the basic concepts of computers, algorithms and Flowcharts**.**
CO2: Develop programs using appropriate control structures**.**
CO3: Write programs using arrays and strings**.**
CO4: Develop programs using structures and pointers**.**
CO5: Make use of functions and file Operations in C programming for a given application**.**

UNIT I
INTRODUCTION TO PROGRAMMING AND PROBLEM SOLVING

History of Computers, Basic organization of a computer: ALU, input-output units, memory, program counter, Introduction to Programming Languages, Basics of a Computer Program-Algorithms, flowcharts (Using Dia Tool), pseudo code. Introduction to Compilation and Execution, Primitive Data Types, Variables, and Constants, Basic Input and Output, Operators, Type Conversion, and Casting.

Problem solving techniques: Algorithmic approach, characteristics of algorithm, Problemsolving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

UNIT II:
CONTROL STRUCTURES

Simple sequential programs Conditional Statements (if, if-else, switch), Loops (for, while, do-while) Break and Continue.

UNIT III:
ARRAYS AND STRINGS

Arrays indexing, memory model, programs with array of integers, two dimensional arrays, Strings: Introduction – Reading Strings – Writing Strings – String Manipulation functions -Array of Strings.

UNIT IV:
POINTERS & USER DEFINED DATA TYPES

Pointers, dereferencing and address operators, pointer and address arithmetic, array manipulation using pointers, User-defined data types-Structures and Unions.

UNIT V:
FUNCTIONS & FILE HANDLING
Introduction to Functions, Function Declaration and Definition, Function call Return Types and Arguments, modifying parameters inside functions using pointers, arrays as parameters. Scopeand Lifetime of Variables, Basics of File Handling

Note: The syllabus is designed with C Language as the fundamental language of implementation**.**

TEXTBOOKS:
1. "The C Programming Language", Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall, 2005.
2. C Programming, A Problem Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE, 3rd edition.
3. How to Solve it by Computer, R G Dromey, Pearson Education.

REFERENCE BOOKS:
1. Computing Fundamentals and C Programming, Balagurusamy, E., McGraw-HillEducation, 2008.
2. Programming in C, Rema Theraja, Oxford, 2016, 2nd edition
3. Schaum's Outline of Programming with C, Byron S Gottfried, McGraw-Hill Education,1998.

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
CODE:R23CC1106	ENGINEERING PHYSICS						

COURSE OBJECTIVES:

- To bridge the gap between the Physics at 10+2 level and UG level engineering courses
- Identifying the importance of Lasers and optical fibers,
- Enlightening the periodic arrangement of atoms in crystalline solids and concepts of quantum mechanics,
- Introduce novel concepts of magnetic materials and superconductors, physics of semiconductors and smart materials.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO 1: Analyze the intensity variation of Laser light and it's propagation in optical fibers.
CO 2: Familiarize with the basics of crystals and their structures.
CO 3: Summarize various types of Magnetic materials and Super conductors.
CO 4: Explain the basic concepts of Quantum Mechanics and the band theory of solids.
CO 5: Identify the type of semiconductor and smart materials.

UNIT I:

LASERS AND OPTICAL FIBERS

LASERS: Introduction – Characteristics of lasers – Spontaneous and Stimulated emission of radiation – Population inversion - Einstein's coefficients and relation between them - Ruby laser – Helium Neon laser- Semiconductor laser-Applications.

OPTICAL FIBERS: Introduction- Basic Structure and Principle of optical fiber - Acceptance angle – Acceptance cone - Numerical Aperture - Step Index and Graded index fibers -Applications.

UNIT II:

CRYSTALLOGRAPHY AND X-RAY DIFFRACTION

CRYSTALLOGRAPHY: Space lattice, Basis, Unit Cell and lattice parameters – Bravais Lattices – crystal systems (3D) – coordination number - packing fraction of SC, BCC & FCC.

X-RAY DIFFRACTION: Miller indices – separation between successive (hkl) planes.
Bragg's law - crystal structure determination by Laue's and powder methods.

UNIT III:

MAGNETIC MATERIALS AND SUPERCONDUCTIVITY

MAGNETIC MATERIALS: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility, permeability and relation between them - Atomic origin of magnetism - Classification of magnetic materials: Dia, para, Ferro, anti-ferro & Ferri magnetic materials - Hysteresis - soft and hard magnetic materials.

SUPERCONDUCTIVITY: Introduction- Properties, Meissner effect - Type-I and Type-II super conductors- BCS Theory- AC and DC Josephson effect-Applications.

UNIT IV:

QUANTUM MECHANICS AND FREE ELECTRON THEORY

QUANTUM MECHANICS: de-Broglie's matter Waves – Heisenberg's Uncertainty Principle – Significance and properties of wave function – Schrodinger's time independent wave equation – Particle in a one-dimensional infinite potential well.

FREE ELECTRON THEORY: Classical free electron theory (Qualitative with discussion of merits and demerits) – electrical conductivity based on Classical free electron theory -Quantum free electron theory –- Fermi energy- Fermi-Dirac distribution.

UNIT V:

SEMICONDUCTORS AND SMART MATERIALS

SEMICONDUCTORS: Formation of energy bands – classification of solids – Types of semiconductors - Drift and diffusion currents – Einstein's equation - Hall Effect and its applications.

SMART MATERIALS: Introduction – properties- types of smart materials- shape memory alloys – piezoelectric materials- magnetostrictive materials – Thermoelectric materials- magneto rheological fluids- electro rheological fluids- Chromic materials – Engineering applications of smart materials.

TEXTBOOKS:

1. A Text book of Engineering Physics - M. N. Avadhanulu, P.G.Kshirsagar & TVS Arun Murthy, S. Chand Publications, 11th Edition 2019.
2. Engineering Physics - D.K.Bhattacharya and Poonam Tandon, Oxford press (2015).

REFERENCE BOOKS:

1. Engineering Physics - B.K. Pandey and S. Chaturvedi, Cengage Learning
2. Engineering Physics - Shatendra Sharma, Jyotsna Sharma, Pearson Education, 2018.
3. Engineering Physics" - Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press.
4. Engineering Physics - M.R. Srinivasan, New Age international publishers (2009).

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
CODE :R23CC1107	BASIC ELECTRICAL & ELECTRONICS ENGINEERING						

PART A: BASIC ELECTRICAL ENGINEERING

COURSE OBJECTIVES

- To expose to the field of electrical & electronics engineering, laws and principles of electrical/ electronic engineering and to acquire fundamental knowledge in the relevant field.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Explain the fundamental laws and concept of DC and AC circuits.

CO2: Demonstrate the working and operating principles of electrical machines, measuring instruments.

CO3: Demonstrate the working and operating principles of different power generation stations.

CO4: Calculate electrical load, electricity bill of residential and commercial buildings and safety measures.

UNIT I:

DC & AC CIRCUITS

DC Circuits: Electrical circuit elements (R, L and C), Ohm's Law and its limitations, KCL & KVL, series, parallel, series-parallel circuits, Super Position theorem, Simple numerical problems.

AC Circuits: A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor, Voltage and current relationship with phasor diagrams in R, L, and C circuits, Concept of Impedance, Active power, reactive power and apparent power, Concept of power factor (Simple Numerical problems).

UNIT II:

MACHINES AND MEASURING INSTRUMENTS

Machines: Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer, (iv) Three Phase Induction Motor and (v) Alternator, Applications of electrical machines.

Measuring Instruments: Construction and working principle of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone Bridge.

UNIT III:

ENERGY RESOURCES, ELECTRICITY BILL & SAFETY MEASURES

Energy Resources: Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Nuclear, Solar & Wind power generation.

Electricity bill: Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of "unit" used for consumption of electrical energy, two-part electricity tariff, calculation of electricity bill for domestic consumers.

Equipment Safety Measures: Working principle of Fuse and Miniature circuit breaker (MCB), merits and demerits. Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

TEXTBOOKS:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

REFERENCE BOOKS:

1. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Mc Graw Hill, 2019, Fourth Edition
2. Principles of Power Systems, V.K. Mehtha, S.Chand Technical Publishers, 2020
3. Basic Electrical Engineering, T. K. Nagsarkar and M. S. Sukhija, Oxford University Press, 2017
4. Basic Electrical and Electronics Engineering, S. K. Bhatacharya, Person Publications, 2018, Second Edition.

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Web Resources:

1. https://nptel.ac.in/courses/108105053
2. https://nptel.ac.in/courses/108108076

PART B: BASIC ELECTRONICS ENGINEERING

COURSE OBJECTIVES:

- To teach the fundamentals of semiconductor devices and its applications, principles of digital electronics.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Describe the working of diode and explore the operation of BJT and its applications.
CO2: Describe the working of Rectifiers and amplifiers in electronic circuits.
CO3: Manipulate numeric information in different forms, various codes such as ASCII, Gray, and BCD, simple Boolean expressions and Boolean Theorems
CO4: Design and analyse combinational circuits, sequential circuits, flip flops Registers and Counters.

UNIT I:

SEMICONDUCTOR DEVICES

Introduction - Evolution of electronics – Vacuum tubes to nano electronics - Characteristics of PN Junction Diode — Zener Effect — Zener Diode and its Characteristics. Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics — Elementary Treatment of Small Signal CE Amplifier.

UNIT II:

BASIC ELECTRONIC CIRCUITS AND INSTRUMENTTAION

Block diagram description of a dc power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple zener voltage regulator. Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response. Electronic Instrumentation: Block diagram of an electronic instrumentation system.

UNIT III:

DIGITAL ELECTRONICS

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, Gray code, Hamming code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits–Half and Full Adders. Introduction to sequential circuits, Flip flops(S-R, J-K, D and T Flip flops), Registers(4-bit Shift Register - serial input and output) and counters (Ripple Counters, Binary Ripple Counter, Ring Counter) (Elementary Treatment only)

TEXTBOOKS:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009

REFERENCE BOOKS:

1. R. S. Sedha, A Textbook of Electronic Devices and Circuits, S. Chand & Co, 2010.
2. Salivahanan, N. Suresh Kumar, A. Vallavaraj, “Electronic Devices and Circuits” Tata McGraw-Hill, Second Edition, 2008.
3. Jacob Millman, C. Halkies, C.D. Parikh, Satyabrata Jit, “Integrated Electronics”, Tata McGraw-Hill, Second Edition, 2011.

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	1	0	4	30	70	100	3
CODE : R23CC1108	ENGINEERING GRAPHICS						

COURSE OBJECTIVES:

- To enable the students with various concepts like dimensioning, conventions and standards related to Engineering Drawing
- To impart knowledge on the projection of points, lines and plane surfaces
- To improve the visualization skills for better understanding of projection of solids
- To develop the imaginative skills of the students required to understand Section of solidsand developments of surfaces.
- To make the students understand the viewing perception of a solid object in Isometricand Perspective projections.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Construct the principles of engineering drawing, including engineering curves, scales, Orthographic and isometric projections**.**

CO2: Construct orthographic projections of points, lines, planes and solids in front,top and Side views**.**

CO3: Analyze and draw projection of solids in various positions in first Quadrant.

CO4: Develop the sections of Solids & Development of Surfaces**.**

CO5: Compare & Draw isometric Views & Orthographic Views**.**

UNIT I

INTRODUCTION: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general methods.

CURVES: construction of ellipse, parabola and hyperbola by general, Cycloids, Involutes, Normal and tangent to Curves.

Scales: Plain scales, diagonal scales and vernier scales.

UNIT II

ORTHOGRAPHIC PROJECTIONS: Reference plane, importance of reference lines or Plane, Projections of a point situated in any one of the four quadrants.

PROJECTIONS OF STRAIGHT LINES: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane. Projections of Straight Line Inclined to both the reference planes

PROJECTIONS OF PLANES: regular planes Perpendicular to both reference planes, parallel to one reference plane and inclined to the other reference plane; plane inclined to both the reference planes.

UNIT III

PROJECTIONS OF SOLIDS: Types of solids: Polyhedral and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to another plane.

UNIT IV

SECTIONS OF SOLIDS: Perpendicular and inclined section planes, Sectional views and True shape of section, Sections of solids in simple position only.

DEVELOPMENT OF SURFACES: Methods of Development: Parallel line development and radial linedevelopment. Development of a cube, prism, cylinder, pyramid and cone.

UNIT V

CONVERSION OF VIEWS: Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

COMPUTER GRAPHICS: Creating 2D&3D drawings of objects including PCB and Transformationsusing Auto CAD (*Not for end examination*).

TEXTBOOK:

1. N. D. Bhatt, Engineering Drawing, Charotar Publishing House, 2016.

REFERENCE BOOKS:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill, 2013.
2. Engineering Drawing, M.B.Shah and B.C. Rana, Pearson Education Inc, 2009.
3. Engineering Drawing with an Introduction to AutoCAD, Dhananjay Jolhe, TataMcGraw Hill, 2017.

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
CODE:R23CC11L1	COMPUTER PROGRAMMING LAB						

COURSE OBJECTIVES:

- The course aims to give students hands – on experience and train them on the concepts of the C- programming language.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Analyze and trace the execution of programs written in C language

CO2: Implement programs with appropriate control structures for solving the problems

CO3: Develop C programs which utilize memory efficiently using programming constructs like pointers

CO4: Code, Debug and **Execute** programs to demonstrate the applications of arrays, functions, files and various other concepts in C

UNIT1

WEEK 1

Objective: Getting familiar with the programming environment on the computer and writingthe first program.

Suggested Experiments/Activities:

Tutorial 1: Problem-solving using Computers.

Lab1: Familiarization with programming environment

i) Basic Linux environment and its editors like Vi, Vim & Emacs etc.

ii) Basic commands of Linux (sudo, pwd, cd, ls, cat, cp, mv, mkdir, rmdir, rm, touch, locate, find, grep, df, du, head, tail, diff, tar, chmod, chown, kill, ping)

iii) Exposure to Turbo C, gcc

iv) Writing simple programs using printf(), scanf()

WEEK 2

Objective: Getting familiar with how to formally describe a solution to a problem in a seriesof finite steps both using textual notation and graphic notation.

Suggested Experiments /Activities:

Tutorial 2: Problem-solving using Algorithms and Flow charts.

Lab 2: Converting algorithms/flow charts into C Source code.

Developing the algorithms/flowcharts for the following sample programs

i) Sum and average of 3 numbers

ii) Conversion of Fahrenheit to Celsius and vice versa

iii) Simple interest calculation

WEEK 3

Objective: Learn how to define variables with the desired data-type, initialize them with appropriate values and how arithmetic operators can be used with variables and constants.

Suggested Experiments/Activities:

Tutorial 3: Variable types and type conversions:

Lab 3: Simple computational problems using arithmetic expressions.

i) Finding the square root of a given number
ii) Finding compound interest
iii) Area of a triangle using heron's formulae
iv) Distance travelled by an object

UNIT II

WEEK 4

Objective: Explore the full scope of expressions, type-compatibility of variables & constantsand operators used in the expression and how operator precedence works.

Suggested Experiments/Activities:

Tutorial4: Operators and the precedence and as associativity:

Lab4: Simple computational problems using the operator' precedence and associativity

i) Evaluate the following expressions.
a. A+B*C+(D*E) + F*G
b. A/B*C-B+A*D/3
c. A+++B---A
d. J= (i++) + (++i)
ii) Find the maximum of three numbers using conditional operator
iii) Take marks of 5 subjects in integers, and find the total, average in float

WEEK 5

Objective: Explore the full scope of different variants of "if construct" namely if-else, null- else, if-else if*-else, switch and nested-if including in what scenario each one of them can be used and how to use them. Explore all relational and logical operators while writing conditionals for "if construct".

Suggested Experiments/Activities:

Tutorial 5: Branching and logical expressions:

Lab 5: Problems involving if-then-else structures.

i) Write a C program to find the max and min of four numbers using if-else.
ii) Write a C program to generate electricity bill.
iii) Find the roots of the quadratic equation.
iv) Write a C program to simulate a calculator using switch case.
v) Write a C program to find the given year is a leap year or not.

WEEK 6

Objective: Explore the full scope of iterative constructs namely while loop, do-while loop and for loop in addition to structured jump constructs like break and continue including when eachof these statements is more appropriate to use.

Suggested Experiments/Activities:

Tutorial 6: Loops, while and for loops

Lab 6: Iterative problems e.g., the sum of series

i) Find the factorial of given number using any loop.
ii) Find the given number is a prime or not.
iii) Compute sine and cos series
iv) Checking a number palindrome
v) Construct a pyramid of numbers.

UNIT III

WEEK 7:

Objective: Explore the full scope of Arrays construct namely defining and initializing 1-D and 2-D and more generically n-D arrays and referencing individual array elements from the defined array. Using integer 1-D arrays, explore search solution linear search.

Suggested Experiments/Activities:

Tutorial 7: 1 D Arrays: searching.

Lab 7:1D Array manipulation, linear search

i) Find the min and max of a 1-D integer array.
ii) Perform linear search on1D array.
iii) The reverse of a 1D integer array
iv) Find 2's complement of the given binary number.
v) Eliminate duplicate elements in an array.

WEEK 8:

Objective: Explore the difference between other arrays and character arrays that can be used as Strings by using null character and get comfortable with string by doing experiments that will reverse a string and concatenate two strings. Explore sorting solution bubble sort using integer arrays.

Suggested Experiments/Activities:

Tutorial 8: 2 D arrays, sorting and Strings.

Lab 8: Matrix problems, String operations, Bubble sort

i) Addition of two matrices
ii) Multiplication two matrices
iii) Sort array elements using bubble sort
iv) Concatenate two strings without built-in functions
v) Reverse a string using built-in and without built-in string functions

UNIT IV

WEEK: 9

Objective: Explore pointers to manage a dynamic array of integers, including memory allocation & value initialization, resizing changing and reordering the contents of an array and memory de-allocation using malloc(), calloc(), realloc() and free() functions. Gainexperience processing command-line arguments received by C

Suggested Experiments/Activities:

Tutorial 9: Pointers, structures and dynamic memory allocation

Lab 9: Pointers and structures, memory dereference.

i) Write a C program to find the sum of a 1D array using malloc()
ii) Write a C program to find the total, average of n students using structures
iii) Enter n students data using calloc() and display failed students list
iv) Read student name and marks from the command line and display the student details along with the total.
v) Write a C program to implement realloc()

WEEK 10:

Objective: Experiment with C Structures, Unions, bit fields and self-referential structures (Singly linked lists) and nested structures

Suggested Experiments/Activities:
Tutorial 10: Bitfields, Self-Referential Structures, Linked lists
Lab10: Bitfields, linked lists
Read and print a date using dd/mm/yyyy format using bit-fields and differentiate the same without using bit- fields
i) Create and display a singly linked list using self-referential structure.
ii) Demonstrate the differences between structures and unions using a C program.
iii) Write a C program to shift/rotate using bitfields.
iv) Write a C program to copy one structure variable to another structure of the same type.

UNIT V
WEEK 11:
Objective: Explore the Functions, sub-routines, scope and extent of variables, doing some experiments by parameter passing using call by value. Basic methods of numerical integration
Suggested Experiments/Activities:
Tutorial 11: Functions, call by value, scope and extent,
Lab 11: Simple functions using call by value, solving differential equations using Eulerstheorem.
i) Write a C function to calculate NCR value.
ii) Write a C function to find the length of a string.
iii) Write a C function to transpose of a matrix.
iv) Write a C function to demonstrate numerical integration of differential equations using Euler'smethod

WEEK 12:
Objective: Explore how recursive solutions can be programmed by writing recursive functionsthat can be invoked from the main by programming at-least five distinct problems that have naturally recursive solutions.
Suggested Experiments/Activities:
Tutorial 12: Recursion, the structure of recursive calls
Lab 12: Recursive functions
i) Write a recursive function to generate Fibonacci series.
ii) Write a recursive function to find the lcm of two numbers.
iii) Write a recursive function to find the factorial of a number.
iv) Write a C Program to implement Ackermann function using recursion.
v) Write a recursive function to find the sum of series.

WEEK 13:
Objective: Explore the basic difference between normal and pointer variables, Arithmetic operations using pointers and passing variables to functions using pointers
Suggested Experiments/Activities:
Tutorial 13: Call by reference, dangling pointers
Lab 13: Simple functions using Call by reference, Dangling pointers.
i) Write a C program to swap two numbers using call by reference.
ii) Demonstrate Dangling pointer problem using a C program.
iii) Write a C program to copy one string into another using pointer.
iv) Write a C program to find no of lowercase, uppercase, digits and othercharacters using pointers.

WEEK14:
Objective: To understand data files and file handling with various file I/O functions. Explore thedifferences between text and binary files.
Suggested Experiments/Activities:
Tutorial 14: File handling
Lab 14: File operations
i) Write a C program to write and read text into a file.
ii) Write a C program to write and read text into a binary file using fread() andfwrite()
iii) Copy the contents of one file to another file.
iv) Write a C program to merge two files into the third file using command-linearguments.
v) Find no. of lines, words and characters in a file
vi) Write a C program to print last n characters of a given file.

WEEK 15: Virtual Labs:
https://ps-iiith.vlabs.ac.in/List%20of%20experiments.html

TEXTBOOKS:
1. Ajay Mittal, Programming in C: A practical approach, Pearson.
2. Byron Gottfried, Schaum' s Outline of Programming with C, McGraw Hill

REFERENCE BOOKS:
1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice-Hall of India
2. C Programming, A Problem-Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE.

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	2	30	70	100	1
CODE:R23CC11L5	IT WORKSHOP						

COURSE OBJECTIVES:

- To introduce the internal parts of a computer, peripherals, I/O ports, connecting cables
- To demonstrate configuring the system as Dual boot both Windows and other OperatingSystems Viz. Linux, BOSS
- To teach basic command line interface commands on Linux.
- To teach the usage of Internet for productivity and self-paced life-long learning
- To introduce Compression, Multimedia and Antivirus tools and Office Tools such asWord processors, spread sheets and Presentation tools.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Identify Hardware components and inter dependencies**.**
CO2: Utilize Antivirus s/w to safeguard computer systems while using Internet
CO3: Develop a Document or Presentation
CO4: Make use of spreadsheets to perform calculations
CO5: Utilize the AI Tool Chat GPT

PC HARDWARE & SOFTWARE INSTALLATION

Task 1: Identify the peripherals of a computer, components in a CPU and its functions. Draw the block diagram of the CPU along with the configuration of each peripheral and submit to your instructor.

Task 2: Every student should disassemble and assemble the PC back to working condition. Lab instructors should verify the work and follow it up with a Viva. Also students need to go throughthe video which shows the process of assembling a PC. A video would be given as part of the course content.

Task 3: Every student should individually install MS windows on the personal computer. Lab instructor should verify the installation and follow it up with a Viva.

Task 4: Every student should install Linux on the computer. This computer should have windows installed. The system should be configured as dual boot (VMWare) with bothWindows and Linux. Lab instructors should verify the installation and follow it up with a Viva

Task 5: Every student should install BOSS on the computer. The system should be configuredas dual boot (VMWare) with both Windows and BOSS. Lab instructors should verify the installation and follow it up with a Viva

INTERNET & WORLD WIDE WEB

Task1: Orientation & Connectivity Boot Camp: Students should get connected to their Local Area Network and access the Internet. In the process they configure the TCP/IP setting. Finallystudents should demonstrate, to the instructor, how to access the websites and email. If there is no internet connectivity preparations need to be made by the instructors to simulate the WWWon the LAN.

Task 2: Web Browsers, Surfing the Web: Students customize their web browsers with the LAN proxy settings, bookmarks, search toolbars and pop up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.

Task 3: Search Engines & Netiquette: Students should know what search engines are and howto use the search engines. A few topics would be given to the students for which they need to search on Google. This should be demonstrated to the instructors by the student.
Task 4: Cyber Hygiene: Students would be exposed to the various threats on the internet and would be asked to configure their computer to be safe on the internet. They need to customizetheir browsers to block pop ups, block active x downloads to avoid viruses and/or worms.

LaTeX and WORD
Task 1 – Word Orientation: The mentor needs to give an overview of La TeX and Microsoft (MS) office or equivalent (FOSS) tool word: Importance of La TeX and MS office or equivalent(FOSS) tool Word as word Processors, Details of the four tasks and features that would be covered in each, Using La TeXand word – Accessing, overview of toolbars, saving files, Usinghelp and resources, rulers, format painter in word.
Task 2: Using La TeX and Word to create a project certificate. Features to be covered:- Formatting Fonts in word, Drop Cap in word, Applying Text effects, Using Character Spacing,Borders and Colors, Inserting Header and Footer, Using Date and Time option in both La TeXand Word.
Task 3: Creating project abstract Features to be covered:-Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.
Task 4: Creating a Newsletter: Features to be covered:- Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes, Paragraphs and Mail Merge in word.

EXCEL
Excel Orientation: The mentor needs to tell the importance of MS office or equivalent (FOSS)tool Excel as a Spreadsheet tool, give the details of the four tasks and features that would be covered in each. Using Excel – Accessing, overview of toolbars, saving excel files, Using help and resources.
Task 1: Creating a Scheduler - Features to be covered: Gridlines, Format Cells, Summation, auto fill, Formatting Text
Task 2: Calculating GPA -. Features to be covered:- Cell Referencing, Formulae in excel – average, std. deviation, Charts, Renaming and Inserting worksheets, Hyper linking, Count function,

LOOKUP/VLOOKUP
Task 1: Split cells, freeze panes, group and outline, Sorting, Boolean and logical operators, Conditional formatting

POWER POINT
Task 1: Students will be working on basic power point utilities and tools which help them create basic power point presentations. PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows in PowerPoint.
Task 2: Interactive presentations - Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts.
Task 3: Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes etc), and Inserting – Background, textures, Design Templates, Hidden slides.

AI TOOLS – Chat GPT

Task 1: Prompt Engineering: Experiment with different types of prompts to see how the model responds. Try asking questions, starting conversations, or even providing incomplete sentencesto see how the model completes them.

- Ex: Prompt: "You are a knowledgeable AI. Please answer the following question: Whatis the capital of France?"

Task 2: Creative Writing: Use the model as a writing assistant. Provide the beginning of a storyor a description of a scene, and let the model generate the rest of the content. This can be a funway to brainstorm creative ideas

- Ex: Prompt: "In a world where gravity suddenly stopped working, people started floating upwards. Write a story about how society adapted to this new reality."

Task 3: Language Translation: Experiment with translation tasks by providing a sentence in one language and asking the model to translate it into another language. Compare the output tosee how accurate and fluent the translations are.

- Ex:Prompt: "Translate the following English sentence to French: 'Hello, how are you doing today?'"

REFERENCE BOOKS:

1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream tech, 2003
2. The Complete Computer upgrade and repair book, Cheryl A Schmidt, WILEY Dream tech, 2013, 3rd edition
3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education, 2012, 2nd edition
4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft)
5. LaTeX Companion, Leslie Lamport, PHI/Pearson.
6. IT Essentials PC Hardware and Software Companion Guide, David Anfins on and Ken Quamme. – CISCO Press, Pearson Education, 3rd edition IT Essentials PC Hardware and Software Labs and Study Guide, Patrick Regan– CISCOPress, Pearson Education, 3rd edition

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
CODE: R23CC11L6	ENGINEERING PHYSICS LAB						

COURSE OBJECTIVES:

- To study the concepts of optical phenomenon like interference, diffraction etc.,
- Recognize the importance of energy gap in the study of conductivity and Hall effect in semiconductors
- Study the parameters and applications of dielectric and magnetic materials by conducting experiments.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO: 1 Operate optical instruments like travelling microscope and spectrometer
CO: 2 Estimate the wavelengths of different colors using diffraction grating.
CO: 3 Plot the intensity of the magnetic field of circular coil carrying current with distance.
CO: 4 Calculate the band gap of a given semiconductor.

LIST OF EXPERIMENTS:

1. Determination of radius of curvature of a given plano convex lens by Newton's rings.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
3. Verification of Brewster's law
4. Determination of dielectric constant using charging and discharging method.
5. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
6. Determination of wavelength of Laser light using diffraction grating.
7. Estimation of Planck's constant using photoelectric effect.
8. Determination of the resistivity of semiconductors by four probe methods.
9. Determination of energy gap of a semiconductor using p-n junction diode.
10. Magnetic field along the axis of a current carrying circular coil by Stewart Gee'sMethod.
11. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall effect.
12. Determination of temperature coefficients of a thermistor.
13. Determination of acceleration due to gravity and radius of Gyration by using acompound pendulum.
14. Determination of magnetic susptibility by Kundt's tube method.
15. Determination of rigidity modulus of the material of the given wire using Torsionalpendulum.
16. Sonometer: Verification of laws of stretched string.
17. Determination of young's modulus for the given material of wooden scale by non-uniform bending (or double cantilever) method.
18. Determination of Frequency of electrically maintained tuning fork by Melde'sexperiment.

Note: Any **TEN** of the listed experiments are to be conducted. Out of which any **TWO** experiments may be conducted in virtual mode.

REFERENCES:

1. A Textbook of Practical Physics - S. Balasubramanian, M.N. Srinivasan, S. ChandPublishers, 2017.

URL: *www.vlab.co.in*

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	2	30	70	100	1
CODE :R23CC11L7	EEE WORKSHOP						

PART A: ELECTRICAL ENGINEERING LAB

COURSE OBJECTIVES:

To impart knowledge on the fundamental laws & theorems of electrical circuits, functions of electrical machines and energy calculations.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Measure** voltage, current and power in an electrical circuit.
CO2: **Measure** of Resistance using Wheatstone bridge
CO3: **Discover** critical field resistance and critical speed of DC shunt generators.
CO4: **Investigate** the effect of reactive power and power factor in electrical loads.

Activities:

1. Familiarization of commonly used Electrical & Electronic Workshop Tools: Bread board, Solder, cables, relays, switches, connectors, fuses, Cutter, plier, screwdriver set, wire stripper, flux, knife/blade, soldering iron, de-soldering pump etc.

- Provide some exercises so that hardware tools and instruments are learned to be used by the students.

2. Familiarization of Measuring Instruments like Voltmeters, Ammeters, multimeter, LCR-Q meter, Power Supplies, CRO, DSO, Function Generator, Frequency counter.

- Provide some exercises so that measuring instruments are learned to be used by the students.

3. Components:

- Familiarization/Identification of components (Resistors, Capacitors, Inductors, Diodes, transistors, IC's etc.) – Functionality, type, size, colour coding package, symbol, cost etc.
- Testing of components like Resistor, Capacitor, Diode, Transistor, ICs etc. - Compare values of components like resistors, inductors, capacitors etc with the measured values by using instruments

LIST OF EXPERIMENTS

1. Verification of KCL and KVL
2. Verification of Superposition theorem
3. Measurement of Resistance using Wheatstone bridge
4. Magnetization Characteristics of DC shunt Generator
5. Measurement of Power and Power factor using Single-phase wattmeter
6. Measurement of Earth Resistance using Megger
7. Calculation of Electrical Energy for Domestic Premises
8. Determination of open circuit and short circuit parameters of a 1-phase transformer (Content Beyond syllabus)

REFERENCE BOOKS:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

***Note:** Minimum Six Experiments to be performed.

PART B: ELECTRONICS ENGINEERING LAB

COURSE OBJECTIVES:

- To impart knowledge on the principles of digital electronics and fundamentals of electron devices & its applications.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Analyze the characteristics of various electronic components.
CO2: Implement Rectifiers circuits.
CO3: Design Amplifiers circuit.
CO4: Examine the operation of Logic gates.

LIST OF EXPERIMENTS

1. Plot V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias.
2. Plot V – I characteristics of Zener Diode and its application as voltage Regulator.
3. Implementation of half wave and full wave rectifiers
4. Plot Input & Output characteristics of BJT in CE and CB configurations
5. Frequency response of CE amplifier.
6. Simulation of RC coupled amplifier with the design supplied
7. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs.
8. Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs.
9. Design a Full Adder Circuit and verify the truth table. (Content beyond syllabus)

Tools / Equipment Required: DC Power supplies, Multi meters, DC Ammeters, DC Voltmeters, AC Voltmeters, CROs, all the required active devices.

REFERENCES:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education, 2009.

Note: Minimum Six Experiments to be performed. All the experiments shall be implemented using both Hardware and Software.

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	1	100	-	100	0.5
SCODE :R23CC11MC2	NSS/NCC/SCOUTS & GUIDES/COMMUNITY SERVICE						

COURSE OBJECTIVES:

The objective of introducing this course is to impart discipline, character, fraternity, teamwork, social consciousness among the students and engaging them in selfless service.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Understand the importance of discipline, character and service motto.
CO2: Solve some societal issues by applying acquired knowledge, facts, and techniques.
CO3: Explore human relationships by analyzing social problems.
CO4: Determine to extend their help for the fellow beings and downtrodden people.
CO5: Develop leadership skills and civic responsibilities.

UNIT I

ORIENTATION

General Orientation on NSS/NCC/ Scouts & Guides/Community Service activities, career guidance.

Activities:

i) Conducting –ice breaking sessions-expectations from the course-knowing personal talents and skills
ii) Conducting orientations programs for the students –future plans-activities-releasing road map etc.
iii) Displaying success stories-motivational biopics- award winning movies on societal issues etc.
iv) Conducting talent show in singing patriotic songs-paintings- any other contribution.

UNIT II

NATURE & CARE

Activities:

i) Best out of waste competition.
ii) Poster and signs making competition to spread environmental awareness.
iii) Recycling and environmental pollution article writing competition.
iv) Organising Zero-waste day.
v) Digital Environmental awareness activity via various social media platforms.
vi) Virtual demonstration of different eco-friendly approaches for sustainable living.
vii) Write a summary on any book related to environmental issues.

UNIT III Community Service

Activities:

i) Conducting One Day Special Camp in a village contacting village-area leaders- Survey in the village, identification of problems- helping them to solve via media- authorities experts-etc.
ii) Conducting awareness programs on Health-related issues such as General Health, Mental health, Spiritual Health, HIV/AIDS,
iii) Conducting consumer Awareness. Explaining various legal provisions etc.

iv) Women Empowerment Programmes- Sexual Abuse, Adolescent Health and Population Education.
v) Any other programmes in collaboration with local charities, NGOs etc.

Reference Books:

1. Nirmalya Kumar Sinha & Surajit Majumder, *A Text Book of National Service Scheme* Vol;.I, Vidya Kutir Publication, 2021 (ISBN 978-81-952368-8-6)
2. *Red Book - National Cadet Corps* – Standing Instructions Vol I & II, Directorate General of NCC, Ministry of Defence, New Delhi
3. Davis M. L. and Cornwell D. A., "Introduction to Environmental Engineering",McGraw Hill, New York 4/e 2008
4. Masters G. M., Joseph K. and Nagendran R. "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi. 2/e 2007
5. Ram Ahuja. *Social Problems in India,* Rawat Publications, New Delhi.

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities.
2. Institutes are required to provide instructor to mentor the students.

Evaluation Guidelines:

1. Evaluated for a total of 100 marks.
2. A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totaling to 90 marks.
3. A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voce on the subject.

I B.Tech II SEMESTER

S. No	Subject	Course Code	Cat. Code	Internal Marks	External Marks	Total Marks	L	T	P	Credits
1	DIFFERENTIAL EQUATIONS & VECTOR CALCULUS	R23CC1201	BS&H	30	70	100	3	0	0	3
2	COMMUNICATIVE ENGLISH	R23CC1206	BS&H	30	70	100	3	0	0	2
3	ENGINEERING CHEMISTRY	R23CC1208	BS&H	30	70	100	3	0	0	3
4	ENGINEERING MECHANICS	R23CC1209	ES	30	70	100	3	0	0	3
5	BASIC CIVIL & MECHANICAL ENGINEERING	R23CC1212	ES	30	70	100	3	0	0	3
6	ENGINEERING WORKSHOP	R23CC12L9	ES	30	70	100	0	0	3	1.5
7	ENGINEERING MECHANICS LAB	R23ME12L7	ES	30	70	100	0	0	3	1.5
8	ENGINEERING CHEMISTRY LAB	R23CC12L11	BS&H	30	70	100	0	0	2	1
9	COMMUNICATIVE ENGLISH LAB	R23CC12L12	BS&H	30	70	100	0	0	2	1
10	HEALTH AND WELLNESS, YOGA AND SPORTS	R23CC12MC1	BS&H	100	-	100	-	-	1	0.5
TOTAL										**19.5**

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
CODE : R23CC1201	DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS (Common to all Engineering Branches)						

COURSE OBJECTIVES:

- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real-world applications.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO 1: **Solve** first order ordinary differential equations to real life situations.
CO 2: **Identify** and apply suitable methods in solving the higher order differential equations
CO 3: **Solve** the partial differentiation equations.
CO 4: **Interpret** the physical meaning of different operators as gradient, curl and divergence.
CO 5: **Estimate** the work done against a field, circulation and flux using vector calculus.

UNIT-I:

DIFFERENTIAL EQUATIONS OF FIRST ORDER AND FIRST DEGREE

Linear differential equations - Bernoulli's equations - Exact equations and equations reducible to exact form - Applications: Newton's law of cooling - Law of natural growth and decay - Electrical circuits.

UNIT-II:

LINEAR DIFFERENTIAL EQUATIONS OF HIGHER ORDER (CONSTANT COEFFICIENTS)

Definitions, homogenous and non-homogenous, complimentary function,particular integral, general solution - Wronskian, Method of variation of parameters - Simultaneous linear equations - Applications to L-C-R circuit problems and Simple harmonic motion.

UNIT-III:

PARTIAL DIFFERENTIAL EQUATIONS

Introduction and formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solutions of first order linear equations using Lagrange's method - Homogeneous and Non-homogeneous linear partial differential equations with constant coefficients.

UNIT-IV:

VECTOR DIFFERENTIATION

Scalar and vector point functions - Vector operator del - Del applied to scalar point functions - Gradient, Directional derivative - Del applied to vector point functions - Divergence and Curl – Solenoidal vector-Irrotational-scalar potential of vector - Vector identities.

UNIT-V:

VECTOR INTEGRATION

Line integral - Circulation - Work done - Surface integral, flux - Green's theorem in the plane (without proof) - Stoke's theorem (without proof) - Volume integral - Gauss divergence theorem (without proof) and related problems.

TEXTBOOKS:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2017, 44th Edition.
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, 2018, 10th Edition.

REFERENCE BOOKS:

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, Dennis G. Zill and Warren S. Wright, Jones and Bartlett, 2018.
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 2021 5th Edition (9th reprint). Higher Engineering Mathematics, B. V. Ramana, Mc Graw Hill Education, 2017

I B.Tech II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	0	0	30	70	100	2
CODE: R23CC1206	COMMUNICATIVE ENGLISH						

COURSE OBJECTIVES:

- The main objective of introducing this course, *Communicative English*, is to facilitate effective listening, Reading, Speaking and Writing skills among the students. It enhances the same in their comprehending abilities, oral presentations, reporting useful information and providing knowledge of grammatical structures and vocabulary. This course helps the students to make them effective in speaking and writing skills and to make them industry ready.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Summarize texts based on the comprehension of the material provided**.**

CO2: Create coherent and well-structured paragraphs, essays, and letters on a range of familiar topics

CO3: Use a diverse array of grammatical structures with flexibility, striving to minimize errors.

CO4: Use vocabulary adequately and appropriately to express and write on a variety of topics.

UNIT I

Lesson: HUMAN VALUES: Gift of Magi **(Short Story)**

Listening: Identifying the topic, the context and specific pieces of information by listeningto short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home,family, work, studies and interests; introducing oneself and others.

Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Writing: Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences.

Grammar: Parts of Speech, Basic Sentence Structures-forming questions

Vocabulary: Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words.

UNIT II

Lesson: NATURE: The Brook by Alfred Tennyson (Poem)

Listening: Answering a series of questions about main ideas and supporting ideas afterlistening to audio texts.

Speaking: Discussion in pairs/small groups on specific topics followed by short structuretalks.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to linkthe ideas in a paragraph together.

Writing: Structure of a paragraph - Paragraph writing (specific topics)

Grammar: Cohesive devices - linkers, use of articles and zero article; prepositions.

Vocabulary: Homonyms, Homophones, Homographs.

UNIT III

Lesson: BIOGRAPHY: Elon Musk

Listening: Listening for global comprehension and summarizing what is listened to.

Speaking: Discussing specific topics in pairs or small groups and reporting what isdiscussed

Reading: Reading a text in detail by making basic inferences -recognizing and interpreting specific context clues; strategies to use text clues for comprehension.
Writing: Summarizing, Note-making, paraphrasing
Grammar: Verbs - tenses; subject-verb agreement; Compound words, Collocations
Vocabulary: Compound words, Collocations

UNIT IV
Lesson: INSPIRATION: The Toys of Peace by Saki
Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.
Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.
Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.
Writing: Letter Writing: Official Letters, Resumes
Grammar: Reporting verbs, Direct & Indirect speech, Active & Passive Voice
Vocabulary: Words often confused, Jargons

UNIT V
Lesson: MOTIVATION: The Power of Intrapersonal Communication (An Essay)
Listening: Identifying key terms, understanding concepts and answering a series ofrelevant questions that test comprehension.
Speaking: Formal oral presentations on topics from academic contexts
Reading: Reading comprehension.
Writing: Writing structured essays on specific topics.
Grammar: Editing short texts –identifying and correcting common errors in grammar andusage (articles, prepositions, tenses, subject verb agreement)
Vocabulary: Technical Jargons

TEXTBOOKS:
1. Pathfinder: Communicative English for Undergraduate Students, 1st Edition, OrientBlack Swan, 2023 (Units 1,2 & 3)
2. Empowering with Language by Cengage Publications, 2023 (Units 4 & 5)

REFERENCE BOOKS:
1. Dubey, Sham Ji & Co. English for Engineers, Vikas Publishers, 2020
2. Bailey, Stephen. Academic writing: A Handbook for International Students. Routledge,2014.
3. Murphy, Raymond. English Grammar in Use, Fourth Edition, Cambridge UniversityPress, 2019.
4. Lewis, Norman. Word Power Made Easy- The Complete Handbook for Building a Superior Vocabulary. Anchor, 2014.

I B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
CODE :R23CC1208	ENGINEERING CHEMISTRY						

COURSE OBJECTIVES:

- To impart the concept of soft and hard waters, softening methods of hard water
- To familiarize engineering chemistry and its applications
- To train the students on the principles and applications of electrochemistry, polymers, cement and advanced engineering materials.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Understand the difference between soft and hard water and why it matters in daily life and industries.

CO2: Apply electrochemical principles to real-problems, making informed decisions about materials selection, corrosion mitigation, and energy storage solutions

CO3: Analyze the production, properties, and environmental implications of polymers, fuels and biofuels.

CO4: Apply the knowledge of diverse engineering materials like composites, refractories, lubricants, and Portland cement, to make material selection and applications.

CO5: Apply the Knowledge of various applications to synthesize colloids and characterize nano materials.

UNIT I

WATER TECHNOLOGY

Soft and hard water, Estimation of hardness of water by EDTA Method, Estimation of dissolved Oxygen - Boiler troubles –Priming, foaming**,** scale and sludge, Caustic embrittlement, Industrial water treatment – Specifications for drinking water, Bureau of Indian Standards(BIS) and World health organization(WHO) standards, Ion-exchange process - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

UNIT II

ELECTROCHEMISTRY AND APPLICATIONS

Electrochemical cell, Reference electrodes: Metal-metal ion electrode (Calomel electrode) Primary cells – Zinc-air battery, Secondary cells – Nickel-Cadmium (NiCd), Sodium –ion and lithium ion batteries- working principle of the batteries including cell reactions; Fuel cells-Basic Concepts, the principle and working of hydrogen-oxygen Fuel cell.

Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling-Bedworth ratios and uses, Factors affecting the corrosion**,** cathodic and anodic protection, electroplating and electroless plating (Nickel and Copper)

UNIT III

POLYMERS AND FUEL CHEMISTRY

Introduction to polymers, Mechanism of chain growth, step growth polymerization. Plastics –Thermo plastics and Thermosetting plastics, Moulding Techniques-Compression moulding, injection moulding, Blow moulding, Elastomers – Preparation, properties and applications of Buna S, Buna N.

Fuels – Types of fuels, calorific value of fuels, numerical problems based on calorific value; Analysis of coal (Proximate and Ultimate analysis), Liquid Fuels, refining of petroleum, Octane and Cetane number- alternative fuels- propane, methanol, ethanol and bio fuel-bio diesel

UNIT IV

MODERN ENGINEERING MATERIALS

Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforced composites, properties and Engineering applications

Refractories- Classification, Properties, Factors affecting the refractory materials and Applications.

Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils – Viscosity, Viscosity Index, Flash point, Fire point, Cloud point, saponification and Applications.

Building materials- Portland cement, constituents, Setting and Hardening of cement.

UNIT V

SURFACE CHEMISTRY AND NANOMATERIALS

Introduction to surface chemistry, colloids, micelle formation, synthesis of colloids (Braggs Method), stabilization of colloids by stabilizing agents.

Nano materials: Introduction–Sol-gel method & chemical reduction method of preparation – Characterization by BET method and TEM methods–Carbon nano tubes and fullerenes: Types–preparation–properties and applications.

TEXTBOOKS:

1. Jain and Jain, Engineering Chemistry, 16/e, DhanpatRai, 2013.
2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10/e, Oxford University Press, 2010.

REFERENCE BOOKS:

1. H.F.W. Taylor, Cement Chemistry, 2/e, Thomas Telford Publications, 1997.
2. D.J. Shaw, Introduction to Colloids and Surface Chemistry, Butterworth- Heineman, 1992.
3. Textbook of Polymer Science, Fred W. Billmayer Jr, 3rd Edition.

I B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
CODE: R23CC1209	ENGINEERING MECHANICS						

COURSE OBJECTIVES:

- Learn and understanding the basic principles of mechanics of rigid bodies, various types of force systems and to analyze problems in a simple and logical manner.
- Study and calculate the concepts of wedge friction, and to analyze simple trusses using method of joints and method of sections.
- Study and determine centroids and centre of gravity of various standard geometrical shapes as well as composite areas and bodies.
- Learn the concept of moment of inertia and the mathematical calculations involved in finding moments of inertia of two dimensional areas.
- The students are to be exposed to concepts of work, energy and particle motion.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO 1: **Apply** the principles of mechanics to determine the resultant of several concurrent Forces acting on a particle.

CO 2: **Analyze** the trusses using method of joints and method of sections; apply the basic Concepts of dry friction and wedges**.**

CO 3: **Solve** the centroid and centre of gravity bodies and composite sections**.**

CO 4: **Solve** the Area Moment of Inertia and Mass Moment of Inertia of areas bodies and Composite sections**.**

CO 5: **Apply** the work-energy principle to particles and connected systems for engineering Applications.

UNIT–I

INTRODUCTION TO ENGINEERING MECHANICS: Basic Concepts, Scope and Applications, Characteristics of a Force, Force system, classification, Resultant of Force Systems, parallelogram law of forces, Triangle law of forces.

SYSTEMS OF FORCES: Resolution of forces, Coplanar Concurrent forces, Components in Space, Moment of Force and its Application–Couples, Varignon's theorem.

EQUILIBRIUM OF SYSTEMS OF FORCES: Equations of Equilibrium of Coplanar concurrent forces, Equations of Equilibrium for spatial system of forces using vector approach, Numerical Examples, Lami's Theorem, support reactions, free body diagrams.

UNIT–II

ANALYSIS OF PLANE TRUSSES: Definition, Assumptions made in the analysis of plane trusses-methods of joints and method of sections.

FRICTION: Introduction, Classification of friction, Laws of Friction, Coefficient of Friction, Angle of Friction, Angle of Repose, Motion of a body on an Inclined Plane, Cone of Static friction.

UNIT–III

CENTROID: Centroids of simple figures (from basic principles)-Centroids of composite figures.

CENTRE OF GRAVITY: Centre of Gravity of simple body (from basic principles), Centre of gravity of composite bodies, Pappu's theorem.

UNIT-IV

AREA MOMENTS OF INERTIA: Definition, Radius of gyration, Parallel axis theorem, perpendicular axis theorem, Moments of Inertia of composite figures, polar moment of Inertia.

MASS MOMENT OF INERTIA: Moment of Inertia of Rigid body-Moment of Inertia from basic principles-Slender bar, Rectangular Plate, Circular Plate, Moment of Inertia of 3D Bodies-Cone, Solid Cylinder.

UNIT-V

RECTILINEAR AND CURVILINEAR MOTION OF A PARTICLE: Kinematics and Kinetics - D'Alembert's Principle - Work Energy method and applications to particle motion-Impulse Momentum method.

RIGID BODY MOTION: Kinematics and Kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse Momentum method. Principle of Virtual work with simple Examples.

TEXT BOOKS:

1. Engineering Mechanics by S.Timoshenko & D.H.Young., 4th Edn - ,Mc Graw Hill publications.
2. Engineering Mechanics by S.S. Bhavikatti-New age publications
3. Engineering Mechanics Statics and Dynamics A.K.TAYAL Umesh publications.

REFERENCE BOOKS:

1. Engineering Mechanics by Fedinand . L. Singer, Harper –Collins.
2. Mechanics of Materials (In Si Units) by Beer and Johnson, Tata McGraw-Hil.
3. Strength of Materials (Mechanics of Materials) by James M.Gere and Barry J.Goodno, PWS-KENT Publishing Company, 1990
4. Strength of Materials (Mechanics of Solids) by R.K. Rajput, S.Chand Publications.

Web References:

1. https://nptel.ac.in/courses/112103109/142
2. https://nptel.ac.in/courses/112103109/113
3. https://nptel.ac.in/courses/122104014/4

E-Books:

1. https://easyengineering.net/engineeringmechanicsbooks/

I B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
CODE: R23CC1212	BASIC CIVIL AND MECHANICAL ENGINEERING						

PART A: BASIC CIVIL ENGINEERING

COURSE OBJECTIVES:

- To introduce basic laws, mesh & nodal analysis techniques for solving electrical circuits
- To impart knowledge on applying appropriate theorem for electrical circuit analysis
- To explain transient behavior of circuits in time and frequency domains
- To teach concepts of resonance
- To introduce open circuit, short circuit, transmission, hybrid parameters and their interrelationship.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Acquire** knowledge on various sub-divisions of Civil Engineering and to appreciate their role inensuring better society.

CO2: **Apply** the concepts of surveying to calculate distances, anglesand levels.

CO3: **Realize** the importance of transportation in nation's economy and to identify the importance of Water Storage and Conveyance Structures.

UNIT I

Basics of Civil Engineering: Role of Civil Engineers in Society- Various Disciplines of Civil Engineering- Structural Engineering- Geo-technical Engineering- Transportation Engineering - Hydraulics and Water Resources Engineering - Environmental Engineering-Scope of each discipline - Building Construction and Planning- Construction Materials-Cement - Aggregate - Bricks- Cement concrete- Steel. Introduction to Prefabricated construction Techniques.

UNIT II

Surveying: Objectives of Surveying- Horizontal Measurements- Angular Measurements- Introduction to Bearings Levelling instruments used for levelling -Simple problems on levelling and bearings-Contour mapping.

UNIT III

Transportation Engineering: Importance of Transportation in Nation's economic development- Types of Highway Pavements- Flexible Pavements and Rigid Pavements - Simple Differences. Basics of Harbour, Tunnel, Airport, and Railway Engineering.

Water Resources and Environmental Engineering: Introduction, Sources of water- Quality of water- Specifications- Introduction to Hydrology–Rainwater Harvesting-Water Storage and Conveyance Structures (Simple introduction to Dams and Reservoirs).

TEXTBOOKS:

1. Basic Civil Engineering, M.S.Palanisamy, , Tata Mcgraw Hill publications (India) Pvt. Ltd. Fourth Edition.
2. Introduction to Civil Engineering, S.S. Bhavikatti, New Age International Publishers. 2022. First Edition.
3. Basic Civil Engineering, Satheesh Gopi, Pearson Publications, 2009, First Edition.

REFERENCE BOOKS:
1. Surveying, Vol- I and Vol-II, S.K. Duggal, Tata McGraw Hill Publishers 2019. Fifth Edition.
2. Hydrology and Water Resources Engineering, Santosh Kumar Garg, Khanna Publishers, Delhi. 2016
3. Irrigation Engineering and Hydraulic Structures - Santosh Kumar Garg, Khanna Publishers, Delhi 2023. 38th Edition.
4. Highway Engineering, S.K.Khanna, C.E.G. Justo and Veeraraghavan, Nemchand and Brothers Publications 2019. 10th Edition.
5. Indian Standard DRINKING WATER — SPECIFICATION IS 10500-2012.

PART B: BASIC MECHANICAL ENGINEERING

COURSE OBJECTIVES:

The students after completing the course are expected to

- Get familiarized with the scope and importance of Mechanical Engineering in differentsectors and industries.
- Explain different engineering materials and different manufacturing processes.
- Provide an overview of different thermal and mechanical transmission systems andintroduce basics of robotics and its applications.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Illustrate** the role of mechanical engineering and its technologies in various sectors and knowledge of engineering materials.

CO2: **Explain** the basics of various manufacturing processes and thermal engineering and its applications.

CO3: **Describe** the working of different powerplants, mechanical power transmission systems and basics of robotics and its applications.

UNIT I

INTRODUCTION TO MECHANICAL ENGINEERING: Role of Mechanical Engineering in Industries andSociety - Mechanical Engineering Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace and Marine Engineering.

ENGINEERING MATERIALS – Basics of **Metals** (Ferrous & Non-ferrous), Ceramics, Composites, Smart materials.

UNIT II

MANUFACTURING PROCESSES: Basics of - Principles of Casting**,** Forming and joining processes, Machining, Introduction to CNC machines, 3D printing, and Smart manufacturing.

THERMAL ENGINEERING: Basics of - working principle of Boilers, Otto cycle, Diesel cycle, Refrigeration and air-conditioning cycles, IC engines, 2-Stroke and 4-Stroke engines, SI/CI Engines, Components of Electric and Hybrid Vehicles.

UNIT III

Power plants: Basics of - Working principle of Steam, Diesel, Hydro, Nuclear power plants.

Mechanical Power Transmission: Basics of - Belt Drives, Chain, Rope drives, Gear Drives and their applications.

Introduction to Robotics: Basics of - Joints & links, configurations, and applications of robotics.

(Note: The subject covers only the basic principles of Civil and Mechanical Engineering systems. The evaluation shall be intended to test only the fundamentals of the subject)

TEXTBOOKS:

1. Internal Combustion Engines by V.Ganesan, By Tata McGraw Hill publications (India)Pvt. Ltd.
2. A Tear book of Theory of Machines by S.S. Rattan, Tata McGraw Hill Publications,(India) Pvt. Ltd.
3. An introduction to Mechanical Engineering by Jonathan Wicker and Kemper Lewis, Cengage learning India Pvt. Ltd.

REFERENCE BOOKS:

1. Appuu Kuttan KK, Robotics, I.K. International Publishing House Pvt. Ltd. Volume-I
2. 3D printing & Additive Manufacturing Technology- L. Jyothish Kumar, Pulak MPandey, Springer publications
3. Thermal Engineering by Mahesh M Rathore Tata McGraw Hill publications (India) Pvt.Ltd.
4. G. Shanmugam and M.S.Palanisamy, Basic Civil and the Mechanical Engineering, Tata McGraw Hill publications (India) Pvt. Ltd.

I B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
CODE: R23CC12L9	ENGINEERING WORKSHOP						

COURSE OBJECTIVES:

- To familiarize students with wood working, sheet metal operations, fitting and electrical house wiring skills

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Identify** workshop tools and their operational capabilities.
CO2: **Make** manufacturing of components using workshop trades including fitting, carpentry, foundry, welding and Plumbing.
CO3: **Apply** fitting operations in various applications.
CO4: **Apply** basic electrical engineering knowledge for House Wiring Practice.

LIST OF EXPERIMENTS

ENGINEERING WORKSHOP TRADES FOR EXERCISE:

1. Demonstration: Safety practices and precautions to be observed in workshop.
2. Wood Working: Familiarity with different types of woods and tools used in wood Working and make following joints.
a) Half – Lap joint
b) Dovetail joint
3. Sheet Metal Working: Familiarity with different types of tools used in sheet metal Working, Developments of following sheet metal job from GI sheets.
a) Conical funnel
b) Brazing
4. Fitting: Familiarity with different types of tools used in fitting and do the following Fitting exercises.
a) V-fit
b) Bicycle tire puncture
5. Electrical Wiring: Familiarity with different types of basic electrical circuits and make The following connections.
a) Parallel and Series
b) Tube light
6. Foundry Trade: Demonstration and practice on Moulding tools and processes, Preparation of Green Sand Moulds for given Patterns.
7. Welding Shop: Demonstration and practice on Arc Welding and Gas welding. Preparation of Lap joint and Butt joint.
8. Plumbing: Demonstration and practice of Plumbing tools, Preparation of Pipe joints With coupling for same diameter and with reducer for different diameters**.**
9. Demonstration and basic repair works of two wheeler vehicle

I B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
CODE: R23ME12L7	ENGINEERING MECHANICS LAB						

COURSE OBJECTIVES: The students completing the course are expected to:

- Verify the Law of Parallelogram and Triangle of Forces.
- Determine the coefficients of friction of Static and Rolling friction and Centre of gravity of different plane Lamina.
- Analyse the system of Pulleys and Moment of Inertia of Compound Pendulum and Flywheel.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1 : **Evaluate** the coefficient of friction between two different surfaces and the roller.
CO2 : **Apply** Law of Polygon of forces and Law of Moment using force polygon.
CO3 : **Determine** the Centre of gravity and Moment of Inertia of different configurations.
CO4 : **Solve** the equilibrium conditions of a rigid body under the action of different force systems.

LIST OF EXPERIMENTS

(*Students have to perform any 10 of the following Experiments)*

1. Verification of Law of Parallelogram of Forces.
2. Verification of Law of Triangle of Forces.
3. Verification of the Law of polygon for coplanar-concurrent forces acting on a particle in equilibrium and to find the value of unknown forces considering particle to be in equilibrium.
4. Determination of coefficient of Static and Rolling Frictions
5. Determination of Centre of Gravity of different shaped Plane Lamina.
6. Verification of the conditions of equilibrium of a rigid body under the action of coplanar non-concurrent, parallel force system with the help of a simply supported beam.
7. Study of the systems of pulleys and draw the free body diagram of the system.
8. Determine the acceleration due to gravity using a compound pendulum.
9. Determine the Moment of Inertia of the compound pendulum about an axis perpendicular to the plane of oscillation and passing through its centre of mass.
10. Determine the Moment of Inertia of a Flywheel.
11. Verification of Law of Moment using Rotation Disc Apparatus.

VIRTUAL LAB: (www.vlabs.co.in)

1. Determine the Moment of Inertia of the compound pendulum – Symmetric (https://vlab.amrita.edu/index.php?sub=1&brch=280&sim=210&cnt=1)
2. To determine the moment of inertia of a flywheel. (https://vlab.amrita.edu/index.php?sub=1&brch=74&sim=571&cnt=1)

TEXTBOOKS:

1. Engineering Mechanics, S. Timoshenko, D. H. Young, J.V. Rao, S. Pati. McGraw Hill Education 2017. 5th Edition.
2. A Textbook of Engineering Mechanics, S.S Bhavikatti. New age international publications 2018. 4th Edition.

I B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	2	30	70	100	1
CODE: R23CC12L11	ENGINEERING CHEMISTRY LAB						

COURSE OBJECTIVES:

- Verify the fundamental concepts with experiments.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO 1: **Develop** and perform analytical chemistry techniques to address the water related problems.
CO 2: **Determine** the strength of an acid, cell constant, potentials and conductance of solutions.
CO 3: **Prepare** advanced polymer Bakelite and nanomaterials.
CO 4: **Explain** the functioning of different analytical instruments.

LIST OF EXPERIMENTS

1. Determination of hardness of water sample by EDTA method
2. Determination of alkalinity of water sample
3. Estimation of Dissolved Oxygen by Winkler's method
4. Estimation of Ferrous Iron by Dichrometry
5. Determination of Strength of an acid in Pb-Acid battery
6. Estimation of Mg in Antacid
7. Estimation of Vitamin C
8. Preparation of a polymer (Bakelite)/urea formaldehyde resin.
9. Preparation of nanomaterials by precipitation method
10. Conductometric titration of strong acid vs. strong base
11. Conductometric titration of weak acid vs. strong base
12. Determination of cell constant and conductance of solutions
13. Potentiometry - determination of redox potentials and emfs
14. Verify Lambert-Beer's law
15. Wavelength measurement of sample through UV-Visible Spectroscopy

Note: Any TEN of the listed experiments are to be conducted.

REFERENCE:

1. "Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition" Pearson Publications by J. Mendham, R.C.Denney, J.D.Barnes and B. Sivasankar

I B.Tech I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	2	30	70	100	1
CODE : R23CC12L12	**COMMUNICATIVE ENGLISH LAB** (COMMON TO ALL BRANCHES)						

COURSE OBJECTIVES:

- The main objective of introducing this course, Communicative English Laboratory, is to expose the students to a variety of self-instructional, learner friendly modes of language learning. The students will get trained in basic communication skills and also make them ready to face job interviews.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO 1: **Use** connected speech, applying a range of phonological features like rhythm, stress and intonation to convey clear meaning.

CO 2: **Create** a compelling resume, cover letter and Sop.

CO 3: **Make** formal presentations and engage effectively in debates and group discussions in academic and professional contexts.

CO 4: **Apply** employability skills to confidently navigate job interviews.

LIST OF TOPICS:

1. Vowels & Consonants
2. Neutralization/Accent Rules
3. Communication Skills & JAM
4. Role Play or Conversational Practice
5. E-mail Writing
6. Resume Writing, Cover letter, SOP
7. Group Discussions-methods & practice
8. Debates - Methods & Practice
9. PPT Presentations/ Poster Presentation
10. Interviews Skills

SUGGESTED SOFTWARE:

- Walden Infotech
- Young India Films

REFERENCE BOOKS:

1. Raman Meenakshi, Sangeeta-Sharma. *Technical Communication*. Oxford Press.2018.
2. Taylor Grant: *English Conversation Practice*, Tata McGraw-Hill Education India,2016
3. Hewing's, Martin. Cambridge *Academic English* (B2). CUP, 2012.
4. J. Sethi & P.V. Dhamija. *A Course in Phonetics and Spoken English*, (2nd Ed),Kindle, 2013.

WEB RESOURCES:

Spoken English:

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. https://www.britishcouncil.in/english/online
5. http://www.letstalkpodcast.com/
6. https://www.youtube.com/c/mmmEnglish_Emma/featured
7. https://www.youtube.com/c/ArnelsEverydayEnglish/featured
8. https://www.youtube.com/c/engvidAdam/featured
9. https://www.youtube.com/c/EnglishClass101/featured
10. https://www.youtube.com/c/SpeakEnglishWithTiffani/playlists
11. https://www.youtube.com/channel/UCV1h_cBE0Drdx19qkTM0WNw

Voice & Accent:

1. https://www.youtube.com/user/letstalkaccent/videos
2. https://www.youtube.com/c/EngLanguageClub/featured
3. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
   https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp_IA

I B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	1	100	-	100	0.5
CODE: R23CC12MC1	HEALTH AND WELLNESS, YOGA AND SPORTS						

COURSE OBJECTIVES:

- The main objective of introducing this course is to make the students maintain their mental and physical wellness by balancing emotions in their life. It mainly enhances the essential traits
  required for the development of the personality.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO 1: Use connected speech, applying a range of phonological features like rhythm, stress and intonation to convey clear meaning.

CO 2: Create a compelling resume, cover letter and Sop.

CO 3: Make formal presentations and engage effectively in debates and group discussions in academic and professional contexts.

CO 4: Apply employability skills to confidently navigate job interviews.

UNIT I

Concept of health and fitness, Nutrition and Balanced diet, basic concept of immunity Relationship between diet and fitness, Globalization and its impact on health, Body Mass Index (BMI) of all age groups.

Activities:

i) Organizing health awareness programmes in community
ii) Preparation of health profile
iii) Preparation of chart for balance diet for all age groups

UNIT II

Concept of yoga, need for and importance of yoga, origin and history of yoga in Indian context, classification of yoga, Physiological effects of Asanas- Pranayama and meditation, stress management and yoga, Mental health and yoga practice.

Activities:

Yoga practices – Asana, Kriya, Mudra, Bandha, Dhyana, Surya Namaskar

UNIT III

Concept of Sports and fitness, importance, fitness components, history of sports, Ancient and Modern Olympics, Asian games and Commonwealth games.

Activities:

i) Participation in one major game and one individual sport viz., Athletics, Volleyball, Basketball, Handball, Football, Badminton, Kabaddi, Kho-kho, Table tennis, Cricket etc.Practicing general and specific warm up, aerobics.
ii) Practicing cardiorespiratory fitness, treadmill, run test, 9 min walk, skipping and running.

REFERENCE BOOKS:

1. Gordon Edlin, Eric Golanty. Health and Wellness, 14th Edn. Jones & Bartlett Learning, 2022
2. T.K.V.Desikachar. The Heart of Yoga: Developing a Personal Practice
3. Archie J.Bahm. Yoga Sutras of Patanjali, Jain Publishing Company, 1993
4. Wiseman, John Lofty, SAS Survival Handbook: The Ultimate Guide to Surviving Anywhere Third Edition, William Morrow Paperbacks, 2014
5. The Sports Rules Book/ Human Kinetics with Thomas Hanlon. -- 3rd ed. Human Kinetics, Inc.2014

GENERAL GUIDELINES:

1. Institutes must assign slots in the Timetable for the activities of Health/Sports/Yoga.
2. Institutes must provide field/facility and offer the minimum of five choices of as many as Games/Sports.
3. Institutes are required to provide sports instructor / yoga teacher to mentor the students.

EVALUATION GUIDELINES:

1. Evaluated for a total of 100 marks.
2. A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totaling to 90 marks.
3. A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voce on the subject.

II B.TECH - I SEMESTER

S. No	Subject	Course Code	Cat. Code	Internal Marks	External Marks	Total Marks	L	T	P	Credits
1	Numerical Methods and Transform Techniques	R23CC2110	BS	30	70	100	3	0	0	3
2	Universal Human Values–Understanding Harmony& Ethical Human Conduct	R23CC2102	HSMC	30	70	100	2	1	0	3
3	Thermo dynamics	R23ME2103	ES	30	70	100	2	0	0	2
4	Mechanics of Solids	R23ME2104	PC	30	70	100	3	0	0	3
5	Material Science and Metallurgy	R23ME2105	PC	30	70	100	3	0	0	3
6	Mechanics of Solids and Materials Science Lab	R23ME21L1	PC	30	70	100	0	0	3	1.5
7	Computer-aided Machine Drawing	R23ME21L2	PC	30	70	100	0	0	3	1.5
8	Python programming Lab	R23ME21L3	ES	30	70	100	0	0	2	1.0
9	Embedded Systems & IoT	R23ME21L4	SC	30	70	100	0	1	2	2
10	Environmental Studies	R23CC21MC	MC	30	70	100	2	0	0	-
Total							**15**	**2**	**10**	**20**

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23CC2110**	**NUMERICAL METHODS AND TRANSFORM TECHNIQUES**						

COURSE OBJECTIVES:

- To elucidate the different numerical methods to solve nonlinear algebraic equations.
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications**.**

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Evaluate** the approximate roots of polynomial and transcendental equations by different algorithms.

CO2: **Apply** numerical integral techniques to different Engineering problems. Apply different Algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations

CO3: **Apply** the Laplace transform for solving differential equations

CO4: **Analyze** the Fourier series of periodic signals

CO5: **Apply** integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms

UNIT – I

ITERATIVE METHODS:

Introduction of Solutions of algebraic and transcendental equations: Bisection method, Secant method, Method of false position, Iteration method, Newton-Raphson method (Simultaneous Equations).

Interpolation: Newton's forward and backward formulae for interpolation, Interpolation with unequal intervals, Lagrange's interpolation formula.

UNIT – II

NUMERICAL INTEGRATION, SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS WITH INITIAL CONDITIONS:

Trapezoidal rule, Simpson's 1/3rd and 3/8th rule, Solution of initial value problems by Taylor's series, Picard's method of successive approximations, Euler's method , Runge- Kutta method (second and fourth order), Milne's Predictor and Corrector Method.

UNIT –III

LAPLACE TRANSFORMS:

Definition of Laplace transform, Laplace transforms of standard functions, Properties of Laplace Transforms , Shifting theorems, Transforms of derivatives and integrals , Unit step function, Dirac's delta function , Inverse Laplace transforms, Convolution theorem (without proof).

Applications: Solving ordinary differential equations (initial value problems) and integral differential equations using Laplace transforms.

UNIT – IV

FOURIER SERIES:

Introduction– Periodic functions – Fourier series of periodic function, Dirichlet's conditions, Even and odd functions, Change of interval, Half-range sine and cosine series.

UNIT – V

FOURIER TRANSFORMS:

Fourier integral theorem (without proof), Fourier sine and cosine integrals, Infinite Fourier transforms , Sine and cosine transforms , Propertie, Inverse transforms , Convolution theorem (without proof), Finite Fourier transforms.

TEXT BOOKS:

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill

REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineering and Science, Tata Mc. Graw Hill Education.
3. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
4. Lawrence Turyn, Advanced Engineering Mathematics, CRC Press.

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	1	0	30	70	100	3
Code: **R23CC2102**	**UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY& ETHICAL HUMAN CONDUCT**						

COURSE OBJECTIVES:

- To help the students appreciate the essential complementary between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such holistic perspective forms the basis of Universal Human Values and movement towards value-based living ina natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enrichinginteraction with Nature.

COURSE OUTCOMES:

CO1: Interpret the terms like Natural Acceptance, Happiness and Prosperity
CO2: Identify one's self, and one's surroundings (family, society nature)
CO3: Apply what they have learnt to their own self in different day-to-day settings in real life
CO4: Relate human values with human relationship and human society.
CO5: Justify the need for universal human values and harmonious existence
CO6: Develop as socially and ecologically responsible engineers

COURSE TOPICS:

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 1- hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions. The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

UNIT I

Introduction to Value Education (6 lectures and 3 tutorials for practice session)
Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session PS1 Sharing about Oneself
Lecture 3: self-exploration as the Process for Value Education
Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice Session PS2 Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfill the Basic Human Aspirations
Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

UNIT II

Harmony in the Human Being (6 lectures and 3 tutorials for practice session)
Lecture 7: Understanding Human being as the Co-existence of the self and thebody.
Lecture 8: Distinguishing between the Needs of the self and the body
Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self andbody.
Lecture 9: The body as an Instrument of the self

Lecture 10: Understanding Harmony in the self
Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the self
Lecture 11: Harmony of the self with the body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6 Exploring Harmony of self with the body

UNIT III
Harmony in the Family and Society (6 lectures and 3 tutorials for practicesession)
Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect
Lecture 16: Other Feelings, Justice in Human-to-Human Relationship
Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

UNIT IV
Harmony in the Nature/Existence (4 lectures and 2 tutorials for practicesession)
Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment amongthe Four Orders of Nature
Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence

UNIT V
Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)
Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26: Competence in Professional Ethics
Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
Lecture 27: Holistic Technologies, Production Systems and Management Models- Typical Case Studies
Lecture 28: Strategies for Transition towards Value-based Life and Profession
Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Practice Sessions for UNIT I – Introduction to Value Education
PS1 Sharing about Oneself
PS2 Exploring Human Consciousness
PS3 Exploring Natural Acceptance

Practice Sessions for UNIT II – Harmony in the Human Being
PS4 Exploring the difference of Needs of self and body
PS5 Exploring Sources of Imagination in the self
PS6 Exploring Harmony of self with the body

Practice Sessions for UNIT III – Harmony in the Family and Society
PS7 Exploring the Feeling of Trust
PS8 Exploring the Feeling of Respect
PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for UNIT IV – Harmony in the Nature (Existence)
PS10 Exploring the Four Orders of Nature
PS11 Exploring Co-existence in Existence

Practice Sessions for UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics
PS12 Exploring Ethical Human Conduct
PS13 Exploring Humanistic Models in Education
PS14 Exploring Steps of Transition towards Universal Human Order

READINGS:

Textbook and Teachers Manual

a. The Textbook
R R Gaur, R Asthana, G P Bagaria, A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual
R R Gaur, R Asthana, G P Bagaria, Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93- 87034-53-2

REFERENCE BOOKS

1. Jeevan Vidya: E k Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karam chand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

MODE OF CONDUCT:

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.
Tutorial hours are to be used for practice sessions.
While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up"ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.
Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.
It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses. This course is to be taught by faculty from every teaching department, not exclusively by any one department.
Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.

ONLINE RESOURCES:

1. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201-Introduction%20to%20Value%20Education.pdf
2. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf
3. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf
4. https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3-S2%20Respect%20July%2023.pdf
5. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf
6. https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf
7. https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf
8. https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human-values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385
9. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	0	0	30	70	100	2
Code: **R23ME2103**	**THERMO DYNAMICS**						

COURSE OBJECTIVES:

- Familiarize concepts of heat, work, energy and governing rules for conversion of one form to other.
- Explain relationships between properties of matter and basic laws of thermodynamics.
- Teach the concept of entropy for identifying the disorder and feasibility of a thermodynamic process.
- Introduce the concept of available energy for maximum work conversion.
- Provide fundamental concepts of Refrigeration and Psychrometry.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Explain** the importance of thermodynamic properties related to conversion of heat energy into work.
CO2: **Apply** the Zeroth and First Law of Thermodynamics.
CO3: **Analyze** the Second Law of Thermodynamics.
CO4: **Analyze** Mollier charts, T-S and h-s diagrams, Phase Transformations, Dryness Fraction and Steam calorimetry.
CO5: **Evaluate** the COP of refrigerating systems and properties, processes of psychrometry and sensible and latent heat loads.

UNIT - I

Introduction: Basic Concepts - System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi static Process, Irreversible Process, Causes of Irreversibility

UNIT -II

Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroth Law of Thermodynamics – PMM-I, Joule's Experiment – First law of Thermodynamics and applications. Limitations of the First Law, First law for flow systems - Steady flow energy equation – Enthalpy, Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance.

UNIT - III

Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM-II, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

UNIT - IV

Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry.

UNIT – V

Introduction to Refrigeration: working of Air, Vapor Compression, VCR system Components, COP Refrigerants.

Introduction to Air Conditioning: Psychrometric properties & processes – characterization of sensible and latent heat loads – load concepts of SHF.
Requirements of human comfort and concept of effective temperature- comfort chart – comfort air conditioning, and load calculations.

TEXT BOOKS:

1. P.K. Nag, Engineering Thermodynamics, 6/e, Tata McGraw Hill, 2017.
2. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 10/e, Wiley, 2020.

REFERENCE BOOKS:

1. J.B. Jones, and R.E. Dugan, Engineering Thermodynamics, 1/e, Prentice Hall, 1995.
2. Y.A. Cengel & M.A. Boles, Thermodynamics – An Engineering Approach, 7/e, McGraw Hill, 2010.
3. P. Chattopadhyay, Engineering Thermodynamics, 1/e, Oxford University Press, 2011.
4. CP Arora, Refrigeration and Air-conditioning, 4/e, McGraw Hill, 2021.

ONLINE LEARNING RESOURCES:

- https://www.edx.org/learn/thermodynamics.
- https://archive.nptel.ac.in/courses/112/106/112106310.
- https://www.youtube.com/watch?v=7NI5P4KqrAs&t=1s
- https://kp.kiit.ac.in/pdf_files/02/Study-Material_3rdSemester_Winter_2021_Mechanical-Engg.-_Thermal-Engineering-1_Abhijit Samant.pdf
- https://www.coursera.org/learn/thermodynamics-intro

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME2104**	**MECHANICS OF SOLIDS**						

COURSE OBJECTIVES:

The objectives of the course are to

- Understand the behavior of basic structural members subjected to uni axial and bi axial loads.
- Apply the concept of stress and strain to analyse and design structural members and machine parts under axial, shear and bending loads, moment and torsional moment.
- Students will learn all the methods to analyse beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components. Students are able to analyse beams and draw correct and complete shear and bending moment diagrams for beams.
- Students attain a deeper understanding of the loads, stresses, and strains acting on a structure and their relations in the elastic behavior
- Design and analysis of Industrial components like pressure vessels.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Analyze** concepts of stress and strain, Elasticity and plasticity, Bars of varying section, composite bars, Temperature stresses, Principal planes and principal stresses, Mohr's circle.

CO2: **Analyze** beams and draw shear force diagrams and bending moment diagrams to the different loads for the different support arrangements.

CO3: **Determine** flexural stresses and shear stresses induced in the beams which are made with different cross sections like rectangular, circular, I and T sections.

CO4: **Evaluate** the equations of slope and deflection for beams by using double integration method, Macaulay's method, Mohr's theorem and Moment area method.

CO5: **Determine** stresses induced in thin and thick cylinders subjected to internal, external pressures for longitudinal and circumferential stresses.

UNIT– I

SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains– Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT–II

SHEAR FORCE AND BENDING MOMENT: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra flexure.

UNIT–III

FLEXURAL STRESSES : Theory of simple bending, Derivation of bending equation, Determination of bending stresses – section modulus of rectangular, circular, I and T sections– Design of simple beam sections.

SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I and T sections.

UNIT–IV

DEFLECTION OF BEAMS : Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method – application to simple cases.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

UNIT– V

THIN AND THICK CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in dia, and volume of thin cylinders– Thin spherical shells. Lame's equation – cylinders subjected to inside & outside pressures.

COLUMNS: Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula.

TEXT BOOKS:

1. GH Ryder, Strength of materials, Palgrave Macmillan publishers India Ltd, 1961.
2. B.C. Punmia, Strength of materials, 10/e, Lakshmi publications Pvt. Ltd, New Delhi, 2018.

REFERENCE BOOKS:

1. Gere & Timoshenko, Mechanics of materials, 2/e, CBS publications, 2004.
2. U.C. Jindal, Strength of Materials, 2/e, Pearson Education, 2017.
3. Timoshenko, Strength of Materials Part – I& II, 3/e, CBS Publishers, 2004.
4. Andrew Pytel and Ferdinand L. Singer, Strength of Materials, 4/e, Longman Pulications, 1990.
5. Popov, Mechanics of Solids, 2/e, New Pearson Education, 2015.

ONLINE LEARNING RESOURCES:

- https://onlinecourses.nptel.ac.in/noc19_ce18/preview.
- https://youtube/iY_ypychVNY?si=310htc4ksTQJ8Fv6.
- https://www.youtube.com/watch?v=WEy939Rkd_M&t=2s
- https://www.classcentral.com/course/swayam-strength-of-materials-iitm-184204
- https://www.coursera.org/learn/mechanics-1
- https://www.edx.org/learn/engineering/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-1-linear-elastic-behavior
- https://archive.nptel.ac.in/courses/112/107/112107146/

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME2105**	**MATERIAL SCIENCE & METALLURGY**						

COURSE OBJECTIVE:

- Understand the crystalline structure of different metals and study the stability of phases in different alloy systems.
- Study the behavior of ferrous and nonferrous metals and alloys and their application in different domains
- Able to understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals.
- Grasp the methods of making of metal powders and applications of powder metallurgy
- Comprehend the properties and applications of ceramic, composites and other advanced methods

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Analyze** the crystalline structure of different metals and study the stability of phases in different alloy systems.

CO2: **Identify** the behavior of ferrous and non-ferrous metals and alloys and their application in different domains.

CO3: **Analyze** the effect of heat treatment, addition of alloying elements on properties of ferrous metals.

CO4: **Analyze** the methods of making of metal powders and applications of powder metallurgy.

CO5: **Inspect** the properties and applications of ceramic, composites and other advanced methods.

UNIT– I

STRUCTURE OF METALS AND CONSTITUTION OF ALLOYS: Crystallization of metals, Packing Factor - SC, BCC, FCC& HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries– determination of grain size. Imperfections, Slip and Twinning. Necessity of alloying, types of solid solutions, Hume Rothery's rules, intermediate alloy phases, and electron compounds

EQUILIBRIUM DIAGRAMS: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, Gibbs Phase rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe_3C.

UNIT–II

FERROUS METALS AND ALLOYS: Structure and properties of White Cast iron, Malleable Cast iron, grey cast-iron, Spheroidal graphite cast-iron, Alloy cast-iron. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

NON-FERROUS METALS AND ALLOYS: Structure and properties of Copper and its alloys, Aluminum and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT–III

HEAT TREATMENT OF STEELS: Effect of alloying elements on Fe-Fe_3C system, annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

UNIT–IV

POWDER METALLURGY: Basic processes- Methods of producing metal powders- milling atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Secondary operations, Applications of powder metallurgical products.

UNIT– V

CERAMIC AND ADVANCED MATERIALS: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, manufacturing methods, particle reinforced composites, fiber reinforced composites, PMC, MMC, CMC and CCCs. Introduction to Nano materials and smart materials.

TEXT BOOKS:

1. S.H.Avner, Introduction to Physical Metallurgy, 3/e, Tata McGraw- Hill, 2017.
2. Donald R.Askeland, Essentials of Materials science and Engineering, 4/e, CL Engineering publications, 2018.

REFERENCE BOOKS:

1. Dr. V.D.kodgire, Material Science and Metallurgy, 39/e, Everest Publishing House, 2017.
2. V.Raghavan, Material Science and Engineering, 5/e, Prentice Hall of India, 2004.
3. William D. Callister Jr, Materials Science and Engineering: An Introduction, 8/e, John Wiley and Sons, 2009.
4. George E.Dieter, Mechanical Metallurgy, 3/e, McGraw-Hill, 2013.
5. Yip-Wah Chung, Introduction to Material Science and Engineering, 2/e, CRC Press, 2022.
6. A V K Suryanarayana, Material Science and Metallurgy, B S Publications, 2014.
7. U. C. Jindal, Material Science and Metallurgy, 1/e, Pearson Publications, 2011.

ONLINE LEARNING RESOURCES:

- https://archive.nptel.ac.in/courses/113/106/113106032/
- https://www.edx.org/learn/mechanics/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-3-time-dependent-behavior.
- https://www.youtube.com/watch?v=9Sf278j1GTU
- https://www.coursera.org/learn/fundamentals-of-materials-science
- https://www.coursera.org/learn/material-behavior.

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
Code: **R23ME21L1**	**MECHANICS OF SOLIDS & MATERIALS SCIENCE LAB**						

COURSE OBJECTIVE:

- Evaluate the values of yield stress, ultimate stress and bending stress of the given specimen under tension test and bending test
- Conduct the torsion test to determine the modulus of rigidity of given specimen.
- Justify the Rockwell hardness test over with Brinell hardness and measure the hardness of the given specimen.
- Examine the stiffness of the open coil and closed coil spring and grade them.
- Analyze the microstructure and characteristics of ferrous and nonferrous alloy specimens.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Analyze** the stress, strain behavior of different materials.
CO2: **Evaluate** the hardness of different materials.
CO3: **Compare** the relation between elastic constants and hardness of materials.
CO4: **Identify** various microstructures of steels and cast irons.
CO5: **Evaluate** hardness of treated and untreated steels.

NOTE: Any 6 experiments from each section A and B.

A) MECHANICS OF SOLIDS LAB:

1. Tensile test
2. Bending test on
   a) Simply supported beam
   b) Cantilever beam
3. Torsion test
4. Hardness test
   a) Brinell's hardness test
   b) Rockwell hardness test
   c) Vickers hardness test
5. Test on springs
6. Impact test
   a) Charpy test
   b) Izod test
7. Magnetic Particle Testing
8. Liquid penetration test

B) MATERIAL SCIENCE LAB:

1. Preparation and study of the Microstructure of pure metals.
2. Preparation and study of the Microstructure of Mild steel, medium carbon steels, and High carbon steels.
3. Study of the Microstructures of Cast Irons.
4. Study of the Microstructures of Non-Ferrous alloys.
5. Study of the Microstructures of Heat treated steels.
6. Hardenability of steels by Jominy End Quench Test.

VIRTUAL LAB:

1. To investigate the principal stresses σa and σb at any given point of a structural element or machine component when it is in a state of plane stress. (https://virtual- labs.github.io/exp-rockwell-hardness-experiment-iiith/objective.html)
2. To find the impact resistance of mild steel and cast iron. (https://sm- nitk.vlabs.ac.in/exp/izod-impact-test).
3. To find the impact resistance of mild steel. (https://sm-nitk.vlabs.ac.in/exp/charpy- impact-test/index.html)
4. To find the Rockwell hardness number of mild steel, cast iron, brass, aluminum and spring steel etc. (https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test)
5. To determine the indentation hardness of mild steel, brass, aluminum etc. using Vickers hardness testing machine. (https://sm-nitk.vlabs.ac.in/exp/vickers-hardness- test).

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
Code: **R23ME21L2**	**COMPUTER-AIDED MACHINE DRAWING**						

COURSE OBJECTIVES:

- Introduce conventional representations of material and machine components.
- Train to use software for 2D and 3D modeling.
- Familiarize with thread profiles, riveted, welded and key joints.
- Teach solid modeling of machine parts and their sections.
- Explain creation of 2D and 3D assembly drawings and Familiarize with limits, fits, and tolerances in mating components

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Utilize** the conventional representations of materials and machine components.
CO2: **Model** the riveted, welded and key joints using CAD system.
CO3: **Model** the solid models and sectional views of machine components by using 3D software package.
CO4: **Model** the solid models of machine parts and assemble them by using 3D software package.
CO5: **Analyze** the limits, fits and tolerances for mating parts and prepare manufacturing drawing

THE FOLLOWING ARE TO BE DONE BY ANY 2D SOFTWARE PACKAGE

Conventional representation of materials and components:

Detachable joints:

Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut, stud joint, screw joint and foundation bolts.

Riveted joints:

Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints.

Welded joints:

Lap joint and T joint with fillet, butt joint with conventions.

Keys:

Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.

Couplings:

Rigid – Muff, flange; flexible – bushed pin-type flange coupling, universal coupling, Oldham's' coupling.

THE FOLLOWING EXERCISES ARE TO BE DONE BY ANY 3D SOFTWARE PACKAGE:

Sectional views:

Creating solid models of complex machine parts and sectional views.

Assembly drawings :(Any four of the following using solid model software)

Lathe tool post, tool head of shaping machine, tail-stock, machine vice, gate valve, carburetor, piston, connecting rod, eccentric, screw jack, plumber block, axle bearing, pipe vice, clamping device, Geneva cam, and universal coupling.

Production drawing:

Representation of limits, fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

TEXT BOOKS:

1. Machine Drawing by K.L.Narayana, P.Kannaiah and K.Venkat Reddy, New Age International Publishers, 3/e, 2014
2. Machine drawing by N.Sideshwar, P. Kannaiah, V.V.S.Sastry, TMH Publishers. 2014.

REFERENCE BOOKS:

1. Cecil Jensen, Jay Helsel and Donald D.Voisinet, Computer Aided Engineering Drawing, Tata McGraw-Hill, NY, 2000.
2. James Barclay, Brain Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2003.
3. N.D.Bhatt, Machine Drawing, Charotar Publishers, 50/e, 2014.

ONLINE LEARNING RESOURCES:

- https://eeedocs.wordpress.com/wp-content/uploads/2014/02/machinedrawing.pdf
- https://archive.nptel.ac.in/courses/112/105/112105294/
- https://www.edx.org/learn/engineering/dassault-systemes-solidworks-solidworks-cad-fundamentals?index=product&queryID=c90b35a82a6ef58b0d6f89679c63f6a1&position=2&linked_from=autocomplete&c=autocomplete
- https://www.youtube.com/watch?v=0bQkS3_3Fq4

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	2	30	70	100	1.0
Code: **R23ME21L3**	**PYTHON PROGRAMMING LAB**						

COURSE OBJECTIVES:

- Fundamental Understanding: Develop a solid foundation in Python programming, covering essential syntax, semantics, and constructs.
- Data Manipulation: Equip students with skills to handle and manipulate data using Python libraries like Pandas and NumPy.
- Problem-Solving: Enhance problem-solving abilities by implementing various algorithms and data structures in Python.
- Software Development: Foster software development skills, including version control, package management, and project documentation.
- Advanced Techniques: Introduce advanced Python topics such as web scraping, API interaction, and database management.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Develop** a solid foundation in Python programming, covering essential syntax, semantics, and constructs.
CO2: **Analyze** data using Python libraries like Pandas and NumPy.
CO3: **Develop** various algorithms and data structures in Python.
CO4: **Develop** skills, including version control, package management, and project documentation.
CO5: **Analyze** web scraping, API interaction, and database management.

Experiment 1: Introduction to Python
Objective: Install Python and set up the development environment.
Tasks:
- Install Python and an IDE (e.g., PyCharm, VSCode, or Jupyter Notebook).
- Write and run a simple "Hello, World!" program.
- Understand and demonstrate basic Python syntax and semantics.

Experiment 2: Basic Python Programming
Objective: Learn basic programming constructs in Python.
Tasks:
- Create programs using variables, data types, and operators.
- Implement basic input and output functions.
- Write programs using control structures (if statements, for loops, while loops).

Experiment 3: Functions and Modules
Objective: Understand functions and module usage in Python.
Tasks:
- Define and call functions with different types of arguments and return values.
- Explore and use built-in Python modules.
- Write a script that imports and utilizes at least two different standard library modules.

Experiment 4: Lists and Tuples
Objective: Work with Python lists and tuples.

Tasks:
- Create, modify, and iterate over lists and tuples.
- Perform list comprehensions to create new lists.
- Demonstrate the immutability of tuples.

Experiment 5: Dictionaries and Sets
Objective: Explore dictionaries and sets in Python.
Tasks:
- Create and manipulate dictionaries.
- Use dictionary comprehension.
- Create and perform operations on sets.

Experiment 6: Strings and File I/O
Objective: Manipulate strings and perform file I/O operations.
Tasks:
- Demonstrate various string methods.
- Write programs to read from and write to text files.
- Work with different file formats, including CSV and JSON.

Experiment 7: Error Handling and Exceptions
Objective: Implement error handling in Python programs.
Tasks:
- Write programs using try, except, else, and finally blocks.
- Handle specific exceptions.
- Create and raise custom exceptions.

Experiment 8: Object-Oriented Programming (OOP)
Objective: Understand and implement OOP concepts in Python.
Tasks:
- Define classes and create objects.
- Demonstrate inheritance and polymorphism.
- Use class and instance variables in programs.

Experiment 9: Libraries and Packages
Objective: Utilize third-party libraries and create Python packages.
Tasks:
- Install and use libraries like NumPy and Pandas.
- Create a simple Python package and distribute it.
- Work with virtual environments to manage dependencies.

Experiment 10: Working with Data
Objective: Perform data manipulation and visualization.
Tasks:
- Use Pandas to load, manipulate, and analyze datasets.
- Create visualizations using Matplotlib and Seaborn.
- Conduct basic data analysis tasks and summarize findings.

Experiment 11: Web Scraping and APIs
Objective: Extract data from the web and interact with APIs.
Tasks:
- Access and parse data from RESTful APIs.
- Process and analyze JSON data from APIs.

Experiment 12: Databases
Objective: Work with databases in Python.
Tasks:
- Connect to a database using SQLite and SQLAlchemy.
- Perform CRUD operations on the database.
- Write queries to manage and retrieve data.

TEXT BOOKS:

1. Kenneth Lambert, "Fundamentals of Python: First Programs".
2. Allen B. Downey, "think python: how to think like a computer scientist",2nd edition, O'reilly,2016

REFERENCE BOOKS:

1. Python programming: A modern approach, vamsi kurama, pearson.
2. Learning python, Mark Lutz, Orielly.
3. Core python programming, W.Chun, pearson.
4. Introduction to python, Kenneth A. Lambert, Cengage.

ONLINE LEARNING RESOURCES:
1. https://www.udemy.com/course/python-the-complete-python-developercourse/?matchtype=e&msclkid=0584dfb54dc715f39c0bb9aaf74033be&utm_campaign=BGPython_v.PROF_la.EN_cc.INDIA_ti.7380&utm_content=deal4584&utm_medium=udemyads&utm_source=bing&utm_term=_._ag_1220458320107116_._ad__._kw_Python+language_._de_c_._dm__._pl__._ti_kwd-76278984197882%3Aloc90_._li_116074_._pd__._&couponCode=IND21PM
2. https://www.w3schools.com/python/python_intro.asp
3. https://www.youtube.com/watch?v=eWRfhZUzrAc
4. https://onlinecourses.nptel.ac.in/noc20_cs83/preview
5. https://www.edx.org/learn/python
6. Virtual Labs - https://python-iitk.vlabs.ac.in/
7. Virtual Labs - https://virtual-labs.github.io/exp-arithmetic-operations-iitk/
8. Virtual Labs - https://cse02-iiith.vlabs.ac.in/
9. https://mlritm.ac.in/assets/cse/cse_lab_manuals/R20_cse_manuals/Python%20Lab%20Manual.pdf

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	1	2	30	70	100	2
Code: **R23ME21L4**	**EMBEDDED SYSTEMS & IOT**						

COURSE OBJECTIVES:

- To comprehend Microcontroller-Transducers Interface techniques
- To establish Serial Communication link with Arduino
- To analyse basics of SPI interface.
- To interface Stepper Motor with Arduino
- To analyse Accelerometer interface techniques
- To introduce the Raspberry PI platform, that is widely used in IoT applications
- To introduce the implementation of distance sensor on IoT devices.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Comprehend** Microcontroller-Transducers Interface techniques.
CO2: **Establish** Serial Communication link with Arduino
CO3: **Analyze** basics of SPI interface.
CO4: **Analyze** the concept of M2M (machine to machine) with necessary protocols and get awareness in implementation of distance sensor.
CO5: **Analyze** the revolution of internet in mobile devices, cloud and sensor networks

EMBEDDED SYSTEMS EXPERIMENTS
(Any 5 experiments from the following)

1. Measure Analog signal from Temperature Sensor.
2. Generate PWM output.
3. Drive single character generation on Hyper Terminal.
4. Drive a given string on Hyper Terminal.
5. Full duplex Link establishment using Hyper Terminal.
6. Drive a given value on a 8 bit DAC consisting of SPI.
7. Drive Stepper motor using Analog GPIOs.
8. Drive Accelerometer and Display the readings on Hyper Terminal.

COMPONENTS/ BOARDS: 1. Arduino Duemilanove Board
2. Arduino Software IDE.

TEXT BOOKS:

1. Embedded Systems Architecture- By Tammy Noergaard, Elsevier Publications, 2013.
2. Embedded Systems-By Shibu. K.V-Tata McGraw Hill Education Private Limited, 2013.
3. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley Publications, 2013.
4. Embedded Systems-Lyla B.Das-Pearson Publications,2013.

INTERNET OF THINGS EXPERIMENTS

(Any 5 experiments from the following)

1. Getting started with Raspberry Pi, Install Raspian on your SD card.
2. Python-based IDE (integrated development environments) for the Raspberry Pi and how to trace and debug Python code on the device.
3. Using Raspberry pi a. Calculate the distance using distance sensor. b. Basic LED functionality.
4. Raspberry Pi interact with online services through the use of public APIs and SDKs.
5. Study and Install IDE of Arduino and different types of Arduino.
6. Study and Implement Zigbee Protocol using Arduino / Raspberry Pi
7. Calculate the distance using distance sensor Using Arduino.
8. Basic LED functionality Using Arduino.
9. Calculate temperature using temperature sensor Using Arduino.
10. Calculate the distance using distance sensor Using Node MCU.
11. Basic LED functionality Using Node MCU.

TEXT BOOKS:

1. Arsheep Bahga &Vijay Madisetti, Internet of Things - A Hands-on Approach, 1/e, Orient Blackswan Private Limited - New Delhi, 2015.
2. Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015.
3. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014.

ONLINE LEARNING SOURCES

1. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
2. https://onlinecourses.nptel.ac.in/noc20_ee98/preview
3. https://archive.nptel.ac.in/courses/108/105/108105057/
4. https://www.edx.org/learn/embedded-systems/the-university-of-texas-at-austin- embedded-systems-shape-the-world microcontroller input output? index=product & object ID=course-785cf551-7f66-4350-b736-64a93427b4db&webview=false&campaign=Embedded+Systems+-+Shape+The+World%3A+Microcontroller+Input%2FOutput&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fembedded-systems
5. https://www.edx.org/learn/iot-internet-of-things/universitat-politecnica-de-valencia-introduction-to-the-internet-of-things?index=product&queryID=e1322674dcb3d246be981d0669265399&position=4&linked_from=autocomplete&c=autocomplete
6. https://www.edx.org/learn/iot-internet-of-things/curtin-university-iot-sensors-and-devices?index=product&queryID=94ff5bcb80b8e4f427a0985bb2a5e07f&position=3&results_level=first-level-results&term=IOT&objectID=course-967eee29-87e8-4f2d-9257a1b38ec07e85&campaign=IoT+Sensors+and+Devices&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
7. Virtual Labs - http://vlabs.iitkgp.ac.in/rtes/
8. Virtual Labs - https://cse02-iiith.vlabs.ac.in/
9. Virtual Labs - https://iotvirtuallab.github.io/vlab/Experiments/index.html

II B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	0	0	30	70	100	-
Code: **R23CC21MC**	**ENVIRONMENTAL STUDIES**						

COURSE OBJECTIVES:

- To make the students to get awareness on environment
- To understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day-to-day activities of human life
- To save earth from the inventions by the engineers.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Analyze** the natural resources and their importance for the sustenance of the life and recognize the need to conserve the natural resources.

CO2: **Explain** the concepts of the ecosystem, need, biodiversity and its functions.

CO3: **Distinguish** various attributes of the pollution, their impacts and measures to reduce or control the pollution along with waste management

CO4: **Analyze** the rainwater harvesting, watershed management, ozone layer depletion and waste land reclamation.

CO5: **Illustrate** the causes of population explosion, value education and welfare programmes.

UNIT – I

Multidisciplinary Nature of Environmental Studies: – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

UNIT – II

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and Its Conservation : Introduction and Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III

Environmental Pollution: Definition, Cause, effects and control measures of:

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution

Solid Waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

UNIT – IV

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT – V

Human Population And The Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

TEXTBOOKS:

1. Erach Bharucha, Text book of Environmental Studies for Undergraduate Courses, Universities Press (India) Private Limited, 2019.
2. Palaniswamy, Environmental Studies, 2/e, Pearson education, 2014.
3. S.Azeem Unnisa, Environmental Studies, Academic Publishing Company, 2021.
4. K.Raghavan Nambiar, "Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus", SciTech Publications (India), Pvt. Ltd, 2010.

REFERENCE BOOKS:

1. Deeksha Dave and E.Sai Baba Reddy, Textbook of Environmental Science, 2/e, Cengage Publications, 2012.
2. M.Anji Reddy, "Textbook of Environmental Sciences and Technology", BS Publication, 2014.
3. J.P. Sharma, Comprehensive Environmental studies, Laxmi publications, 2006.
4. J. Glynn Henry and Gary W. Heinke, Environmental Sciences and Engineering, Prentice Hall of India Private limited, 1988.
5. G.R. Chatwal, A Text Book of Environmental Studies, Himalaya Publishing House, 2018.
6. Gilbert M. Masters and Wendell P. Ela, Introduction to Environmental Engineering and Science, 1/e, Prentice Hall of India Private limited, 1991.

ONLINE LEARNING RESOURCES:

- https://onlinecourses.nptel.ac.in/noc23_hs155/preview
- https://www.edx.org/learn/environmental-science/rice-university-ap-r-environmental-science-part-3-pollution-and- resources? index=product&objectID=course-3a6da9f2-d84c-4773-8388-1b2f8f6a75f2&webview=false&campaign=AP%C2%AE+Environmental+Science++Part+3%3A+Pollution+and+Resources&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fenvironmental-science
- http://ecoursesonline.iasri.res.in/Courses/Environmental%20Science-I/Data%20Files/pdf/lec07.pdf
- https://www.youtube.com/watch?v=5QxxaVfgQ3k

II B.TECH - II SEMESTER

S. No	Subject	Course Code	Cat. Code	Internal Marks	External Marks	Total Marks	L	T	P	Credits
1	Industrial Management	R23ME2201	HS	30	70	100	2	0	0	2
2	Complex Variables, Probability and Statistics	R23ME2202	BS	30	70	100	3	0	0	3
3	Manufacturing processes	R23ME2203	PC	30	70	100	3	0	0	3
4	Fluid Mechanics & Hydraulic Machines	R23ME2204	PC	30	70	100	3	0	0	3
5	Theory of Machines	R23ME2205	PC	30	70	100	3	0	0	3
6	Fluid Mechanics & Hydraulic Machines Lab	R23ME22L1	PC	30	70	100	0	0	3	1.5
7	Manufacturing processes Lab	R23ME22L2	PC	30	70	100	0	0	3	1.5
8	Soft Skills	R23ME22L4	SC	30	70	100	0	1	2	2
9	Design Thinking & Innovation	R23CC22L3	ES	30	70	100	1	0	2	2
Total							**15**	**1**	**10**	**20**
Mandatory Community Service Project Internship of 08 weeks duration during summer Vacation										

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	0	0	30	70	100	2
Code: **R23ME2201**	**INDUSTRIAL MANAGEMENT**						

COURSE OBJECTIVES:

The objectives of the course are to

- Introduce the scope and role of industrial engineering and the techniques for optimal design of layouts
- Illustrate how work study is used to improve productivity
- Explain TQM and quality control techniques
- Introduce financial management aspects and
- Discuss human resource management and value analysis.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Explain** about how to design the optimal layout
CO2: **Demonstrate** work study methods
CO3: **Explain** Quality Control techniques
CO4: **Discuss** the financial management aspects and
CO5: **Interpret** the human resource management methods.

UNIT– I

INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and break down maintenance.

UNIT–II

WORK STUDY: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs.

UNIT–III

STATISTICAL QUALITY CONTROL: Quality control, Queuing assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – X and R –charts X and S charts and their applications, numerical examples.

TOTALQUALITYMANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. Six Sigma–definition, basic concepts

UNIT– IV

FINANCIAL MANAGEMENT: Scope and nature of financial management, Sources of finance, Concept of Capital, Working Capital cycle, Fixed Capital V/s Working Capital, Management of working capital, estimation of working capital requirements, Capital budgeting – Nature of Investment Decisions – Investment Evaluation criteria- NPV, IRR, PI, Payback Period, and ARR, numerical problems.

UNIT–V

HUMAN RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job- evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, and types.

VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

TEXT BOOKS:

1. O.P Khanna, Industrial Engineering and Management, Dhanpat Rai Publications (P) Ltd, 2018.
2. Mart and Telsang, Industrial Engineering and Production Management, S.Chand&Company Ltd. NewDelhi, 2006.

REFERENCE BOOKS:

1. Bhattacharya DK, Industrial Management,S.Chand, publishers, 2010.
2. J.G Monks, Operations Management,3/e, McGraw Hill Publishers1987.
3. T.R. Banga, S.C.Sharma, N. K. Agarwal, Industrial Engineering and Management Science, Khanna Publishers, 2008.
4. KoontzO' Donnell, Principles of Management, 4/e, McGraw Hill Publishers, 1968.
5. R.C. Gupta, Statistical Quality Control, Khanna Publishers, 1998.
6. NVS Raju, Industrial Engineering and Management,1/e, Cengage India Private Limited, 2013.

ONLINE LEARNING SOURCES

- https://onlinecourses.nptel.ac.in/noc21_me15/preview
- https://onlinecourses.nptel.ac.in/noc20_mg43/preview
- https://www.edx.org/learn/industrial-engineering
- https://youtube.com/playlist?list=PL299B5CC87110A6E7&si=TghLCbEobuxjEaXi
- https://youtube.com/playlist?list=PLbjTnj-t5Gkl0z3OHOGK5RB9mvNYvnImW&si=oaX_5RG69hS3v2ll

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME2202**	**COMPLEX VARIABLES, PROBABILITY AND STATISTICS**						

COURSE OBJECTIVES:

- To familiarize the complex variables.
- To familiarize the students with the foundations of probability and statistical methods.
- To equip the students to solve application problems in their disciplines.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic.

CO2: Make use of the Cauchy residue theorem to evaluate certain integrals.

CO3: Infer the statistical inferential methods based on small and large sampling tests.

CO4: Solve the differentiation and integration of complex functions used in engineering problems.

CO5: Design the components of a classical hypothesis test.

UNIT– I:

Functions of a complex variable and Complex integration:

Introduction, Continuity ,Differentiability, Analyticity, Cauchy-Riemann equations in Cartesian and polar coordinates, Harmonic and conjugate harmonic functions, Milne– Thompson method. Complex integration: Line integral, Cauchy's integral theorem, Cauchy's integral formula, generalized integral formula (all without proofs) and problems on above theorems.

UNIT – II:

Series expansions and Residue Theorem:

Radius of convergence, Expansion of function in Taylor's series, Maclaurin's series and Laurent series. Types of Singularities: Isolated, Essential singularities, Pole of order m, Residues, Residue theorem (without proof), Evaluation of real integral of the types

$\int_{-\infty}^{\infty} f(x)dx$ and $\int_{C}^{c+2\pi} f(\cos\theta, \sin\theta)d\theta.$

UNIT – III:

Probability and Distributions:

Review of probability and Baye's theorem, Random variables, Discrete and Continuous random variables. Distribution functions: Probability mass function, Probability density function and Cumulative distribution functions, Mathematical Expectation and Variance, Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV:

Sampling Theory:

Introduction, Population and Samples, Sampling distribution of Means and Variance (definition only), Point and Interval estimations, Maximum error of estimate, Central limit theorem (without proof), Estimation using t- test.

UNIT – V:

Tests of Hypothesis:

Introduction of Hypothesis, Null and Alternative Hypothesis, Type I and Type II errors , Level of significance, One tail and two-tail tests.

Test of significance for large samples and Small Samples: Single and difference means, Single and two proportions, Student's t- test, F-test, χ^2-test.

TEXT BOOKS:

1. B.S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers.
2. Miller and Freund's, Probability and Statistics for Engineers,7/e,Pearson,2008.

REFERENCE BOOKS:

1. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 9/e, Mc-Graw Hill, 2013.
2. S.C.Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand&Sons Publications, 2012.
3. Jay l. Devore, Probability and Statistics for Engineering and the Sciences, 8/e, Cengage publishers.
4. ShronL. Myers, KeyingYe, Ronald E Walpole, Probability and Statistics Engineers and the Scientists, 8/e, Pearson publishers, 2007.
5. Sheldon, M.Ross, Introduction to probability and statistics Engineers and the Scientists, 4/e, Academic Foundation, 2011.

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME2203**	**MANUFACTURING PROCESSES**						

COURSE OBJECTIVE: The objectives of the course are to

- Know the working principle of different metal casting processes and gating system.
- Classify the welding processes, working of different types of welding processes and welding defects.
- Know the nature of plastic deformation, cold and hot working process, working of a rolling mill and types, extrusion processes.
- Understand the principles of forging, tools and dies, working of forging processes.
- Know about the Additive manufacturing.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Design the patterns and core boxes for metal casting processes
CO2: Inspect the different welding processes
CO3: Analyze the different types of bulk forming processes
CO4: Analyze sheet metal forming processes
CO5: Distinguish about the different types of additive manufacturing processes

UNIT– I

CASTING: Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Molding, different types of cores , Principles of Gating, Risers, casting design considerations. Methods of melting and types of furnaces, Solidification of castings and casting defects- causes and remedies. Basic principles and applications of special casting processes - Centrifugal casting, Die casting, Investment casting and shell molding.

UNIT–II

WELDING: Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy – Acetylene Gas cutting. Basic principles of Arc welding, power characteristics, Manual metal arc welding, submerged arc welding, TIG & MIG welding. Electro–slag welding. Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering &Brazing. Heat affected zones in welding; pre & post heating, welding defects –causes and remedies.

UNIT–III

BULK FORMING: Plastic deformation in metals and alloys-recovery, recrystallization and grain growth. Hot working and Cold working-Strain hardening and Annealing. Bulk forming processes: Forging-Types of Forging, forging defects and remedies; Rolling – fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing.

UNIT– IV

SHEET METAL FORMING: Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, spring back and its remedies, Coining, Spinning, Types of presses and press tools.

HIGH ENERGY RATE FORMING PROCESSES: Principles of explosive forming, electromagnetic forming, Electro hydraulic forming, rubber pad forming, advantages and limitations.

UNIT -V

ADDITIVE MANUFACTURING: Steps in Additive Manufacturing (AM), Classification of AM processes, Advantages of AM, and types of materials for AM, VAT photo polymerization AM Processes, Extrusion - Based AM Processes, Powder Bed Fusion AM Processes, Direct Energy Deposition AM Processes, Post Processing of AM Parts, Applications.
Basics of Coatings and Semiconductor manufacturing Processes.

TEXT BOOKS:

1. Kalpakjain S and Steven R Schmid, Manufacturing Processes for Engineering Materials, 5/e, Pearson Publications, 2007.
2. P.N. Rao, Manufacturing Technology -Vol I, 5/e, McGraw Hill Education, 2018.

REFERENCE BOOKS:

1. A.Ghosh & A.K.Malik, Manufacturing Science, East West Press Pvt. Ltd, 2010.
2. Lindberg and Roy, Processes and materials of manufacture, 4/e, Prentice Hall India Learning Private Limited, 1990.
3. R.K. Jain, Production Technology, Khanna Publishers, 2022.
4. Sharma P.C., A Text book of Production Technology, 8/e, S Chand Publishing, 2014.
5. H.S. Shaun, Manufacturing Processes, 1/e, Pearson Publishers, 2012.
6. WAJ Chapman, Workshop Technology, 5/e, CBS Publishers & Distributors Pvt. Ltd, 2001.
7. Hindustan Machine Tools, Production Technology, Tata McGraw Hill Publishers, 2017.
8. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2/e, Springer, 2015.

ONLINE LEARNING RESOURCES:

- https://www.edx.org/learn/manufacturing/massachusetts-institute-of-technology-fundamentals-of-manufacturing-processes
- https://onlinecourses.nptel.ac.in/noc21_me81/preview
- www.coursera.org/learn/introduction-to-additive-manufacturing-processessera
- https://archive.nptel.ac.in/courses/112/103/112103263/
- https://elearn.nptel.ac.in/shop/nptel/principles-of-metal-forming-technology/?v=c86ee0d9d7ed

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME2204**	**FLUID MECHANICS & HYDRAULIC MACHINES**						

COURSE OBJECTIVES: The students completing this course are expected to

- Understand the properties of fluids, manometry, hydrostatic forces acting on different surfaces
- Understand the kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations.
- Understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Analyze** the basic concepts of fluid properties and Calculation of metacenter height. Stability analysis and applications

CO2: **Estimate** the mechanics of fluids in static and dynamic conditions.

CO3: **Apply** the Boundary layer theory, flow separation and dimensional analysis.

CO4: **Estimate** the hydro dynamic forces of jet on vanes indifferent positions.

CO5: **Evaluate** the performance of hydraulic pumps and turbines.

UNIT-I

FLUID STATICS: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

BUOYANCY AND FLOATATION: Meta center, stability of floating body. Submerged bodies. Calculation of metacenter height. Stability analysis and applications.

UNIT-II

FLUID KINEMATICS: Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, differences and relation between them. Condition for ir rotational flow, flow net, source and sink, doublet and vortex flow.

FLUID DYNAMICS: surface and body forces –Euler's and Bernoulli's equations for flow along a streamline, momentum equation and its applications, force on pipe bend.

CLOSED CONDUIT FLOW: Reynolds's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel total energy line hydraulic gradient line.

UNIT-III

BOUNDARY LAYER THEORY: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

DIMENSIONAL ANALYSIS: Dimensions and Units, Dimensional Homogeneity, Non dimensionalization of equations, Method of repeating variables and Buckingham Pi Theorem.

UNIT-IV

BASICS OF TURBO MACHINERY: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

HYDRAULIC TURBINES: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design –draft tube-theory-functions and efficiency.

UNITV

PERFORMANCE OF HYDRAULIC TURBINES: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling. Advantages, limitations and applications.

CENTRIFUGAL PUMPS: classification, working, work done – manometric head- losses and efficiencies-specific speed-performance characteristic curves, cavitation & NPSH.

RECIPROCATING PUMPS: Working, Discharge, slip, indicator diagrams.

TEXT BOOKS:

1. Y.A. Cengel, J.M.Cimbala, Fluid Mechanics, Fundamentals and Applications, 6/e, McGraw Hill Publications, 2019.
2. Dixon, Fluid Mechanics and Thermodynamics of Turbo machinery, 7/e, Elsevier Publishers, 2014.

REFERENCE BOOKS:

1. P N Modi and S M Seth, Hydraulics & Fluid Mechanics including Hydraulics Machines, Standard Book House, 2017.
2. RK Bansal, Fluid Mechanics and Hydraulic Machines, 10/e, Laxmi Publications (P)Ltd, 2019.
3. Rajput, Fluid Mechanics and Hydraulic Machines, S Chand & Company, 2016.
4. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, S K Kataria &Sons, 2013.
5. D. Rama Durgaiah, Fluid Mechanics and Machinery,1/e, New Age International, 2002.

ONLINE LEARNING RESOURCES:

- https://archive.nptel.ac.in/courses/112/105/112105206/
- https://archive.nptel.ac.in/courses/112/104/112104118/
- https://www.edx.org/learn/fluid-mechanics
- https://onlinecourses.nptel.ac.in/noc20_ce30/previewnptel.ac.in
- www.coursera.org/learn/fluid-powerera

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME2205**	**THEORY OF MACHINES**						

COURSE OBJECTIVES: The objectives of the course are to make the students learn about

- Introduce various basic mechanisms and their applications.
- Explain importance of degree of freedom.
- Familiarize velocity and acceleration in mechanisms.
- Describe the cams and follower motions.
- Explain the importance of gyroscopic couples.
- Introduce the equation of motion for single degree of freedom system.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Analyze** different mechanisms and inversions of four bar chain and slider crank chains.
CO2: **Evaluate** displacement, velocity and acceleration of different links in a mechanism.
CO3: **Apply** effects of gyroscopic couple in ships, aero planes and road vehicles and **Evaluate** the unbalanced mass in rotating machines using analytical and graphical methods.
CO4: **Design** different types of Cam and Gear Profiles.
CO5: **Analyze** free and forced vibrations of single degree freedom systems.

UNIT – I:

SIMPLE MECHANISMS: Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, mobility – Grashof's law, Grubler's Criteria, kinematic inversions of four bar chain and slider crank chains- Limit positions – Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line mechanisms – Universal Joint.

UNIT – II:

PLANE AND MOTION ANALYSIS: Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis – kinematic analysis of simple mechanisms – slider crank mechanism dynamics.

UNIT – III:

GYROSCOPE: Principle of gyroscope, gyroscopic effect in an aero plane, ship, car and two wheeler, simple problems.

BALANCING OF ROTATING MASSES: Need for balancing, balancing of single mass and several masses in different planes, using analytical and graphical methods.

UNIT – IV:

CAMS: Classification of cams and followers- Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – derivatives of follower motions- specified contour cams- circular and tangent cams –pressure angle and undercutting.

GEAR PROFILE: Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting – helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

UNIT – V:

VIBRATIONS: Introduction, degree of freedom, types of vibrations, free natural vibrations, Newton method and energy method for single degree of freedom. Damped vibrations- under damped, critically damped; and over damped systems, forced vibrations without damping in single degree of freedom; Vibration isolation and transmissibility.

TURNING MOMENT DIAGRAMS: Turning moment diagrams for steam engine, I.C engine and Multi Cylinder Engine. Crank effort – coefficient of fluctuation of energy, coefficient of fluctuation of speed.

TEXT BOOKS:

1. S.S.Rattan, Theory of Machines, 4/e, Tata Mc-Graw Hill, 2014.
2. P.L.Ballaney, Theory of Machines & Mechanisms, 25/e, Khanna Publishers, Delhi, 2003.

REFERENCE BOOKS:

1. F. Haidery, Dynamics of Machines, 5/e, NiraliPrakashan, Pune, 2003.
2. J.E. Shigley, Theory of Machines and Mechanisms, 4/e, Oxford, 2014.
3. G.K. Groover, Mechanical Vibrations, 8/e, Nemchand Bros, 2009.
4. Norton, R.L., Design of Machinery – An Introduction to Synthesis and Analysis of Mechanisms and Machines, 2/e, McGraw Hill, New York, 2000.
5. William T. Thomson, Theory of vibration with applications, 4/e, Englewood Cliffs, N.J.: Prentice Hall, 1993.

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
Code: **R23ME22L1**	**FLUID MECHANICS & HYDRAULIC MACHINES LAB**						

COURSE OBJECTIVE:

To impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Measure** the Impact of jets on Vanes
CO2: **Evaluate** the operating parameters of turbines.
CO3: **Evaluate** the operating parameters of pumps.
CO4: **Determine** the friction factor and major losses in pipes.
CO5: **Measure** the flow rate in Venturimeter, Orificemeter and Turbine Flow Meter

LIST OF EXPERIMENTS

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturimeter.
9. Calibration of Orificemeter.
10. Determination of friction factor for a given pipeline.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Turbine flow meter.

VIRTUAL LAB:

1. To study different patterns of a flow through a pipe and correlate them with the Reynolds number of the flow.
   (https://me.iitp.ac.in/Virtual-Fluid- Laboratory/Reynolds/introduction.html)
2. To calculate Total Energy at different points of venture meter.
   (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/bernoulli/introduction.html).
3. To calculate the flow (or point) velocity at center of the given tube using different flow rates. (https://me.iitp.ac.in/Virtual-Fluid- Laboratory/pitot/introduction.html)
4. To determine the hydrostatic force on a plane surface under partial submerge and full submerge condition. (https://me.iitp.ac.in/Virtual-Fluid- Laboratory/cop/introduction.html).
5. To determine the discharge coefficient of a triangular notch.
   (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/notch/introduction.html)
6. To determine the coefficient of impact of jet on vanes.
   (https://fm- nitk.vlabs.ac.in/exp/impact-of-jet).
7. To determine friction in pipes. (https://fm-nitk.vlabs.ac.in/exp/friction-in- pipes/index.html).

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
Code: **R23ME22L2**	**MANUFACTURING PROCESSES LAB**						

COURSE OBJECTIVE:

Acquire practical knowledge on Metal Casting, Welding, Press Working and Processing of Plastics.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Make moulds for sand casting.

CO2: Make different types of components using various manufacturing techniques.

CO3: Analyze unconventional manufacturing methods.

CO4: Develop Different Weld joints.

CO5: Analyze different types of 3D Printing techniques.

LIST OF EXPERIMENTS

1. Design and making of pattern
    - i. Single piece pattern
    - ii. Split pattern
2. Sand properties testing
    - i. Sieve analysis(dry sand)
    - ii. Clay content test
    - iii. Moisture content test
    - iv. Strength test(Compression test & Shear test)
    - v. Permeability test
3. Mould preparation
    - i. Straight pipe
    - ii. Bent pipe
    - iii. Dumble
    - iv. Gear blank
4. Gas cutting and welding
5. Manual metal arc welding
    - i. Lap joint
    - ii. Butt joint
6. Injection Moulding
7. Blow Moulding
8. Simple models using sheet metal operations
9. Study of deep drawing and extrusion operations
10. To make weldments using TIG/MIG welding
11. To weld using Spot welding machine
12. To join using Brazing and Soldering
13. To make simple parts on a 3D printing machine
14. Demonstration of metal casting.

VIRTUAL LAB:

1. To study and observe various stages of casting through demonstration of casting process. (https://virtual-labs.github.io/exp-sand-casting-process- dei/theory.html)
2. To weld and cut metals using an oxyacetylene welding setup. (https://virtual- labs.github.io/exp-gas-cutting-processes-iitkgp/index.html).
3. To simulate Fused deposition modelling process (FDM) (https://3dpdei.vlabs.ac.in/exp/simulation-modelling-process)
4. https://altair.com/inspire-mold/
5. https://virtual-labs.github.io/exp-simulation-cartesian-system-dei/theory.html

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	1	2	30	70	100	2
Code: **R23ME22L4**	**SOFT SKILLS**						

COURSE OBJECTIVES:

- To prepare for global competition in employment and achieve professional excellence.
- To help students develop interpersonal and intrapersonal skills, enabling them to lead meaningful professional lives.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: **Grasp** the meaning and importance of soft skills and learn how to develop them.

CO2: **Comprehend** the significance of soft skills in the working environment for professional excellence.

CO3: **Prepare** to undergo the placement process with confidence and clarity.

CO4: **Interpret** any situation in life and equip themselves to handle them effectively.

CO5: **Interpret** the importance of etiquette in both professional and personal life.

UNIT – 1:

INTRODUCTION

Introduction- Emergence of life skills, Definition & Meaning, Importance& need, reasons for skill gap, Analysis--Soft Skills vs Hard skills, Linkage between industry and soft skills, Challenges, Personality Developments. Soft Skills, English - Improving Techniques.

UNIT – II:

INTRA-PERSONAL:

Definition-Meaning – Importance-SWOT analysis, Johari windows - Goal Setting- skills quotient - Emotional Intelligence- Attitudinal skills - positive thinking- Problem Solving-Time management, stress management.

UNIT – III:

INTER-PERSONAL:

Definition – Meaning – Importance-Communications skills- Team Work, managerial skills -Negotiation skills- Leadership skills, corporate etiquettes.

UNIT – IV:

VERBAL SKILLS:

Definition and Meaning-Listening skills, need- types, advantages, Importance- Tips for Improving Listening, Speaking, need- types, advantages, Importance- Tips for Improving Reading- Writing Skills, Report, Resume, statement of purpose, need- types, advantages, Importance.

UNIT – V:

NON VERBAL SKILLS& INTERVIEW SKILLS

Definition and Meaning – Importance- Facial Expressions- Eye Contact – Proxemics- Haptics - Posture, body language in cross cultural context , body language in interview room, appearance and dress code – Kinetics- Para Language - tone, pitch, pause, neutralization of accent, use of appropriate language, Interview skills, interview methods and questions.

TEXT BOOKS:

1. Sherfield, M. Robert at al, Cornerstone Developing Soft Skills, 4/e, Pearson Publication, New Delhi, 2014.
2. Alka Wadkar, Life Skills for Success, 1/e, Sage Publications India Private Limited, 2016.

REFERENCE BOOKS:

1. Sambaiah.M. Technical English, Wiley publishers India. New Delhi. 2014.
2. Gangadhar Joshi, From Campus to Corporate, SAGE TEXT.
3. Alex.K, Soft Skills, 3rd ed. S. Chand Publication, New Delhi, 2014.
4. Meenakshi Raman and Sangita Sharma, Technical Communication: Principle and Practice, Oxford University Press, 2009.
5. Shalini Varma, Body Language for Your Success Mantra, 4/e, S. Chand Publication, New Delhi, 2014.
6. Stephen Covey, Seven Habits of Highly Effective People, JMD Book, 2013.

ONLINE LEARNING RESOURCES:

- https://onlinecourses.nptel.ac.in/noc20_hs60/preview
- http://www.youtube.com/@softskillsdevelopment6210
- https://youtube.com/playlist?list=PLLy_2iUCG87CQhELCytvXh0E_y-bOO1_q&si=Fs05Xh8ZrOPsR8F4
- https://www.coursera.org/learn/people-soft-skills-assessment?language=English
- https://www.edx.org/learn/soft-skills

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	1	2	30	70	100	2
Code: **R23CC22L3**	**DESIGN THINKING & INNOVATION**						

COURSE OBJECTIVES:

The objectives of the course are to

- Bring awareness on innovative design and new product development.
- Explain the basics of design thinking.
- Familiarize the role of reverse engineering in product development.
- Train how to identify the needs of society and convert into demand.
- Introduce product planning and product development process.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Explain the concepts related to design thinking.

CO2: Explain the fundamentals of Design Thinking and innovation.

CO3: Apply the design thinking techniques for solving problems in various sectors.

CO4: Analyse to work in a multidisciplinary environment.

CO5: Evaluate the value of creativity.

UNIT – I

INTRODUCTION TO DESIGN THINKING: Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

UNIT - II

DESIGN THINKING PROCESS: Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development.

Activity: Every student presents their idea in three minutes, every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

UNIT - III

INNOVATION: Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

UNIT - IV

PRODUCT DESIGN: Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies.

Activity: Importance of modeling, how to set specifications, Explaining their own product design.

UNIT – V

DESIGN THINKING IN BUSINESS PROCESSES: Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes.

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

TEXTBOOKS:

1. Tim Brown, Change by design, 1/e, Harper Bollins, 2009.
2. Idris Mootee, Design Thinking for Strategic Innovation, 1/e, Adams Media, 2014.

REFERENCE BOOKS:

1. David Lee, Design Thinking in the Classroom, Ulysses press, 2018.
2. Shrrutin N Shetty, Design the Future, 1/e, Norton Press, 2018.
3. William lidwell, Kritinaholden, &Jill butter, Universal principles of design, 2/e, Rockport Publishers, 2010.
4. Chesbrough.H, The era of open innovation, 2003.

ONLINE LEARNING RESOURCES:

- https://nptel.ac.in/courses/110/106/110106124/
- https://nptel.ac.in/courses/109/104/109104109/
- https://swayam.gov.in/nd1_noc19_mg60/preview
- https://onlinecourses.nptel.ac.in/noc22_de16/preview

B.Tech – III Year I Semester

S. No.	Title	Course Code	Cat. Code	Internal Marks	External marks	Total Marks	L	T	P	Credits
1	Machine Tools and Metrology	R23ME3101	PC	30	70	100	3	0	0	3
2	Thermal Engineering	R23ME3102	PC	30	70	100	3	0	0	3
3	Design of Machine Elements	R23ME3103	PC	30	70	100	3	0	0	3
4	**Professional Elective - I**									
	Design for Manufacturing	R23ME3104	PE	30	70	100	3	0	0	3
	Conventional and futuristic vehicle technology	R23ME3105								
	Renewable Energy Technologies	R23ME3106								
	Non-destructive Evaluation	R23ME3107								
5	**Open Elective - I**									
	Sustainable Energy Technologies	R23OE3108	OE	30	70	100	3	0	0	3
	Applied Operations Research	R23OE3109								
	Nano Technology	R23OE3110								
	Thermal Management of Electronic systems	R23OE3111								
	Entrepreneurship	R23OE3112								
6	Thermal Engineering Lab	R23ME31L1	PC	30	70	100	0	0	3	1.5
7	Theory of Machines Lab	R23ME31L2	PC	30	70	100	0	0	3	1.5
8	Machine tools and Metrology Lab	R23ME31L3	SEC	30	70	100	0	0	4	2
9	Tinkering Lab	R23ME31L4	ES	30	70	100	0	0	2	1
10	Community Service Internship	R23ME31CSP	ECSI	30	70	100	-	-	-	2
Total							**15**	**0**	**12**	**23**

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3101**	**MACHINE TOOLS & METROLOGY**						

COURSE OBJECTIVES:

1. To learn the fundamental knowledge and principles of material removal processes.
2. To understand the basic principles of lathe, shaping, slotting and planning machines
3. To demonstrate the fundamentals of drilling, milling and boring processes.
4. To discuss the concepts of super finishing processes and limits and fits.
5. To understand the concepts of surface roughness and optical measuring instruments

UNIT – 1

FUNDAMENTALS OF MACHINING:

Elementary treatment of metal cutting theory – element of cutting process – Single point cutting tools, nomenclature, tool signature, mechanism of metal cutting, types of chips, mechanics of orthogonal and oblique cutting –Merchant's force diagram, cutting forces, Taylor's tool life equation, simple problems - Tool wear, tool wear mechanisms, machinability, economics of machining, coolants, tool materials and properties.

UNIT – 2

LATHE MACHINES:

Introduction- types of lathe - Engine lathe – principle of working - construction - specification of lathe - accessories and attachments – lathe operations – taper turning methods and thread cutting – drilling on lathes.

SHAPING, SLOTTING AND PLANNING MACHINES: Introduction - principle of working – principle parts – specifications - operations performed - slider crank mechanism - machining time calculations.

UNIT – 3

DRILLING & BORING MACHINES: Introduction – construction of drilling machines – types of drilling machines - principles of working – specifications- types of drills - operations performed – machining time calculations - Boring Machines – types.

MILLING MACHINES: Introduction - principle of working – specifications – milling methods - classification of Milling Machines –types of cutters - methods of indexing- machining time calculations, Gear hobbing.

FINISHING PROCESSES: Classification of grinding machines- types of abrasives- bonds, specification and selection of a grinding wheel- Lapping, Honing & Broaching operations- comparison to grinding.

UNIT – 4

SYSTEMS OF LIMITS AND FITS: Types of fits and tolerances -Unilateral and bilateral tolerance system, hole and shaft basis systems- interchangeability & selective assembly- International standard system of tolerances, simple problems related to limits and fits, Taylor's principle – design of GO and NOGO gauges; types of gauges-plug, ring, snap, gap, taper, profile and position gauges.

LINEAR MEASUREMENT: Length standards, end standards, slip gauges- calibration of the slip Gauges, Applications of Slip gauges, dial indicators, micrometers.

UNIT – 5

ANGULAR MEASUREMENT: Bevel protractor, angle slip gauges- angle dekkor- spirit levels- sine bar- sine table.

SURFACE ROUGHNESS MEASUREMENT: Differences between surface roughness and surface waviness –Numerical assessment of surface finish, Profilograph, Talysurf, ISI symbols.
OPTICAL MEASURING INSTRUMENTS: Tools maker's microscope, Autocollimators, Optical projector, Optical flats-working principle, construction, merits, demerits and their uses. Laser alignment using laser technology.

TEXT BOOKS:
1. Manufacturing Processes / JP Kaushish/ PHI Publishers-2nd Edition, 2010.
2. Manufacturing Technology Vol-II/P.N Rao/Tata McGraw Hill-4th Edition, 2018.
3. Engineering Metrology – R.K. Jain/Khanna Publishers-22nd Edition, 2022.

REFERENCES:
1. Metal cutting and machine tools /Geoffrey Boothroyd, Winston A.Knight/Taylor & Francis, 2005.
2. Production Technology / H.M.T. Hand Book (Hindustan Machine Tools).
3. Production Engineering/K.C Jain & A.K Chitaley/PHI Publishers, 2001.
4. Technology of machine tools/S.F.Krar, A.R. Gill, Peter SMID/ TMH, 9th Edition, 2023.
5. Manufacturing Processes for Engineering Materials-Kalpak Jian S & Steven R Schmid/Pearson Publications 5th Edition.

COURSE OUTCOMES: At the end of the course, student will be able to
CO1: Learned the fundamental knowledge and principals in material removal process.
CO2: Acquire the knowledge on operations in conventional, automatic, Capstan and turret lathes
CO3: Capable of understanding the working principles and operations of shaping, slotting, planning, drilling and boring machines.
CO4: Make gear and keyway in milling machines and understand the indexing mechanisms
CO5: Understand the different types of Surface roughness and Optical measuring instruments

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3102**	**THERMAL ENGINEERING**						

COURSE OBJECTIVES:

1. To give insight into basic principles of air standard cycles.
2. To impart knowledge about IC engines and Boilers
3. To make the students learn the working principles of steam nozzles, turbines and compressors
4. To impart the knowledge about the various types of compressors and gas turbines
5. To make the students gain insights about, rockets and jet propulsion and solar engineering.

UNIT– I

AIR STANDARD CYCLES: Otto, diesel and dual cycles, its comparison, Brayton cycle.

ACTUAL CYCLES AND THEIR ANALYSIS: Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blow down-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines.

UNIT–II

I.C ENGINES: Classification - Working principles of SI and CI engines, Valve and Port Timing Diagrams, -Engine systems – Fuel, Carburetor, Fuel Injection System, Ignition, Cooling and Lubrication, principles of supercharging and turbocharging,

BOILERS: Boiler cycles, Principles of L.P & H.P boilers, mountings and accessories, Draught- induced and forced.

UNIT -III

STEAM NOZZLES: Functions, applications, types, flow through nozzles, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape, Wilson line.

STEAM TURBINES: Classification – impulse turbine; velocity diagram, effect of friction, diagram efficiency, combined velocity diagram. Reaction turbine: Principle of operation, velocity diagram, Parson's reaction turbine – condition for maximum efficiency, Steam turbine cycles

UNIT -IV

COMPRESSORS: Classification, Reciprocating type - Principle, multi-stage compression, Rotary type–Lysholm compressor–principle and efficiency considerations, Intercoolers.

CENTRIFUGAL COMPRESSORS: Principle, velocity and pressure variation, velocity diagrams.

AXIAL FLOW COMPRESSORS: Principle, pressure rise and efficiency calculations.

UNIT -V

GAS TURBINES: Simple gas turbine plant – ideal cycle, components –regeneration, inter cooling and reheating.

JET PROPULSION: Principle, classification, t-s diagram - turbo jet engines –thermodynamic cycle, performance evaluation.

ROCKETS: Principle, solid and liquid propellant rocket engines.

TEXT BOOKS:

1. Thermal Engineering – vol-I by Mahesh Rathore- McGraw Hill publishers, 2018.
2. Heat Engineering /V.P Vasandani and D.S Kumar/Metropolitan Book Company, New Delhi, 4th Edition, ISBN 13, 9788120003500.

REFERENCES:

1. I.C. Engines - V. Ganesan- McGraw Hill Education; 4th edition (1 July 2017); 2024.
2. Thermal Science And Engineering (S.I. Units) By M.L. Mathur , F.S. Mehta /Jain bros. Publishers, 3rd Edition,2017,
3. Thermal Engineering-P.L.Ballaney/ Khanna publishers, 5th edition, 2003.
4. Thermal Engineering / RK Rajput/ Lakshmi Publications, 11h edition, 2003
5. Thermal Engineering-R.S Khurmi, &J S Gupta/S.Chand, 2020.

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

CO1: Explain the basic concepts of air standard cycles.
CO2: Get knowledge about IC Engines and Boilers.
CO3: Discuss the concepts of steam nozzles and steam turbines and steam condensers.
CO4: Gain knowledge about the concepts of compressors and gas turbines.
CO5: Acquire insights about jet propulsion, rockets and solar engineering.

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3103**	**DESIGN OF MACHINE ELEMENTS**						

COURSE OBJECTIVES:

1. Familiarize with fundamental approaches to failure prevention for static and dynamic loading.
2. Provide an introduction to design of bolted and welded joints.
3. Explain design procedures for shafts and couplings.
4. Discuss the principles of design for clutches and brakes and springs.
5. Explain design procedures for bearings and gears.

UNIT-I:

INTRODUCTION, DESIGN FOR STATIC AND DYNAMIC LOADS

MECHANICAL ENGINEERING DESIGN: Design process, design considerations, codes and standards of designation of materials, selection of materials.

DESIGN FOR STATIC LOADS: Modes of failure, design of components subjected to axial, bending, torsional and impact loads. Theories of failure for static loads.

DESIGN FOR DYNAMIC LOADS: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, Soderberg, Goodman and modified Goodman criterion for fatigue failure.

UNIT-II:

DESIGN OF BOLTED AND WELDED JOINTS

DESIGN OF BOLTED JOINTS: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, gasketed joints.

WELDED JOINTS: Strength of lap and butt welds, Joints subjected to bending and torsion, Riveted joints.

UNIT-III:

POWER TRANSMISSION SHAFTS AND COUPLINGS

POWER TRANSMISSION SHAFTS: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.

COUPLINGS: Types of couplings, Design of flange and bushed pin couplings, universal coupling.

UNIT-IV:

DESIGN OF CLUTCHES, BRAKES AND SPRINGS

FRICTION CLUTCHES: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory and uniform pressure theory.

BRAKES: Different types of brakes. Concept of self-energizing and self-locking of brake. Band and block brakes.

SPRINGS: Design of helical, compression, tension, torsion and leaf springs.

UNIT-V:

DESIGN OF BEARINGS AND GEARS – Types of bearings

DESIGN OF SLIDING CONTACT BEARINGS: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.

DESIGN OF ROLLING CONTACT BEARINGS: Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue.

DESIGN OF GEARS: Types of Gears, Spur gears, beam strength, Lewis equation, design for dynamic and wear loads.

Note: Data book is allowed.

TEXTBOOKS:

1. R.L. Norton, Machine Design an Integrated approach, 6/e, Pearson Education, 2020.
2. V.B.Bhandari, Design of Machine Elements, 5/e, Tata McGraw Hill, 2020.
3. Dr. N. C. Pandya &Dr. C. S. Shah, Machine design, 21/e, Charotar Publishing House Pvt. Ltd, 2022.

REFERENCE BOOKS:

1. R.K. Jain, Machine Design (Reprint), Khanna Publications, 2022.
2. J.E. Shigley, Mechanical Engineering Design, 12/e, Tata McGraw Hill, 2024.
3. M.F.Spotts and T.E.Shoup, Design of Machine Elements, 8/e, Prentice Hall (Pearson Education), 2019.

ONLINE LEARNING RESOURCES:

1. https://www.yumpu.com/en/document/view/18818306/lesson-3-course-name-design-ofmachine-elements-1-npte
2. https://www.digimat.in/nptel/courses/video/112105124/L01.html
3. https://dokumen.tips/documents/nptel-design-of-machine-elements-1.html
4. http://www.nitttrc.edu.in/nptel/courses/video/112105124/L25.html

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

CO1: Design the machine members subjected to static and dynamic loads.
CO2: Design shafts and couplings for power transmission
CO3: Learn how to design bolted and welded joints.
CO4: Analyze the design procedures of clutches, brakes and springs.
CO5: Design bearings and gears.

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3104**	**DESIGN FOR MANUFACTURING (Professional Elective-I)**						

COURSE OBJECTIVES: The students will acquire the knowledge:
1. To understand the basic concepts of design for manual assembly
2. To interpret basic design procedure of machining processes
3. To understand design considerations metal casting, extrusion and sheet metal work
4. To interpret the design considerations of various metal joining process.
5. To interpret the basic design concepts involved in the assembly automation

UNIT-1

INTRODUCTION TO DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design? Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

DESIGN FOR MANUAL ASSEMBLY: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, weight on Handling Time, Effects of Combinations of Factors and application of the DFA Methodology.

UNIT– 2

MACHINING PROCESSES: Overview of various machining processes-general design rules for machining dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

UNIT – 3

METAL CASTING: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design product design rules for sand casting.

EXTRUSION & SHEET METAL WORK: Design guide lines extruded sections-design principles for punching, blanking, -Keeler Goodman forging line diagram.

UNIT– 4

METAL JOINING: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints.

FORGING: Design factors for forging – closed die forging design – parting lines of dies –drop forging die design – general design recommendations.

UNIT– 5

DESIGN FOR ASSEMBLY AUTOMATION: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Transfer lines.

DESIGN FOR ADDITIVE MANUFACTURING:

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.

TEXT BOOKS:

1. Design for manufacture, John Cobert, Adisson Wesley. 1995.
2. Design for Manufacture by Boothroyd, 2025.
3. Design for manufacture, James Bralla,2/e, 1999.

REFERENCE:

1. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998
2. ASM Hand book Vol.20, 2020.

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

CO1: Understand the basic concepts of design for manual assembly
CO2: Identify basic design procedure of various machining processes.
CO3: Illustrate the design considerations metal casting, extrusion and sheet metal work
CO4: Interpret the design considerations of various metal joining process.
CO5: Understand the basic design concepts involved in the assembly automation

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3105**	**CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY (Professional Elective-I)**						

COURSE OBJECTIVES:

1. To study the advanced engine technologies
2. To learn various advanced combustion technologies and its benefits
3. To learn the methods of using low carbon fuels and its significance
4. To learn and understand the hybrid and electric vehicle configurations
5. To study the application of fuel cell technology in automotive

UNIT – I:

ADVANCED ENGINE TECHNOLOGY: Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

UNIT – II:

COMBUSTION TECHNOLOGY: Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT – III:

LOW CARBON FUEL TECHNOLOGY: Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT – IV:

HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED): Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

UNIT – V:

FUEL CELL TECHNOLOGY: Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

TEXT BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press,3/e, 2018.
2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines, 2017.

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 3/e, 2021.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2/e 2012.
3. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998.

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

CO1: Discuss the latest trends in engine technology

CO2: Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.

CO3: Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.

CO4: Discuss the working and energy flow in various hybrid and electric configurations.

CO5: Analyzing the need for fuel cell technology in automotive applications.

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3106**	**RENEWABLE ENERGY TECHNOLOGIES (Professional Elective-I)**						

COURSE OBJECTIVES:

1. To demonstrate the importance the impact of solar radiation, solar PV modules
2. To understand the principles of storage in PV systems
3. To discuss solar energy storage systems and their applications.
4. To get knowledge in wind energy and bio-mass
5. To gain insights in geothermal energy, ocean energy and fuel cells.

UNIT – 1

SOLAR RADIATION: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine.

SOLAR PV MODULES AND PV SYSTEMS:

PV Module Circuit Design, Module Structure, Packing Density, Interconnections, Mismatch and Temperature Effects, Electrical and Mechanical Insulation, Lifetime of PV Modules.

UNIT – 2

STORAGE IN PV SYSTEMS:

Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.

UNIT – 3

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT – 4

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels.

UNIT – 5

GEOTHERMAL ENERGY: Origin, Applications, Types of Geothermal Resources, Relative Merits

OCEAN ENERGY: Wave Energy Conversion, Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges, MHD Power Generation.

FUEL CELLS: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell.

TEXT BOOKS:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH, 4/e, 2017.
2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 3/e, 2017.
3. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013

REFERENCES:

1. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth& John F Kreider / Taylor &Francis, 4/e, 2022.
2. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd., 2/e, 2022.
3. Renewable Energy Technologies -Ramesh & Kumar /Narosa, 3/e, 1997.
4. Non-conventional Energy Source- G.D Roy/Standard Publishers, 1998.

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

CO1: Illustrate the importance of solar radiation and solar PV modules.
CO2: Discuss the storage methods in PV systems
CO3: Explain the solar energy storage for different applications
CO4: Understand the principles of wind energy, and bio-mass energy.
CO5: Attain knowledge in geothermal energy, ocean energy and fuel cells.

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3107**	**NON- DESTRUCTIVE EVALUATION (Professional Elective-I)**						

COURSE OBJECTIVES:

1. To learn basic concepts of non-destructive testing and industrial applications
2. To understand the elements of ultrasonic test and limitations of ultrasonic test
3. To learn the concepts involved in the liquid penetrant test and eddy current test
4. To know the basic principles and operating procedures of magnetic particle testing
5. To understand the basic concepts involved in the infrared and thermal testing

UNIT – 1

INTRODUCTION TO NON-DESTRUCTIVE TESTING AND INDUSTRIAL APPLICATIONS OF NDE: NDE of pressure vessels, castings, welded constructions. Radiographic test**,** Sources of X and Gamma Rays and their interaction with Matter, Safety Aspects of Industrial Radiography, Radiographic equipment, Radiographic Techniques, Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry.

UNIT – 2

ULTRASONIC TEST: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection - Effectiveness and Limitations of Ultrasonic Testing.

UNIT – 3

LIQUID PENETRANT TEST: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness, DPI, FPI, Limitations of Liquid Penetrant Testing**.**

EDDY CURRENT TEST: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing

UNIT – 4

MAGNETIC PARTICLE TEST: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test.

UNIT – 5

INFRARED AND THERMAL TESTING: Introduction and fundamentals to infrared and thermal testing–Heat transfer –Active and passive techniques –Lock in and pulse thermography, tomography-Contact and non-contact thermal inspection methods–Heat sensitive paints –Heat sensitive papers –-thermally quenched phosphors liquid crystals –techniques for applying liquid crystals –other temperature sensitive coatings –Inspection methods –Infrared radiation and infrared detectors–thermo mechanical behavior of materials–IR imaging in aerospace applications, electronic components, Honey comb and sandwich structures–Case studies.

TEXT BOOKS:

1. Nondestructive test and evaluation of Materials/J Prasad, GCK Nair/TMH Publishers, 2/e, 2017.
2. Ultrasonic testing of materials/ H Kraut Kramer/Springer, 4/e, 2013.
3. Non-destructive testing/Warren, J Mc Gonnagle / Godan and Breach Science publishers, 2/e, 1971.
4. Non-destructive evaluation of materials by infrared thermography / X. P. V. Maldague, Springer-Verlag, 1st edition, (1993)

REFERENCES:

1. Ultrasonic inspection training for NDT/E.A.Gingel/Prometheus Press,
2. ASTM Standards,Vol3.01,Metalsandalloys
3. Non-destructive Evaluation, Hand Book – R. Ham Chand

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

CO1: Understand the concepts of various NDE techniques and the requirements of radiography techniques and safety aspects.
CO2: Interpret the principles and procedure of ultrasonic testing
CO3: Understand the principles and procedure of Liquid penetration and eddy current testing
CO4: Illustrate the principles and procedure of Magnetic particle testing
CO5: Interpret the principles and procedure of infrared testing and thermal testing

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23OE3108**	**SUSTAINABLE ENERGY TECHNOLOGIES (Open Elective-I)**						

COURSE OBJECTIVES:

1. To demonstrate the importance the impact of solar radiation, solar PVmodules
2. To understand the principles of storage in PV systems
3. To discuss solar energy storage systems and their applications.
4. To get knowledge in wind energy and bio-mass
5. To gain insights in geothermal energy, ocean energy and fuel cells.

UNIT – 1

SOLAR RADIATION: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine.

SOLAR PV MODULES AND PV SYSTEMS:

PV Module Circuit Design, Module Structure, Packing Density, Interconnections, Mismatch and Temperature Effects, Electrical and Mechanical Insulation, Lifetime of PV Modules.

UNIT – 2

STORAGE IN PV SYSTEMS:

Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.

UNIT – 3

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT – 4

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels.

UNIT – 5

GEOTHERMAL ENERGY: Origin, Applications, Types of Geothermal Resources, Relative Merits

OCEAN ENERGY: Wave Energy Conversion, Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges, MHD Power Generation.

FUEL CELLS: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell.

TEXT BOOKS:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH, 4/e, 2017.
2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 3/e, 2017.
3. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013

REFERENCES:

1. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth& John F Kreider / Taylor &Francis, 4/e, 2022.
2. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd., 2/e, 2022.
3. Renewable Energy Technologies -Ramesh & Kumar /Narosa, 3/e, 1997.
4. Non-conventional Energy Source- G.D Roy/Standard Publishers, 1998.

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

CO1: Illustrate the importance of solar radiation and solar PV modules.
CO2: Discuss the storage methods in PV systems
CO3: Explain the solar energy storage for different applications
CO4: Understand the principles of wind energy, and bio-mass energy.
CO5: Attain knowledge in geothermal energy, ocean energy and fuel cells.

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23OE3109**	**APPLIED OPERATIONS RESEARCH (Open Elective-I)**						

COURSE OBJECTIVES: To
1. Understand Linear Programming models
2. Learn Transportation and sequencing problems
3. Solve replacement problems and analyze games theory models
4. Understand waiting line and project management problems
5. Learn dynamic programming and simulation.

UNIT – 1

INTRODUCTION: Definition– characteristics and phases – types of operation research models – applications.

LINEAR PROGRAMMING PROBLEM (LPP): Problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT – 2

TRANSPORTATION PROBLEM: Formulation, types of initial basic feasible solution using different methods – optimal solution, unbalanced transportation problem – degeneracy,

ASSIGNMENT PROBLEM – formulation – optimal solution **-** variants of assignment problem- travelling salesman problem.

UNIT – 3

REPLACEMENT THEORY: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

PROJECT MANAGEMENT: Basics for construction of network diagram, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats- Project crashing and its procedure

UNIT – 4

WAITING LINES: Introduction – single channel – poison arrivals – exponential service times – with infinite population and finite population models– multichannel – poison arrivals – exponential service times with infinite population single channel.

SEQUENCING – Introduction – flow **–**shop sequencing – *n* jobs through two machines – *n* jobs through three machines – job shop sequencing – two jobs through 'm' machines.

UNIT – 5

GAME THEORY: Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.

DYNAMIC PROGRAMMING: Introduction – Bellman's principle of optimality – applications of dynamic programming-shortest path problem – linear programming problem.

SIMULATION: Definition – types of simulation models – phases of simulation– applications of simulation advantages and disadvantages.

TEXT BOOKS:

1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers, 11/e, 2023.
2. Operations Research –Theory & publications / S.D.Sharma Kedarnath/McMillan publishers India Ltd, 5/e, 2020.

REFERENCES:

1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.
6. Operation Research /J.K.Sharma/Macmillan Publ.
7. Operations Research/ Pai/ Oxford Publications
8. Operations Research/S Kalavathy / Vikas Publishers
9. Operations Research / DS Cheema/University Science Press
10. Operations Research / Ravindran, Philips, Solberg / Wiley publishers

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

CO1: Understand Linear Programming models
CO2: Interpret Transportation and sequencing problems
CO3: Solve replacement problems and analyze queuing models
CO4: Understand game theory and inventory problems
CO5: Interpret dynamic programming and simulation.

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23OE3110**	**NANO TECHNOLOGY (OPEN ELECTIVE-I)**						

COURSE OBJECTIVES:

1. To understand the classification of Nano structured Materials
2. To understand the unique properties of Nano materials
3. To interpret the Synthesis Routes - Bottom up and Top down approaches
4. To identify the tools to characterize Nano materials
5. To understand the applications of Nano materials

UNIT – 1

INTRODUCTION: History and Scope. Introduction to Nanotechnology, Nanotechnology-Definition, Difference between Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology, Moore's law. Classification of Nano structured Materials, Fascinating Nanostructures.

UNIT – 2

NANO MATERIALS:

History of materials, Nanomaterials-Definition. Nanoparticles: Processes for producing ultrafine powders-mechanical milling, wet chemical synthesis, gas condensation process, chemical vapour condensation, laser ablation.

UNIT – 3

SYNTHESIS ROUTES: Bottom up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly. Top down approaches: Mechanical alloying, Nano-lithography. Consolidation of Nano powders: Shock wave consolidation, Hot iso-static pressing and Cold iso-static pressing, Spark plasma sintering.

UNIT – 4

TOOLS TO CHARACTERIZE NANOMATERIALS: X-Ray Diffraction (XRD),
Small Angle X-ray scattering, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nano indentation, Dual-State Emission (DSE) and Raman Spectroscopy.

UNIT – 5

APPLICATIONS OF NANO MATERIALS: Nano-electronics, Micro- and Nano- electromechanical systems (MEMS/NEMS),Nano sensors, Nano catalysts, Food and Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering,
Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defense and Space Applications, Concerns and challenges of Nanotechnology

TEXT BOOKS:

1. Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens.Wiley India Pvt. Ltd., 2020.
2. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers, 2nd edition, 2010.
3. Nano Essentials- T.Pradeep/TMH., 2017.

REFERENCE BOOKS:

1. Solid State physics by Pillai, Wiley Eastern Ltd.
2. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.

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

CO1: Understand the classification of nanostructured Materials
CO2: Understand the unique properties of nano materials
CO3: Interpret the Synthesis Routes - Bottom up and Top down approaches
CO4: Identify the tools to characterize nano materials
CO5: Understand the applications of nano materials

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23OE3111**	**THERMAL MANAGEMENT OF ELECTRONIC SYSTEMS (Open Elective-I)**						

COURSE OBJECTIVE:

1. To understand the basics of heat transfer and analyze heat transfer through fins
2. To acquire the knowledge on Free and forced convective systems.
3. To understand the air cooling and single phase liquid cooling systems with case studies.
4. To demonstrate the concepts of two phase cooling and heat pipes.
5. To understand thermo electric coolers, mini and micro channels.

UNIT – 1

Introduction of Heat Transfer: Modes – Conduction, Convection and Radiation – Basic Laws – Applications of Heat Transfer.

Basics of Conduction – Conduction equation – Thermal analogy – Lumped heat capacity analysis - Heat conduction with phase change - Thermal Resistance – Extended Surfaces – Uniform cross section fins.

UNIT – 2

Forced and Free Convection – Heat transfer coefficient - Parameters effecting heat transfer – Thermal Properties of fluids.

Radiation – Stefan- Boltzmann Law – Kirchoff's law and Emissivity – Radiation between Black Isothermal Surfaces – Radiation between Grey Isothermal Surfaces – Extreme Climatic conditions - Radiation at normal ambient Temperature measurement and its Instrumentation.

UNIT – 3

Printed Circuit boards – Chip packaging – thermal Resistance – Board Cooling methods – Board thermal Analysis – Equivalent thermal Conductivity.

Air Cooling – Fans – Heat transfer Enhancement – Air handling systems - Blowers

Single Phase Cooling – Coolant Selection – Natural Convection – Forced Convection - Air Cooling - Convective cooling in Small systems.

UNIT – 4

Two Phase Cooling – Direct Immersion Cooling – Basics of Pool Boiling – Enhancement of Pool Boiling – Flow Boiling.

Heat Pipes – Operation Principles – Useful Characteristics – Operating Limits and Temperatures – Operation Methods – Applications.

UNIT – 5

Thermo Electric coolers: Basics theories – Thermo electric effect – Operation Principles.

Phase change materials, Thermal Interface materials, Heat Spreaders and Heat Sinks – Working Principles Mini and Micro Channels.

TEXT BOOKS:

1. Fundamentals of Microelectronics Packaging – Ed: Rao Tummala, McGraw Hill, New York, NY, 2019.
2. Thermal Analysis and Control of Electronic Equipment – Allan D. Kraus and Avram BarCohen, McGraw Hill, New York, NY, 1983.
3. Packaging of Electronic Systems – James W. Dally, McGraw Hill, New York, NY, 1990.

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

CO1: Understand the basics of heat transfer and analyze heat transfer through fins
CO2: Acquire the knowledge on Free and forced convective systems
CO3: Understand the air cooling and single phase liquid cooling systems with case studies
CO4: Demonstrate the concepts of Two phase cooling and heat pipes
CO5: Understand thermo electric coolers, mini and micro channels

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R23OE3112	**ENTREPRENEURSHIP (OPEN ELECTIVE-I)**						

COURSE OBJECTIVE:

1. To develop and strengthen entrepreneurial quality and motivation in students.
2. To impart basic entrepreneurial skills and understandings to run a business efficiently and effectively.

UNIT-I:

ENTREPRENEURAL COMPETENCE: Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful Entrepreneur – types of Entrepreneurs, Knowledge and Skills of Entrepreneur., ethics and social responsibilities of an entrepreneur.

UNIT-II:

ENTREPRENEURAL ENVIRONMENT: Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organizational Services. Woman as entrepreneur

UNIT-III:

INDUSTRIAL POLACIES: Central and State Government Industrial Policies and Regulations- International Business. Opportunities for entrepreneurs in India and abroad

UNIT-IV:

BUSINESS PLAN PREPARATION: Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT- V:

LAUNCHING OF SMALL BUSINESS: Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups. Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business. MSME- Definition and Classification, Economic Importance, Government Policies and Schemes.

TEXT BOOKS

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 11th edition, 2020.
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 13th edition, 2020.

REFERENCES

1. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra, 2nd Edition, 2005
2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
3. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.
4. Arya Kumar. Entrepreneurship. Pearson. 2012 5. Donald F Kuratko, T.V Rao. Entrepreneurship: A South Asian perspective. Cengage Learning. 2012

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

CO1: Outline the concepts of Entrepreneurship and ethical responsibilities of successful entrepreneurs.
CO2: Analyze the entrepreneurial environment and evaluate the role of women in entrepreneurship.
CO3: Interpret industrial policies and explore business opportunities for entrepreneurs.
CO4: Develop a comprehensive business plan and preparing feasibility reports.
CO5: Apply strategies for small businesses and understanding MSME policies and government schemes.

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
Code: **R23ME31L1**	**THERMAL ENGINEERING LAB**						

COURSE OBJECTIVES:

1. To demonstrate the characteristics of two stroke and four stroke compression and spark ignition engines.
2. To determine flash point, fire point, calorific value of different fuels using various apparatus.
3. To find out engine friction, and conduct load test of petrol and diesel engines.
4. To demonstrate performance test on petrol and diesel engines.
5. To conduct performance test and determine efficiency of air compressor.

EXPERIMENTS:

1. To determine the actual Valve Timing diagram of a four stroke Compression/Spark Ignition Engine.
2. To determine the actual Port Timing diagram of a two stroke Compression/Spark Ignition Engine.
3. Determination of Flash & Fire points of Liquid fuels / Lubricants using (i) Abels Apparatus; (ii) Pensky Martin's apparatus and (iii) Cleveland's apparatus.
4. Determination of Viscosity of Liquid lubricants/Fuels using (i) Saybolt Viscometer and (ii) Redwood Viscometer.
5. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol/diesel engine.
6. To perform the Heat Balance Test on Single Cylinder four Stroke Petrol/Diesel Engine.
7. To conduct a load test on a single cylinder Petrol/Diesel engine to study its performance under various loads.
8. To conduct a performance test on a VCR engine, under different compression ratios and determine its heat balance sheet.
9. To conduct a performance test on an air compressor and determine its different efficiencies.
10. Study of boilers with accessories and mountings
11. Experimentation on installation of Solar PV Cells
12. Demonstration of electronic controls in an automobile.

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

CO1: Experiment with two stroke and four stroke compression and spark ignition engines for various characteristics.
CO2: Determine flash point, fire point, calorific value of different fuels using various apparatus.
CO3: Perform engine friction, heat balance test, load test of petrol and diesel engines.
CO4: Conduct performance test on petrol and diesel engines
CO5: Perform test and determine efficiency of air compressor

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
Code: **R23ME31L2**	**THEORY OF MACHINES LAB**						

COURSE OBJECTIVES:

1. To demonstrate the motion of a gyroscope
2. To study the characteristics of governors
3. To find the frequencies of damped and undamped free and forced vibrations
4. To analyze different mechanisms
5. To demonstrate various types of gears

LIST OF EXPERIMENTS:

1. To determine whirling speed of shaft theoretically and experimentally.
2. To determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation.
3. To analyse the motion of a motorized gyroscope when the couple is applied along its spin axis
4. To determine the frequency of undamped free vibration of an equivalent spring mass system.
5. To determine the frequency of damped force vibration of a spring mass system
6. To study the static and dynamic balancing using rigid blocks.
7. To find the moment of inertia of a flywheel
8. To plot follower displacement vs cam rotation for various Cam Follower systems.
9. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/Four bar mechanism
10. To find the coefficient of friction between the belt and pulley.
11. To study simple and compound screw jack and determine the mechanical advantage, velocity ratio, and efficiency
12. To study various types of gears- Spur, Helical, Worm and Bevel Gears

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

CO1: Get knowledge about the motion of a gyroscope
CO2: Discuss the characteristics of governors
CO3: Find the frequencies of damped and undamped free and forced vibrations
CO4: Analyze different mechanisms
CO5: Demonstrate various types of gears

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	4	30	70	100	2
Code: **R23ME31L3**	**MACHINE TOOLS & METROLOGY LAB**						

COURSE OBJECTIVES:

1. To understand the parts of various machine tools and about different shapes of products that can be produced on them.
2. To measure bores, angles and tapers
3. To perform alignment tests on various machines

Note: The students have to conduct at least 6 experiments from each lab

MACHINE TOOLS LAB:

1. Introduction of general purpose machines -Lathe, Drilling machine, Milling machine, Shaper, Planning machine, Slotting machine, Cylindrical grinder, Surface grinder and Tool and cutter grinder.
2. Operations on Lathe machines- Step turning, Knurling, Taper turning, Thread cutting and Drilling
3. Operations on Drilling machine - Drilling, reaming, tapping, Rectangular drilling, circumferential drilling
4. Operations on Shaping machine - (i) Round to square (ii) Round to Hexagonal
5. Operations on Slotter - (i) Keyway (T –slot) (ii) Keyway cutting
6. Operations on milling machines - (i) Indexing (ii) Gear manufacturing

METROLOGY LAB:

1. Calibration of vernier calipers, micrometers, vernier height gauge, Dial gauges, Slip gauges and Depth gauges.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier caliper for tooth thickness inspection and flange micrometer for checking the chordal thickness of spur gear.
4. Machine tool alignment test on the lathe.
5. Machine tool alignment test on drilling machine.
6. Machine tool alignment test on milling machine.
7. Angle and taper measurements with bevel protractor, Sine bar, rollers and balls.
8. Use of spirit level in finding the straightness of a bed and flatness of a surface.
9. Thread inspection with two wire/ three wire method & tool maker's microscope.
10. Surface roughness measurement with roughness measuring instrument.

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

CO1: Gain knowledge about the parts of various machine tools and about different shapes of products that can be produced on them.
CO2: Learn measure bores, angles and tapers
CO3: Perform alignment tests on various machines

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	2	30	70	100	1
Code: R23ME31L4	**TINKERING LAB**						

The aim of tinkering lab for engineering students is to provide a hands-on learning environment where students can explore, experiment, and innovate by building and testing prototypes. These labs are designed to demonstrate practical skills that complement theoretical knowledge.

COURSE OBJECTIVES: To
1. Encourage Innovation and Creativity
2. Provide Hands-on Learning
3. Impart Skill Development
4. Foster Collaboration and Teamwork
5. Enable Interdisciplinary Learning
6. Impart Problem-Solving mind-set
7. Prepare for Industry and Entrepreneurship

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

LIST OF EXPERIMENTS:
1) Make your own parallel and series circuits using breadboard for any application of your choice.
2) Demonstrate a traffic light circuit using breadboard.
3) Build and demonstrate automatic Street Light using LDR.
4) Simulate the Arduino LED blinking activity in Tinkercad.
5) Build and demonstrate an Arduino LED blinking activity using Arduino IDE.
6) Interfacing IR Sensor and Servo Motor with Arduino.
7) Blink LED using ESP32.
8) LDR Interfacing with ESP32.
9) Control an LED using Mobile App.
10) Design and 3D print a Walking Robot
11) Design and 3D Print a Rocket.
12) Build a live soil moisture monitoring project, and monitor soil moisture levels of a remote plan in your computer dashboard.
13) Demonstrate all the steps in design thinking to redesign a motor bike.

Students need to refer to the following links:
1) https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2) https://atl.aim.gov.in/ATL-Equipment-Manual/
3) https://aim.gov.in/pdf/Level-1.pdf
4) https://aim.gov.in/pdf/Level-2.pdf
5) https://aim.gov.in/pdf/Level-3.pdf

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

CO1: Design basic electronic and embedded systems using breadboards, microcontrollers, sensors, and actuators to solve real-world problems.

CO2: Develop IoT-based and wireless control applications for automation and remote monitoring using mobile apps and cloud dashboards.

CO3: Apply design thinking principles and 3D printing techniques to fabricate innovative mechanical models and redesigns.

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	-	-	-	30	70	100	1
Code: **R23ME31CSP**	**COMMUNITY SERVICE INTERNSHIP**						

INTRODUCTION

- Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development
- Community Service Project involves students in community development and service activities and applies the experience to personal and academic development.
- Community Service Project is meant to link the community with the college for mutual benefit. The community will be benefited with the focused contribution of the college students for the village/ local development. The college finds an opportunity to develop social sensibility and responsibility among students and also emerge as a socially responsible institution.

OBJECTIVE

Community Service Project should be an integral part of the curriculum, as an alternative to the 4 to 8 weeks of Summer Internships / Apprenticeships / On the Job Training, whenever there is an exigency when students cannot pursue their summer internships. The specific objectives are;

- To sensitize the students to the living conditions of the people who are around them,
- To help students to realize the stark realities of the society.
- To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
- To make students aware of their inner strength and help them to find new /out of box solutions to the social problems.
- To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
- To help students to initiate developmental activities in the community in coordination with public and government authorities.
- To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

Implementation of Community Service Project

- Every student should put in a minimum of 180 hours for the Community Service Project during the summer vacation.
- Each class/section should be assigned with a mentor.
- Specific Departments could concentrate on their major areas of concern. For example, Dept. of Computer Science can take up activities related to Computer Literacy to different sections of people like - youth, women, house-wives, etc
- A log book has to be maintained by each of the student, where the activities undertaken/involved to be recorded.
- The log book has to be countersigned by the concerned mentor/faculty incharge.
- Evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.
- The final evaluation to be reflected in the grade memo of the student.

- The Community Service Project should be different from the regular programmes of NSS/NCC/Green Corps/Red Ribbon Club, etc.
- Minor project report should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.
- Award of marks shall be made as per the guidelines of Internship/apprentice/ on the job training

PROCEDURE

- A group of students or even a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, so as to enable them to commute from their residence and return back by evening or so.
- The Community Service Project is a twofold one –
  - First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area. Or it can even be a general survey, incorporating all the different areas. A common survey format could be designed. This should not be viewed as a duplication of work by the Village or Ward volunteers, rather, it could be another primary source of data.
  - Secondly, the student/s could take up a social activity, concerning their domain or subject area. The different areas, could be like –

    - Agriculture
    - Health
    - Marketing and Cooperation
    - Animal Husbandry
    - Horticulture
    - Fisheries
    - Sericulture
    - Revenue and Survey
    - Natural Disaster Management
    - Irrigation
    - Law & Order
    - Excise and Prohibition
    - Mines and Geology
    - Energy
    - Internet
    - Free Electricity
    - Drinking Water

B.Tech - III Year II Semester

S. No.	Title	Course Code	Cat. Code	Internal Marks	External marks	Total Marks	L	T	P	Credits
1	Heat Transfer	R23ME3201	PC	30	70	100	3	0	0	3
2	Artificial Intelligence and Machine Learning	R23ME3202	PC	30	70	100	3	0	0	3
3	Finite Element Methods	R23ME3203	PC	30	70	100	3	0	0	3
4	**Professional Elective - II**									
	Mechanical Vibrations	R23ME3204	PE	30	70	100	3	0	0	3
	Advanced Manufacturing Processes	R23ME3205								
	Micro Electro Mechanical Systems	R23ME3206								
	Sensors and Instrumentation	R23ME3207								
5	**Professional Elective - III**									
	Energy Storage Technologies	R23ME3208	PE	30	70	100	3	0	0	3
	Industrial Hydraulics and Pneumatics	R23ME3209								
	Industrial Robotics	R23ME3210								
	Refrigeration & Air-Conditioning	R23ME3211								
6	**Open Elective - II**									
	Introduction to Industrial Robotics	R23OE3209	OE	30	70	100	3	0	0	3
	Industrial Management	R23OE3210								
	Additive Manufacturing	R23OE3211								
	Vechicle Technology	R23OE3212								
	Industrial Safety	R23OE3213								
6	Heat Transfer Lab	R23ME32L1	PC	30	70	100	0	0	3	1.5
7	Artificial Intelligence and Machine Learning Lab	R23ME32L2	PC	30	70	100	0	0	3	1.5
8	Robotics and Drone Technologies Lab	R23ME32L3	SEC	30	70	100	0	0	4	2
9	Technical paper writing and IPR	R23ME32MC	AC	30	70	100	2	0	0	-
Total							**20**	**0**	**10**	**23**
Mandatory Industry Internship of 08 weeks duration during summer vacation										

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3201**	**HEAT TRANSFER**						

COURSE OBJECTIVES:

1. To learn the different modes of heat transfer and conduction heat transfer through various solid bodies
2. To learn the one dimensional steady state heat conduction heat transfer and one dimensional transient heat conduction
3. To learn the basic concepts of convective heat transfer and forced convection heat transfer of external flows and internal flows
4. To learn the free convection heat transfer concepts and heat transfer processes in heat exchangers
5. To learn the concepts of radiation heat transfer.

UNIT – 1

INTRODUCTION: Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.

CONDUCTION HEAT TRANSFER: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical– steady, unsteady and periodic heat transfer – Initial and boundary conditions

ONE DIMENSIONAL STEADY STATE CONDUCTION HEAT TRANSFER: Homogeneous slabs, hollow cylinders and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation. Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin.

UNIT – 2

ONE DIMENSIONAL TRANSIENT CONDUCTION HEAT TRANSFER: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi-infinite body.

CONVECTIVE HEAT TRANSFER: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham π Theorem and method, application for developing semi – empirical non-dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations

UNIT – 3

FORCED CONVECTION: EXTERNAL FLOWS: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

INTERNAL FLOWS: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal Flow based on this –Use of empirical relations for Horizontal Pipe Flow.

FREE CONVECTION: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.

UNIT – 4

HEAT TRANSFER WITH PHASE CHANGE:

BOILING: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling

CONDENSATION: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

HEAT EXCHANGERS: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT – 5

RADIATION HEAT TRANSFER: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity.

Note: Heat transfer data book by C P Kothandaraman and Subrahmanyan **is allowed.**

TEXT BOOKS:

1. Heat Transfer by HOLMAN, Tata McGraw-Hill, 10th edition, 2017.
2. Heat Transfer by P.K.Nag, TMH., 3rd edition, 2011.

REFERENCE BOOKS:

1. Fundamentals of Heat Transfer by Incropera& Dewitt, John Wiley, 8th edition, 2011.
2. Fundamentals of Engineering, Heat& Mass Transfer by R.C.Sachdeva, New Age.
3. Heat& Mass Transfer by Amit Pal – Pearson Publishers.
4. Heat Transfer by Ghoshadastidar, Oxford University press.
5. Heat Transfer by a Practical Approach, YunusCengel, Boles, TMH
6. Engineering Heat and Mass Transfer by Sarit K. Das, Dhanpat Rai Pub., 2010.

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

CO1: Find heat transfer rate for 1D, steady state composite systems with heat generation and performance of pins.

CO2: Understand the concepts transient heat conduction and basic laws involved in the convection heat transfer.

CO3: Apply the empirical equations for forced convection and free convection problems

CO4: Examine the rate of heat transfer with phase change and in the heat exchangers.

CO5: Illustrate the concepts of radiation heat transfer

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R23ME3202	**ARTIFICIAL INTELLIGENCE & MACHINE LEARNING**						

COURSE OBJECTIVES:

1. To impart the basic concepts of artificial intelligence and the principles of knowledge representation and reasoning.
2. To introduce the machine learning concepts and supervised learning methods
3. To enable the students gain knowledge in unsupervised learning method and Bayesian algorithms.
4. To make the students learn about neural networks and genetic algorithms.
5. To understand the machine learning analytics and deep learning techniques.

UNIT– I:

INTRODUCTION: Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and Environments; Good Behaviour - concept of rationality, the nature of environments, structure of agents.

KNOWLEDGE–REPRESENTATION AND REASONING: Logical Agents: Knowledge-based agents, Patterns in Propositional Logic, Inference in First-Order Logic-Propositional vs. first order inference.

UNIT– II:

INTRODUCTION TO MACHINE LEARNING (ML): Definition, Evolution, Need, applications of ML in industry and real-world, regression and classification problems, performance metrics, differences between supervised and unsupervised learning paradigms, bias, variance, over fitting and under fitting.

SUPERVISED LEARNING: Linear regression, logistic regression, Nearest-Neighbours, Decision Trees, Support Vector Machines,

UNIT– III:

UNSUPERVISED LEARNING: Clustering**,** K-means, Dimensionality Reduction, PCA and Kernel.

BAYESIAN AND COMPUTATIONAL LEARNING: Bayes theorem, concept learning, maximum likelihood of normal, binomial, exponential, and Naïve Bayes Classifier, Instance-based Learning- K-Nearest neighbour learning.

UNIT– IV:

NEURAL NETWORKS AND GENETIC ALGORITHMS: Neural network representation, problems, perceptron, multilayer networks and back propagation, steepest descent method, Convolutional neural networks and their applications Recurrent Neural Networks and their applications, Local vs Global optima.

UNIT– V:

DEEP LEARNING: Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks.

MACHINE LEARNING ALGORITHM ANALYTICS: Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods - Boosting, Bagging, and Random Forests.

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
2. Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
3. Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), the MIT Press, 2004.

REFERENCE BOOKS:

1. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.

ONLINE RESOURCES:

1. **https://www.tpointtech.com/artificial-intelligence-ai**
2. **https://www.geeksforgeeks.org/**

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

CO1: Explain the basic concepts of artificial intelligence
CO2: Learn about the principles of supervised learning methods
CO3: Gain knowledge in unsupervised learning method and Bayesian algorithms
CO4: Get knowledge about neural networks and genetic algorithms.
CO5: Understand the machine learning analytics and apply deep learning techniques.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R23ME3203	**FINITE ELEMENT METHODS**						

COURSE OBJECTIVES:

1. To learn basic principles of finite element analysis procedure
2. To learn how to solve the bar and truss problems
3. To learn how to solve beam problems
4. To understand the formulation of 2D problems
5. To get knowledge in heat transfer analysis and dynamic analysis.

UNIT – 1

INTRODUCTION: Introduction to finite element method, stress and equilibrium, strain–displacement relations, stress–strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy.

UNIT – 2

ONE DIMENSIONAL BAR ELEMENTS: Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

UNIT – 3

ANALYSIS OF TRUSSES: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress and strain and support reaction calculations.

ANALYSIS OF BEAMS: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT – 4

TWO DIMENSIONAL STRESS ANALYSIS: Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems. Higher order and iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node iso-parametric elements and numerical integration.

UNIT – 5

STEADY STATE HEAT TRANSFER ANALYSIS: One dimensional analysis of a fin.

DYNAMIC ANALYSIS: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of Eigen values and Eigen vectors, free vibration analysis.

TEXTBOOK:

1. Introduction to Finite Elements in Engineering, Second Edition/ Tirupati Reddy Chandrupatla/Prentice-Hall, 5th edition, 2022.
2. The Finite Element Methods in Engineering /S.S.Rao/Pergamon, 6th edition, 2017.

REFERENCES:

1. Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah /Pearson publishers
2. An introduction to Finite Element Method /JNReddy/McGraw-Hill
3. The Finite Element Method for Engineers–Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and TedG. By rom/John Wiley & sons (ASIA) Pvt Ltd.

4. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education
5. Finite Element Analysis: for students & Practicing Engineers / G.LakshmiNarasaiah

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

CO1: Understand the concepts behind variational methods and weighted residual methods in FEM.
CO2: Solve bar and truss problems.
CO3: Solve beam problems.
CO4: Apply suitable boundary conditions for 2D stress analysis and develop the formulation for axi-symmetric problems and higher order iso-parametric elements
CO5: Evaluate the concepts of steady state heat transfer analysis and dynamic analysis.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R23ME3204	**MECHANICAL VIBRATIONS (Professional Elective-II)**						

COURSE OBJECTIVES:

1. To learn basic principles of mathematical modeling of vibrating systems
2. To understand the basic concepts free and forced multi degree freedom systems
3. To get concepts involved in the torsional vibrations
4. To learn the principles involved in the critical speed of shafts
5. To understand the basic concepts of Laplace transformations response to different inputs

UNIT – 1: Relevance of Conditional Monitoring and need for vibrational analysis – Basics of SHM - Mathematical modelling of vibrating systems - Discrete and continuous systems - single-degree freedom systems - free and forced vibrations, damped and undamped systems.

UNIT – 2: Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes - Matrix methods of solution- normal modes - Orthogonality principle-Energy methods, Eigen values and Eigen vectors, modal analysis.

UNIT – 3: Torsional vibrations - Longitudinal vibration of rods - transverse vibrations of beams – Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to non- linear and random vibrations.

UNIT – 4: Vibration Measuring Instruments and Critical Speeds of Shafts: Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Critical speed of a light shaft having a single disc without damping and with damping, critical speeds of shaft having multiple discs, secondary critical speed, critical speeds light cantilever shaft with a large heavy disc at its end.

UNIT – 5: Laplace transformations response to an impulsive input, response to a step input, response to pulse (rectangular and half sinusoidal pulse), phase plane method.

TEXT BOOKS:

1. S.S.Rao, “Mechanical Vibrations ", 5th Edition, Prentice Hall, 2011.
2. L.Meirovitch, “Elements of vibration Analysis", 2nd Edition, McGraw-Hill, New York, 1985.

REFERENCES:

1. W.T. Thomson, M.D. Dahleh and C Padmanabhan, “Theory of Vibration with Applications”, 5thEdition, Pearson Education, 2008.
2. M.L.Munjal, “Noise and Vibration Control”, World Scientific, 2013.
3. Beranek and Ver, “Noise and Vibration Control Engineering: Principles and Applications”, JohnWiley and Sons, 2006.
4. Randall F. Barron, “Industrial Noise Control and Acoustics”, Marcel Dekker, Inc., 2003.

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

CO1: Understand the concepts of vibrational analysis
CO2: Understand the concepts of free and forced multi degree freedom systems
CO3: Summarize the concepts of torsional vibrations
CO4: Solve the problems on critical speed of shafts
CO5: Apply and Analyze the systems subjected to Laplace transformations response to different inputs

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3205**	**ADVANCED MANUFACTURING PROCESSESS (Professional Elective-II)**						

COURSE OBJECTIVES:
1. To learn the basic principle of advanced machining processes
2. To know about the various additive manufacturing processes
3. To understand the principles of coating and processing of ceramics.
4. To get insights about processing of composites and nanomaterials
5. To know the fabrication of microelectronic components.

UNIT – 1
ADVANCED MACHINING PROCESSES: Introduction, Need, AJM, WJM, Wire-EDM, ECM, LBM, EBM, PAM – Principle, working, advantages, limitations, Process Parameters & capabilities and applications.

UNIT – 2
ADDITIVE MANUFACTURING: Working Principles, Methods, Stereo Lithography, LENS, LOM, Laser Sintering, Fused Deposition Method, 3DP Applications and Limitations,

UNIT – 3
SURFACE TREATMENT: Scope, Cleaners, Methods of cleaning, Surface coating types, Electro forming, Chemical vapour deposition, Physical vapour deposition, thermal spraying methods, Ion implantation, diffusion coating, ceramic and organic methods of coating, and cladding methods.
PROCESSING OF CERAMICS: Applications, characteristics, classification, Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application.

UNIT – 4
PROCESSING OF COMPOSITES: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, processing methods for MMC, CMC, Polymer matrix composites.
PROCESSING OF NANOMATERIALS: Introduction, Top down Vs Bottom up techniques-Ball milling, Lithography, Plasma Arc Discharge, Pulsed Laser Deposition.

UNIT – 5
FABRICATION OF MICROELECTRONIC DEVICES: Crystal growth and wafer preparation, Film Deposition, oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, surface mount technology, Integrated circuit economics.

TEXT BOOKS:
1. Manufacturing Engineering and Technology*I*Kalpakijian / AdissonWesley, 9th edition, 2025.
2. Process and Materials of Manufacturing / R. A. Lindburg / 4th edition, PHI 1990.

REFERENCES:
1 Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van Nostrand Renihold,
2 MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH
3 Advanced Machining Processes / V.K.Jain / Allied Publications.
4 Introduction to Manufacturing Processes / John A Schey*I*McGraw Hill.
5 Introduction to Nanoscience and NanoTechnology/ Chattopadhyay K.K/A.N.Banerjee/ PHI Learing

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

CO1: Explain the working principle of various nonconventional machining processes and their applications.

CO2: Explain the working principles of additive manufacturing methods.

CO3: Understand various laser material processing techniques.

CO4: Gain on Advanced coating processes

CO5: Describe various fabrication methods for microelectronic devices

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3206**	**MICRO ELECTRO MECHANICAL SYSTEMS (Professional Elective-II)**						

COURSE OBJECTIVES:

1. To understand basics of Micro Electro Mechanical Systems(MEMS), mechanical sensors and actuators
2. To illustrate thermal sensors and actuators used in MEMS.
3. To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems
4. (MOEMS), magnetic sensors and actuators.
5. To analyze applications and considerations on micro fluidic systems.
6. To illustrate the principles of chemical and biomedical microsystems.

UNIT–I:

INTRODUCTION: Definition of MEMS, MEMS history and development, micromachining, lithography principles &methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micromachining, wafer bonding, LIGA.

MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo-electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inch worm technology.

UNIT–II:

THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermistors, thermo devices, thermo couple, micro machined thermo couple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, datastorage cantilever.

UNIT–III:

MICRO-OPTO-ELECTROMECHANICALSYSTEMS: Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.

MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

UNIT– IV:

MICRO FLUIDIC SYSTEMS: Applications, considerations on micro scale fluid, fluid actuation methods, dielectro-phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, micro fluid dispenser, micro needle, molecular gate, micro pumps. RADIOFREQUENCY (RF) MEMS: RF – based communication systems, RF MEMS, MEMS inductors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

UNIT– V:

CHEMICAL AND BIOMEDICAL MICRO SYSTEMS: Sensing mechanism &principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemo-resistors, chemo-capacitors, chemo-transistors, electronic nose (E-nose), mass sensitive chemo-sensors, fluorescence detection, calorimetric spectroscopy.

TEXTBOOK:

1. MEMS, Nitaigour Prem chand Mahalik, TMH, 2009.

REFERENCE BOOKS:

1. Foundation of MEMS, Chang Liu, Prentice HallLtd.
2. MEMS and NEMS, Sergey Edward Lyshevski, CRC Press, Indian Edition.
3. MEMS and Micro Systems: Design and Manufacture, Tai-RanHsu, TMHPublishers.
4. Introductory MEMS,Thomas MAdams, Richard ALayton, Springer International Publishers.

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

CO1: Understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators.

CO2: Illustrate thermal sensors and actuators used in MEMS.

CO3: Apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.

CO4: Analyze applications and considerations on micro fluidic systems.

CO5: Illustrate the principles of chemical and biomedical micro systems.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3207**	**SENSORS AND INSTRUMENTATION (Professional Elective-II)**						

COURSE OBJECTIVES:

1. To understand the concepts of measurement technology.
2. To learn the various sensors used to measure various physical parameters.
3. To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development
4. To learn about the optical, pressure and temperature sensor
5. To understand the signal conditioning and DAQ systems

UNIT I

INTRODUCTION: Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II

MOTION, PROXIMITY AND RANGING SENSORS: Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III

FORCE, MAGNETIC AND HEADING SENSORS: Strain Gage, Load Cell, Magnetic Sensors – types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV

OPTICAL, PRESSURE AND TEMPERATURE SENSORS: Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V

SIGNAL CONDITIONING AND DAQ SYSTEMS: Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TEXT BOOKS:

1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw- Hill, 2009.
2. Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.

REFERENCES

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

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

CO1: Recognize with various calibration techniques and signal types for sensors.

CO2: Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.

CO3: Apply the various sensors and transducers in various applications

CO4: Select the appropriate sensor for different applications.

CO5: Acquire the signals from different sensors using Data acquisition systems.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3208**	**ENERGY STORAGE TECHNOLOGIES (Professional Elective-III)**						

COURSE OBJECTIVES: To

1. Get the insights into importance of energy storage systems
2. Understand the chemical and electromagnetic storage systems
3. Know the principles of electrochemical storage systems
4. Learn the working of super capacitors and fuel cells
5. Know how to design batteries for transportation

UNIT 1:

ENERGY STORAGE SYSTEMS OVERVIEW - Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market. Thermal storage system-heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage.

UNIT 2:

CHEMICAL STORAGE SYSTEM: Hydrogen, methane etc., concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and future prospects of chemical storage systems.

ELECTROMAGNETIC STORAGE SYSTEMS: Double layer capacitors with electrostatically charge storage, superconducting magnetic energy storage (SMES), concepts, advantages and limitations of electromagnetic energy storage systems, and future prospects of electrochemical storage systems.

UNIT 3:

ELECTROCHEMICAL STORAGE SYSTEM: Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery& Metal hydride battery vs. lead-acid battery.

UNIT 4:

SUPER CAPACITORS: Working principle of super capacitor, types of super capacitors, cycling and performance characteristics, difference between battery and super capacitors

FUEL CELL- Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-super capacitor systems.

UNIT 5:

BATTERY DESIGN FOR TRANSPORTATION: Mechanical Design and Packaging of Battery Packs for Electric Vehicles, Advanced Battery, Assisted Quick Charger for Electric Vehicles, Thermal run-away for battery systems, Thermal management of battery systems, State of Charge and State of Health Estimation over the Battery Lifespan, Recycling of Batteries from Electric Vehicles.

TEXT BOOKS:

1. Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011)
2. Ralph Zito, Energy storage: A new approach, Wiley (2010)

REFERENCES:

1. Pistoia, Gianfranco, and Boryann Liaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.
2. Robert A. Huggins, Energy storage, Springer Science & Business Media (2010**)**

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

CO1: Learn the importance of energy storage systems
CO2: Gain knowledge on chemical and electromagnetic storage systems
CO3: Understand the principles of electrochemical storage systems
CO4: Know the working of super capacitors and fuel cells
CO5: Learn how to design batteries for transportation

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3209**	**INDUSTRIAL HYDRAULICS AND PNEUMATICS (Professional Elective-III)**						

COURSE OBJECTIVES:

1. To learn basic concepts of fluid power
2. To understand the functions and working of basic elements of Hydraulic and Pneumatic system
3. To get knowledge about the basic components and their functions of Hydraulic and Pneumatic circuits
4. To learn the operating principles and working of hydraulic and pneumatic devices
5. To gain knowledge about the procedures of installation, maintenance and trouble shooting of Hydraulic and pneumatic systems

UNIT – 1

FLUID POWER: Power transmission modes, hydraulic systems, pneumatic systems, laws governing fluid flow: Pascal's law, continuity equation, Bernoulli's theorem, Boyle's, Charles', Gay-Lussec' laws, flow through pipes - types, pressure drop in pipes, Working fluids used in hydraulic and pneumatic systems- types, ISO/BIS standards and designations, properties.

UNIT – 2

HYDRAULIC AND PNEUMATIC SYSTEMS: Hydraulic pipes-Types, standards, designation methods and specifications, pressure ratings, applications and selection criteria, pumping theory, Hydraulic Pumps - types, construction, working principle, applications, selection criteria and comparison, hydraulic Actuators, Control valves, Accessories - their types, construction and working, Oil conditioning, pneumatic Pipes - materials, designations, standards, properties and piping layout, air compressors, Air receivers, air dryers, Air Filters, Regulators, Lubricators (FRL unit): their types, construction, working, specifications and selection criteria of following air preparation and conditioning elements, pneumatic Actuators and Control valves - types, construction, working, materials and specifications

UNIT – 3

HYDRAULIC AND PNEUMATIC CIRCUITS: ISO symbols used in hydraulic and pneumatic circuit, basic Hydraulic Circuits – types (such as intensifier, regenerative, synchronizing, sequencing, speed control, safety), circuit diagram, components, working and applications, basic Pneumatic Circuits – types (such as speed control, two step feed control, automatic cylinder reciprocation, time delay, quick exhaust), circuit diagram, components, working and applications, pneumatic Logic circuit design - classic method, cascade method, step counter method, Karnaugh- veitch maps and combinational circuit design.

UNIT – 4

HYDRAULIC AND PNEUMATIC DEVICES: Hydraulic and Pneumatic devices – Concept and applications, construction, working principle, major elements, performance variables of: Automotive hydraulic brake, Industrial Fork lift, Hydraulic jack, Hydraulic press, automotive power steering, Automotive pneumatic brake, Automotive air suspension, Pneumatic drill, Pneumatic gun.

UNIT – 5

INSTALLATION, MAINTENANCE AND TROUBLE-SHOOTING: Installation of hydraulic and pneumatic system causes and remedies for common troubles arising in hydraulic elements, maintenance of hydraulic systems, causes and remedies for troubles arising in pneumatic elements, maintenance of pneumatic systems.

TEXTBOOKS:

1. Majumdar, S.R. Oil Hydraulic Systems Tata McGraw-Hill Publication, New Delhi,3/e, 2017.
2. Majumdar, S.R. Pneumatic Systems Tata McGraw-Hill Publication, New Delhi,3/e, 2013.

REFERENCES:

1. Srinivasan, R. Hydraulic and Pneumatic Controls Vijay Nicole Imprints Private, New Delhi, Limited, 2/e, 2008
2. Jagadeesha, T. Fluid Power Generation, Transmission and Control Universities Press (India) Private Limited, New Delhi, 1/e, 2014
3. Jagadeesha, T. Pneumatics Concepts, Design and Applications Universities Press (India) Private Limited, New Delhi, 1/e, 2014
4. Parr, Andrew Hydraulic and Pneumatics, A Technician's and Engineer's Guide, Jaico Publishing House, New Delhi, 2/e, 2013
5. Shanmuga Sundaram, K. Hydraulic and Pneumatics Controls - Understanding Made Easy S. Chand Company Ltd., New Delhi, 1/e, 2006

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

CO1: Illustrate the basic concepts of fluid power
CO2: Understand the functions of elements of Hydraulic and Pneumatic systems
CO3: Analyze the functions of hydraulic and Pneumatic circuits
CO4: Illustrate the working of various hydraulic and pneumatic devices.
CO5: Interpret the procedure of installation, maintenance of hydraulic and pneumatic systems**.**

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R23ME3210	INDUSTRIAL ROBOTICS (Professional Elective-III)						

COURSE OBJECTIVES: The Students will acquire the knowledge to
1. Discuss various applications and components of industrial robot systems
2. Learn about the types of actuators used in robotics
3. Calculate the forward kinematics and inverse kinematics.
4. Learn about programming principles and languages for a robot control system
5. Discuss the applications of image processing and machine vision in robotics.

UNIT – 1

INTRODUCTION: Automation and Robotics, CAD/CAM and Robotics – An overview of Robotics – present and future applications – classification by coordinate system and control system.

COMPONENTS OF THE INDUSTRIAL ROBOTICS:

Robot anatomy, work volume, components, number of degrees of freedom - robot drive systems, function line diagram representation of robot arms, common types of arms -–requirements and challenges of end effectors, determination of the end effectors.

UNIT – 2

ROBOT ACTUATORS AND FEED BACK COMPONENTS:

Actuators: Pneumatic, Hydraulic actuators, electric& stepper motors. Comparison of Electric, Hydraulic and Pneumatic types of actuation devices.

Feedback components: position sensors–potentiometers, resolvers, encoders–Velocity sensors.

UNIT – 3

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation –problems.

MANIPULATOR KINEMATICS: Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics–problems.

UNIT – 4

GENERAL CONSIDERATIONS IN PATH DESCRIPTION AND GENERATION: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion–Robot programming, languages and software packages-description of paths with a robot programming language.

UNIT – 5

IMAGE PROCESSING AND MACHINE VISION: Introduction to Machine Vision, Sensing and Digitizing function in Machine Vision, Training and Vision System, Robotic Applications.

TEXTBOOKS:

1. Industrial Robotics/Groover MP/Pearson Edu., 2nd edition, 2017.
2. Robotics and Control /Mittal R K &Nagrathi J /TMH, 2017.

REFERENCES:

1. Robotics/Fu KS/ McGraw Hill.
2. Robotic Engineering /Richard D. Klafter, Prentice Hall
3. Robot Analysis and Control/ H. Asada and J.J.E. Slotine/BSP Books Pvt.Ltd.
4. Introduction to Robotics/John J Craig/PearsonEdu.

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

CO1: Discuss various applications and components of industrial robot systems
CO2: Learn about the types of actuators used in robotics
CO3: Calculate the forward kinematics and inverse kinematics.
CO4: Learn about programming principles and languages for a robot control system
CO5: Discuss the applications of image processing and machine vision in robotics.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23ME3211**	**REFRIGERATION & AIR-CONDITIONING (Professional Elective-III)**						

COURSE OBJECTIVES:

1. To illustrate the operating cycles and different systems of refrigeration
2. To analyze cooling capacity and coefficient of performance of vapour compression refrigeration systems and understand the fundamentals of cryogenics
3. To calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration system and understand the properties refrigerants.
4. To calculate cooling load for air conditioning systems and identify the requirements of comfort air conditioning
5. To describe different component of refrigeration and air conditioning systems

UNIT – 1

INTRODUCTION TO REFRIGERATION: Necessity and applications – unit of refrigeration and C.O.P. – Mechanical refrigeration – types of ideal cycles of refrigeration.

AIR REFRIGERATION: Bell Coleman cycle - open and dense air systems – refrigeration systems used in air crafts and problems.

UNIT – 2

VAPOUR COMPRESSION REFRIGERATION SYSTEM &COMPONENTS: Working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems.

UNIT – 3

REFRIGERANTS– Desirable properties – classification - refrigerants –green refrigerants- nomenclature – ozone depletion – global warming.

VAPOR ABSORPTION SYSTEM: Calculation of maximum COP – description and working of NH_3 – water system and Li Br –water (Two shell & Four shell) System.

STEAM JET REFRIGERATION SYSTEM: Working Principle and basic components, principle and operation of thermoelectric refrigerator and vortex tube.

UNIT – 4

INTRODUCTION TO AIR CONDITIONING: Psychometric properties & processes – characterization of sensible and latent heat loads — need for ventilation, consideration of infiltration – load concepts of RSHF, GSHF- problems, concept of ESHF and ADP temperature.

Requirements of human comfort and concept of effective temperature- comfort chart –comfort air conditioning – requirements of industrial air conditioning, Introduction to HVAC.

UNIT – 5

AIR CONDITIONING SYSTEMS: Classification of equipments, cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers. Heat pump – heat sources – different heat pump circuits.

Note: Refrigeration and Psychrometric tables and charts are allowed.

TEXT BOOKS:

1. A Course in Refrigeration and Air conditioning / SC Arora & Domkundwar / Dhanpatrai, 2019.
2. Refrigeration and Air Conditioning / CP Arora / TMH. 4th edition, 2021.

REFERENCES:

1. Refrigeration and Air Conditioning / Manohar Prasad / New Age.
2. Principles of Refrigeration /Dossat / Pearson Education.
3. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH

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

CO1: Illustrate the operating cycles and different systems of refrigeration.

CO2: Analyze cooling capacity and coefficient of performance of vapour compression refrigeration systems and understand the fundamentals of cryogenics

CO3: Calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration systems and understand the properties of refrigerants

CO4: Solve cooling load for air conditioning systems and identify the requirements of comfort air conditioning.

CO5: Demonstrate different components of refrigeration and air conditioning systems.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: **R23OE3209**	**INTRODUCTION TO INDUSTRIAL ROBOTICS (Open Elective-II)**						

COURSE OBJECTIVES: To
1. Discuss various applications and components of industrial robot systems
2. Learn about the types of actuators used in robotics
3. Calculate the forward kinematics and inverse kinematics.
4. Learn about programming principles and languages for a robot control system
5. Discuss the applications of image processing and machine vision in robotics.

UNIT – 1
INTRODUCTION: Automation and Robotics, CAD/CAM and Robotics – An overview of Robotics – present and future applications – classification by coordinate system and control system.

COMPONENTS OF THE INDUSTRIAL ROBOTICS:
Robot anatomy, work volume, components, number of degrees of freedom - robot drive systems, function line diagram representation of robot arms, common types of arms -–requirements and challenges of end effectors, determination of the end effectors.

UNIT – 2
ROBOT ACTUATORS AND FEED BACK COMPONENTS:
Actuators: Pneumatic, Hydraulic actuators, electric& stepper motors. Comparison of Electric, Hydraulic and Pneumatic types of actuation devices.
Feedback components: position sensors–potentiometers, resolvers, encoders–Velocity sensors.

UNIT – 3
MOTIO ANANALYSIS: Homogeneous transformations as applicable to rotation and translation – problems.
MANIPULATOR KINEMATICS: Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics–problems.

UNIT – 4
GENERAL CONSIDERATIONS IN PATH DESCRIPTION AND GENERATION: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion–Robot programming, languages and software packages-description of paths with a robot programming language.

UNIT – 5
IMAGE PROCESSING AND MACHINE VISION: Introduction to Machine Vision, Sensing and Digitizing function in Machine Vision, Training and Vision System, Robotic Applications.

TEXTBOOKS:
1. Industrial Robotics/Groover MP/Pearson Edu., 2nd edition, 2017.
2. Robotics and Control /Mittal R K &Nagrathi J /TMH, 2017.

REFERENCES:
1. Robotics/Fu KS/ McGraw Hill.
2. Robotic Engineering /Richard D. Klafter, PrenticeHall

3. Robot Analysis and Control/ H. Asada and J.J.E. Slotine/BSP Books Pvt.Ltd.
4. Introduction to Robotics/John J Craig/PearsonEdu.

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

CO1: Discuss various applications and components of industrial robot systems
CO2: Learn about the types of actuators used in robotics
CO3: Calculate the forward kinematics and inverse kinematics.
CO4: Learn about programming principles and languages for a robot control system
CO5: Discuss the applications of image processing and machine vision in robotics.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R23OE3210	**INDUSTRIAL MANAGEMENT (Open Elective-II)**						

COURSE OBJECTIVES: The objectives of the course are to

1. Introduce the scope and role of industrial engineering and the techniques for optimal design of layouts.
2. Illustrate how work study is used to improve productivity
3. Explain TQM and quality control techniques
4. Introduce financial management aspects and
5. Discuss human resource management and value analysis

UNIT– I

INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. Concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y.

PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, plant maintenance.

UNIT–II

WORK STUDY: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs.

UNIT–III

STATISTICAL QUALITY CONTROL: Quality control, Quality assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – X and R –$\bar{c}$harts X and S charts a$\bar{n}$d their applications.

TOTAL QUALITY MANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. Six Sigma–definition, basic concepts

UNIT– IV

FINANCIAL MANAGEMENT: Scope and nature of financial management, Sources of finance, Ratio analysis, Management of working capital, estimation of working capital requirements, stock management, Cost accounting and control, budget and budgetary control, Capital budgeting – Nature of Investment Decisions – Investment Evaluation criteria- NPV, IRR, PI, Payback Period, and ARR.

UNIT–V

HUMAN RESOURCEMANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, and types, Introduction to Value engineering.

TEXT BOOKS:

1. Industrial Engineering and Management/ O.P Khanna /Khanna Publishers, 17th edition, 2020.
2. Industrial Engineering and Production Management/Mart and Telsang / S.Chand&Company Ltd. New Delhi, 3rd revised edition, 2018.

REFERENCE BOOKS:

1. Industrial Management/ Bhattacharya DK/ Vikas publishers
2. Operations Management/ J.GMonks / McGrawHilPublishers.
3. Industrial Engineering and Management Science/T.R. Banga, S.C.Sharma, N. K. Agarwal /Khanna Publishers
4. Principles of Management / KoontzO'Donnel/ McGraw Hill Publishers.
5. Statistical Quality Control / Gupta/ Khanna Publishers
6. Industrial Engineering and Management/ NVSRaju/ CengagePublishers

COURSE OUTCOMES: After completing this course, students will be able to:

CO1: Learn about how to design the optimal layout
CO2: Demonstrate work study methods
CO3: Explain quality control techniques
CO4: Discuss the financial management aspects and
CO5: Understand the human resource management methods.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R23OE3211	**ADDITIVE MANUFACTURING (Open Elective-II)**						

COURSE OBJECTIVES:

1. To understand the principles of prototyping, classification of RP processes and liquid-based RP systems
2. To understand and apply different types of solid-based RP systems.
3. To understand and apply powder-based RP systems.
4. To understand and apply various rapid tooling techniques.
5. To understand different types of data formats and to explore the applications of AM processes in various fields.

UNIT – 1

INTRODUCTION: Prototyping fundamentals, historical development, fundamentals of rapid prototyping, advantages and limitations of rapid prototyping, commonly used terms, classification of RP process.

LIQUID-BASED RAPID PROTOTYPING SYSTEMS:

Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages.

Solid Ground Curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT – 2

SOLID-BASED RAPID PROTOTYPING SYSTEMS:

Laminated object manufacturing (LOM) - models and specifications, process, working principle, applications, advantages and disadvantages.

Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT – 3

POWDER BASED RAPID PROTOTYPING SYSTEMS:

Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages and disadvantages.

Three dimensional printing (3DP): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT – 4

RAPID TOOLING: Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. Rapid tooling classification.

INDIRECT RAPID TOOLING METHODS: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting process.

DIRECT RAPID TOOLING: Direct AIM, LOM Tools, and Direct Metal Tooling using 3DP.

UNIT – 5

RAPID PROTOTYPING DATA FORMATS: STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translators, and Newly Proposed Formats.

RP APPLICATIONS: Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, RP medical and bioengineering applications: customized implants and prosthesis, forensic sciences.

TEXT BOOKS:

1. Rapid prototyping: Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific publications, 3rd edition, 2010.

REFERENCES:

1. Rapid Manufacturing / D.T. Pham and S.S. Dimov/Springer
2. Wohlers Report 2000 /Terry T Wohlers/Wohlers Associates
3. Rapid Prototyping & Manufacturing / Paul F.Jacobs/ASME Press
4. Rapid Prototyping / Chua and Liou

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

CO1: Understand the principles of prototyping, classification of RP processes and liquid-based RP systems.
CO2: Understand and apply different types of solid-based RP systems.
CO3: Apply powder-based RP systems.
CO4: Analyze and apply various rapid tooling techniques.
CO5: Understand different types of data formats and explore the applications of AM processes in various fields.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R23OE3212	**VEHICLE TECHNOLOGY (Open Elective-II)**						

COURSE OBJECTIVES

1. To study the advanced engine technologies
2. To learn various advanced combustion technologies and its benefits
3. To learn the methods of using low carbon fuels and its significance
4. To learn and understand the hybrid and electric vehicle configurations
5. To study the application of fuel cell technology in automotives.

UNIT – I:

ADVANCED ENGINE TECHNOLOGY: Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

UNIT – II:

COMBUSTION TECHNOLOGY: Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT – III:

LOW CARBON FUEL TECHNOLOGY: Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT – IV:

HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED): Conventional Hybrids (Conventional ICE + Battery), Conventional Hybrids (Conventional ICE + CNG), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

UNIT – V:

FUEL CELL TECHNOLOGY: Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

TEXT BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press,3rd edition, 2018.
2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6, SPRINGER, 2018.

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998

COURSE OUTCOMES*: At the end of the course the students would be able to*

CO1: Discuss the latest trends in engine technology

CO2: Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.

CO3: Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.

CO4: Discuss the working and energy flow in various hybrid and electric configurations.

CO5: Analyzing the need for fuel cell technology in automotive applications.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R23OE3213	**INDUSTRIAL SAFETY (Open Elective-II)**						

COURSE OBJECTIVES:

1. To understand the concepts of industrial safety and management.
2. To demonstrate the accident preventions and protective equipment.
3. To understand and apply the knowledge of safety acts
4. To have the knowledge about fire prevention and protection systems
5. To understand and apply fire safety principles in buildings

UNIT-I

INTRODUCTION TO THE DEVELOPMENT OF INDUSTRIAL SAFETY AND MANAGEMENT:

History and development of Industrial safety: Need for safety, Implementation of factories act, Safety and productivity, Safety organizations. Safety committees and structure - need, types, advantages, Role of management and role of Govt.in industrial safety.

UNIT-II

ACCIDENT PREVENTIONS AND PROTECTIVE EQUIPMENT:

Personal protective equipment, types of PPEs and their uses, Survey the plant for locations, Part of body to be protected, Education and training in safety, Prevention causes and cost of accident, Housekeeping, First aid, Accident reporting, Investigations. Industrial psychology in accident prevention, Safety trials, Safety related to operations.

UNIT-III

SAFETY ACTS: Features of Factory Act, Introduction of Explosive Act, Boiler Act, ESI Act, Workman's compensation Act, Industrial hygiene, Occupational Health & safety, Diseases prevention, Ergonomics, Occupational diseases, stress, fatigue, health, safety and the physical environment, Engineering methods of controlling chemical hazards, safety and the physical environment, Control of industrial noise and protection against it.

UNIT-IV

FIRE PREVENTION AND PROTECTION: Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-Fire extinguishing agents- Water, Foam, Dry chemical powder, Carbon-dioxide Halon alternatives Halocarbon compounds-Inert gases, dry powders – types of fire extinguishers – fire stoppers –hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills –first aid for burns.

UNIT-V

BUILDING FIRE SAFETY: Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design -exit– width calculations –fire certificates – fire safety requirements for high rise buildings.

TEXT BOOKS:

1. Industrial Maintenance Management Srivastava, S.K.- S.Chandand Co., 2002.
2. Occupational Safety Management and Engineering Willie Hammer–Prentice Hall, 2000.

3. Purandare D.D & Abhay D.Purandare, "Handbook on Industrial Fire Safety" P&A publications, NewDelhi, 2020.
4. McElroy, Frank E., "Accident Prevention Manual for Industrial Operations", NSC, Chicago, 1988.
5. Green, A.E.,"High Risk Safety Technology", John Wiley and Sons, 1984.

REFERENCE BOOKS:

1. Installation, Servicing and Maintenance Bhattacharya, S.N.-S.Chandand Co.
2. Jain VK "Fire Safety in Building" New Age International 1996.
3. Reliability, Maintenance and Safety Engineering by Dr.A. K.Guptha
4. A Text book of Reliability and Maintenance Engineering by Alakesh Manna

COURSE OUTCOMES*: At the end of the course the students would be able to*

CO1: Students learn the concepts of industrial safety and management.
CO2: Learn about the smart machines and smart sensors
CO3: Apply IoT to Industry 4.0 and they are able to make a system tailor-made as per requirement of the industry
CO4: Students learn about fire prevention and protection systems.
CO5: Students learn and apply the fire safety principles in buildings

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
Code: **R23ME32L1**	**HEAT TRANSFER LAB**						

COURSE OBJECTIVE:

The laboratory course is aimed to provide the practical exposure to the students with regard to the determination of amount of heat exchange in various modes of heat transfer including condensation & boiling for several geometries.

PART-A

1. Determination of overall heat transfer co-efficient of a composite slab
2. Determination of heat transfer rate through a lagged pipe.
3. Determination of heat transfer rate through a concentric sphere
4. Determination of thermal conductivity of a metal rod.
5. Determination of efficiency of a pin-fin
6. Determination of heat transfer coefficient in natural and forced convection
7. Determination of effectiveness of parallel and counter flow heat exchangers.
8. Determination of emissivity of a given surface.
9. Determination of Stefan-Boltzmann constant.
10. Determination of heat transfer rate in drop and film wise condensation.
11. Determination of critical heat flux.
12. Determination of Thermal conductivity of liquids and gases.

PART-B

Virtual labs (https://mfts-iitg.vlabs.ac.in/) on

(i) Conduction Analysis of a Single Material Slab
(ii) Conduction Analysis of a single Material Sphere
(iii) Conduction Analysis of a single Material Cylinder
(iv) Conduction Analysis of a Double Material Slab
(v) Conduction Analysis of a Double Material Sphere
(vi) Conduction Analysis of Double Material Cylinder
(vii) To determine the overall heat transfer coefficient (U) in the (a) parallel flow heat exchanger and (b) Counter flow heat exchanger
(viii) To investigate the Lambert's distance law.
(ix) To investigate the Lambert's direction law (cosine law).

Note: Virtual labs are only for learning purpose, and are not for external examination.

COURSE OUTCOMES*: At the end of the course the students would be able to*

CO1: Analyze different modes of heat transfer through experiments such as composite slabs, metal rods, convection setups, and radiation measurements.

CO2: Determine thermal properties for various materials and systems under steady and transient conditions.

CO3: Evaluate the performance of heat transfer equipment to understand practical thermal system behaviour.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	30	70	100	1.5
Code: **R23ME32L2**	**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB**						

COURSE OBJECTIVES:

1. Students will acquire the knowledge of artificial intelligence and machine learning models using various software tools.
2. To enable the students write coding for various artificial intelligence and machine learning algorithms.

1. Learning of Python libraries – Numpy, Pandas, Matplotlib, Seaborn and Tensor Flow
2. Numerical examples on Python libraries
3. Data Pre-processing and data cleaning using Python
4. Write a program for Linear regression
5. Write a program for Logistic regression
6. Write a program for ANN
7. Write a program for CNN
8. Write a program for RNN
9. Write a program to build a Decision tree
10. Write a program to build a Naïve Bayes classifier
11. Write a program for SVM
12. Write a program for Auto-encoder

COURSE OUTCOMES*:* At the end of the course the students would be able to

CO1: Learn various Python libraries.
CO2: Do programming for regression methods
CO3: Write coding for different types of neural networks
CO4: Write a program for decision tree, Naïve Bayes and SVM
CO5: Generate code for autoencoders

Note: Databases can be taken from https://www.kaggle.com/datasets.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	4	30	70	100	2
Code: R23ME32L3	ROBOTICS AND DRONE TECHNOLOGIES LAB						

COURSE OBJECTIVE:
Robotics and Drone Technologies Laboratory offers the students hands-on experience in robotics, and unmanned aerial systems.

LIST OF EXPERIMENTS:

ROBOTICS:
1) Simulation of Mathematical Model of Robot.
2) Forward and Inverse Dynamic Analysis of a 2-DOF Robotic Manipulator using Software Tools.
3) Building and Programming a Simple Arduino-Based Robot for basic movement.
4) Build a robot that can navigate through a maze or an environment by using sensors to detect obstacles and avoid them.
5) Construct a robotic arm using servo motors or stepper motors and program the arm to perform various tasks, such as picking up objects, sorting the colour, or drawing shapes.
6) Build a robot that follows a black line on a contrasting surface using line-following sensors.
7) Designing a 3D Model of a Robotic Arm and Grippers Using Software
8) Implement a PID controller for a robotic arm or mobile robot and simulate its performance in tracking a desired trajectory.

DRONE TECHNOLOGIES:
1) Demonstration of parts and functions of a drone.
2) Demonstration of effects of forces, manoeuvres of a drone by roll, pitch and yaw.
3) Demonstration of various sensors and battery management used in drones.
4) Build a prototype drone to record videos and photos.
5) Make a drone for a certain payload.

Students need to refer to the following links:
1) https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2) https://atl.aim.gov.in/ATL-Equipment-Manual/
3) https://aim.gov.in/pdf/Level-1.pdf
4) https://aim.gov.in/pdf/Level-2.pdf
5) https://aim.gov.in/pdf/Level-3.pdf
6) https://aim.gov.in/pdf/ATL_Drone_Module.pdf

COURSE OUTCOME: **At the end of the course the students would be able to**
CO1: Analyze robotic systems using dynamic analysis and PID control implementation.
CO2: Design and program various robotic prototypes for real-world task automation.
CO3: Demonstrate drone components, flight dynamics and power management by operating functional drones for specific applications.

III B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	0	0	30	70	100	-
Code: R23ME32MC	**TECHNICAL PAPER WRITING AND IPR**						

COURSE OBJECTIVES:

1. To understand the structure of the technical paper and its components.
2. To review the literature and acquire the skills to write a technical paper for first submission.
3. To understand the process and development of IPR.
4. To create awareness about the scope of patent rights.
5. To analyze the new developments in IPR include latest software.

UNIT-I: PLANNING AND PREPARATION

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness. Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT-II: LITERATURE REVIEW

Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check.
Key skills needed when writing a Title, Abstract, Introduction, a Review of the Literature, the Methods, the Results, the Discussion, and the Conclusions. Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

UNIT-III: PROCESS AND DEVELOPMENT

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

UNIT-IV: PATENT RIGHTS

Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases, Geographical Indications.

UNIT-V: NEW DEVELOPMENTS IN IPR

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies.

TEXT BOOKS:

1. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press, 9th edition, 2022.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

REFERENCES:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
3. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age" 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

COURSE OUTCOMES*: At the end of the course the students would be able to*

CO1: Understand the structure of the technical paper and its components.
CO2: Review the literature and acquire the skills to write a technical paper for first submission.
CO3: Understand the process and development of IPR.
CO4: Create awareness about the scope of patent rights.
CO5: Analyze the new developments in IPR include latest software.

For Honors:

I. Machine Design (Any 5 theory and 2 Labs)

1. Advanced Mechanics of Solids
2. Mechanical Vibrations and Acoustics
3. Advanced Finite Element Methods
4. Product Design
5. Geometric Modeling
6. Advanced Mechanisms & Robotics
7. Advanced Machine Design
8. Fracture Mechanics
9. Mechanisms and Robotics Lab
10. Vibration and Acoustics Lab

II. CAD/CAM (Any 5 theory and 2 Labs)

1. Advanced Finite Element Methods
2. Advanced CAD
3. Advanced CAM
4. Optimization & Reliability
5. Mechanical Behavior of Materials
6. Industrial Robotics & Automation
7. Materials Characterization Techniques
8. Product Design and Development
9. CAD/CAM Lab
10. Robotics & Automation Lab

III. Thermal Engineering (Any 5 theory and 2 Labs)

1. Advanced Heat Transfer
2. Advanced Fluid Mechanics
3. Advanced Thermodynamics & Combustion
4. Cryogenic Engineering
5. Turbo Machines
6. Thermal Management in EV Battery and Fuel Cell System
7. Design of Heat Transfer Equipment
8. HVAC Systems
9. Advanced Heat Transfer Lab
10. CFD lab

Honors	ADVANCED MECHANICS OF SOLIDS (Machine Design)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the concept of theory of elasticity equations for solving various engineering problems
2. To study the failure modes of different structural members.
3. To analyse the internal stresses in curved beams and beams subjected to un-symmetrical bending.
4. To understand the deformations and stresses in non-circular cross section members with torsional loading.
5. To analyse the contact stresses.

UNIT – 1

THEORIES OF STRESS AND STRAIN: Definition of stress at a point, stress notation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains, strain of a volume element, small displacement theory. Stress –strain temperature relations, Elastic response of a solid, Hooke's Law, isotropic elasticity, anisotropic elasticity, initiation of Yield, Yield criteria.

UNIT – 2

FAILURE CRITERIA: Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles $N > 10^6$, buckling. Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

UNIT – 3

UNSYMMETRICAL BENDING: Bending stresses in Beams subjected to Non symmetrical bending; Deflection of straight beams due to non-symmetrical bending.

CURVED BEAM THEORY: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.

UNIT – 4

TORSION : Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section ;Hollow thin wall torsion members ,Multiply connected Cross Section.

UNIT – 5

CONTACT STRESSES: Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

TEXT BOOKS:

1. Advanced Mechanics of materials by Boresi& Sidebottom-Wiely International.
2. Theory of elasticity by Timoschenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd Edition
3. Advanced Mechanics of Solids, L.S Srinath

REFERENCE BOOKS:

1. Advanced strength of materials by Den Hortog J.P.
2. Theory of plates – Timoshenko.
3. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia
4. Strength of materials by Sadhu Singh

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

CO1: Calculate stresses in the machine components and analysing the failure modes.

CO2: Identify the failure modes of different structural members and applying various energy methods for statically determinant and indeterminate structures

CO3: Calculate bending stresses in curved beams and beams subjected to non-symmetrical bending

CO4: Calculate torsional stresses in circular and non-circular cross section members and multi walled thin walled tubes

CO5: Calculate and analyse contact stresses when two bodies are in contact.

Honors	MECHANICAL VIBRATIONS AND ACOUSTICS (Machine Design)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To impart the basic fundamental knowledge to compute the properties of complex structures to evaluate the overall characteristics in design systems.
2. To imbibe the computational knowledge to find the natural frequencies and mode shapes of various degree of freedom systems to analyse vibration parameters.
3. To disseminate the practical knowledge to solve the real time problems in the field sound and noise measurement.

UNIT – 1

INTRODUCTION: Relevance of and need for vibrational analysis – Basics of SHM - Mathematical modelling of vibrating systems - Discrete and continuous systems - single-degree freedom systems - free and forced vibrations, damped and undamped systems.

UNIT – 2

MULTI DEGREE FREEDOM SYSTEMS: Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes - Matrix methods of solution- normal modes - Orthogonality principle-Energy methods, Eigen values and Eigen vectors

UNIT – 3

CONTINUOUS SYSTEMS: Torsional vibrations – Longitudinal vibration of rods - transverse vibrations of beams - Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to non-linear and random vibrations.

UNIT – 4

BASICS OF ACOUSTICS: Speed of Sound, Wavelength, Frequency, and Wave Number, Acoustic Pressure and Particle Velocity, Acoustic Intensity and Acoustic Energy Density, Spherical Wave propagation, Directivity Factor and Directivity Index, Levels and the Decibel, Addition and subtraction of Sound levels, Octave Bands, Source ranking, Weighting network, Dosage.

UNIT – 5

NOISE MEASUREMENT AND CONTROL: Sound Level Meters, Intensity Level Meters, Octave Band Filters Acoustic Analyzers, Dosimeter, Measurement of Sound Power, Impact of noise on humans, sound absorption and insulation, Noise Sources, Noise control strategy.

TEXT BOOKS:

1. S.S.Rao, “Mechanical Vibrations ", 5th Edition, Prentice Hall, 2011.
2. M.L.Munjal, “Noise and Vibration Control”, World Scientific, 2013.

REFERENCES:

1. W.T. Thomson, M.D. Dahleh and C Padmanabhan, “Theory of Vibration with Applications”, 5th Edition, Pearson Education, 2008.
2. L.Meirovitch, “Elements of vibration Analysis", 2nd Edition, McGraw-Hill, New York, 1985.
3. Beranek and Ver, “Noise and Vibration Control Engineering: Principles and Applications”, John Wiley and Sons, 2006.
4. Randall F. Barron, “Industrial Noise Control and Acoustics”, Marcel Dekker, Inc., 2003.

WEB RESOURCES:

1. http://www.nptel.ac.in/courses/112103111
2. http://www.nptel.ac.in/courses/112103112

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

CO1: Explain and idealize the properties of complex structures into lumped parameter models for the overall vibration characteristics in design systems which require dynamical properties like damping, free and forced vibrations response.

CO2: Compute the natural frequencies and mode shapes of a multi degree of freedom system and explain the modal analysis of a vibrating system

CO3: Evaluate the vibration parameters of continuous/elastic body systems for natural frequencies and subsequent mode shapes

CO4: Make a practical experience of basics of sound, noise and vibration as well as their measurement and control strategies.

CO5: Describe the noise measurement by using transducers and able to assess occupational and environmental noise problems.

Honors	ADVANCED FINITE ELEMENT METHODS (Machine Design)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

1. The objective of this course is to learn advanced topics in finite element methods so that this tool can be used for analysis, design, and optimization of engineering systems. The course will focus on nonlinear structural analysis. Various nonlinearities in structural problems will be studied in the mathematical and numerical aspects.

UNIT – 1

FORMULATION TECHNIQUES: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT – 2

ONE-DIMENSIONAL ELEMENTS: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – 3

TWO DIMENSIONAL PROBLEMS: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

UNIT – 4

ISOPERIMETRIC FORMULATION: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle, Patch test.

FINITE ELEMENTS IN STRUCTURAL ANALYSIS: Static and dynamic analysis, Eigen value problems, and their solution methods, case studies using commercial finite element packages.

UNIT – 5

INTRODUCTION TO NON-LINEAR FINITE ELEMENT ANALYSIS (Syllabus from Ref. 3)

NONLINEAR MATERIAL PROBLEMS (Syllabus from Ref. 2): Introduction, General procedure for solutions of Non- linear Discrete Problems, Nonlinear Constitutive problems in solid mechanics. Non-linear elasticity, Plasticity.

GEOMETRICALLY NON-LINEAR PROBLEMS (Syllabus from Ref. 2)**:** General considerations.

TEXT BOOKS:

1. Chandrubatla & Belagondu, Finite element methods.
2. S.S. Rao ,The Finite Element Method in Engineering, Fifth Edition

REFERENCES:

1. 1.J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994.
2. Zienckiwicz O.C. Finite Element Method, McGraw-Hill,Third Edition, 1977.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996.

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

CO1: Apply Variational methods and weighted residual methods to solve governing equations of different engineering problems.

CO2: Derive elements matrices for one-dimensional elements and solve related engineering problems

CO3: Derive elements matrices for two-dimensional elements and solve related engineering problems

CO4: Apply the concepts of Iso parametric formulation for different finite elements. Solve free vibration problems and heat transfer problems

CO5: Explain the procedures to solve the problems involving material non-linearity and geometrical non-linearity.

Honors	PRODUCT DESIGN (Machine Design)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. Understanding of materials, processes, ergonomics, human behaviour and systems with reference to product design.
2. To develop conceptual thinking, and workshop and computer skills for modelling and simulation of a variety of individual and group projects ranging from basic to the complex.
3. To understand various risks involved through various techniques and perform reliability analysis.
4. To acquaint with different product testing procedures under thermal, vibration, electrical and combined environments.

UNIT – 1

PRODUCT DESIGN PROCESS: Design Process Steps, Morphology of Design. Problem Solving and Decision Making: Problem-Solving Process, Creative Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavioural Aspects of Decision Making, Decision Theory, Decision Matrix, Decision Trees.

MODELING AND SIMULATION: Triz, Role of Models in Engineering Design, Mathematical Modeling, Similitude and Scale Models, Computer Simulation, Geometric Modeling on Computer, Finite-Element Analysis.

UNIT – 2

PRODUCT MANAGEMENT: The operation of product management: Customer focus of product management, product planning process, Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle Life cycle theory and practice.

PRODUCT DEVELOPMENT: Managing new products, Generating ideas, Sources of product innovation, selecting the best ideas, the political dimension of product design, Managing the product launch and customer feedback.

PRODUCT MANAGERS AND MANUFACTURING: The need for effective relationships, 10The impact of manufacturing processes on product decisions, Prototype planning, Productivity potentials, Management of product quality, Customer service levels.

UNIT – 3

RISK AND RELIABILITY: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature.

UNIT – 4

PRODUCT TESTING; thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data.

UNIT – 5

DESIGN FOR MAINTAINABILITY: Maintenance Concepts and Procedures, Component Reliability, Maintainability and Availability, Fault Isolation in design and Self-Diagnostics. Product Design for Safety, Product Safety and User Safety Concepts, Examples of Safe Designs.

DESIGN STANDARDIZATION AND COST REDUCTION: Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization

TEXT BOOKS:

1. Engineering Design , George E. Dieter, McGRAW-HILL
2. Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer Verlag

REFERENCES:

1. The Product Management Handbook, Richard S. Handscombe, Mc.GRAW-HILL
2. New Product Design, Ulrich Eppinger
3. Product Design, Kevin Otto.

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

CO1: Apply creative thinking skills for idea generation
CO2: Translate conceptual ideas into clear sketches
CO3: Present ideas using IT application software and physical model
CO4: Able to identify causes of failure through fault free analysis and perform failure analysis
CO5: Test a product under thermal, vibration, electrical and combined environments.

Honors	GEOMETRIC MODELING (Machine Design)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Model the 3-D geometric information of machine components including assemblies, and automatically generate 2-D production drawings,
2. Understand the basic analytical fundamentals that are used to create and manipulate geometric model s in a computer program,
3. Improve visualization ability of machine components and assemblies before their actual fabrication t hrough modeling, animation, shading, rendering, lighting and coloring, Model complex shapes inclu ding freeform curves and surfaces,
4. Understand the possible applications of the CAD systems in motion analysis, structure analysis, opti mization, rapid prototyping, reverse engineering and virtual engineering Usefulscale CAD software systems designed for geometric modeling of machine components and au tomatic generation of manufacturing information.

UNIT–1: INTRODUCTION: Definition, Explicit and implicit equations, parametric equations.

UNIT–2: CUBIC SPLINES-1: Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four point form, reparametrization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves.

UNIT–3: BEZIER CURVES: Bernstein basis, equations of Bezier curves, properties, derivatives.
B-SPLINE CURVES: B-Spline basis, equations, knot vectors, properties, and derivatives.

UNIT–4: SURFACES: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.

UNIT–5: SOLIDS: Tricubic solid, Algebraic and geometric form.
SOLID MODELING CONCEPTS: Wire frames, Boundary representation, half space modeling, spatial cell, cell decomposition, classification problem.

TEXT BOOKS:

1. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
2. Elements of Computer Graphics by Roger & Adams Tata McGraw Hill.

REFERENCES:

1. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers

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

CO1: Derive parametric equations for simple geometric entities, formulate algebraic and geometric form of a cubic spline.
CO2: Derive equations for Bezier curve.
CO3: Derive equations for B-Spline curve
CO4: Derive parametric representation of analytic and synthetic surfaces
CO5: Understand and implement various schemes used for construction of solid models

Honors	ADVANCED MECHANISMS & ROBOTICS (Machine Design)	L	T	P	C
		3	0	0	3

COURSE OUTCOME:

1. The overall objective of this course is to learn how to analyze the motions of mechanisms, design mechanisms to have given motions, and analyze forces in machines. To find radius of curvature of polodes. In the field of Robotics and stimulate their interests in science and engineering through the participation of the entire engineering design process.

UNIT – 1

ADVANCED KINEMATICS OF PLANE MOTION- I: The Inflection circle; Euler – Savary Equation; Analytical and graphical determination of d_i; Bobillier's Construction; Collineastionaxis; Hartmann's Construction.

ADVANCED KINEMATICS OF PLANE MOTION - II: Polode curvature; Hall's Equation; Polode curvature in the four-bar mechanism; coupler motion; relative motion of the output and input links.

UNIT – 2

INTRODUCTION TO SYNTHESIS-GRAPHICAL METHODS - I: The Four bar linkage; Guiding a body through Two distinct positions; Guiding a body through Three distinct positions; The Roto center triangle ; Guiding a body through Four distinct positions; Burmester's curve.

INTRODUCTION TO SYNTHESIS-GRAPHICAL METHODS - II: Function generation-General discussion; Function generation: Overlay's method; Path generation: Roberts's theorem.

UNIT – 3

INTRODUCTION TO SYNTHESIS - Analytical Methods: Function Generation: Freudenstien's equation, Precision point approximation, Precision – derivative approximation; Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition; Method of components; Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link; Method of components.

UNIT – 4

MANIPULATOR KINEMATICS: D-H transformation matrix; Direct and Inverse kinematic analysis of Serial manipulators: Articulated, spherical& industrial robot manipulators- PUMA, SCARA, STANFORD ARM, MICROBOT

UNIT – 5

DIFFERENTIAL MOTIONS AND VELOCITIES: Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

TEXT BOOKS:

1. Jeremy Hirschhorn, Kinematics and Dynamics of plane mechanisms, McGraw-Hill, 1962.
2. L.Sciavicco and B.Siciliano, Modelling and control of Robot manipulators, Second edition, Springer -Verlag, London, 2000.
3. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines. E.W.P.Publishers.

REFERENCES:

1. Allen S.Hall Jr., Kinematics and Linkage Design, PHI, 1964.
2. J.E Shigley and J.J. Uicker Jr., Theory of Machines and Mechanisms, McGraw-Hill, 1995.
3. Joseph Duffy, Analysis of mechanisms and Robot manipulators, Edward Arnold,1980

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

CO1: Derive the Euler Savary equations and use Hartmann's construction to determine the centre of curvature.

CO2: Design four bar linkages in order that an entire body be guided through two, three, four or five distinct positions.

CO3: Apply the Freudenstein's equation to find the lengths of the links in a four-bar mechanism in order i) to correlate the motions of input and output links through a prescribed function ii) that a point on its floating link trace a path defined with respect to the fixed frame of reference

CO4: Write direct kinematic and indirect kinematic equations for robot manipulators using D-H parameters.

CO5: Write differential kinematic equations for robot manipulators.

Honors	ADVANCED MACHINE DESIGN (Machine Design)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To make the students learn about the selection of materials for various design criteria
2. To learn about the various failure theories
3. To gain knowledge about how to design component against fatigue
4. To study various surface failures
5. To learn about designing against creep along with the ergonomics

UNIT – 1

DESIGN PHILOSOPHY: Design process, Problem formation, Introduction to product design, various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity and Creative techniques, Material selection in machine design, design for safety and Reliability, concept of product design

UNIT – 2

FAILURE THEORIES: Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics Theory. Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles

UNIT – 3

FATIGUE FAILURE THEORIES: cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation.

UNIT – 4

SURFACE FAILURES: Surface geometry, mating surfaces, oil film and their effects, design values and procedures, adhesive wear, abrasive wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.

UNIT – 5

CREEP AND DAMPING: creep phenomenon, creep curve, creep parameters, time temperature parameters and life estimate, energy dissipation in materials.

HUMAN ENGINEERING CONSIDERATIONS: Ergonomics, Modern approaches in design, Ethics in engineering design, Ethical issues considered during engineering design process

TEXT BOOKS:

1. Machine Design an Integrated Approach by Robert L. Norton, Prentice-Hall New Jersey, USA.
2. Mechanical Engineering Design by J.E. Shigley and L.D. Mitchell published by McGraw Hill International Book Company, New Delhi.
3. Mechanical Behaviour of Materials- Norman E.Dowling, Stephen L. Kampe, Milo V.Kral Pearson publishers, 5th edition.

REFERENCES:

1. Fundamentals of machine elements by Hamrock, Schmid and Jacobian, 2nd edition, McGraw- Hill International edition.
2. Product design and development by Karl T. Ulrich and Steven D. Eppinger. 3rd edition, Tata McGraw Hill.
3. Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, Prentice Hall
4. Engineering Design / George E Dieter / McGraw Hill /2008
5. Fundamentals of machine elements/ Hamrock, Schmid and Jacobian/ 2nd edition /McGraw Hill International edition.

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

CO1: Analyse various design models and product design.
CO2: Identify the failure modes and various fatigue mechanisms of different machine components and life estimation.
CO3: Design the machine components against fatigue loads
CO4: Learn about surface failures.
CO5: Design the machine components against creep.

Honors	FRACTURE MECHANICS (Machine Design)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Students will have the knowledge of 2D and 3D field equations of elasticity, stress concentrations and Airy stress functions.
2. Students will have a fundamental understanding of linear-elastic fracture mechanics (LEFM), energy release rate; stress intensity factors (SIFs) and will be able to solve elementary LEFM-related problems.
3. Students will understand the crack-tip plasticity and elastic fracture and will be able to solve practical elastic plastic fracture problems using J-Integral methods
4. Students will become familiar with finite elements modeling of fracture problems, crack tip singularity elements, and evaluation of stress and strain at crack tips.
5. Students will be able to analyze stationary cracks and perform crack propagation in 2D linear-elastic mechanical components of arbitrary geometry, and determine SIF using SIF tables and commercially available finite element software.

UNIT – 1

INTRODUCTION: Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behaviour. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, the ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature.

UNIT – 2

GRIFFITHS ANALYSIS: Concept of energy release rate, G, and fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves.

LINEAR ELASTIC FRACTURE MECHANICS (LEFM). Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness.

UNIT – 3

ELASTIC-PLASTIC FRACTURE MECHANICS (EPFM).The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use.

UNIT – 4

FATIGUE: Definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodman's rule and Miners rule. Micro mechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction

UNIT – 5

CREEP DEFORMATION: The evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

TEXT BOOKS:

1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993.

REFERENCES:

1. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)
2. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials.
3. H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold, (1984).
4. S. Suresh, Fatigue of Materials, Cambridge University Press, (1998)
5. L.B. Freund and S. Suresh, Thin Film Materials Cambridge University Press,(2003).

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

CO1: Explain the concepts of types of failure of materials and the Fracture phenomenon in materials.

CO2: Explain Griffith's realization, Griffith's analysis and energy release rate and predict the crack growth response of linear elastic materials using LEFM

CO3: Characterize crack tip stresses and strains using the J-Integral concept

CO4: Estimate fatigue life using Goodman's rule and Miners rule. Describe mechanisms of fatigue damage.

CO5: Explain effect of creep on damage of materials and the concepts of types of failure of materials and the Fracture phenomenon in materials

Honors	**MECHANISMS AND ROBOTICS LAB (Machine Design)**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVE:

1. The course will develop overall background of the student in interdisciplinary robotic technology with emphasis on mechanical aspects. Mechanisms which can be used in robots, their characteristics, kinematic and dynamic analysis and design will be discussed in detail along with the issues, applications and implementation principles of industrial robotics.

LIST OF EXPERIMENTS

I. KINEMATICS AND DYNAMICS OF MECHANISMS LABORATORY

(Design the following mechanisms and simulate using CATIA Software /ADAMS Software)

1. A RRRR mechanism whose coupler curve will pass through 3 given point.
2. A RRRR mechanism whose coupler will guide a straight line segment through at least three given positions.
3. A RRRR mechanism whose input and output motion is coordinated at at least three given positions.
4. A RRRP mechanism whose coupler will guide a straight line segment through at least three given positions.
5. A RRRP mechanism whose input and output motion is coordinated at least two given positions
6. A RRRP mechanism whose input and output motion is coordinated at least three given positions.
7. A RRRR mechanism whose input and output motion is coordinated at least two given positions.
8. A RRRR mechanism whose coupler curve will pass through 4 given points.
9. A RRRR mechanism whose coupler curve will pass through 3 given points.

II. ROBOTICS LAB

Experiments:

1. To demonstrate Forward and inverse Kinematics of articulated robot
2. To program and perform the following operations by using an articulated robot.
   i. Pick and place operation
   ii. To traverse given path (for arc welding)

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

CO1: Write programs to perform the pick and place operations and trace a path for arc welding process using any articulated robot

CO2: Demonstrate the procedure for forward and inverse kinematic analysis any articulated robot

CO3: Design planar mechanisms using procedures for path generation and rigid body guidance and simulate the motions using ADAMS software.

Honors	**VIBRATIONS AND ACOUSTICS LAB (Machine Design)**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

1. Determine natural frequency, mode shapes and unbalance (static/dynamic) of mechanical systems.
2. Study the signature of common machinery faults such as unbalance & alignment.

LIST OF EXPERIMENTS:

1. Determination of damped natural frequency of vibration of the vibrating system with different viscous oils.
2. Determination of steady state amplitude of a vibratory system with base excitation.
3. Determination of natural frequency and mode shape of multi degree freedom system.
4. Whirling speed of a shaft
5. Diagnosis of Shaft Misalignment and its Effects using MFS
6. Static Balancing Studies of Rotary Systems using MFS
7. Experimental modal analysis of Beams (ME Scope).
8. Experimental modal analysis of plates (ME Scope).
9. Source directivity measurement
10. Sound power and intensity measurement
11. Sound absorption measurement by impedance tube
12. Sound transmission loss measurement by impedance tube
13. Outdoor Noise Measurements and Hemispherical Divergence

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

CO1: Estimate the damping coefficient of a viscous damper and its effect on the free vibration of a single degree of freedom system.

CO2: Perform forced vibration analysis of discrete and continuous systems using measurement instruments VFT

CO3: Demonstrate experimental modal analysis on different of beams and plates with variable boundary condition.

CO4: Identify the shaft misalignment and rotary unbalance using Machine fault simulator

CO5: Measure acoustic parameters and outdoor noise

Honors	ADVANCED FINITE ELEMENT METHODS (CAD/CAM)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

1. The objective of this course is to learn advanced topics in finite element methods so that this tool can be used for analysis, design, and optimization of engineering systems. The course will focus on nonlinear structural analysis. Various nonlinearities in structural problems will be studied in the mathematical and numerical aspects.

UNIT – 1

FORMULATION TECHNIQUES: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT – 2

ONE-DIMENSIONAL ELEMENTS: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – 3

TWO DIMENSIONAL PROBLEMS: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions.

HEAT TRANSFER PROBLEMS: Conduction and convection, examples: - two-dimensional fin.

UNIT – 4

ISOPARAMETRIC FORMULATION: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle, Patch test.

FINITE ELEMENTS IN STRUCTURAL ANALYSIS: Static and dynamic analysis, Eigen value problems, and their solution methods, case studies using commercial finite element packages.

UNIT – 5

Introduction to Non-linear finite element Analysis (Syllabus from Ref. 3)

Nonlinear Material Problems (Syllabus from Ref. 2)**:** Introduction, General procedure for solutions of Non- linear Discrete Problems, Nonlinear Constitutive problems in solid mechanics. Non-linear elasticity, Plasticity.

Geometrically Non-linear problems (Syllabus from Ref. 2): General considerations

TEXT BOOKS:

1. Chandrubatla & Belagondu, Finite element methods.
2. S.S. Rao ,The Finite Element Method in Engineering, Fifth Edition

REFERENCES:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994.
2. Zienckiwicz O.C. Finite Element Method, McGraw-Hill,Third Edition, 1977.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996.

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

CO1: Apply Variational methods and weighted residual methods to solve governing equations of different engineering problems.

CO2: Derive elements matrices for one-dimensional elements and solve related engineering problems

CO3: Derive elements matrices for two-dimensional elements and solve related engineering problems

CO4: Apply the concepts of Isoparametric formulation for different finite elements. Solve free vibration problems and heat transfer problems

CO5: Explain the procedures to solve the problems involving material non-linearity and geometrical non-linearity.

Honors	ADVANCED CAD (CAD/CAM)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Model the 3-D geometric information of machine components including assemblies, and automatically generate 2-D production drawings,
2. Understand the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program,
3. Improve visualization ability of machine components and assemblies before their actual fabrication th rough modeling, animation, shading, rendering, lighting and coloring, Model complex shapes includin g freeform curves and surfaces,
4. Understand the possible applications of the CAD systems in motion analysis, structure analysis, optim ization, rapid prototyping, reverse engineering and virtual engineerin
5. Use fullscale CAD software systems designed for geometric modeling of machine components and au tomatic generation of manufacturing information.

UNIT – 1

INTRODUCTION: Definition, Explicit and implicit equations, parametric equations.

UNIT – 2

CUBIC SPLINES-1: Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four point form, reparametrization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves.

UNIT – 3

BEZIER CURVES: Bernstein basis, equations of Bezier curves, properties, derivatives.
B-Spline Curves: B-Spline basis, equations, knot vectors, properties, and derivatives.

UNIT – 4

SURFACES: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.

UNIT – 5

SOLIDS: Tricubic solid, Algebraic and geometric form.
SOLID MODELING CONCEPTS: Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, classification problem.

TEXT BOOKS:

1. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
2. Elements of Computer Graphics by Roger & Adams Tata McGraw Hill.

REFERENCES:

1. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers

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

CO1: Derive parametric equations for simple geometric entities, formulate algebraic and geometric form of a cubic spline.

CO2: Derive equations for Bezier curve.

CO3: Derive equations for B-Spline curve

CO4: Derive parametric representation of analytic and synthetic surfaces

CO5: Understand and implement various schemes used for construction of solid models

Honors	ADVANCED CAM (CAD/CAM)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the fundamentals of computer-aided programming (APT, NC) and demonstrate their application in modern manufacturing.
2. To provide knowledge of various CNC tooling systems and adaptive control technologies used in precision machining.
3. To understand the concept, structure, and implementation of post processors for CNC machines.
4. To explore the hardware and software fundamentals of microcontrollers and programmable logic controllers (PLCs), and their applications in CNC automation.
5. To impart knowledge about computer-aided process planning, inspection, and testing methods including the role of AI and expert systems in CAD/CAM systems.

UNIT – 1 **COMPUTER AIDED PROGRAMMING:** General information, APT programming, Examples Apt programming problems (2D machining only). NC programming on CAD/CAM systems, the design and implementation of post processors .Introduction to CAD/CAM software, Automatic Tool Path generation.

UNIT – 2 **TOOLING FOR CNC MACHINES:** Interchangeable tooling system, preset and qualified toois, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers. DNC Systems and Adaptive Control: Introduction, type of DNC systems, advantages arid disadvantages of DNC, adaptive control with optimization, Adaptive control with constrains, Adaptive control of machining processes like turning, grinding.

UNIT – 3 **POST PROCESSORS FOR CNC:** Introduction to Post Processors: The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP — based- Post Processor: Communication channels and major variables in the DAPP — based Post Processor, th creation of a DAPP — Based Post Processor.

UNIT – 4 **MICRO CONTROLLERS:** Introduction, Hardware components, I/O pins, ports, external memory: counters, timers and serial data I/O interrupts. Selection of Micro Controllers Embedded Controllers, Applications and Programming of Micro Controllers. Programmable Logic Controllers (PLC' s): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines.

UNIT – 5 **COMPUTER AIDED PROCESS PLANNING:** Hybrid CAAP System, Computer Aided Inspection and quality control, Coordinate Measuring Machine, Limitations of CMM, Computer Aided Testing, Optical Inspection Methods, Artificial Intelligence and expert system: Artificial Neural Networks, Artificial Intelligence in CAD, Experts systems and its structures.

TEXT BOOKS:

1. Computer Control of Manufacturing Systems / Yoram Koren / Mc Graw Hill. 1983.
2. CAD/CAM Principles and Applications, P.N.Rao, TMH

REFERENCES:

1. Computer Aided Design Manufacturing – K. Lalit Narayan, K. Mallikarjuna Rao and M.M.M. Sarcar, PHI, 2008.
2. CAD / CAM Theory and Practice,/ Ibrahim Zeid,TMH
3. CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age
4. Principles of Computer Aided Design and Manufacturing, Farid Amirouche, Pearson
5. Computer Numerical Control Concepts and programming, Warren S Seames, Thomson.

COURSE OUTCOMES: By the end of this course, the student will be able to:

CO1: Develop and analyze APT and NC programs for 2D machining and generate tool paths using CAD/CAM systems.

CO2: Identify and apply appropriate CNC tooling systems, and evaluate the benefits of DNC systems and adaptive control in machining.

CO3: Design and implement post processors for CNC machines and explain the working of DAPP-based post processor systems.

CO4: Describe the architecture and working of microcontrollers and PLCs and develop basic programs for CNC machine control applications.

CO5: Apply computer-aided process planning techniques and utilize inspection systems such as CMM and optical tools; understand the integration of AI and expert systems in CAD/CAM environments.

Honors	OPTIMIZATION AND RELIABILITY (CAD/CAM)	L	T	P	C
		3	0	0	3

Course Objectives

- To impart the knowledge on classical optimization techniques
- To solve engineering problems using numerical methods for optimization
- To understand genetic algorithms and genetic programming
- To get knowledge about applications of optimization techniques in design and manufacturing systems
- To gain knowledge about the reliability concepts.

UNIT – 1 **Classical Optimization Techniques:** Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn- Tucker conditions, merits and demerits of classical optimization technique.

UNIT – 2 **Numerical Methods for Optimization:** Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods.

UNIT – 3 **Genetic Algorithm (GA) :** Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

Multi-Objective GA: Pareto's analysis, non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi- objective problems.

UNIT – 4 **Applications of Optimization in Design and Manufacturing Systems:** Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

UNIT – 5 **Reliability:** Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis.

TEXTBOOKS:

1. Optimization for Engineering Design – Kalyan Moy Deb, PHI Publishers.
2. Engineering Optimization – S. S. Rao, New Age Publishers.
3. Reliability Engineering by L. S. Srinath.
4. Multi objective genetic algorithm by Kalyan Moy Deb, PHI Publishers.

REFERENCE BOOKS:

1. Genetic algorithms in Search, Optimization, and Machine learning – D. E. Goldberg, Addison-Wesley Publishers.
2. Multi objective Genetic algorithms - Kalyan Moy Deb, PHI Publishers.
3. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers.
4. An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009
5. Reliability Theory and Practice by I Bazovsky, Dover Publications, 2013

COURSE OUTCOMES: By the end of this course, the student will be able to:

CO1: Apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems.

CO2: Apply numerous numerical methods to solve the engineering problems for optimization.

CO3: Apply GA and GP optimization methods to solve the differential equations and analyse the differences between GA and GP.

CO4: Apply optimization techniques to design and manufacturing systems for the optimisation of process parameters.

CO5: Understand and apply major concepts of reliability in engineering design for analysing the statistical experiments leading to reliability modelling.

Honors	MECHANICAL BEHAVIOUR OF MATERIALS (CAD/CAM)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To teach students the mechanical properties and behaviour of materials.
- To develop the student's ability to understand and apply the various theories of stress and strain in three dimensions along with the applications.
- To train students to identify, formulate, and solve engineering problems involving resistance to plastic deformation, fatigue, and fracture.

UNIT – 1 Elasticity in metals, mechanism of plastic deformation, slip and twinning, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behaviour, super plasticity, Yield criteria: Von-mises and Tresca criteria.

UNIT – 2 Griffth's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps.

UNIT – 3 Fatigue, fatigue limit, features of fatigue fracture, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and Paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis. Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep.

UNIT – 4 Dual Phase Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallics, Ni and Ti Aluminides.

Processing and applications of Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials, High Entropy alloys.

UNIT – 5 Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings; Structure, Properties and Applications of Engineering Polymers; Advanced Structural Ceramics- WC, TiC, TaC, $A1_2O_3$, SiC, Si_3N_4, CBN and Diamond – properties, Processing and applications.

TEXTBOOKS:

1. Mechanical Behavior of Materials/ Thomas H. Courtney/ McGraw Hill/2nd Edition/2000.
2. Mechanical Metallurgy/George E. Dieter/McGraw Hill, 1998.
3. Material Science and Engineering/William D Callister/John Wiley and Sons.

REFERENCE BOOKS:

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2. Engineering Materials Technology/James A Jacob Thomas F Kilduff/Pearson.
3. Material Science and Engineering/William D Callister/John Wiley and Sons.
4. Introduction to Ceramics, 2nd Edition by W. David Kingery, H. K. Bowen, Donald R. Uhlmann.

COURSE OUTCOMES: By the end of this course, the student will be able to:

- **CO1:** Describe effects of elasticity and plastic deformation on mechanical properties of engineering materials subjected to various static and dynamic loadings.
- **CO2:** Apply the Griffith's theory to different materials to analyse the fracture toughness and stress intensity factor on their performance.
- **CO3:** Analyse the effect of various metallurgical properties on the engineering materials subjected to fatigue and creep.
- **CO4:** Identify modern metallic materials for the various engineering applications.
- **CO5:** Describe the properties, processing and applications of polymer–matrix and ceramic–matrix composites.

Honors	INDUSTRIAL ROBOTICS AND AUTOMATION (CAD/CAM)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce Robotics and Automation including robot classification, design and selection, analysis and applications in industry.
- To provide information on various types of end effectors, their design, interfacing and selection.
- To provide the details of operations for a variety of sensory devices that are used on robot.
- To familiarize the basic concepts of transformations performed by robot, to perform kinematics and gain knowledge on programming of robots.

UNIT – 1 **Introduction**: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation scheme, work volume, robot drive systems, control systems and dynamic performance, precision of movement.

Control System and Components: basic concepts and motion controllers, control system analysis, robot actuation and feedback components.

Sensors: Desirable features, tactile, proximity and range sensors, uses sensors in robotics. Positions sensors, velocity sensors, actuators, power transmission systems

UNIT – 2 **Motion Analysis and Control:** Manipulator kinematics, position representation, forward and inverse transformations, homogeneous transformations, manipulator path control, robot arm dynamics, configuration of a robot controller. Robot joint control design.

UNIT – 3 **End Effectors:** Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.

Machine Vision: Functions, Sensing and Digitizing-imaging devices, Lighting techniques, Analog to digital single conversion, image storage: Image processing and Analysis-image data reduction, Segmentation, feature extraction, Object recognition. Training the vision system, Robotic application.

UNIT – 4 **Robot Programming:** Lead through programming, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching, capabilities and Limitations of lead through methods.

Robot Languages: Textual robot Languages, Generations of robot programming languages, Robot language structures, Elements and function.

UNIT – 5 **Robot Cell Design and Control**: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Interlocks, Error detection, Work cell controller.

Robot Applications: Material transfer, Machine loading/unloading, Processing operation, Assembly and Inspection, Future Application

TEXTBOOKS:

1. Industrial Robotics / Groover M P /Pearson Edu.
2. Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition.

REFERENCE BOOKS:

1. Robotics / Fu K S/ McGraw Hill.
2. Robotic Engineering / Richard D. Klafter, Prentice Hall.
3. Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.
4. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley .
5. Introduction to Robotics by SK Saha, The McGrah Hill Company, 6th, 2012.
6. Robotics and Control / Mittal R K &Nagrath I J / TMH.

Course Outcomes: By the end of this course, the student will be able to:

CO1: Figure out, demonstrate the terminologies related to robotics technology, hardware components and apply logic for selection of robotic sub systems and systems.

CO2: Apply the spatial transformations to evaluate forward Kinematics, inverse kinematics and Jacobian for serial and parallel robots.

CO3: Demonstrate knowledge of end effectors, design considerations and the interpretation of data from data acquisition systems.

CO4: Apply the fundamental knowledge of robot programming methods to write small programs for desired application.

CO5: Apply and design robot cell layouts and analyse their applications in various fields.

Honors	MATERIAL CHARACTERISATION TECHNIQUES (CAD/CAM)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To provide an introduction about the materials characterization and its importance.
- To impart the knowledge about different types of characterization techniques and their use in reviewing the crystal structure.
- To provide the application knowledge of the properties and behaviour of x-rays and their use in materials characterization and use of TEM and SEM.

UNIT – 1 **Optical Microscopy**– Introduction, Optical principles, Instrumentation, Specimen preparation-metallographic principles, Imaging Modes, Applications and Limitations.
Transmission Electron Microscopy (TEM)– Introduction, Instrumentation, Specimen preparation-pre thinning, final thinning, Image modes- mass density contrast, diffraction contrast, phase contrast, Applications and Limitations.

UNIT – 2 **Scanning Electron Microscopy (SEM)**– Introduction, Instrumentation, Contrast formation, Operational variables, Specimen preparation, imaging modes, Applications and Limitations.
X- Ray Diffraction (XRD)– Introduction, Basic principles of diffraction, X - ray generation, Instrumentation, Types of analysis, Data collection for analysis, Applications and Limitations.

UNIT – 3 **Scanning Probe Microscopy (SPM) & Atomic Force Microscopy (AFM)**– Introduction, Instrumentation, Scanning Tunnelling Microscopy-Basics, probe tips, working environment, operational modes, Applications and Limitations.
Electron Probe Micro Analyser (EPMA) – Introduction, Sample preparation, Working procedure, Applications and Limitations.

UNIT – 4 **X-Ray Spectroscopy for Elemental Analysis**– Introduction, Characteristics of X- rays, X- ray Fluorescence Spectrometry, Wavelength Dispersive Spectroscopy-Instrumentation, Working procedure, Applications and Limitations.

UNIT – 5 **Energy Dispersive Spectroscopy** – Instrumentation, working procedure, Applications and Limitations.
Thermal Analysis– Instrumentation, experimental parameters, Different types used for analysis, Differential thermal analysis, Differential Scanning Calorimetry. Basic principles, Instrumentation, working principles, Applications and Limitations.

TEXTBOOKS:

1. Yang Leng: Materials Characterization-Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia) Pte Ltd., 2008.
2. Robert F. Speyer: Thermal Analysis of Materials, Marcel Dekker Inc., New York, 1994.
3. V. T. Cherapin and A. K. Mallik: Experimental Techniques in Physical Metallurgy, Asia Publishing House, 1967.
4. ASM Handbook: Materials Characterization, ASM International, 2008.

COURSE OUTCOMES: By the end of this course, the student will be able to:

CO1: Apply appropriate characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials

CO2: Choose and apply appropriate electron microscopy techniques to investigate microstructure of materials at high resolution.

CO3: Apply X-ray diffraction techniques to determine crystal structure of specimen and estimate its crystallite size and stress.

CO4: Select an appropriate spectroscopic technique to analyse the vibrational/ electronic transitions to estimate parameters like energy band gap, elemental concentration, etc.

CO5: Apply thermal analysis techniques to determine thermal stability and thermodynamic transitions of the specimen.

Honors	PRODUCT DESIGN AND DEVELOPMENT (CAD/CAM)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To direct the learners to use their creativity, design thinking, and design process to bring new ideas, products, experiences, and value to companies, communities, and people.
- To learn a wide range of hand skills and processes using soft and hard materials, digital design skills in 2-D graphics, and 3-D modelling skills to create well-conceived and executed objects and products that service a human need.

UNIT – 1 **Introduction**: Classification/Specifications of Products, Product life cycle. Product mix, Introduction to product design, Modern product development process, Innovative thinking.

UNIT – 2 **Morphology of design & Conceptual Design**: Generation, selection & embodiment of concept. Product architecture, Industrial design: process, need, Robust Design: Taguchi Designs & DOE, Design Optimization.

UNIT – 3 **Design for Manufacturing & Assembly**: Methods of designing for Manufacturing and assembly, Designs for Maintainability, Designs for Environment, Product costing, Legal factors and social issues, Engineering ethics and issues of society related to design of products. Value Engineering / Value Analysis: Definition. Methodology, Case studies.

UNIT – 4 **Economic Analysis**: Qualitative & Quantitative Ergonomics/Aesthetics, Gross human autonomy, Anthropometry, Man-Machine interaction, Concepts of size and texture, colour. Comfort criteria, Psychological & Physiological considerations.

UNIT – 5 **Creativity Techniques**: Creative thinking, conceptualization, brainstorming, primary design, drawing, simulation, detail design. Concurrent Engineering, Rapid prototyping, Tools for product design – Drafting/Modelling software, CAM Interface, Patents & IP Acts. Overview, Disclosure preparation.

TEXTBOOKS:

1. Karl T Ulrich, Steven D Eppinger , " Product Design & Development." Tata McGraw-Hill New Delhi 2003.
2. David G Ullman, "The Mechanical Design Process." McGraw-Hill Inc Singapore 1992.
3. N J M Roozenberg , J Ekels , N F M Roozenberg " Product Design Fundamentals and Methods", John Willey & Sons 1995.

REFERENCE BOOKS:

1. Kevin Otto & Kristin Wood Product Design: "Techniques in Reverse Engineering and New Product Development." 1/e 2004, Pearson Education New Delhi.
2. L D Miles "Value Engineering."
3. Hollins B & Pugh S "Successful Product Design." Butter worths London.
4. Baldwin E N &Neibel B W "Designing for Production." Edwin Homewood Illinois.
5. Jones J C "Design Methods." Seeds of Human Futures. John Willey New York.
6. Bralla J G "Handbook of Product Design for Manufacture, McGraw-Hill, New York.

COURSE OUTCOMES: By the end of this course, the student will be able to:

CO1: Apply the product design and development process to manage the development of modern product development process from the new idea.

CO2: Know the principles of product architecture, industrial design and design for manufacturing principles in new product development.

CO3: Learn the principles of product architecture and the importance of DFM, value engineering and Analysis principles for new product development.

CO4: Analyze the qualitative &quantitative economic ergonomics to evaluate the new product development.

CO5: Learn about patenting.

Honors	CAD/CAM LAB (CAD/CAM)	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To learn software like Z-Cast Pro, AFDEX and NX-11
- To apply basic concept to drawing and editing to develop 3D Modelling.
- To make 3D modelling, Assembling, modification & manipulation along with detailing.
- To learn and prepare the part programming for the simulation of various machining processes.

CYCLE – I:

Casting and Metal Forming processes:

Simulate and analyses the following processes using a software package.

a) Sand Casting
b) Die Casting
c) Cyclic Casting
d) Two stage Cold Forging
e) Multi-stage Cold Forging
f) Two stage Hot Forging
g) Trimming
h) Piercing
i) Drawing
j) Extrusion

CYCLE – II:

CAM Packages:

a) To write and simulate the plain turning and facing part program for a given component.
b) To write and simulate the taper turning part program for a given component.
c) To write and simulate the step turning part program for a given component.
d) To write and simulate the circular interpolation part program for a given component.
e) To write and simulate the threading part program for a given component.
f) To write and simulate the face milling part program for a given component.
g) To write and simulate the contour milling part program for a given component.
h) To write and simulate the pocket drilling part program for a given component.

Course Outcomes: By the end of this course, the student will be able to:

CO1: Simulate and analyse different Casting processes using a software packages- Z-Cast Pro

CO2: Simulate and analyse different Forging processes using a software package- AFDEX

CO3: Simulate and analyse different Forming processes using a software package- AFDEX

CO4: Write and simulate the manual part programming of lathe, drilling and milling operations using G & M codes- NX11

CO5: Write and simulate the manual part programming drilling and milling operations using G & M codes- NX11

Honors	ROBOTICS AND AUTOMATION LAB (CAD/CAM)	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To develop the student's knowledge in various robot structures and their workspace, skills in performing spatial transformations, analysis skills associated with trajectory planning and robot control.

The following robot programming exercises are to be performed on a robot:

a) Operator control and jogging in the world coordinate system; Jogging in the tool coordinate system
b) Tool calibration – pen; Tool calibration – gripper, 2-point method
c) Jogging in the base coordinate system; Base calibration – table, 3-point method
d) Executing robot programs
e) CP motion and approximate positioning
f) Path contour with spline block
g) Motion programming with spline
h) Gripper programming – plastic panel and Pen
i) Jogging with a fixed tool; Calibrating an external tool and robot-guided work piece
j) Motion programming with external TCP
k) Programming a subprogram call
l) Use of loops, Constant velocity range and conditional stop and Automatic External.
m) Demonstrate the use of a robot for automation of pick and place and arc and spot-welding processes
n) Demonstrate automation of machining processes using a Flexible Manufacturing system

Course Outcomes: By the end of this course, the student will be able to:

CO1: Demonstrate the functional aspects of various subcomponents of robot in the workspace environment.

CO2: Write and simulate trajectory planning in performing various operations like Pick and Place. Loading and unloading, etc.

Honors	ADVANCED HEAT TRANSFER (Thermal Engineering)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. Develop a strong foundation in conduction heat transfer and introduce various methods for mathematical formulation and problem-solving.
2. Provide analytical techniques for solving transient and steady-state heat conduction problems in various geometries.
3. Explore the fundamentals of convection heat transfer, including forced and free convection, with exact and approximate solutions for internal and external flows.
4. Introduce the theory and application of heat exchangers with both LMTD and NTU methods.
5. Impart a comprehensive understanding of radiation heat transfer between surfaces and in enclosures, including radiation in participating media.

UNIT – 1 **INTRODUCTION:** Review of basic concepts of conduction. Method of formulation: lumped, differential and integral formulations. Initial and boundary conditions
TRANSIENT HEAT CONDUCTION: Differential formulation of transient heat conduction problems with time independent boundary conditions in different geometries and their analytical solutions: method of separation of variables, method of Laplace transforms. Differential formulation of steady two-dimensional heat conduction problems in different geometries and their analytical solutions: method of separation of variables, method of superposition.

UNIT – 2 **CONVECTION:** Review of basics concepts and different non-dimensional numbers; Three-dimensional differential energy equation in Cartesian and Cylindrical coordinates.
FORCED CONVECTION: External flow: External laminar forced convection for flow over a semi-infinite flat plate; Integral and similarity solutions for different thermal boundary conditions; Viscous dissipation effects in laminar boundary layer flow over a semi-infinite flat plate.

UNIT – 3 **FORCED CONVECTION: Internal flow:** Internal laminar forced convection: exact solutions to solution for rectilinear flows, axisymmetric rectilinear flows, and axisymmetric torsional flows; Solution for fully developed flow through a pipe with different thermal boundary conditions, Flow in the thermal entrance region of a circular duct: Graetz solution for uniform velocity, Graetz solution for parabolic velocity profile.

UNIT – 4 **FREE CONVECTION:** External laminar free convection: integral and similarity solutions for semi-infinite vertical plate with different thermal boundary conditions
HEAT EXCHANGERS: Classification, LMTD and NTU methods.

UNIT – 5 **RADIATION:** Basic definitions, Radiant energy exchange between two differential area elements. Radiation shape factor: properties and algebra. Radiant energy exchange between two surfaces. Reradiating surfaces. Radiation Shield.
RADIANT ENERGY EXCHANGE IN ENCLOSURES: enclosures composed of black and diffuse-grey surfaces. Electrical network analogy. Radiation in participating media: Radiative heat transfer equation, Radiant energy exchange in presence of absorbing and transmitting media, radiant energy exchange in presence of transmitting, reflecting, and absorbing media.

TEXTBOOKS:

1. Myers, G.E., 1971, Analytical methods in conduction heat transfer, McGraw Hill, New York.
2. Kays, W. M. and Crawford, M. E., 2005, Convective Heat and Mass Transfer, 3rd ed., McGraw Hill.
3. Howell, J.R., Mengüc, M.P., Daun, K., and Siegel, R., 2020, Thermal radiation heat transfer, CRC press, New York.

REFERENCE BOOKS:

1. Arpaci, V.S.,1966, Conduction heat transfer, Addison-Wesley,Reading, Massachusetts.
2. Janna, W.S., 2018, Engineering heat transfer, CRC press, Boca Raton.
3. Fundamentals of Heat and Mass Transfer,5th Ed. / Frank P. Incropera/John Wiley
4. Sparrow, E.M., 2018, Radiation heat transfer, Routledge, New York.
5. Modest, M.F., and Mazumder, S., 2021, Radiative heat transfer, Academic press, New York.
6. Introduction to Heat Transfer/SK Som/PHI
7. Oostuizen, P. H. and Naylor, D., 1999, Introduction to Convective Heat Transfer Analysis, International ed., McGraw Hill.
8. Kakac, S. Yener, Y., and Pramuanjaroenkij. A., 2014, Convective Heat Transfer, 3rd ed., CRC Press

COURSE OUTCOMES: By the end of this course, the student will be able to:

CO1: Formulate and solve heat conduction problems using lumped, differential, and integral approaches with appropriate initial and boundary conditions.

CO2: Analyze and derive analytical solutions for transient and steady-state two-dimensional heat conduction problems using methods like separation of variables and Laplace transforms.

CO3: Apply fundamental principles and governing equations of forced and free convection to analyze thermal behavior in internal and external laminar flows.

CO4: Evaluate heat exchanger performance using both the Log Mean Temperature Difference (LMTD) and the Number of Transfer Units (NTU) methods for various configurations.

CO5: Compute radiant heat exchange between surfaces and within enclosures, using shape factors, network analogies, and radiative heat transfer equations in participating media.

Honors	ADVANCED FLUID MECHANICS (Thermal Engineering)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. Develop a deep understanding of the theoretical foundations of inviscid and incompressible fluid flow, including kinematics and flow descriptions.
2. Introduce the Navier-Stokes equations and provide analytical solutions for fundamental viscous flow problems.
3. Explain boundary layer theory and its practical implications in external flow, including drag prediction and flow separation.
4. Present the fundamentals of turbulence modeling and time-averaged equations, including models for velocity distribution.
5. Provide a rigorous understanding of internal flows and compressible fluid flow phenomena, including shock waves and supersonic aerodynamics.

UNIT – 1 **INVISCID FLOW OF INCOMPRESSIBLE FLUIDS:** Lagrangian and Eulerian descriptions of fluid motion, Path lines, Streamlines, Streak lines, stream tubes – velocity of a fluid particle, types of flows, Equations of three-dimensional continuity equation, Stream and Velocity potential functions, Condition for irrotationality, circulation & vorticity, accelerations in Cartesian systems, normal and tangential accelerations.

UNIT – 2 **VISCOUS FLOW:** Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain cases: Plain Poiseuille flow, Couette flow with and without pressure gradient, Hagen Poiseuille flow.

UNIT – 3 **BOUNDARY LAYER CONCEPTS :** Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory, Boundary layer thicknessfor flow over a flat plate, Blasius solution – Approximate solutions, Von-Karman momentum integral equation for laminar boundary layer — Expressions for local and mean drag coefficients for different velocity profiles.

UNIT – 4 **INTRODUCTION TO TURBULENT FLOW:** Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations, Prandtl Mixing Length Model, Universal Velocity Distribution Law: Van Driest Model, k-epsilon model, boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders.

INTERNAL FLOW: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth and rough Pipes – Roughness of Commercial Pipes – Moody's diagram.

UNIT – 5 **COMPRESSIBLE FLUID FLOW:** Thermodynamic basics – Equations of continuity, Momentum and Energy, Acoustic Velocity, Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State, Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Raleigh Lines– Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag.

TEXTBOOKS:

1. L. Victor Steeter, Fluid Mechanics, 10th Edition, Tata McGraw-Hill, 1996.
2. Frank M. White, Fluid Mechanics, 8th Edition, McGraw-Hill Education, 2016.

REFERENCE BOOKS:

1. Modi and Seth, Fluid Mechanics and Machines, Standard Book House
2. Pijush K. Kundu, Ira M. Cohen, and David R. Dowling, Fluid Mechanics, 5th Edition, Elsevier
3. David R. Dowling, Ira M. Cohen, and Pijush K. Kundu, Fluid Mechanics, 5th Edition, Cengage Learning, 2011
4. William S Janna, Fluid Mechanics, CRC Press, 3rd Edition, 2019
5. Y.A Cengel and J.M Cimbala, Fluid Mechanics, MGH, 4th Edition, 2018
6. Schlichting H, Boundary Layer Theory, Springer Publications, 9th Edition, 2017
7. Shapiro, Dynamics & Theory and Dynamics of Compressible Fluid Flow, 2nd Edition
8. William F. Hughes & John A. Brighton, Fluid Dynamics, TMH, 2nd Edition, 2018
9. K.L Kumar, Fluid Mechanics, S Chand & Co., 6th Edition, 2019

Course Outcomes: By the end of this course, the student will be able to:

- **CO1:** Describe fluid motion using both Lagrangian and Eulerian frameworks, and analyze streamlines, pathlines, streaklines, and stream tubes; derive and apply continuity equations for incompressible flows.
- **CO2:** Derive and solve the Navier-Stokes equations for classical viscous flow problems such as Couette and Poiseuille flows in various geometries.
- **CO3:** Apply boundary layer theory, including Blasius and Von Karman solutions, to calculate boundary layer thickness and drag coefficients over flat plates.
- **CO4:** Understand the fundamentals of turbulent flow, apply turbulence models (e.g., mixing length, k-ε model), and analyze boundary layer separation and vortex shedding. And Evaluate internal flows through smooth and rough pipes using velocity distribution equations, friction factors, and interpret results using Moody's diagram.
- **CO5:** Analyze compressible fluid flows using the concepts of Mach number, shock waves, and flow regimes; apply equations for nozzles, diffusers, and flow with area variation (Fanno and Rayleigh lines).

Honors	ADVANCED THERMODYNAMICS & COMBUSTION (Thermal Engineering)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. Provide a comprehensive understanding of availability (exergy), irreversibility, and second-law efficiencies in thermal systems.
2. Develop proficiency in thermodynamic property relations and mathematical formulations involving Maxwell relations, fugacity, and generalized charts.
3. Introduce thermodynamic principles governing gas mixtures and psychrometric processes, with applications to real and ideal gas mixtures.
4. Explore the behavior and equilibrium conditions of real liquid mixtures and the criteria for phase and chemical equilibrium.
5. Apply thermodynamic laws to chemical reactions and combustion processes, including equilibrium constant calculations and adiabatic flame temperature analysis.

UNIT – 1 **AVAILABILITY AND IRREVERSIBILITY:** Quality of Energy, available and unavailable energy, availability, surroundings work, reversible work and irreversibility, availability in a closed system, availability in a SSSF process in an open system, second law efficiencies of processes, second law efficiency of cycles and exergy balance equations.

UNIT – 2 **THERMODYNAMIC PROPERTY RELATIONS:** Helmholtz and Gibbs Functions, two Mathematical Conditions for Exact Differentials, Maxwell Relations, Clapeyron Equation, Relations for Changes in Enthalpy, Internal Energy and Entropy, Specific Heat Relations, Generalized Relations/Charts for Residual Enthalpy and Entropy, Gibbs Function at zero Pressure: A Mathematical Anomaly, Fugacity, Fugacity Coefficient and Residual Gibbs Function, The Joule, Thomson Coefficient and Inversion Curve, Thermodynamic similarity.

UNIT – 3 **GAS MIXTURES:** Mixtures of ideal Gases, Gas-Vapor Mixtures, Application of First Law to Psychometric Processes, Real Gas Mixtures.

THERMODYNAMIC RELATIONS FOR REAL MIXTURES: Partial Properties, Relation for Fugacity and Fugacity Coefficient in Real Gas Mixtures, Relations for Activity and Activity Coefficient in Real Liquid Mixtures/Solutions.

UNIT – 4 **PHASE EQUILIBRIUM: VAPOR LIQUID EQUILIBRIUM OF MIXTURES:** Phase Diagrams for Binary Mixtures, Vapor, Liquid Equilibrium in Ideal Solutions, Criteria for Equilibrium, Criterion for phase Equilibrium, Calculation of Standard State Fugacity of Pure Component, Vapor Liquid Equilibrium at Low to Moderate Pressures, Determination of Constants of Activity Coefficient Equations, Enthalpy Calculations.

UNIT – 5 **CHEMICAL REACTIONS AND COMBUSTION:** Thermochemistry, Measures of Composition in Chemical Reactions, Application of First Law of Thermodynamics to chemical Reactions, the Combustion Process-Standard Heat/Enthalpy of Combustion, Reactions at actual Temperatures, adiabatic Flame Temperature, Entropy Change of Reacting Systems, Application of second Law of Thermodynamics to chemical Reactions, chemical equilibrium-Advancement of Chemical Reactions, Equilibrium Criterion in Chemical Reactions, equilibrium Constant and Law of Mass Action, Equilibrium Constant for Gas Phase Reactions in the standard state.

TEXTBOOKS:

1. P.K.Nag, Basic and Applied Thermodynamics, 2nd Edition, Tata McGraw-Hill, 2019.
2. J.P Holman, Thermodynamics, 10th Edition, McGraw Hill, 2017.
3. CP Arora, Thermodynamics: An Engineering Approach, 5th Edition, McGraw Hill Education (India) Pvt. Limited, 2016.

REFERENCES:

1. Moran, M. J., Shapiro, H. N., Boettner, D. D., and Bailey, M. B., 2018, Fundamentals of Engineering Thermodynamics, 9th ed., Wiley.
2. Cengel, Y. A., 2010, Introduction to Thermodynamics and Heat Transfer, 2nd ed., McGraw-Hill Education.
3. Bejan, A., 2016, Advanced Engineering Thermodynamics, 4th ed., Wiley. 5. Nag, P.K, 2017, Engineering Thermodynamics, 6th ed., McGraw Hill Education.
4. Sonntag, R. E, Borgnakke, C and Wylen, G. J. V., and., 2023, Fundamentals of Classical thermodynamics, 6th ed., Wiley Eastern Ltd.
5. Jones, J. B. and Hawkins, G. A., 1986, Engineering Thermodynamics, John Wiley Sons.

Course Outcomes: By the end of this course, the student will be able to:

CO1: Analyze energy quality and calculate availability, reversible work, and irreversibility for closed and open systems, and determine second law efficiencies of processes and cycles.

CO2: Apply Maxwell relations, Clapeyron equations, and Gibbs and Helmholtz functions to derive property relations and interpret thermodynamic charts and anomalies.

CO3: Evaluate the thermodynamic behavior of ideal and real gas mixtures, perform psychrometric analysis, and apply the first law to mixed systems. And Determine fugacity, activity, and their respective coefficients for real gas and liquid mixtures, and understand partial properties in multicomponent systems.

CO4: Analyze vapor-liquid equilibrium (VLE) for binary mixtures using phase diagrams and apply equilibrium criteria to solve VLE problems at various pressures.

CO5: Apply the first and second laws of thermodynamics to chemical reactions and combustion processes, evaluate enthalpy and entropy changes, and compute equilibrium constants and adiabatic flame temperatures.

Honors	CRYOGENIC ENGINEERING (Thermal Engineering)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. Introduce the fundamental principles of cryogenics and the behavior of fluids and materials at cryogenic temperatures.
2. Explain various gas liquefaction techniques, including the working principles and thermodynamic aspects of each system.
3. Teach the theory and design principles of cryogenic air separation systems using phase equilibrium and thermodynamic laws.
4. Familiarize students with different types of cryogenic refrigeration systems and cryocoolers used in scientific and industrial applications.
5. Provide an understanding of storage, instrumentation, and insulation methods for cryogenic fluids and systems.

UNIT – 1 **FLUID AND MATERIAL PROPERTIES AT LOW TEMPERATURE & APPLICATIONS OF CRYOGENICS:** Introduction to cryogenics: Cryogenic temperature scale, Properties of cryogenic fluids, super fluidity of He3 & He 4, properties of engineering materials at cryogenic temperatures, mechanical properties, thermal properties, electric & magnetic properties, super conducting materials. Applications of cryogenic systems: Super conductive devices, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions.

UNIT – 2 **CRYOGENIC GAS LIQUIFICATION:** Gas liquefaction systems: Introduction, thermodynamically ideal systems, Joule Thomson effect, liquefaction systems such as Linde Hampton, precooled Linde Hampson, Linde dual pressure, cascade system, Claude system, Kapitza system, Heyland systems using expanders, comparison of liquefaction systems and its performance evaluations.

UNIT – 3 **CRYOGENIC AIR-SEPARATION:** Basics of Gas Separation, Ideal Gas Separation System, Gibbs Phase Rule, Phase Equilibrium Curves, Temperature Composition Diagrams, Raoult's Law, Gibbs – Dalton's Law, Distribution Coefficient, Enthalpy composition diagrams, Rectification Column Murphree efficiency, Theoretical Plate Calculations.

UNIT – 4 **CRYOGENIC REFRIGERATOR AND CRYOCOOLERS:** Cryogenic Refrigeration System: Ideal isothermal and reversible isobaric source refrigeration cycles, Joule Thomson system, cascade or pre-cooled joule–Thomson refrigeration systems, expansion engine and cold gas refrigeration systems, Sterling refrigerators, Importance of regenerator effectiveness for the Sterling refrigerators, Gifford single volume refrigerator, Gifford double volume refrigerators analysis, Refrigerators using solids as working media: Magnetic cooling, magnetic refrigeration systems, thermal; valves, nuclear demagnetization, dilution refrigerator

UNIT – 5 **CRYOGENIC FLUID STORAGE, INSTRUMENTATION, AND INSULATION:** Dewar vessel for cryogenic fluid storage, Construction, Inner vessel design, outer vessel design, Temperature measurements, pressure measurements, flow measurements, liquid level measurements, fluid quality measurements, Cryogenic insulation – expanded foams, gas filled & fibrous insulation, vacuum insulation, evacuated powder & fibrous insulation, Opacified powder insulation, multilayer insulation, comparison of performance of various insulations.

TEXTBOOKS:

1. Barron, R., 1985, Cryogenic Systems, SI version, Oxford university press.
2. Scott, R. B., 1962, Cryogenic Engineering, D. Van Nostrand Company.

REFERENCES:

1. Timmerhaus, K. D. and Flynn, T. M., 1989, Cryogenic Process Engineering, Plenum Press.
2. Vance, R. W., and Duke, W. M., 1962, Applied Cryogenic Engineering, John Wiley.
3. Sittig, M., 1963, Cryogenics Research and Applications, D. Van Nostrand Company.
4. Hands, B.A., 1986, Cryogenic engineering, Academic press.
5. Flynn, T. M., 2005, Cryogenic Engineering, Marcel Dekker Inc., New York.

Course Outcomes: By the end of this course, the student will be able to:

CO1: Describe the cryogenic temperature scale, properties of cryogenic fluids, and the behavior of materials under cryogenic conditions including superconductivity and superfluidity.

CO2: Analyze and compare different gas liquefaction systems like Linde-Hampson, Claude, and Kapitza systems based on thermodynamic principles and efficiency.

CO3: Apply thermodynamic laws and phase diagrams to evaluate and design cryogenic air-separation systems, including theoretical plate calculations and rectification columns.

CO4: Explain the working of various cryogenic refrigeration and cooling systems such as Joule-Thomson, Sterling, and Gifford-McMahon refrigerators, and understand magnetic and nuclear-based refrigeration techniques.

CO5: Design and evaluate cryogenic fluid storage systems, select appropriate insulation methods, and understand the use of various measurement and instrumentation tools used in cryogenic applications.

Honors	TURBO MACHINES (Thermal Engineering)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. Provide a thorough understanding of the basic principles and classifications of turbomachines along with their thermodynamic and fluid dynamic foundations.
2. Analyze steam nozzles and turbines, including the design aspects and performance considerations of impulse and reaction turbines.
3. Introduce the fundamentals of gas dynamics and apply shock and supersonic flow theories to turbo machines.
4. Develop the ability to analyze and design centrifugal and axial flow compressors using velocity triangles, thermodynamics, and performance metrics.
5. Explore the working, design, and performance analysis of axial flow gas turbines, including cascade theory, blade design, materials, and cooling technologies.

UNIT – 1 **FUNDAMENTALS OF TURBO MACHINES:** Classification, Application Thermodynamic analysis; Isentropic flow, Energy transfer; Efficiencies; static and Stagnation conditions; continuity equation; Euler's flow through variable cross-sectional area; unsteady flow in turbo machines.

UNIT – 2 **STEAM NOZZLES:** Effect of back – pressure on the analysis; Design of nozzles. Steam Turbines of C & C –D nozzles : Impulse Turbines: work done and velocity triangles; Efficiencies; Constant Reaction Blading; Design of blade passages, angles and height; Secondary flow; leakage losses; Thermodynamic analysis of steam turbines.

UNIT – 3 **GAS DYNAMICS:** Fundamentals thermodynamic concepts; Isentropic conditions; Mach number and Area – Velocity relation; Dynamic pressure; normal shock relations for perfect gas; supersonic flow, oblique shock waves; normal shock recovery; detached shocks; Aero foil theory. Centrifugal Compressor: Types; Velocity triangles and efficiencies; Blade passage design; Diffuser and pressure recovery; slip factor; stanitz and stodolas formulae; Effect of inlet Mach number; Pre-whirl; performance.

UNIT – 4 **AXIAL FLOW COMPRESSORS:** Flow analysis, work and velocity triangles; Efficiencies; Thermodynamic analysis; stage pressure rise; Degree of reaction; stage loading; general design, effect of velocity incidence; performance. Cascade Analysis: Geometry and Terminology; Blade forces, Efficiency; losses; free and forced vortex blades.

UNIT – 5 **AXIAL FLOW GAS TURBINES:** Work done; velocity triangles and efficiencies; thermodynamic flow analysis; degree of reaction; Zweifels relation; Design cascade analysis – Soderberg – Hawthrone – ainley-correlations; secondary flow; Free-vortex blades; Blade angles for variable degree of reaction; Actuator disc theory; stresses in blades; Blade assembling; materials and cooling of blades; performance; Matching of compressor and turbine; off-design performance.

TEXTBOOKS:

1. Shepherd, I. G., Fundamentals of Turbomachinery, 2nd Edition, John Wiley & Sons, 2005.
2. 2. Yahya, S. M., Elements of Gas Dynamics, 2nd Edition, PHI Learning Pvt. Ltd., 2013.

REFERENCES:

1. Fluid Mechanics and Thermodynamics of Turbomachinery, Dixon, S.L, Elsevier, 2014, 7th Edition.
2. Gas Turbine Theory, Sarvanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, H., Pearson Prentice Hall, 2017, 7th Edition.
3. G. Gopalakrishnan and D. Prithviraj, Practice on Turbomachines, SciTech Publishers, Chennai.

Course Outcomes: By the end of this course, the student will be able to:

- **CO1:** Understand the fundamentals of Turbo machines to evaluate the performance.
- **CO2:** Apply the knowledge in the design of steam nozzles.
- **CO3:** Understand the basics of gas dynamics and centrifugal compressors.
- **CO4:** Apply the knowledge in the design of axial flow compressors.
- **CO5:** Apply the knowledge in the design of axial flow turbines.

Honors	THERMAL MANAGEMENT IN EV BATTERY AND FUEL CELL SYSTEM (Thermal Engineering)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. Introduce the principles of battery management systems (BMS) including battery types, functionality, and key electrical parameters.
2. Provide in-depth knowledge of lithium-ion battery operations, aging phenomena, thermal management, and protection mechanisms.
3. Familiarize students with various fuel cell technologies, their working principles, types, and thermodynamic behavior.
4. Understand fundamental convective heat transfer concepts and cooling techniques in Battery Thermal Management Systems (BTMS).
5. Explore advanced thermal modeling and simulation of EV battery systems and analyze case studies from electric vehicle (EV) and fuel cell vehicle (FCV) applications.

UNIT – 1 Introduction to battery management systems and devices, fuel Cells & Batteries, Nominal voltage and capacity, Energy and power.
BATTERY CELLS: Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Lithium-ion aging: Negative electrode, Lithium-ion aging: Positive electrode, Cell Balancing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation.

UNIT – 2 Introduction – working and types of fuel cell – low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell solid oxide, hydrogen fuel cells – thermodynamics and electrochemical kinetics of fuel cells.
Basic Convective heat transfer and fluid flow, The fundamental of BTMS: Liquid cooling and Air cooling, Thermoelectric cooling, Heat Transfer Fluids in phase change materials, Heat Pipe (HP), Vapor compression, Direct refrigerant cooling Electric Motor Cooling.

UNIT – 3 Heat dissipations dependence on cold plate's channel's pattern, Heat dissipations dependence on the cold plate's number of channels and their shape, Heat dissipations dependence on the placement of the cooling plate.
High temperature batteries for back-up applications, Flow batteries for load levelling and large-scale grid application, Ni-Hydrogen batteries for space and marine applications.

UNIT – 4 PHEV and BEV Battery Systems, Thermal Conductivity Measurements for EV Battery Applications, Battery State Estimation. EV Battery Cooling- challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs-system set up, selection of PCMs. Chevrolet Volt Model Battery, Thermal Management System - Case study. Modeling Liquid Cooling of a Li-Ion Battery Pack with software-simulation concepts.

UNIT – 5 Fuel cell system-balance of plant-components required. Fuel cell power plant sizing problems-Fuel Cell Electric Vehicle, Fuel economy calculations-Battery EVs Vs Fuel Cell EVs, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Case studies-Battery and fuel cells, Challenges and Risks.

TEXTBOOKS:

1. Dinçer, I., Hamut, H. S. and Javani, N., Thermal Management of Electric Vehicle Battery Systems, Wiley Network, 2017.
2. Hart A.B. and Womack G.J., "Fuel Cells – Theory and Applications", Chapman and Hall, 1967.

REFERENCES:

1. Andrea, D., Battery Management Systems for Large Lithium-Ion Battery Packs, Artech, 2010.
2. Söffker D., and Moulik, B., Battery Management System for Future Electric, Mdpi AG, 2020.
3. Linden D., and Reddy, T.S., Handbook of Batteries, 3rd Edition, McGraw-Hill, 2002.
4. Kiehne, H.A., Battery Technology Handbook, Marcel Dekker, NYC, 2003.
5. Nazri G.A., and Pistoa G., Lithium Batteries, Science and Technology, Kluwer Academic Publisher, 2003.
6. Husain, I., Electric and Hybrid Vehicles, Design: Fundamentals, 3rd Edition, CRC press, 2021.
7. Jiang, J., and Zhang, C., Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles, John Wiley & Sons, 2015.
8. Revankar, S.T., and Majumdar, P., Fuel Cells: Principles, Design, and Analysis, CRC press, 2014.
9. Sammes, N. ed., Fuel Cell Technology: Reaching Towards Commercialization, Springer Science & Business Media, 2006.

Course Outcomes: By the end of this course, the student will be able to:

CO1: Understand the fundamentals of electric vehicles, battery management systems, and fuel cells.

CO2: Apply heat transfer principles to analyze and manage battery systems.

CO3: Understand the critical role of heat transfer in the successful functioning of fuel cells.

CO4: Understand different measurements for Battery Applications.

CO5: Design and implement effective thermal management strategies for modern applications involving batteries and fuel cells.

Honors	DESIGN OF HEAT TRANSFER EQUIPMENT (Thermal Engineering)	L	T	P	C
		3	0	0	3

Course Objectives

1. Provide a comprehensive understanding of various types of heat exchangers and their industrial applications.
2. Introduce fundamental and advanced methods for heat exchanger analysis, including LMTD, ε-NTU, and other analytical techniques.
3. Develop students' skills in the thermal and mechanical design of different types of heat exchangers such as shell-and-tube, plate, and compact types.
4. Explain the principles of heat transfer in condensers, boilers, and the mechanisms of boiling and condensation.
5. Introduce the concept, design, and application of heat pipes in thermal systems, including advanced and cryogenic systems.

UNIT – 1 Classification of heat exchangers and applications, Concept of overall heat transfer coefficient, fouling factor, LMTD, effectiveness, film coefficients for tubes and annuli, equivalent diameter of annuli, caloric temperature, true temperature difference. Regenerators and recuperates. Various methods in use: ε-NTU, P-NTU, MTD methods, ψ-P and P1-P2 methods, Δ-Π Method.

Thermal design of regenerators, compact heat exchangers. Design calculation of double pipe heat exchanger, double pipe exchangers in series-parallel arrangement.

UNIT – 2 Shell and Tube Heat Exchangers-Tube layouts, baffles, classification of shell and tube heat exchangers, TEMA standards. Design calculation of shell and tube heat exchangers-shell side film coefficient, shell-side equivalent diameter, True temperature difference in a 1-2 exchanger, shell and tube sides pressure drops; Performance analysis of 1-2 heat exchangers, flow arrangements for increased heat recovery.

UNIT – 3 **PLATE HEAT EXCHANGERS:** Mechanical features-plate pack and the frame. Plate types; Advantages and performance limits, passes and flow arrangements, Heat transfer and pressure drop calculations. Basics of compact heat exchangers: heat transfer enhancement, plate-fin heat exchangers, tube-fin heat exchangers.

UNIT – 4 **PRINCIPLES OF CONDENSERS AND BOILERS:** Condensers, Types of condensers, Heat transfer fundamentals of condensers, Nusselt theory of laminar film wise condensation; Thermal design of shell and tube condensers, Condensation outside and inside of horizontal tubes, Condensation outside and inside vertical tubes, Empirical correlations;

BOILERS- fundamentals and types of boiling, Various empirical correlations pertaining to flow boiling.

UNIT – 5 **HEAT PIPES**: Types and applications, operating principle, Working fluids, Wick structures, Pressure balance, Effective thermal conductivity of wick structures, Heat pipe limits, Heat pipe design procedure, Nonconventional heat pipes, Micro heat pipes, cryogenic heat pipes, pulsating heat pipes.

TEXTBOOKS:

1. Kern, D.Q., and Kern, D.Q., Process Heat Transfer, McGraw-Hill, 1950.
2. Shah, R.K., and Sekulic, D.P., Fundamentals of Heat Exchanger Design, John Wiley & Sons, 2003.

REFERENCES:

1. Kakac, S., Liu, H., and Pramuanjaroenkij, A., Heat Exchangers: Selection, Rating, and Thermal Design, CRC Press, 2020.
2. Chi, S. W., Heat Pipe Theory and Practice- A Source Book, McGraw-Hill, 1976.
3. Fraas, A. P., Heat Exchanger Design, John Wiley & Sons, 1989.
4. Dunn, P.D., and Reay, D.A., Heat Pipes, Pergamon, 1994.

Course Outcomes: By the end of this course, the student will be able to:

- **CO1** Understand different types of Heat Exchangers, and their applications in the process industry and be able to analyze their thermal performance.
- **CO2** Design various single-phase heat exchangers.
- **CO3** Design various Plate Type Heat Exchangers.
- **CO4** Apply the principles of boiling and condensation in the design of boilers and condensers.
- **CO5** Understand the principles and workings of various types of heat pipes.

Honors	HVAC SYSTEMS (Thermal Engineering)	L	T	P	C
		3	0	0	3

Course Objectives

1. Provide an understanding of the historical development and impact of air conditioning and HVAC systems. And also Introduce the thermodynamic properties of moist air and psychrometric processes, and teach their applications in air conditioning systems.
2. Equip students with knowledge of comfort air conditioning and factors affecting thermal comfort in indoor environments.
3. Explain the heat transfer mechanisms through building structures, including solar radiation, infiltration, and stack effects.
4. Develop skills in ventilation system design and air distribution, with an emphasis on maintaining good indoor air quality.
5. Teach methods for load calculation and the factors influencing cooling and heating requirements in air conditioning systems. And also Introduce heat pump systems, their operation, and applications, focusing on energy efficiency and COP.

UNIT – 1 **INTRODUCTION:** Brief history of air conditioning and impact of air conditioning. HVAC systems and classifications,
PSYCHROMETRY OF AIR CONDITIONING PROCESSES: Thermodynamic properties of moist air, Important Psychrometry properties, Psychrometric chart; Psychrometric process in air conditioning equipment, applied Psychrometry, air conditioning processes, air washers.

UNIT – 2 **COMFORT AIR CONDITIONING:** Thermodynamics of human body, metabolic rate, energy balance and models, thermoregulatory mechanism. Comfort & Comfort chart, Effective temperature, Factors governing optimum effective temperature, Design consideration. Selection of outside and inside design conditions.

UNIT – 3 **HEAT TRANSFER THROUGH BUILDING STRUCTURES:** Solar radiation; basic concepts, sun-earth relationship, different angles, measurement of solar load, Periodic heat transfer through walls and roofs. Empirical methods to calculate heat transfer through walls and roofs using decrement factor and time lag method. Infiltration, stack effect, wind effect. CLTD/ETD method – Use of tables, Numerical and other methods, Heat transfer through fenestration – Governing equations, SHGF/SC/CLF Tables

UNIT – 4 **VENTILATION SYSTEM:** Introduction- Fundamentals of good indoor air quality, need for building ventilation, Types of ventilation system, Air Inlet system. Filters heating & cooling equipment, Fans, Duct design, Grills, Diffusers for distribution of air in the workplace, HVAC interface with fire and gas detection systems - system requirements, devices and their functioning.

UNIT – 5 **LOAD CALCULATIONS:** Types of air-conditioning systems, General consideration, internal heat gains, system heat gain, cooling and heating load estimate.
HEAT PUMPS: General principles, appropriate conditions for using heat pumps, theoretical and practical COP, refrigerants, absorption heat pump, applications of heat pumps; gas driven heat pumps.

TEXT BOOKS:

1. Dossat, Roy J. and Horan, Thomas J., Principles of Refrigeration, 5th Edition, Prentice Hall, 2001.
2. Arora, R.C., Refrigeration & Air Conditioning, PHI, 2010.

REFERENCES:

1. Gosney W.B., Principles of Refrigeration, Cambridge University Press, 1982.
2. Threlkeld, J.L., Thermal Environmental Engineering, Prentice Hall, 1962.

Course Outcomes: By the end of this course, the student will be able to:

- **CO1:** Understand the fundamentals of Psychrometry of Air-conditioning processes.
- **CO2:** Apply human comfort indices and comfort charts to design indoor conditions of HVAC systems.
- **CO3:** Estimate heating and loads for buildings according to ASHRAE procedures and standards.
- **CO4:** Design and evaluate a complete air distribution system including fan, duct, and installation requirements for a typical HVAC system.
- **CO5:** Understand the basic principles and applications of Heat Pumps.

		L	T	P	C
Honors	**ADVANCED HEAT TRANSFE LAB (Thermal Engineering)**	**0**	**0**	**3**	**1.5**

COURSE OBJECTIVES

1. To provide hands-on experience in measuring temperature using thermocouples, including fabrication and calibration techniques. And To enable students to experimentally analyze the performance of various heat exchangers and heat transfer systems.
2. To develop a practical understanding of solar energy devices such as solar flat plate collectors and solar stills. And To experimentally investigate the thermal conductivity of various liquids and gases.
3. To study phase change heat transfer phenomena such as condensation and boiling through lab experiments.
4. To perform critical heat flux experiments and understand boiling heat transfer characteristics.
5. To conduct performance testing on thermal systems such as diesel engines and compressors. And To evaluate the performance of vapor compression refrigeration systems and determine their COP.

LIST OF EXPERIMENTS:

1. To fabricate and calibrate a thermocouple and illustrate its use in the temperature measurement.
2. To determine the LMTD, Effectiveness and Heat Transfer rate of a Shell and Tube Heat Exchanger.
3. To determine the Performance of a Solar Flat Plate Collector.
4. To determine the Performance of a Solar Still.
5. To determine the thermal conductivity of liquids and gases.
6. To determine the heat transfer rate in drop and film wise condensation.
7. To determine the critical heat flux of a wire.
8. To conduct the performance test on four stroke variable compression ratio diesel engine.
9. To conduct the performance test on a reciprocating air compressor
10. To determine the coefficient of performance in a Vapour Compression Refrigeration system.

Course Outcomes: By the end of this course, the student will be able to:

- **CO1** Fabricate, calibrate, and use thermocouples for accurate temperature measurements in thermal systems. And Calculate the LMTD, effectiveness, and heat transfer rate in shell and tube heat exchangers using experimental data.
- **CO2** Assess the thermal performance of solar flat plate collectors and solar stills under different operating conditions. And Measure and analyze the thermal conductivity of liquids and gases using appropriate experimental setups.
- **CO3** Differentiate between dropwise and filmwise condensation and quantify the associated heat transfer rates.
- **CO4** Determine the critical heat flux and understand its importance in boiling heat transfer and system design.
- **CO5** Perform engine and compressor tests to evaluate thermal and mechanical performance parameters. And Calculate and analyze the coefficient of performance of vapor compression refrigeration systems through experimentation.

Honors	CFD LAB (Thermal Engineering)	L	T	P	C
		0	0	3	1.5

Course Objectives

1. Develop the ability to solve 1-D parabolic equations using explicit (FTCS, DuFort-Frankel) and implicit (Laasonen) numerical methods.
2. Apply numerical techniques to analyze heat transfer in fin problems with insulated and convective boundaries.
3. Implement numerical methods to simulate Couette flow with and without pressure gradients.
4. Solve elliptic equations using iterative methods such as Point Gauss-Seidel and Successive Over Relaxation (SOR), with emphasis on boundary condition handling.
5. Analyze and solve general parabolic heat conduction problems in various geometries.
6. Model and solve linear hyperbolic equations using explicit (Upwind, Lax) and implicit (BTCS, Crank-Nicolson) schemes for wave propagation problems.

Using any Programming Language, code the following methods with an example:

1. Solution of 1-D parabolic equations

Explicit (FTCS, DuFort-Frankel)

Implicit (Laasonen)

2. Fin problem with insulated and Convective end

3. Couette Problem with and without pressure Gradient

4. Solution of Elliptic Equations

With Point Gauss-Seidel method

With Point Successive Over Relaxation Method

■ Examples: (i) Temperature Distribution over a rectangular plate with different Boundary conditions on the sides.

5. Solution of Parabolic Equations

6. Solution of Linear Hyperbolic Equations.

Using upwind and Lax explicit methods

Using BTCS and Crank-Nicolson implicit methods

■ Examples: Wave propagation at a high altitude

Course Outcomes: By the end of this course, the student will be able to:

CO1 Formulate and solve 1-D unsteady heat conduction problems using both explicit and implicit finite difference schemes.

CO2 Analyze fin-type heat transfer systems with realistic boundary conditions using numerical methods.

CO3 Simulate viscous flow profiles in a Couette system for different pressure gradient scenarios.

CO4 Compute temperature distributions over a 2-D domain by solving elliptic PDEs using Gauss-Seidel and SOR iterative solvers.

CO5 Apply finite difference methods to simulate transient heat conduction problems in engineering systems.

CO6 Implement numerical schemes for hyperbolic PDEs and interpret wave propagation results, including stability and accuracy aspects.

For Minors in "Mechanical Engineering" (Any 5 theory and 2 Labs):

1. Design of Machine Members
2. Theory of Machines
3. Manufacturing Processes
4. CAD/CAM
5. Thermodynamics
6. Thermal Engineering
7. Material Science and metallurgy
8. Operations Research
9. Manufacturing Processes Lab
10. CAD/CAM Lab
11. Thermal Engineering Lab
12. Theory of Machines Lab

Minors	DESIGN OF MACHINE MEMBERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Provide an introduction to design of machine elements.
2. Familiarize with fundamental approaches to failure prevention for static and dynamic loading.
3. Explain design procedures to different types of joints.
4. Teach principles of clutches and brakes and design procedures.
5. Instruct different types of bearings and design procedures.

UNIT – 1 **Introduction, Design for Static and Dynamic loads**

Mechanical Engineering Design: Design process, design considerations, codes and standards of designation of materials, selection of materials.

Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads. Theories of failure for static loads.

Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

UNIT – 2 **Design of Bolted and Welded Joints**

Design of Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, gasketed joints.

Welded Joints: Strength of lap and butt welds, Joints subjected to bending and torsion.

UNIT – 3 **Power transmission shafts and Couplings**

Power Transmission Shafts: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.

Couplings: Design of flange and bushed pin couplings, universal coupling.

UNIT – 4 **Design of Clutches, Brakes and Springs**

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory and uniform pressure theory.

Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band and block brakes, disc brakes.

Springs: Design of helical compression, tension, torsion and leaf springs

UNIT – 5 **Design of Bearings and Gears**

Design of Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.

Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue.

Design of Gears: Spur gears, beam strength, Lewis equation, design for dynamic and wear loads.

Note: Design data book is permitted for examination

TEXT BOOKS:

1. R.L. Norton, Machine Design an Integrated approach, 2/e, Pearson Education, 2004.
2. V.B.Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.
3. Dr. N. C. Pandya &Dr. C. S. Shah, Machine design, 17/e, Charotar Publishing House Pvt. Ltd, 2009.

REFERENCES:

1. R.K. Jain, Machine Design, Khanna Publications, 1978.
2. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986.
3. M.F.Spotts and T.E.Shoup, Design of Machine Elements, 3/e, Prentice Hall (Pearson Education), 2013.

COURSE OUTCOMES: By the end of this course, the student will be able to:

- **CO1** Estimate safety factors of machine members subjected to static and dynamic loads.
- **CO2** Design fasteners subjected to variety of loads.
- **CO3** Select of standard machine elements such as keys, shafts, couplings, springs and bearings.
- **CO4** Design clutches brakes and spur gears.

Minors	THEORY OF MACHINES	L	T	P	C
		3	0	0	3

Course objectives:

The students completing this course are expected to understand the nature and role of the kinematics of machinery, mechanisms and machines. The course includes velocity and acceleration diagrams, analysis of mechanisms joints, Cams and their applications. It exposes the students to various kinds of power transmission devices like belt, rope, chain and gear drives and their working principles and their merits and demerits.

UNIT – 1 **MECHANISMS :** Elements or Links Classification Rigid Link, flexible and fluid link Types of kinematic pairs sliding, turning, rolling, screw and spherical pairs lower and higher pairs closed and open pairs constrained motion completely, partially or successfully constrained and incompletely constrained. Grashoff's law, Degree of Freedom, Kutzbach criterian for planar mechanisms, Mechanism and machines classification of machines kinematic chain inversion of mechanism inversions of quadric cycle chain single and double slider crank chains.

UNIT – 2 **LOWER PAIR MECHANISM:** Exact and approximate copiers and generated types Peaucellier, Hart and Scott Russul Grasshopper Watt T. Chebicheff and Robert Mechanisms and straight line motion, Pantograph. Conditions for correct steering Davis Steering gear, Ackermans steering gear - velocity ratio, Hooke's Joint: Single and double Universal coupling application problems.

UNIT – 3 **KINEMATICS:** Velocity and acceleration Motion of a link in machine Determination of Velocity and acceleration diagrams Graphical method Application of relative velocity method four bar chain. Velocity and acceleration analysis of for a given mechanism, Klein's construction, determination of Coriolis component of acceleration.

PLANE MOTION OF BODY: Instantaneous center of rotation, centroids and axodes relative motion between two bodies Three centres in line theorem Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.

UNIT – 4 **CAMS:** Definitions of cam and followers their uses Types of followers and cams Terminology Types of follower motion: Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases. Analysis of motion of followers: Roller follower circular cam with straight, concave and convex flanks.

BELT DRIVES: Introduction, Belt and rope drives, selection of belt drive- types of belt drives, V-belts, materials used for belt and rope drives, velocity ratio of belt drives, slip of belt, creep of belt, tensions for flat belt drive, angle of contact, centrifugal tension, maximum tension of belt, Chains- length, angular speed ratio, classification of chains.

UNIT – 5 **GEARS:** Higher pairs, friction wheels and toothed gears types law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth: cycloidal and involute profiles. Velocity of sliding phenomena of interferences Methods of interference. Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact Introduction to Helical, Bevel and worm gearing.

GEAR TRAINS: Introduction to gear Trains, Train value, Types Simple and reverted wheel train Epicyclic gear Train. Methods of finding train value or velocity ratio Epicyclic gear trains. Selection of gear box-Differential gear for an automobile.

TEXT BOOKS:

1. Theory of Mechanisms & Machines by Jagadeesh lal, Metropolitan Pvt.Ltd.
2. Theory of Machines by Thomas Bevan/ CBS Publishers

REFERENCES:

1. Theory of Machines S. S Rattan- TMH Publishers
2. Theory of machines and Machinery-Vickers - Oxford .
3. Theory of Mechanisms and machines A.Ghosh & A.K.Malik East West Press Pvt. Ltd.
4. Kinematics and dynamics of Machinery- R.L Norton- TATA McGraw-Hill

Course Outcomes: By the end of this course, the student will be able to:

- **CO1** Learn about the kinematics of machinery.
- **CO2** Understand lower pair mechanisms.
- **CO3** Analyze the motion of a plane mechanism
- **CO4** Explain Cams and belt drives.
- **CO5** Select gears for a given applications

Minors	MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand the principles of various coating techniques and fabrication methods for MEMS devices
2. To make the students understand the properties, processing and design of ceramic and composite materials
3. To understand the fabrication methods for MEMS devices.
4. To understand the concepts and principles of nano manufacturing methods.
5. To learn various Rapid Prototyping (RP) processes and their applications.

UNIT – 1 **COATING TECHNIQUES:** Scope, Cleaners, Methods of cleaning, Surface coating types, ceramic and organic methods of coating, and economics of coating. Electro forming, Chemical vapor deposition, Physical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT – 2 **PROCESSING OF CERAMICS:** Applications, characteristics, classification, Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application.

PROCESSING OF COMPOSITES: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT – 3 **FABRICATION OF MICROELECTRONIC DEVICES**: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro-electronics, surface mount technology, Integrated circuit economics.

UNIT – 4 **NANOMANUFACTURING:** Nanotubes, Nanoparticles, nanowires, Lithography, Electrospinning, mechanical milling, Inert gas condensation, sputtering, laser ablation, Arc discharge, Solgel methods, working, applications, advantages.

UNIT – 5 **RAPID PROTOTYPING:** Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing.

TEXT BOOKS:

1. Manufacturing Engineering and Technology*I*Kalpakijian / Adisson Wesley, 1995.
2. Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990.

REFERENCES:

1. Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski /VanNostrand Renihold.
2. MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH
3. Advanced Machining Processes / V.K.Jain / Allied Publications.
4. Introduction to Manufacturing Processes / John A Schey*I*Mc Graw Hill.

Course Outcomes: By the end of this course, the student will be able to:

CO1 Understand the working principles of various surface coating methods.
CO2 Discuss novel and promising techniques in the processing of ceramics and composites.
CO3 Select suitable fabrication methods for MEMS components.
CO4 Learn the concepts and principles of nano manufacturing methods.
CO5 Illustrate the working principles of RP and select appropriate RP process for the application.

Minors	CAD/CAM	L	T	P	C
		3	0	0	3

Course objectives:

1. To introduce curve modeling techniques including cubic splines, Bézier curves, and B-spline curves along with their mathematical and geometric properties.
2. To develop an understanding of surface modeling methods used in computer-aided geometric design including various parametric and freeform surfaces.
3. To provide knowledge on solid modeling techniques and CNC tooling systems used in modern manufacturing practices.
4. To explain the concepts, architecture, and integration of Computer Integrated Manufacturing (CIM) and its role in automation and production systems.
5. To explore various Automatic Identification and Data Capture (AIDC) technologies and their applications in smart manufacturing, including current trends like AI, IoT, and digital manufacturing.

UNIT – 1 Cubic splines : Algebraic and geometric forms of cubic spline.
Bezier Curves: Bernstein basis, equations of Bezier curves, properties, derivatives.
B-Spline Curves: B-Spline basis, equations, knot vectors, properties, NURBS

UNIT – 2 **Surface modeling**: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.

UNIT – 3 **Solid Modeling**: Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, CSG.
CNC tooling – cutting tools materials, high speed steel tools, cement carbide tools, ceramic tools, tools magazines, Automatic Tool Changer, modular accessories in CNC,CNC part programming – manual, computer assisted, APT, CAD/CAM programming, CAM software.

UNIT – 4 **CIM** : Introduction to CIM, Data flow in CIM, CIM wheel, Process involved in CIM, Need for CIM, Advantages & disadvantages of CIM, CIM integration, Challenges, Sub systems in CIM, Present Scenario, Future prospects; Production system: automation in production systems, Manual labour in production systems, Automation principles and strategies.

UNIT – 5 Automatic Identification and Data Capture: Introduction, Reasons for AIDC, bar code, RFID and other AIDC technologies, CAQC – Inspection metrology, CMM, Machine Vision, other optical inspection methods, Non optical Non-contact inspection technologies, Material handling and identification, computers in manufacturing industry – current scenario(AI, ML,DL, Digital manufacturing, IOT, Cloud based manufacturing).

TEXT BOOKS:

1. Elements of Computer Graphics by Roger & Adams Tata McGraw Hill.
2. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers.
3. CAD/CAM: Theory and Practice, Ibrahim Zeid, McGraw Hill Publishers.
4. Chang T C and Wysk R A, 1997, Computer Aided Manufacturing, Prentice hall PTR
5. Xu X, 2009, Integrating Advanced computer aided design, manufacturing and numerical control, Information science reference.

REFERENCES:

1. Groover M P, 2007, Automation, Production systems and computer integrated manufacturing, Prentice hall Press
2. Weatherall A, 2013, Computer integrated manufacturing from fundamentals to implementation. Butterworth – Heinemann.
3. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers.

Course Outcomes: By the end of this course, the student will be able to:

CO1 Construct and analyze cubic splines using both algebraic and geometric approaches. And Develop Bézier curves using Bernstein basis and apply their properties and derivatives in CAD applications. And also Formulate B-spline curves, understand the role of knot vectors and apply Non-Uniform Rational B-Splines (NURBS) in design.

CO2 Create and manipulate different types of surfaces such as bicubic, Coons, sweep, ruled, and tabulated surfaces using surface modeling techniques. And Evaluate Gaussian curvature for analyzing surface geometry and smoothness in 3D models.

CO3 Demonstrate proficiency in solid modeling using wireframes, boundary representation, CSG, and spatial decomposition. And Identify CNC tooling materials and components and develop CNC part programs using manual and computer-assisted techniques.

CO4 Explain the components, data flow, and challenges of CIM systems and describe their impact on production automation and integration. And Compare automation strategies and evaluate their applicability in various production environments.

CO5 Understand and apply AIDC technologies such as barcodes, RFID, and machine vision in manufacturing systems. And Describe modern inspection techniques, including CMM and non-contact methods, and analyze their integration in CAQC systems. And Evaluate the role of emerging digital technologies such as AI, machine learning, IoT, and cloud computing in the manufacturing sector.

Minors	THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the thermodynamic laws and corollaries.
2. To illustrate the concepts of real gas behavior
3. To apply the general concepts of combustion
4. To analyze power cycles
5. To illustrate the working principles of direct energy conversion techniques.

UNIT – 1 **REVIEW OF THERMODYNAMIC LAWS AND COROLLARIES:** Transient flow analysis, Second law thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation. Evaluation of thermodynamic properties of working substance

UNIT – 2 **P.V.T SURFACE:** Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius-Clapeyron equation. Throttling, Joule Thomson coefficient.

UNIT – 3 **COMBUSTION:** Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat reaction, Adiabatic flame temperature generated product, Enthalpies, Equilibrium. Chemical equilibrium of ideal gases, Effect of non-reacting gases equilibrium in multiple reactions, The vent Hoff's equation - Gibbs phase rule.

UNIT – 4 **POWER CYCLES:** Review binary vapor cycle, co-generation and combined cycles, Second law analysis of cycles. Refrigeration cycles. Thermodynamics off irreversible processes. Introduction, Phenomenological laws, Onsager Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

UNIT – 5 **DIRECT ENERGY CONVERSION INTRODUCTION**: Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydrodynamic generations, Photovoltaic cells

TEXT BOOKS:

1. Basic and Applied Thermodynamics/ P.K.Nag/ TMH
2. Thermodynamics/Holman/ Mc Graw Hill.

REFERENCES:

1. Engineering Thermodynamics/PL. Dhār / Elsevier
2. Thermodynamics/Sonntag & Van Wylen / John Wiley & Sons
3. Thermodynamics for Engineers/Doolittle-Messe / John Wiley & Sons
4. Irreversible thermodynamics/HR De Groff.
5. Thermal Engineering / Soman / PHI
6. Thermal Engineering / Rathore / TMH
7. Engineering Thermodynamics/Chatopadyaya/

Course Outcomes: By the end of this course, the student will be able to:

CO1 Understand the thermodynamic laws and corollaries.

CO2 Illustrate the concepts of real gas behavior

CO3 Apply the general concepts of combustion reactions and chemical equilibrium of ideal gases.

CO4 Analyze power cycles

CO5 Apply the working principles of direct energy conversion techniques

Minors	THERMAL ENGINEERING	L	T	P	C
		3	0	0	3

Course objectives:

1. To give insight into basic laws of thermodynamics along with the working principles of boilers
2. To impart knowledge about the standard cycles and IC engine parts
3. To make the students learn the working principles of steam nozzles, turbines and compressors
4. To impart the knowledge about the various types of compressors
5. To make the students gain insights about gas turbines, rockets and jet propulsion.

UNIT – 1 **Air standard Cycles:** Otto, diesel and dual cycles, its comparison, Brayton cycle

Actual Cycles and their Analysis: Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blowdown-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines.

UNIT – 2 **I.C ENGINES:** Classification - Working principles of SI and CI engines, Valve and Port Timing Diagrams, -Engine systems – Fuel, Carburettor, Fuel Injection System, Ignition, Cooling and Lubrication, principles of supercharging and turbocharging, Measurement, Testing and Performance.

Boilers: Principles of L.P & H.P boilers, mountings and accessories, Draught- induced and forced.

UNIT – 3 **Steam nozzles:** Functions, applications, types, flow through nozzles, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape, Wilson line.

Steam turbines: Classification – impulse turbine; velocity diagram, effect of friction, blade or diagram efficiency, De-leval turbine - methods to reduce rotor speed, combined velocity diagram. Reaction turbine: Principle of operation, thermodynamic analysis of a stage, velocity diagram, Parson's reaction turbine – condition for maximum efficiency.

Steam condensers: Classification, working principles of different types – vacuum efficiency and condenser efficiency.

UNIT – 4 **Compressors:** Classification, positive displacement, and non-positive displacement type, Reciprocating type - Principle, multi-stage compression, Rotary type – Lysholm compressor –principle and efficiency considerations.

Centrifugal Compressors: Principle, velocity and pressure variation, velocity diagrams.

Axial flow Compressors: Principle, pressure rise and efficiency calculations.

UNIT – 5 **Gas Turbines:** Simple gas turbine plant – ideal cycle, components –regeneration, inter cooling and reheating.

Jet Propulsion: Principle, classification, t-s diagram - turbo jet engines –thermodynamic cycle, performance evaluation.

Rockets: Principle, classification, propellant type, thrust, propulsive efficiency, solid and liquid propellant rocket engines.

TEXT BOOKS:

1. Thermal Engineering - Mahesh Rathore- McGraw Hill publishers
2. Heat Engineering /V.P Vasandani and D.S Kumar/Metropolitan Book Company, New Delhi.

REFERENCES:

1. Engineering Thermodynamics, PK Nag, TMH.
2. I.C. Engines - V. Ganesan- Tata McGraw Hill Publishers
3. Thermal Engineering-M.L.Mathur& Mehta/Jain bros. Publishers
4. Thermal Engineering-P.L.Ballaney/ Khanna publishers.
5. Thermal Engineering / RK Rajput/ Lakshmi Publications
6. Thermal Engineering-R.S Khurmi, &J S Gupta/S.Chand.

Course Outcomes: By the end of this course, the student will be able to:

CO1 Explain the basic concepts of thermodynamic laws and boilers.
CO2 Get knowledge about standard cycles and IC Engines.
CO3 Discuss the concepts of steam nozzles and steam turbines and steam condensers.
CO4 Gain knowledge about the concepts of compressors.
CO5 Acquire insights about gas turbines, jet propulsion and rockets.

Minors	MATERIAL SCIENCE AND METALLURGY	L	T	P	C
		3	0	0	3

Course objectives:

1. To provide a fundamental understanding of the structure of metals, metallic bonding, crystal structures, and the significance of grain boundaries and defects in determining material properties.
2. To introduce the principles of alloy formation, types of solid solutions, and interpretation of phase diagrams including binary systems and phase transformations.
3. To impart knowledge on the structure, classification, and properties of ferrous and non-ferrous metals and alloys, including specialized alloys like superalloys.
4. To explain various heat treatment processes and their effects on the microstructure and mechanical properties of alloys.
5. To introduce the principles, processes, and applications of powder metallurgy in modern manufacturing. and To explore the structure, properties, and manufacturing techniques of ceramic and composite materials, including nanomaterials and their engineering applications.

UNIT – 1 Structure of Metals and Constitution of Alloys: Bonds in Solids, Metallic bond, crystallization of metals, Packing Factor – SC, BCC, FCC& HCP-line density, plane density. Grain and grain boundaries, the effect of grain boundaries on the Properties of metal/alloys – determination of grain size. Imperfections – point, line, surface, and volume-Slip and Twinning. Necessity of alloying, types of solid solutions, Hume Rotherys rules, intermediate alloy phases, and electron compounds

Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, the relationship between equilibrium diagrams, and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe3C.

UNIT – 2 Ferrous metals and Alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron, and Alloy cast irons. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

Non-ferrous Metals and Alloys: Structure and properties of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium, and its alloys, Super alloys.

UNIT – 3 Heat treatment of Alloys: Effect of alloying elements on Fe-Fe3C system, Annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface–hardening methods, Age hardening treatment, Cryogenic treatment of alloys.

UNIT – 4 Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization Granulation – Reduction - Electrolytic Deposition. Compacting methods – Sintering – Methods of manufacturing sintered parts. Sintering Secondary operations, coining, machining -Factors determining the use of powder metallurgy-Application of this process.

UNIT – 5 Ceramic and composite Materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, various methods of component manufacture of composites, particle–reinforced materials, fiber-reinforced materials, metal-ceramic mixtures, metal–matrix composites and C – C composites. Nanomaterials – definition, properties and applications.

TEXT BOOKS:

1. Introduction to Physical Metallurgy - Sidney H. Avener - McGrawHill
2. Essential of Materials science and engineering - Donald R.Askeland - Cengage.

REFERENCES:

1. Material Science and Metallurgy – Dr. V.D.Kodgire.
2. Materials Science and engineering - Callister & Baalasubrahmanyam
3. Material Science for Engineering students – Fischer – Elsevier Publishers
4. Material science and Engineering - V. Rahghavan
5. Introduction to Material Science and Engineering – Yip-Wah Chung CRC Press
6. Material Science and Metallurgy – A V K Suryanarayana – B S Publications
7. Material Science and Metallurgy – U. C. Jindal – Pearson Publications

Course Outcomes: By the end of this course, the student will be able to:

CO1 Understand Metal Crystalline Structures: Learn about the crystal structures of various metals and examine how different alloy systems stabilize phases.

CO2 Study Ferrous and Non-Ferrous Metals: Explore the properties and uses of both ferrous and non-ferrous metals and alloys across different industries.

CO3 Analyze Heat Treatment Effects: Understand how heat treatment and the addition of alloying elements affect the properties of ferrous metals, such as strength and hardness.

CO4 Learn Metal Powder Production: Grasp the techniques used to produce metal powders and understand the applications of powder metallurgy in manufacturing processes.

CO5 Explore Advanced Materials: Gain knowledge about the properties and uses of advanced materials like ceramics and composites, and understand their applications in various industries.

Minors	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand Linear Programming models
2. Learn Transportation and sequencing problems
3. Solve replacement problems and analyze games theory models
4. Understand waiting line and project management problems
5. Learn dynamic programming and simulation.

UNIT – 1 **INTRODUCTION** - definition– characteristics and phases – types of operation research models – applications.
Linear programming: Problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT – 2 **TRANSPORTATION PROBLEM:** Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.
SEQUENCING – Introduction – flow –shop sequencing – *n* jobs through two machines – *n* jobs through three machines – job shop sequencing – two jobs through 'm' machines.

UNIT – 3 **REPLACEMENT THEORY:** Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.
GAME THEORY: Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.

UNIT – 4 **WAITING LINES:** Introduction – single channel – poison arrivals – exponential service times – with infinite population and finite population models– multichannel – poison arrivals – exponential service times with infinite population single channel.
PROJECT MANAGEMENT: Basics for construction of network diagram, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats- Project crashing and its procedure.

UNIT – 5 **DYNAMIC PROGRAMMING:** Introduction – Bellman's principle of optimality – applications of dynamic programming-shortest path problem – linear programming problem.
SIMULATION: Definition – types of simulation models – phases of simulation– applications of simulation – inventory and queuing problems – advantages and disadvantages

TEXT BOOKS:

1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.Sharma-Kedarnath/McMillan publishers India Ltd

REFERENCES:

1. Introduction to O.R/Hiller &Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman/Wiley

4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.
6. Operation Research /J.K.Sharma/Macmillan Publ.
7. Operations Research/ Pai/ Oxford Publications
8. Operations Research/S Kalavathy / Vikas Publishers
9. Operations Research / DS Cheema/University Science Press
10. Operations Research / Ravindran, Philips, Solberg / Wiley publishers

Course Outcomes: By the end of this course, the student will be able to:

CO1 Understand Linear Programming models
CO2 Interpret Transportation and sequencing problems
CO3 Solve replacement problems and analyze queuing models
CO4 Understand game theory and inventory problems
CO5 Interpret dynamic programming and simulation.

Minors	MANUFACTURING PROCESS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

1. To impart practical knowledge of pattern design and sand casting processes.
2. To familiarize students with welding techniques such as gas cutting, arc welding, TIG/MIG, and resistance spot welding.
3. To introduce molding techniques including injection and blow molding, along with sheet metal operations.
4. To provide exposure to modern and traditional manufacturing techniques including powder metallurgy, brazing, and plastic molding.
5. To develop hands-on skills in various forming, joining, and casting methods used in manufacturing industries.

List of experiments:

1. Design and making ofpattern
   - i. Single piece pattern
   - ii. Split pattern
2. Sand properties testing
   - i. Sieve analysis (dry sand)
   - ii. Clay content test
   - iii. Moisture content test
   - iv. Strength test (Compression test & Shear test)
   - v. Permeability test
3. Mould preparation
   - i. Straight pipe
   - ii. Bent pipe
   - iii. Dumble
   - iv. Gear blank
4. Gas cutting and welding
5. Manual metal arcwelding
   - i. Lapjoint
   - ii. Buttjoint
6. Injection Molding
7. Blow Molding
8. Simple models using sheet metal operations
9. Study of deep drawing and extrusion operations
10. Study of Basic powder compaction and sintering
11. Study of TIG/MIG Welding
12. Study of Resistance Spot Welding
13. Study of Brazing and soldering
14. Study of Plastic Moulding Process.

Course Outcomes: By the end of this course, the student will be able to:

- **CO1** Design and fabricate various patterns and prepare molds for basic castings.
- **CO2** Perform and interpret sand testing procedures to evaluate molding sand properties.
- **CO3** Demonstrate competency in basic welding processes and identify suitable joints for various applications.
- **CO4** Understand and perform injection/blow molding and sheet metal operations for manufacturing simple components.
- **CO5** Analyze and understand advanced manufacturing processes such as powder compaction, deep drawing, extrusion, and plastic molding.

Minors	CAD/CAM LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

1. To experiment with trusses and beams to determine stress, deflection, natural frequencies, harmonic analysis, HT analysis and buckling analysis.
2. To demonstrate part programmes using FANUC controller.
3. To generate G-code for automated tool path using CAM software.
4. To demonstrate with rapid prototyping machine and to print simple parts.
5. To experiment with virtual 3D printing simulation using Vlabs.

List of Experiments

1. Determination of deflection and stresses in 2D and 3D trusses and beams.
2. Determination of principal and Von-mises stresses in plane stress, plane strain and axisymmetric components.
3. Determination of stresses in 3D and shell structures (at least one example in each case)
4. Estimation of natural frequencies and mode shapes, harmonic response of 2D beam.
5. Steady state heat transfer analysis of plane and axisymmetric components.
6. Buckling analysis
7. CNC part programming for turned components using FANUC Controller

(i) Plain turning and facing
(ii) Step Turning Operation
(iii) Taper turning

8. CNC programming for milled components using FANUC Controller

(i) Circular interpolation
(ii) End milling
(iii) Pocket milling

9. Automated CNC Tool path and G-Code generation using CAM packages.
10. Study and demonstration of RP machine-creation of simple parts.
11. Virtual 3D Printing Simulation lab using Vlabs.

https://3dp-dei.vlabs.ac.in/List%20of%20experiments.html

Course Outcomes: By the end of this course, the student will be able to:

CO1 Apply finite element analysis (FEA) techniques to determine deflection, stresses, and strain distributions in 2D and 3D structural components such as trusses, beams, and shells.

CO2 Analyze principal and Von Mises stresses in components under plane stress, plane strain, and axisymmetric conditions using computational tools.

CO3 Perform dynamic analysis including natural frequency estimation, mode shapes, and harmonic response of mechanical structures.

CO4 Develop and execute CNC part programs for turning and milling operations using FANUC controllers and CAM software for automated toolpath generation.

CO5 Demonstrate understanding of additive manufacturing technologies through virtual 3D printing simulations and hands-on experimentation with RP machines.

Minors	THERMAL ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

1. To demonstrate the characteristics of two stroke and four stroke compression and spark ignition engines.
2. To determine flash point, fire point, calorific value of different fuels using various apparatus.
3. To find out engine friction, and conduct load test of petrol and diesel engines.
4. To demonstrate performance test on petrol and diesel engines.
5. To conduct performance test and determine efficiency of air compressor.

List of Experiments:

1. To determine the actual Valve Timing diagram of a four stroke Compression/Spark Ignition Engine.
2. To determine the actual Port Timing diagram of a two stroke Compression/Spark Ignition Engine.
3. Determination of Flash & Fire points of Liquid fuels / Lubricants using (i) Abels Apparatus; (ii) Pensky Martin's apparatus and (iii) Cleveland's apparatus.
4. Determination of Viscosity of Liquid lubricants/Fuels using (i) Saybolt Viscometer and (ii) Redwood Viscometer.
5. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol/diesel engine.
6. To perform the Heat Balance Test on Single Cylinder four Stroke Petrol/Diesel Engine.
7. To conduct a load test on a single cylinder Petrol/Diesel engine to study its performance under various loads.
8. To conduct a performance test on a VCR engine, under different compression ratios and determine its heat balance sheet.
9. To conduct a performance test on an air compressor and determine its different efficiencies.
10. Study of boilers with accessories and mountings
11. Experimentation on installation of Solar PV Cells
12. Demonstration of electronic controls in an automobile

Course Outcomes: By the end of this course, the student will be able to:

CO1 Experiment with two stroke and four stroke compression and spark ignition engines for various characteristics.

CO2 Determine flash point, fire point, calorific value of different fuels using various apparatu

CO3 Perform engine friction, heat balance test, load test of petrol and diesel engines.

CO4 Conduct performance test on petrol and diesel engines

CO5 Perform test and determine efficiency of air compressor

Minors	THEORY OF MACHINES LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

1. To introduce students to experimental techniques used to analyze dynamic and kinematic behavior of mechanical systems.
2. To provide practical understanding of governors, gyroscopes, vibrations, and balancing of rotating masses.
3. To enhance knowledge of mechanical advantage, efficiency, and motion transmission through gears, cams, and mechanisms.
4. To develop competency in measuring forces, speeds, friction, and inertia in mechanical systems.
5. To apply theoretical principles to real-world mechanical systems and validate them through experiments.

List of Experiments:

1. To determine whirling speed of shaft theoretically and experimentally.
2. To determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation.
3. To analyse the motion of a motorized gyroscope when the couple is applied along its spin axis
4. To determine the frequency of undamped free vibration of an equivalent spring mass system.
5. To determine the frequency of damped force vibration of a spring mass system
6. To study the static and dynamic balancing using rigid blocks.
7. To find the moment of inertia of a flywheel
8. To plot follower displacement vs cam rotation for various Cam Follower systems.
9. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/Four bar mechanism
10. To find the coefficient of friction between the belt and pulley.
11. To study simple and compound screw jack and determine the mechanical advantage, velocity ratio, and efficiency
12. To study various types of gears- Spur, Helical, Worm and Bevel Gears

Course Outcomes: By the end of this course, the student will be able to:

- **CO1** Determine and analyze critical speeds, dynamic balancing, and gyroscopic effects in rotatir systems.
- **CO2** Experimentally evaluate the behavior of governors and spring-mass systems under vario operating conditions.
- **CO3** Analyze cam-follower and slider-crank mechanisms to obtain displacement, velocity, ar acceleration profiles.
- **CO4** Measure and interpret mechanical parameters such as moment of inertia, coefficient of frictio and system efficiency.
- **CO5** Identify and understand the function and applications of various gears and mechanical pow transmission components.