Miracle Educational Society Group of Institutions(A)

Bhoghapuram-535216

DEPARTMENT OF BASIC SCIENCE & HUMANITIES

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Course Structure & Syllabus for

BS&H- MECHANICAL ENGINEERING (Regular-Full time)

(Effective for the students admitted into I year from the Academic Year 2024-25 onwards)

Academic Regulations (R23)

Academic Regulations (R23) for B. Tech (Regular-Full time)

(Effective for the students admitted into I year from
the Academic Year **2023-24** 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 four academic years and not more than eight 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 for graduation (Eight years).

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

(b) **Award of B.Tech. degree with Honors** if he/she fulfils the following:

(i) Student secures additional 15 credits fulfilling all the requisites of a B.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 in B.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, qualifications and 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 student in 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 hours of 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 students to 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 Courses	Foundation courses	Includes Mathematics, Physics and Chemistry; fundamental engineering courses; humanities, social sciences and management courses
2.	Core Courses	Professional Core Courses (PC)	Includes subjects related to the parent discipline/department/branch of Engineering
3.	Elective Courses	Professional Elective Courses (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 skill enhancement courses (SEC)	interdisciplinary/job-oriented/domain courses which are 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 of 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 NSS /NSS /Scouts & Guides / Community service activities are made mandatory as credit courses for all the undergraduate students.

vi. Courses like Environmental Sciences, Indian Constitution, 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 credit courses 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 five skill 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 University for the students having good academic record.

xvi. Each college shall take measures 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 advanced concept through remote experimentation. Student shall be made to work on virtual lab experiments during the regular labs.

xvii. Each college shall 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 shall be 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, 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. In case 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 70 marks for the End-Examination.
ii) For practical subject, the distribution shall be 30 marks for Internal Evaluation and 70 marks for the End- Examination.
iii) If any course contains two different branch subjects, the syllabus shall be written in two 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 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 for 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 weightage of 10 marks. Any fraction shall be rounded off to the next higher mark.
- The objective paper shall be conducted by the respective institution on the day of subjective paper test.
- Assignments shall be in the form of problems, mini projects, design problems, slip tests, quizzes etc., depending on the course content. It should be continuous assessment throughout the semester and the average marks shall be considered.

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: Absent
Marks 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 of 20marks such that each question carries 2 marks.
iii) There shall be 2 short answer questions from each unit.
a) 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.
iv) The questions from 2 to 6 shall be set by covering one unit of the syllabus for each question.

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 35 marks each.
ii) In each part, question 1 shall contain 5 compulsory short answer questions for a total of 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 marks each. 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**

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

c) Day-to-day work in the laboratory shall be evaluated for 15 marks by the concerned laboratory teacher based on the record/viva and 15 marks for the internal test.

d) The end examination shall be evaluated for 70 marks, conducted by the concerned laboratory teacher and a senior expert in the subject from the same department.
   - 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 single laboratory 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.

e) 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 teacher based 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 with weightage of 80% to better mid marks and 20% for the other. The subjective paper shall contain 3 either or type questions of equal weightage of 5 marks. There shall be no objective paper in mid semester examination. The sum of day-to-day evaluation 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 with the syllabus.

f) 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.

g) The laboratory records and mid semester test papers shall be preserved for a minimum of 3 years in the respective institutions as per the University norms and shall be produced to the Committees of the University as and when the same are asked for.

10. 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 the remaining 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 shall be 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 the course. A committee consisting of the Head of the Department, coordinator and a senior Faculty member nominated by the Head of the Department shall monitor the evaluation 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 offered by 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 the agency. 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 equivalent marks/grades.

vi) The recommended courses offered by external agencies, conversions and appropriate grades/marks are to be approved by the University at the beginning of the semester. The principal of the respective college shall forward such proposals to the University for approval.

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 University.

11. Massive Open Online Courses (MOOCs):

A Student has to pursue and complete one course compulsorily through MOOCs approved by the University. 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) offered through 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 student needs to earn a certificate by passing the exam. The student shall be awarded the credits assigned 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 MOOCs platform 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 university.

Necessary amendments in rules and regulations regarding adoption of MOOC courses would 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 University 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 University shall offer credit mobility for MOOCs and give the equivalent credit weightage to the students for the credits earned through online learning courses.
ii) Student registration for the MOOCs shall be only through the respective department of the institution, 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 University/institution shall notify at the beginning of semester the list of the online learning courses eligible for credit transfer.
vi) The institution shall designate a faculty member as a Mentor for each course to guide the students from registration till completion of the credit course.
vii) The university shall ensure no overlap of MOOC exams with that of the university examination schedule. In case of delay in results, the university will re-issue the marks sheet for such students.
viii) Student pursuing courses under MOOCs shall acquire the required credits only

after successful completion of the course and submitting a certificate issued by the competent authority along with the percentage of marks and grades.

ix) The institution shall submit the following to the examination section of the university:
   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 universities 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 University from time to time.

13. Academic Bank of Credits (ABC)

The University 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 digital platforms.
iii. facilitate award of certificate/diploma/degree in line with the accumulated credits in ABC
iv. execute Multiple Entry and Exit system with credit count, credit transfer and credit acceptance from students' 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 shall be 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 the end of second year (Community Service Project) shall be society oriented and shall be completed 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 faculty member 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% weightage each. 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 University.

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 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 showcased at the department for the benefit of all students and staff and the same is to be evaluated by 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-Voce Examination conducted in the presence of internal examiner and external examiner appointed by the University and is evaluated for 140 marks.

The college shall facilitate and monitor the student internship programs. Completion of internships is mandatory, if any student fails to complete internship, he/she will not be eligible 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 maybe waived for students who have done similar/equivalent courses. 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 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 and research.

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 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 two subjects per semester pertaining to the Honors from V Semester onwards.
iv) The concerned Principal of the college shall 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 courses offered under Honors either in the college or in online platforms like SWAYAM with a minimum duration of 12 weeks for a 3-credit course and 8 weeks duration for a 2-credit course satisfying the criteria for credit mobility. If the courses under Honors are offered in conventional mode, then 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.
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 sheet mentioning 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

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 CGPA obtained in the major degree program. CGPA shall be taken up to III semester in case of regular entry students and only III semester in case of lateral entry students. Students having 7 CGPA 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. The whole process should be completed within one week before the start of every semester. 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 students to monitor the progress.
iv) There is no fee for registration of subjects for Honors program offered in offline at the respective institutions.

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 University.
iv) Students whose shortage of attendance is not condoned in any semester are not eligible 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.

18. For induction programme attendance shall be maintained as per AICTE norms. 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 university 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 may be 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 using the 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 be converted 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 marks in the subject fall	Grade	Grade points Assigned
90 & above	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 and will be required to reappear for that subject when it is offered 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.,

$$SGPA = \Sigma (C_i \times G_i)/\Sigma C_i$$

where, C_i is the number of credits of the i^{th} subject and G_i is the grade point scored by the student in the i^{th} 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.,

$$CGPA = \Sigma (C_i \times S_i)/ \Sigma C_i$$

where "S_i" is the SGPA of the i^{th} semester and C_i 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.

While computing the SGPA the subjects in which the student is awarded Zero grade points will also be included.

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 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 one of the following four classes:

Class Awarded	CGPA Secured
First Class with Distinction	≥ 7.5
First Class	≥ 6.5 < 7.5
Second Class	≥ 5.5 < 6.5
Pass Class	≥ 5.0 < 5.5

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 university or if any case of indiscipline or malpractice is pending against him/her, the result of the candidate shall be withheld in such cases.

21. Multiple Entry / Exit Option

(a) Exit Policy:

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

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 acquire job-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 acquire job-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 outstanding students 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 most and these two years would not be counted for the time for the maximum time for graduation. The principal of the respective college shall forward such proposals submitted by the students to the University. An evaluation committee constituted by the University 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 have been detained for want of attendance or not fulfilled academic requirements or who have 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 or equivalent 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 are readmitted.

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:

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

*** *** ***

ACADEMIC REGULATIONS (R23)

FOR B. TECH. (LATERAL ENTRY SCHEME)

*(Effective for the students admitted into II year through Lateral Entry Scheme from the Academic Year **2024-25** 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 not more 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 for graduation (Six years).

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

(b) **Award of B.Tech. degree with Honors** if he/she fulfils the following:

(i) Student secures additional 15 credits fulfilling all the requisites of a B.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 six consecutive 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 end examination 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 academic year, 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 student may 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).

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY GURAJADA
VIZIANAGARAM-535 003, A.P
(Established by Andhra Pradesh Act No.22 of 2021)

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B. Tech (Regular-Full time)

(Mechanical & Automobile Engineering)

(Effective for the students admitted into I year from the Academic Year **2023-24** onwards)

B.TECH. - COURSE STRUCTURE – R23
(Applicable from the academic year 2023-24 onwards)

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 Counseling	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

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VIZIANAGARAM–535003Andhra Pradesh (India)
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Group-B

B.TECH- Mechanical & Automobile Engineering

I Year I Semester						
S.No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1.	R23BS01	Linear Algebra & Calculus	3	0	0	3
2.	R23BS04	Engineering Chemistry	3	0	0	3
3.	R23ES07	Introduction to Programming	3	0	0	3
4.	R23ES03	Engineering Graphics	1	0	4	3
5.	R23ES04	Basic Electrical & Electronics Engineering	3	0	0	3
6.	R23BS04	Engineering Chemistry Lab	0	0	2	1
7.	R23ES07	Computer Programming Lab	0	0	3	1.5
8.	R23ES05	Electrical &Electronics Engineering Workshop	0	0	3	1.5
9.	R23MC02	NSS/NCC/Scouts &Guides/Community Service	0	0	1	0.5
		Total				**19.5**

I Year II Semester						
S.No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1.	R23BS02	Differential Equations and Vector Calculus	3	0	0	3
2.	R23BS03	Engineering Physics	3	0	0	3
3.	R23HS01	Communicative English	2	0	0	2
4.	R23ES01	Basic Civil & Mechanical Engineering	3	0	0	3
5.	R23PC01	Engineering Mechanics	3	0	0	3
6.	R23HS01	Communicative English Lab	0	0	2	1
7.	R23BS03	Engineering Physics Lab	0	0	2	1
8.	R23ES06	IT workshop	0	0	2	1
9.	R23ES02	Engineering Workshop	0	0	3	1.5
10.	R23PC01	Engineering Mechanics Lab	0	0	3	1.5
11.	R23MC01	Health and Wellness, Yoga and Sports	0	0	1	0.5
		Total				**20.5**

I Year-I Semester

L	T	P	C
3	0	0	3

LINEAR ALGEBRA & CALCULUS

(Common to All Branches of Engineering)

Course Objectives:

To equip the students with standard concepts and tools of mathematics to handle various real-world problems and their applications.

Course Outcomes:

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

- develop matrix algebra techniques that is needed by engineers for practical applications.
- to find the eigen values and eigen vectors and solve the problems by using linear transformation
- learn important tools of calculus in higher dimensions.
- familiarize with functions of several variables which is useful in optimization.
- familiarize with double and triple integrals of functions of several variables in two and three dimensions.

UNIT - I: Matrices

Rank of a matrix by echelon form, 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 by Gauss elimination method, Gauss Seidel Iteration Method.

UNIT- II: Linear Transformation and Orthogonal Transformation:

Eigen values, Eigen vectors and their properties(without Proof), Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation

UNIT- III : Calculus

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

UNIT- IV : Partial differentiation and Applications (Multi variable calculus)

Partial derivatives, total derivatives, chain rule, change of variables, Taylor's and Maclaurin's series expansion of functions of two variables. Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

UNIT – V : Multiple Integrals (Multi variable Calculus)

Duble integrals - change of variables (Cartesian and Polar coordinates), Change of order of integration, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

Text books:

1. B.S.Grewal,HigherEngineeringMathematics,44/e,KhannaPublishers,2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e,John Wiley & Sons, 2018.

Reference Books:

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

I Year-I Semester

L	T	P	C
3	0	0	3

ENGINEERING CHEMISTRY

Course Objectives:

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

.

Course Outcomes: At the end of the course, the students will be able to

CO1: Demonstrate the corrosion prevention methods and factors affecting corrosion.

CO2: Explain the preparation, properties, and applications of thermoplastics & thermosetting, elastomers & conducting polymers.

CO3: Explain calorific values, octane number, refining of petroleum and cracking of oils.

CO4: Explain the setting and hardening of cement.

CO5: Summarize the concepts of colloids, micelle and nanomaterials.

UNIT I Water Technology

Soft and hardwater, 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 processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

UNIT II Electrochemistry and Applications

Electrodes –electrochemical cell, Nernst equation, cell potential calculations.

Primary cells – Zinc-air battery, Secondary cells – Nickel-Cadmium (NiCad),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 electro less plating (Nickel and Copper).

UNIT III Polymers and Fuel Chemistry

Introduction to polymers, functionality of monomers, Mechanism of chain growth, step growth polymerization.

Thermoplastics and Thermo-setting plastics-: Preparation, properties and applications of poly styrene. PVC Nylon 6,6 and Bakelite.

Elastomers – Preparation, properties and applications of Buna S, Buna N, Thiokol rubbers.

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, nanometals and nanometal oxides, micelle formation, synthesis of colloids (Braggs Method), chemical and biological methods of preparation of nanometals and metal oxides, stabilization of colloids and nanomaterials by stabilizing agents, adsorption isotherm (Freundlich and Longmuir), BET equation (no derivation) applications of colloids and nanomaterials – catalysis, medicine, sensors, etc.

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

L	T	P	C
3	0	0	3

I Year-I Semester

INTRODUCTION TO PROGRAMMING
(Common to All branches of Engineering)

Course Objectives:

The objectives of this course is to acquire knowledge on the
i. To impart adequate knowledge on the need of programming languages and problem-solving techniques and develop programming skills.
ii. To enable effective usage of Control Structures and Implement different operations on arrays.
iii. To demonstrate the use of Strings and Functions.
iv. To impart the knowledge of pointers and understand the principles of dynamic memory allocation.
v. To understand structures and unions and illustrate the file concepts and its operations.
vi. To impart the Knowledge Searching and Sorting Techniques

UNIT-I Introduction to Computer Problem Solving:
Programs and Algorithms, Computer Problem Solving Requirements, Phases of Problem Solving, Problem. Solving Strategies, Top-Down Approach, Algorithm Designing, Program Verification, Improving Efficiency, Algorithm Analysis and Notations.

UNIT-II Introduction to C Programming:
Introduction, Structure of a C Program. Comments, Keywords, Identifiers, Data Types, Variables, Constants, Input/output Statements. Operators, Type Conversion. Control Flow, Relational Expressions: Conditional Branching Statements: if, if-else, if-else—if, switch. Basic Loop Structures: while, do-while loops, for loop, nested loops, The Break and Continue Statements, goto statement**.**

UNIT-III Arrays:
Introduction, Operations on Arrays, Arrays as Function Arguments, Two Dimensional Arrays, Multidimensional Arrays. Pointers: Concept of a Pointer, Declaring and Initializing Pointer Variables, Pointer Expressions and Address Arithmetic, Null Pointers, Generic Pointers, Pointers as Function Arguments, Pointers and Arrays, Pointer to Pointer, Dynamic Memory Allocation, Dangling Pointer, Command Line Arguments.

UNIT-IV Functions:
Introduction Function : Declaration, Function Definition, Function Call, Categories of Functions, Passing Parameters to Functions, Scope of Variables, Variable Storage Classes. Recursion. Strings: String Fundamentals, String Processing with and without Library Functions, Pointers and Strings.

UNIT-V
Structures, Unions, Bit Fields:Introduction, Nested Structures, Arrays of Structures, Structures

and Functions, Self-Referential Structures, Unions, Enumerated Data Type —Enum variables, Using Typedef keyword, Bit Fields. Data Files: Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files, Random File Access.

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

Course Outcomes:
At the end of the Course, Student should be able to:
i . Illustrate the Fundamental concepts of Computers and basics of computer programming and problem-solving approach
ii. Understand the Control Structures, branching and looping statements
iii. Use of Arrays and Pointers in solving complex problems.
iv. Develop Modular program aspects and Strings fundamentals.
v. Demonstrate the ideas of User Defined Data types, files. Solve real world problems using the concept of Structures, Unions and File operations.

Text Books:
1. A Structured Programming Approach Using C, Forouzan, Gilberg, Cengage.
2. How to solve it by Computer, R. G. Dromey, and Pearson Education.
3. Programming In C A-Practia1 Approach. Ajay Mittal, Pearson

References:
1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. Computer Programming. Reema Thareja, Oxford University Press
3. The C Programming Language, Dennis Richie And Brian Kernighan, Pearson Education.
4. Programming In C, Ashok Kamthane, Second Edition, Pearson Publication.
5. Let us C ,YaswanthKanetkar, 16th Edition,BPB Publication.
6.Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education, 2008

Web References:
1. http://www.c4learn.com/
2. http://www.geeksforgeeks.org/c/
3. http://nptel.ac.in/courses/122104019/
4. http://www.learn-c.org/
5. https://www.tutorialspoint.com/cprogramming/

I Year-I Semester

L	T	P	C
1	0	4	3

ENGINEERING GRAPHICS
(Common to All branches of Engineering)

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 solids and Developments of surfaces.
- To make the students understand the viewing perception of a solid object in Isometric and Perspective projections.

Course Outcomes:

CO1: Understand the principles of engineering drawing, including engineering curves, scales, orthographic and isometric projections.
CO2: Draw and interpret orthographic projections of points, lines, planes and solids in front, top and side views.
CO3: Understand and draw projection of solids in various positions in first quadrant.
CO4: Explain principles behind development of surfaces.
CO5: Prepare isometric and perspective sections of simple solids.

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: Polyhedra 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 line development. 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 ofobjects including PCB and Transformations using 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, Tata McGraw Hill, 2017.

I Year-I Semester

L	T	P	C
3	0	0	3

BASIC ELECTRICAL & ELECTRONICS ENGINEERING
(Common to All branches of 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 the completion of the course students will be able to

Course Outcomes:
CO1: Remember the fundamental laws, operating principles of motors, generators, MC and MI instruments.
CO2: Understand the problem solving concepts associated to AC and DC circuits, construction and operation of AC and DC machines, measuring instruments; different power generation mechanisms, Electricity billing concept and important safety measures related to electrical operations.
CO3: Apply mathematical tools and fundamental concepts to derive various equations related to machines, circuits and measuring instruments; electricity bill calculations and layout representation of electrical power systems.
CO4: Analyze different electrical circuits, performance of machines and measuring instruments.
CO5: Evaluate different circuit configurations, Machine performance and Power systems operation.

PART A: BASIC ELECTRICAL ENGINEERING

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.

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.

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

Rectifiers and power supplies: 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, Registers and counters (Elementary Treatment only)

Textbooks:

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

Reference Books:

1. R. S. Sedha, A Textbook of Electronic Devices and Circuits, S. Chand & Co, 2010.
2. Santiram Kal, Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India, 2002.
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education,2009.

L	T	P	C
0	0	2	1

I Year-I Semester

ENGINEERING CHEMISTRY LAB

Course Objectives:

- To verify the fundamental concepts with experiments

Course Outcomes: At the end of the course, the students will be able to
CO1: Determine the cell constant and conductance of solutions.
CO2: Prepare advanced polymer materials.
CO3: Determine the physical properties like surface tension, adsorption and viscosity.
CO4: Estimate the Iron and Calcium in cement.
CO5: Calculate the hardness of water.

List of Experiments:

1. Determination of Hardness of a groundwater sample.
2. Estimation of Dissolved Oxygen by Winkler's method
3. Determination of Strength of an acid in Pb-Acid battery
4. Preparation of a polymer (Bakelite)
5. Determination of percentage of Iron in Cement sample by colorimetry
6. Estimation of Calcium in port land Cement
7. Preparation of nanomaterials by precipitation method.
8. Adsorption of acetic acid by charcoal
9. Determination of percentage Moisture content in a coal sample
10. Determination of Viscosity of lubricating oil by Redwood Viscometer 1
11. Determination of Viscosity of lubricating oil by Redwood Viscometer 2
12. Determination of Calorific value of gases by Junker's gas Calorimeter

Reference:

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

I Year-I Semester

L	T	P	C
0	0	3	1.5

COMPUTER PROGRAMMING LAB
(Common to All branches of Engineering)

Course Objectives:

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

Course Outcomes:
CO1: Read, understand, and trace the execution of programs written in C language.
CO2: Select the right control structure for solving the problem.
CO3: Develop C programs which utilize memory efficiently using programming constructs like pointers.
CO4: Develop, Debug and Execute programs to demonstrate the applications of arrays, functions, basic concepts of pointers in C.

UNIT I

WEEK 1
Objective: Getting familiar with the programming environment on the computer and writing the 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) Exposure to Turbo C, gcc
iii) Writing simple programs using printf(), scanf()

WEEK 2
Objective: Getting familiar with how to formally describe a solution to a problem in a series of finite steps both using textual notation and graphic notation.

Suggested Experiments /Activities:
Tutorial 2: Problem-solving using Algorithms and Flow charts.
Lab 1: 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 & constants and 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 each of 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. Gain experience 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 Eulers theorem.

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's method

WEEK 12:
Objective: Explore how recursive solutions can be programmed by writing recursive functions that 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 other characters using pointers.

WEEK14:
Objective: To understand data files and file handling with various file I/O functions. Explore the differences 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() and fwrite()
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-line arguments.
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.

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 Year-I Semester

L	T	P	C
0	0	3	1.5

ELECTRICAL & ELECTRONICS ENGINEERING WORKSHOP
(Common to All branches of Engineering)

Course Objectives:

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

Course Outcomes:

CO1: Understand the Electrical circuit design concept; measurement of resistance, power, power factor; concept of wiring and operation of Electrical Machines and Transformer.
CO2: Apply the theoretical concepts and operating principles to derive mathematical models for circuits, Electrical machines and measuring instruments; calculations for the measurement of resistance, power and power factor.
CO3: Apply the theoretical concepts to obtain calculations for the measurement of resistance, power and power factor.
CO4: Analyse various characteristics of electrical circuits, electrical machines and measuring instruments.
CO5: Design suitable circuits and methodologies for the measurement of various electrical parameters; Household and commercial wiring.

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

PART A: ELECTRICAL ENGINEERING LAB

List of experiments:

1. Verification of KCL and KVL
2. Verification of Superposition theorem
3. Measurement of Resistance using Wheat stone 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

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: At the end of the course, the student will be able to
CO1: Identify & testing of various electronic components.
CO2: Understand the usage of electronic measuring instruments.
CO3: Plot and discuss the characteristics of various electron devices.
CO4: Explain the operation of a digital circuit.

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.

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 Year-I Semester

L	T	P	C
0	0	1	0.5

NSS/NCC/SCOUTS & GUIDES/COMMUNITY SERVICE
(Common to All branches of Engineering)

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 completion of the 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:

- Evaluated for a total of 100 marks.
- 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, totalling to 90 marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voce on the subject.

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I Year-II Semester

L	T	P	C
3	0	0	3

DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS
(Common to All Branches of Engineering)

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 in to advanced level by handling various real-world applications.

Course Outcomes:

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

- solve the differential equations related to various engineering fields.
- model engineering problems as higher order differential equations and solve analytically.
- identify solution methods for partial differential equations that model physical processes.
- interpret the physical meaning of different operators such as gradient, curl and divergence.
- 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, general particular integral, Wronskean, 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 Linear Partial differential equations with constant coefficients.

UNIT - IV : Vector differentiation

Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions - Divergence and Curl, 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, Divergence theorem (without proof) and applications of these theorems.

Textbooks:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e,John Wiley & Sons, 2018.
2. B.S.Grewal,HigherEngineeringMathematics,44/e,Khanna publishers,2017.

Reference Books:

1. Dennis G.Zill and Warren S.Wright, Advanced Engineering Mathematics, Jones and Bartlett, 2018.
2. Micheael Greenberg, Advanced Engineering Mathematics, 9th edition, Pearson edn
3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 14/e, Pearson Publishers, 2018.
4. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5/e, Alpha Science International Ltd., 2021 (9th reprint).
5. B.V. Ramana, Higher Engineering Mathematics, McGraw Hill Education, 2017

L	T	P	C
3	0	0	3

I Year-II Semester

ENGINEERING PHYSICS

(Common for all branches of Engineering)

Course Objectives:

To bridge the gap between the Physics in school at 10+2 level and UG level engineering courses by identifying the importance of the optical phenomenon like interference, diffraction etc, enlightening the periodic arrangement of atoms in crystalline solids and concepts of quantum mechanics, introduce novel concepts of dielectric and magnetic materials, physics of semiconductors.

Course Outcomes:

CO1: Analyze the intensity variation of light due to polarization, interference and diffraction.
CO2: Familiarize with the basics of crystals and their structures.
CO3: Explain fundamentals of quantum mechanics and apply it to one dimensional motion of particles.
CO4: Summarize various types of polarization of dielectrics and classify the magnetic materials.
CO5: Explain the basic concepts of Quantum Mechanics and the band theory of solids.
CO6: Identify the type of semiconductor using Hall effect.

UNIT I Wave Optics
Interference: Introduction - Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) & applications - Colours in thin films- Newton's Rings, Determination of wavelength and refractive index.
Diffraction: Introduction - Fresnel and Fraunhofer diffractions - Fraunhofer diffraction due to single slit, double slit & N-slits (Qualitative) – Diffraction Grating - Dispersive power and resolving power of Grating (Qualitative). Polarization: Introduction -Types of polarization - Polarization by reflection, refraction and Double refraction - Nicol's Prism -Half wave and Quarter wave plates.

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 - Miller indices – separation between successive (hkl) planes.

X-ray diffraction: Bragg's law - X-ray Diffractometer – crystal structure determination by Laue's and powder methods

UNIT III Dielectric and Magnetic Materials
Dielectric Materials: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility, Dielectric constant and Displacement Vector – Relation between the electric vectors - Types of polarizations- Electronic (Quantitative), Ionic (Quantitative) and Orientation

polarizations (Qualitative) - Lorentz internal field - Clausius- Mossotti equation - complex dielectric constant – Frequency dependence of polarization – dielectric loss

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability – Atomic origin of magnetism - Classification of magnetic materials: Dia, para, Ferro, anti-ferro & Ferri magnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials.

UNIT IV Quantum Mechanics and Free electron Theory

Quantum Mechanics: Dual nature of matter – Heisenberg's Uncertainty Principle – Significance and properties of wave function – Schrodinger's time independent and dependent wave equations– Particle in a one-dimensional infinite potential well.

Free Electron Theory: Classical free electron theory (Qualitative with discussion of merits and demerits) – Quantum free electron theory – electrical conductivity based on quantum free electron theory - Fermi-Dirac distribution - Density of states - Fermi energy

UNIT V Semiconductors

Semiconductors: Formation of energy bands – classification of crystalline solids - Intrinsic semiconductors: Density of charge carriers – Electrical conductivity – Fermi level – Extrinsic semiconductors: density of charge carriers – dependence of Fermi energy on carrier concentration and temperature - Drift and diffusion currents – Einstein's equation – Hall effect and its applications.

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 2021.
2. Engineering Physics - Shatendra Sharma, Jyotsna Sharma, Pearson Education, 2018.
3. Engineering Physics" - Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press. 2010
4. Engineering Physics - M.R. Srinivasan, New Age international publishers (2009).

Web Resources: https://www.loc.gov/rr/scitech/selected-internet/physics.html

L	T	P	C
2	0	0	2

I Year-II Semester

COMMUNICATIVE ENGLISH

(Common to All Branches of Engineering)

Course Objectives:

The main objective of introducing this course, *Communicative English*, is to facilitate using Listening, Reading, Speaking and Writing skills effectively by the students. It should result in their better comprehending abilities, oral presentations, reporting useful information and with enhanced knowledge of grammatical structures and vocabulary. This course helps the students in using speaking and writing (productive) skills more efficiently and to make them industry-ready

Course Outcomes

- **By the end of the course the students will have** Learned how to understand the context, topic, and specific information from social or transactional dialogues.
- Remedially learn applying grammatical structures to formulate sentence sand use appropriate words and correct word forms.
- Using discourse markers to speak clearly on a specific topic in formal as well as informal discussions.(not required)
- Improved communicative competence in formal and informal contexts and for social and academic purposes.
- Critically comprehending and appreciatingading /listening texts and to write summaries based on global comprehension of these texts.
- Writing coherent paragraphs essays, letters/e-mails and resume.

Instructions:

1. The reading texts can be given as podcasts to the students so that their listening skills can be enhanced
2. While listening and reading to the text can be given as homework, the classwork for the students can be to discuss and critically evaluate the texts based on the context, purpose or writing the text and understanding it from the author's as well as reader's point of view.
3. Reading as habit for both academic and non-academic (pleasure) purposes has to be inculcated in the students. So training has to be given in intensive and extensive reading strategies.
4. Writing for both academic (assignments, examinations, reports, e-mails/letters etc)
5. The writing tasks given in the class are to be self and peer evaluated by the students before they are finally graded by the faculty.

   Note: Please note that the texts given here are just contexts for teaching various language skills and sub skills. The students' ability to use language cannot be confined to comprehending or using the language related to the given texts (textbooks). The given texts can be used only for practice.
6. All the activities to develop language skills have to be integrated and interconnected, within each unit and across the units.

7. Use as many supplementary materials as possible in various modes (Audio, visual and printed versions) in the classroom so that the students get multimode input and will how to use language skills in the absence of the teacher.

UNIT I

Lesson: HUMAN VALUES: A Power of a Plate of Rice by Ifeoma Okoye (Short Story)

Listening: Identifying the topic, the context and specific pieces of information by listening to 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.(That has to be part of the bridge course- 2 weeks before the actual academic programme starts)

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

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

UNITII

Lesson: NATURE: Night of the Scorpion by Nissim Ezekiel (Indian and contemporary)

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

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

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the 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.

UNITIII

Lesson: BIOGRAPHY Steve Jobs

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

Speaking: Discussing specific topics in pairs or small groups and reporting whatis discussed

Reading: Readingatextindetailbymakingbasicinferences-recognizingandinterpretingspecific contextclues;strategies touse textclues for comprehension.

Writing: Summarizing, Note-making, paraphrasing

Grammar: Verbs - tenses;subject-verbagreement; 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 of relevant questions that test comprehension.
Speaking: Formal oral presentations on topics from academic on texts
Reading: Reading comprehension.
Writing: Writings structured essays on specific topics.
Grammar: Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject-verb agreement)
Vocabulary: Technical Jargons

Textbooks:

1. Pathfinder: Communicative English for Undergraduate Students, 1st Edition,Orient BlackSwan, 2023 (Units 1,2 & 3)
2. Empowering English by Cengage Publications, 2023 (Units 4 & 5)

Suggestion: Instead of giving the syllabus in the form of textbooks it would be better toprocurethe soft copies of individual texts (stories or poems or biographies and non-fiction texts)by the university and make them available on the university website for registered students to access and download

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 University Press, 2019.
4. Lewis, Norman. Word Power Made Easy- The Complete Handbook for Building a Superior Vocabulary. Anchor, 2014.

Web Resources:
GRAMMAR:

1. www.bbc.co.uk/learningenglish
2. https://dictionary.cambridge.org/grammar/british-grammar/
3. www.eslpod.com/index.html
4. https://www.learngrammar.net/

5. https://english4today.com/english-grammar-online-with-quizzes/
6. https://www.talkenglish.com/grammar/grammar.aspx

VOCABULARY

1. https://www.youtube.com/c/DailyVideoVocabulary/videos
2. https://www.youtube.com/channel/UC4cmBAit8i_NJZE8qK8sfpA

L	T	P	C
3	0	0	3

I Year-II Semester

BASIC CIVIL & MECHANICAL ENGINEERING

(Common to All branches of Engineering)

Course Objectives:

- Get familiarized with the scope and importance of Civil Engineering sub-divisions.
- Introduce the preliminary concepts of surveying.
- Acquire preliminary knowledge on Transportation and its importance in nation's economy.
- Get familiarized with the importance of quality, conveyance and storage of water.
- Introduction to basic civil engineering materials and construction techniques.

Course Outcomes: On completion of the course, the student should be able to:

CO1: Understand various sub-divisions of Civil Engineering and to appreciate their role in ensuring better society.

CO2: Know the concepts of surveying and to understand the measurement of distances, angles and levels through surveying.

CO3: Realize the importance of Transportation in nation's economy and the engineering measures related to Transportation.

CO4: Understand the importance of Water Storage and Conveyance Structures so that the social responsibilities of water conservation will be appreciated.

CO5: Understand the basic characteristics of Civil Engineering Materials and attain knowledge on prefabricated technology.

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 different sectors and industries.
- Explain different engineering materials and different manufacturing processes.
- Provide an overview of different thermal and mechanical transmission systems and introduce basics of robotics and its applications.

Course Outcomes: On completion of the course, the student should be able to
CO1: Understand the different manufacturing processes.
CO2: Explain the basics of thermal engineering and its applications.
CO3: Describe the working of different mechanical power transmission systems and power plants.
CO4: Describe the basics of robotics and its applications.

UNIT I

Introduction to Mechanical Engineering: Role of Mechanical Engineering in Industries and Society- Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.
Engineering Materials - Metals-Ferrous and Non-ferrous, Ceramics, Composites, Smart materials.

UNIT II

Manufacturing Processes: Principles of Casting**,** Forming, joining processes, Machining, Introduction to CNC machines, 3D printing, and Smart manufacturing.
Thermal Engineering – 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 – working principle of Steam, Diesel, Hydro, Nuclear power plants.
Mechanical Power Transmission - Belt Drives, Chain, Rope drives, Gear Drives and theirapplications.
Introduction to Robotics - Joints & links, configurations, and applications of robotics.

(Note: The subject covers only the basic principles of Civil and Mechanical Engineeringsystems. 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 Engg by Jonathan Wicker and Kemper Lewis, Cengagelearning 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, TataMcGraw Hill publications (India) Pvt. Ltd.

I Year-II Semester

L	T	P	C
3	0	0	3

ENGINEERING MECHANICS

Course Objectives:

- To get familiarized with different types of force systems.
- To draw accurate free body diagrams representing forces and moments acting on a bodyto analyze the equilibrium of system of forces.
- To teach the basic principles of center of gravity, centroid and moment of inertia anddetermine them for different simple and composite bodies.
- To apply the Work-Energy method to particle motion.
- To understand the kinematics and kinetics of translational and rotational motion of rigidbodies.

Course Outcomes: On Completion of the course, the student should be able to
CO1: Understand the fundamental concepts in mechanics and determine the frictional forcesfor bodies in contact.
CO2: Analyze different force systems such as concurrent, coplanar and spatial systems andcalculate their resultant forces and moments.
CO3: Calculate the centroids, center of gravity and moment of inertia of different geometricalshapes.
CO4: Apply the principles of work-energy and impulse-momentum to solve the problems ofrectilinear and curvilinear motion of a particle.
CO5: Solve the problems involving the translational and rotational motion of rigid bodies.

UNIT I
Introduction to Engineering Mechanics– Basic Concepts. Scope and Applications
Systems of Forces: Coplanar Concurrent Forces– Components in Space–Resultant– Momentof Force and its Application –Couples and Resultant of Force Systems.
Friction: Introduction**,** limiting friction and impending motion, Coulomb'slaws of dryfriction,coefficient of friction, Cone of Static friction.

UNIT II
Equilibrium of Systems of Forces: Free Body Diagrams, Lami's Theorm, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium forSpatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses.
Principle of virtual work with simple examples

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 gravityof composite bodies, Pappus theorems.

Area Moments of Inertia: Definition– Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia.
Mass Moment of Inertia: Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, Mass Moment of Inertia of composite bodies.

UNIT IV
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.
UNIT V
Rigid body Motion: Kinematics and Kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse Momentum method.

Textbooks:

1. Engineering Mechanics, S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., , McGraw Hill Education 2017. 5th Edition.
2. Engineering Mechanics, P.C.Dumir- S.Sengupta and Srinivas V veeravalli , University press. 2020. First Edition.
3. A Textbook of Engineering Mechanics, S.S Bhavikatti. New age international publications 2018. 4th Edition.

Reference Books:

1. Engineering Mechanics, Statics and Dynamics, Rogers and M A. Nelson., McGraw Hill Education. 2017. First Edition.
2. Engineering Mechanics, Statics and Dynamics, I.H. Shames., PHI, 2002. 4th Edition.
3. Engineering Mechanics, Volume-I: Statics, Volume-II: Dynamics, J. L. Meriam and L. G. Kraige., John Wiley, 2008. 6th Edition.
4. Introduction to Statics and Dynamics, Basudev Battachatia, Oxford University Press, 2014. Second Edition
5. Engineering Mechanics: Statics and Dynamics, Hibbeler R.C., Pearson Education, Inc., New Delhi, 2022, 14th Edition

I Year-II Semester

L	T	P	C
0	0	2	1

COMMUNICATIVE ENGLISH LAB

(Common to All Branches of Engineering)

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:

CO1: Understand the different aspects of the English language proficiency with emphasis on LSRW skills.
CO2: Apply communication skills through various language learning activities.
CO3: Analyze the English speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension.
CO4: Evaluate and exhibit professionalism in participating in debates and group discussions.
CO5: Create effective Course Objectives:

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
4. https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp_IA

I Year-II Semester

L	T	P	C
0	0	2	1

ENGINEERING PHYSICS LAB
(Common to All Branches of Engineering)

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 and study the parameters and applications of dielectric and magnetic materials by conducting experiments.

Course Outcomes: The students will be able to
CO1: Operate optical instruments like travelling microscope and spectrometer.
CO2: Estimate the wavelengths of different colours using diffraction grating.
CO3: Plot the intensity of the magnetic field of circular coil carrying current with distance.
CO4: Evaluate dielectric constant and magnetic susceptibility for dielectric and magnetic materials respectively.
CO5: Calculate the band gap of a given semiconductor.
CO6: Identify the type of semiconductor using Hall effect.

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's Method.
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 a compound pendulum.
14. Determination of magnetic susceptibility by Kundt's tube method.
15. Determination of rigidity modulus of the material of the given wire using Torsional pendulum.
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's

experiment.

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

References:

- A Textbook of Practical Physics - S. Balasubramanian, M.N. Srinivasan, S. Chand Publishers, 2017.

Web Resources

- www.vlab.co.in

https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype

I Year-II Semester

L	T	P	C
0	0	2	1

IT WORKSHOP
(Common to all branches of Engineering)

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 Operating Systems 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 as Word processors, Spread sheets and Presentation tools.

Course Outcomes:
CO1: Perform Hardware troubleshooting.
CO2: Understand Hardware components and inter dependencies.
CO3: Safeguard computer systems from viruses/worms.
CO4: Document/ Presentation preparation.
CO5: Perform calculations using spreadsheets.

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 through the 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 both Windows 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 configured as 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. Finally students 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 WWW on 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 how to 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 customize their 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, Using help 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 TeX and 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 3: 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 – ChatGPT

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 sentences to see how the model completes them.

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

Task 2: Creative Writing: Use the model as a writing assistant. Provide the beginning of a story or a description of a scene, and let the model generate the rest of the content. This can be a fun way 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 to see how accurate and fluent the translations are.

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

Reference Books:

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

I Year-II Semester

L	T	P	C
0	0	3	1.5

ENGINEERING WORKSHOP

(Common to All branches of Engineering)

Course Objectives:

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

Course Outcomes:

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

SYLLABUS

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) Mortise and Tenon joint c) Corner Dovetail joint or Bridle 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) Tapered tray b) Conical funnel c) Elbow pipe d) Brazing
4. **Fitting:** Familiarity with different types of tools used in fitting and do the following fitting exercises.
   a) V-fit b) Dovetail fit c) Semi-circular fit d) Bicycle tire puncture and change of two-wheeler tyre
5. **Electrical Wiring**: Familiarity with different types of basic electrical circuits and make the following connections.
   a) Parallel and series b) Two-way switch c) Godown lighting
   d) Tube light e) Three phase motor f) Soldering of wires
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.

Textbooks:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published,2019. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.
2. A Course in Workshop Technology Vol I. & II, B.S. Raghuwanshi, Dhanpath Rai & Co., 2015 & 2017.

Reference Books:

1. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14th edition
2. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.
3. Wiring Estimating, Costing and Contracting; Soni P.M. & Upadhyay P.A.; Atul Prakashan, 2021-22.

I Year-II Semester

L	T	P	C
0	0	3	1.5

ENGINEERING MECHANICS LAB
(Mechanical Engineering & allied branches)

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:

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

Students have to perform any 10 of the following Experiments:

List of 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 using universal force table.
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 tothe 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 and Bell Crank Lever.

References:

1. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., Engineering Mechanics, 5th Edition, McGraw Hill Education.
2. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14th Edition, Pearson Education, Inc., New Delhi, 2022.

I Year-II Semester

L	T	P	C
0	0	1	0.5

HEALTH AND WELLNESS, YOGA AND SPORTS
(Common to All branches of Engineering)

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 completion of the course the student will be able to

CO1: Understand the importance of yoga and sports for Physical fitness and sound health.
CO2: Demonstrate an understanding of health-related fitness components.
CO3: Compare and contrast various activities that help enhance their health.
CO4: Assess current personal fitness levels.
CO5: Develop Positive Personality

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:

- Evaluated for a total of 100 marks.
- 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, totalling to 90 marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voce on the subject.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM
VIZIANAGARAM – 535 003 Andhra Pradesh (India)
(Established by Andhra Pradesh Act No.22 of 2021)

Department Of Mechanical Engineering

COURSE STRUCTURE

(Applicable from the academic year 2023-24 onwards)

B.Tech.– II Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	BS	Numerical & Statistical methods	3	0	0	3
2	HSMC	Universal Human Values– Understanding Harmony & Ethical human conduct	2	1	0	3
3	ES	Thermodynamics	2	0	0	2
4	PCC	Mechanics of Solids	3	0	0	3
5	PCC	Material Science and Metallurgy	3	0	0	3
6	PCC	Mechanics of Solids and Materials Science Lab	0	0	3	1.5
7	PCC	Computer-aided Machine Drawing	0	0	3	1.5
8	ES	Python programming Lab	0	0	2	1.0
9	SEC	Embedded Systems and IoT	0	1	2	2
10	Audit Course	Environmental Science	2	0	0	-
		Total	**15**	**2**	**10**	**20**

B.Tech.– II Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	Management Elective- I	Industrial Management	2	0	0	2
2	BS	Probability and Complex Variables	3	0	0	3
3	PCC	Manufacturing processes	3	0	0	3
4	PCC	Fluid Mechanics & Hydraulic Machines	3	0	0	3
5	PCC	Design of Machine Members	3	0	0	3
6	PCC	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5
7	PCC	Manufacturing processes Lab	0	0	3	1.5
8	SEC	Soft Skills	0	1	2	2
9	ES	Design Thinking & Innovation	1	0	2	2
		Total	**15**	**1**	**10**	**21**
Mandatory Community Service Project Internship of 08 weeks duration during summer Vacation						

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM
VIZIANAGARAM – 535 003 Andhra Pradesh (India)
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NUMERICAL & STATISTICAL METHODS
(CIVIL & MECH)

Course Outcomes:
After successful completion of this course, the students should be able to:
Apply numerical methods to solve algebraic and transcendental equations
Derive interpolating polynomials using interpolation formulae.
Solve differential and integral equations numerically.
To identify real life problems into Mathematical Models.
To apply the probability theory and testing of hypothesis in the field of civil engineering Applications.

Pre-requisite: Basic algebraic Equations, Probability, random variables (discrete and continuous) and probability distributions.

UNIT- I: Solution of Algebraic & Transcendental Equations
Introduction-Bisection Method-Iterative method, Regula-falsi method and Newton Raphson method
Interpolation: Finite differences-Newton’s forward and backward interpolation formulae – Lagrange’s formulae.

UNIT- II: Curve fitting:
Fitting of straight line, second-degree and Exponential curve by method of least squares.
Numerical Differentiation and Integration-Trapezoidal rule, Simpson’s 1/3 Rule, Simpson’s 3/8 Rule

UNIT- III: Solution of Initial value problems to Ordinary differential equations
Numerical solution of Ordinary Differential equations: Solution by Taylor’s series-Picard’s Method of successive Approximations-Euler’s and modified Euler’s methods-Runge -Kutta methods (second and fourth order).

UNIT- IV: Estimation and Testing of hypothesis, large sample tests
Estimation-parameters, statistics, sampling distribution, point estimation, Formulation of null hypothesis, alternative hypothesis, the critical and acceptance regions, level of significance, two types of errors and power of the test.
Large Sample Tests: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems

UNIT- V: Small sample tests
Student t-distribution (test for single mean, two means and paired t-test), testing of equality of variances (F-test), $\chi 2$ - test for goodness of fit, $\chi 2$ - test for independence of attributes.

Textbooks:

1. S S Sastry, Introductory Methods of Numerical Analysis, PHI Learning Private Limited.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2017, 44th Edition
3. Miller and Freunds, Probability and Statistics for Engineers,7/e, Pearson, 2008.India.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2018, 10th Edition.
2. R.K.Jainand S.R.K.Iyengar, Advanced Engineering Mathematics, Alpha Science International

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UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY AND 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 in a 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 enriching interaction with Nature.

Course Outcomes:

- Define the terms like Natural Acceptance, Happiness and Prosperity (L1, L2)
- Identify one's self, and one's surroundings (family, society nature) (L1, L2)
- Apply what they have learnt to their own self in different day-to-day settings in real life (L3)
- Relate human values with human relationship and human society. (L4)
- Justify the need for universal human values and harmonious existence (L5)
- Develop as socially and ecologically responsible engineers (L3, L6)

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

Lecture4: 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 the body.

Lecture 8: Distinguishing between the Needs of the self and the body

Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self and body.

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 practice session)

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 practice session)

Lecture 19: Understanding Harmony in the Nature

Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among

the 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. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, 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 Karamchand 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 – PanditSunderlal
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

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THERMODYNAMICS

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.

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. Zeroeth Law of Thermodynamics – PMM-I, Joule's Experiment – First law of Thermodynamics and applications. Limitations of the First Law – 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, Vapour 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, 5/e, Tata McGraw Hill, 2013.
2. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley, 2009.

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_3rd-Semester_Winter_2021_Mechanical-Engg.-_Thermal-Engineering-1_Abhijit-Samant.pdf
- https://www.coursera.org/learn/thermodynamics-intro

Course Outcomes:

- Explain the importance of thermodynamic properties related to conversion of heat energy into work.
- Apply the Zeroeth and First Law of Thermodynamics.
- Understand Second Law of Thermodynamics.
- Analyze the Mollier charts, T-S and h-s diagrams, Steam calorimetry, Phase Transformations.
- Evaluate the COP of refrigerating systems and properties, processes of psychrometry and sensible and latent heat loads.

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MECHANICS OF SOLIDS

Course Objectives:

The objectives of the course are to

- Understand the behaviour 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.

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 – Relation between S.F., B.M and rate of loading at a section of abeam.

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. Wire wound thin cylinders. Lame's equation – cylinders subjected to inside & outside pressures –compound cylinders.
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/

Course Outcomes:

- Learn all the methods to analyze beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components.
- Analyse beams and draw correct and complete shear and bending moment diagrams for beams.
- Apply the concept of stress and strain to analyze and design structural members and machine parts under axial, shear and bending loads, and moments.
- Model & Analyze the behavior of basic structural members subjected to various loads.
- Design and analysis of Industrial components like pressure vessels.

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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 non ferrous 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

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, 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, Aluminium 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 Nanomaterials and smart materials.

Text Books:
1. S.H.Avner, Introduction to Physical Metallurgy, 2/e, Tata McGraw- Hill, 1997.
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.

Course Outcomes:
- Understand the crystalline structure of different metals and study the stability of phases in different alloy systems
- Study the behavior of ferrous and non-ferrous metals and alloys and their application in different domains
- 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

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MECHANICS OF SOLIDS & MATERIAL 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 non ferrous alloy specimens.

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. Punch shear test
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).

Course Outcomes:

- Understand the stress strain behavior of different materials.
- Evaluate the hardness of different materials.
- Explain the relation between elastic constants and hardness of materials.
- Identify various microstructures of steels and cast irons.
- Evaluate hardness of treated and untreated steels.

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VIZIANAGARAM – 535 003 Andhra Pradesh (India)
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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

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, 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.

Textbooks:

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

Course Outcomes:

- Demonstrate the conventional representations of materials and machine components.
- Model riveted, welded and key joints using CAD system.
- Create solid models and sectional views of machine components
- Generate solid models of machine parts and assemble them.
- Translate 3D assemblies into 2D drawings.

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VIZIANAGARAM – 535 003 Andhra Pradesh (India)
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PYTHON PROGRAMMING LAB

Course Objective: To understand the PYTHON environment and make numerical computationsand analysis.

Write Programs in PYTHON Programming for the following:

1. To find the roots of non-linear equation using Newton Raphson's method.
2. Curve fitting by least – square approximations
3. To solve the system of linear equations using Gauss - elimination method
4. To solve the system of linear equations using Gauss - Siedal method
5. To solve the system of linear equations using Gauss - Jordan method
6. To integrate numerically using Trapezoidal rule
7. To integrate numerically using Simpsons rule
8. To find the largest eigen value of a matrix by Power – method
9. To find numerical solution of ordinary differential equations by Euler's method
10. To find numerical solution of ordinary differential equations by Runge-Kutta method
11. To find numerical solution of ordinary differential equations by Milne's method
12. To find the numerical solution of Laplace equation
13. To find the numerical solution of Wave equation
14. To find the solution of a tri-diagonal matrix using Thomas algorithm
15. To fit a straight using least square technique

Online Learning Sources

- https://www.udemy.com/course/python-the-complete-python-developer-course/?matchtype=e&msclkid=0584dfb54dc715f39c0bb9aaf74033be&utm_campaign=BG-Python_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%3Aloc-90_._li_116074_._pd__._&couponCode=IND21PM
- https://www.w3schools.com/python/python_intro.asp
- https://www.youtube.com/watch?v=eWRfhZUzrAc
- https://onlinecourses.nptel.ac.in/noc20_cs83/preview
- https://www.edx.org/learn/python
- Virtual Labs - https://python-iitk.vlabs.ac.in/
- Virtual Labs - https://virtual-labs.github.io/exp-arithmetic-operations-iitk/
- Virtual Labs - https://cse02-iiith.vlabs.ac.in/
- https://mlritm.ac.in/assets/cse/cse_lab_manuals/R20_cse_manuals/Python%20Lab%20Manual.pdf

Course Outcomes:

- Solve the different methods for linear, non-linear and differential equations
- Learn the PYTHON Programming language
- Familiar with the strings and matrices in PYTHON
- Write the Program scripts and functions in PYTHON to solve the methods
- Evaluate different methods of numerical solutions

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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.

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
3. and debug Python code on the device.
4. Using Raspberry pi a. Calculate the distance using distance sensor. b. Basic LED functionality.
5. Raspberry Pi interacts with online services through the use of public APIs and SDKs.
6. Study and Install IDE of Arduino and different types of Arduino.
7. Study and Implement Zigbee Protocol using Arduino / Raspberry Pi.
8. Calculate the distance using distance sensor Using Arduino.

9. Basic LED functionality Using Arduino.
10. Calculate temperature using temperature sensor Using Arduino.
11. Calculate the distance using distance sensor Using Node MCU.
12. 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&objectID=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-9257-a1b38ec07e85&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

Course Outcomes:

- Comprehend Microcontroller-Transducers Interface techniques
- Establish Serial Communication link with Arduino
- Analyse basics of SPI interface
- Understand the concept of M2M (machine to machine) with necessary protocols and get awareness in implementation of distance sensor
- Realize the revolution of internet in mobile devices, cloud and sensor networks

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ENVIRONMENTAL SCIENCE

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.

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. – Energy resources:

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 0 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
f. Thermal pollution
g. Nuclear hazards

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. Textbook of Environmental Studies for Undergraduate Courses Erach Bharucha for University Grants Commission, Universities Press.
2. Palaniswamy, “Environmental Studies”, Pearson education
3. S.Azeem Unnisa, “Environmental Studies” Academic Publishing Company
4. K.Raghavan Nambiar, “Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus”, Scitech Publications (India), Pvt. Ltd.

References:

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

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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.

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 breakdown 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 – $\overline{X}$ and R – charts $\overline{X}$ and S charts and their applications, numerical examples.

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, 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. New Delhi, 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. Koontz O'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

Course Outcomes:

- Learn about how to design the optimal layout.
- Demonstrate work study methods.
- Explain Quality Control techniques.
- Discuss the financial management aspects and,
- Understand the human resource management methods.

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PROBABILITY AND COMPLEX VARIABLES (MECH)

Course Outcomes:

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

- acquire knowledge in finding the analysis of the data quantitatively or categorically and various statistical elementary tools.
- develop skills in designing mathematical models involving probability, random variables and the critical thinking in the theory of probability and its applications in real life problems.
- apply the theoretical probability distributions like binomial, Poisson, and Normal in the relevant application areas.
- analyze limit, continuity and differentiation of functions of complex variables and Understand Cauchy-Riemann equations, analytic functions and various properties of analytic functions
- understand Cauchy theorem, Cauchy integral formulas and apply these to evaluate complex contour integrals. Classify singularities and poles; find residues and evaluate complex integrals using the residue theorem.

UNIT- I: Descriptive statistics

Statistics Introduction, Population vs Sample, Collection of data, primary and secondary data, Measures of Central tendency, Measures of Variability (spread or variance) Skewness, Kurtosis, correlation, correlation coefficient, rank correlation, regression coefficients, regression lines.

UNIT –II: Probability

Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation.

UNIT - III: Probability distributions

Probability distributions: Binomial, Poisson and Normal-their properties (Chebyshevs inequality). Approximation of the binomial distribution to normal distribution.

UNITI-IV: Complex Variable – Differentiation

Introduction to functions of complex variable-concept of Limit & continuity- Differentiation, Cauchy-Riemann equations, analytic functions harmonic functions, finding harmonic conjugate-construction of analytic function by Milne Thomson method.

UNIT- V: Complex Variable – Integration

Line integral-Contour integration, Cauchy's integral theorem (Simple Case), Cauchy Integral formula, Power series expansions: Taylor's series, zeros of analytic functions, singularities, Laurent's series, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine.

Textbooks:

1. Miller and Freunds, Probability and Statistics for Engineers,7/e, Pearson, 2008.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.

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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.

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 photopolymerization AM Processes, Extrusion - Based AM Processes, Powder Bed Fusion AM Processes, Direct Energy Deposition AM Processes, Post Processing of AM Parts, Applications

Textbooks:

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

Course Outcomes:

- Design the patterns and core boxes for metal casting processes.
- Understand the different welding processes.
- Demonstrate the different types of bulk forming processes.
- Understand sheet metal forming processes.
- Learn about the different types of additive manufacturing processes.

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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.

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 irrotational flow, flownet, source and sink, doublet and vortex flow.
Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its applications, force on pipe bend.
Closed conduit flow: Reynold'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 ofequations, 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.

UNIT V

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. Fluidics – amplifiers, sensors andoscillators. Advantages, limitations and applications.

Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies- specific speed- pumps in series and parallel-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 Turbomachinery, 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

Course Outcomes:

- Understand the basic concepts of fluid properties.
- Estimate the mechanics of fluids in static and dynamic conditions.
- Apply the Boundary layer theory, flow separation and dimensional analysis.
- Estimate the hydrodynamic forces ofjet on vanes in different positions.
- Understand the working Principles and performance evaluation of hydraulic pump and turbines.

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VIZIANAGARAM – 535 003 Andhra Pradesh (India)
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DESIGN OF MACHINE MEMBERS

Course Objectives:

- Provide an introduction to design of machine elements.
- Familiarize with fundamental approaches to failure prevention for static and dynamic loading.
- Explain design procedures to different types of joints.
- Teach principles of clutches and brakes and design procedures.
- Instruct different types of bearings and design procedures.

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, fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

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 and eccentrically loaded bolted joints.

Welded Joints: Strength of lap and butt welds, Joints subjected to bending and torsion. Eccentrically loaded welded 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: 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, disc brakes.

Springs: Design of helical compression, tension, torsion and leaf springs.

UNIT V 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 Spur Gears: Spur gears, beam strength, Lewis equation, design for dynamic and wear loads.

Textbooks:

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.

Reference Books:

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.
4. K. Mahadevan & K. Balaveera Reddy, Design data handbook, CBS Publications, 4/e, 2018.

Online Learning Resources:

- https://www.yumpu.com/en/document/view/18818306/lesson-3-course-name-design-ofmachine-elements-1-nptel
- https://www.digimat.in/nptel/courses/video/112105124/L01.html
- https://dokumen.tips/documents/nptel-design-of-machine-elements-1.html
- https://archive.nptel.ac.in/courses/112/105/112105125/
- https://www.coursera.org/learn/machine-design1

Course Outcomes:

- Estimate safety factors of machine members subjected to static and dynamic loads.
- Design the fasteners subjected to variety of loads.
- Select of standard machine elements such as keys, shafts, couplings, springs and bearings
- Design of clutches, brakes and springs.
- Design of bearing and gears.

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FLUID MECHANICS & HYDRAULIC MACHINERY LAB

Course Objective:

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

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 Orifice meter.
10. Determination of friction factor for a given pipeline.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Turbine flowmeter.

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).

Course Outcomes:

- Demonstrate the devices used for measuring flow.
- Compute major losses in pipes.
- Illustrate the operating parameters of turbines
- Explain the working of different types of pumps.
- Explain the devices used for measuring flow.

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VIZIANAGARAM – 535 003 Andhra Pradesh (India)
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MANUFACTURING PROCESSES LAB

Course Objective:

Acquire practical knowledge on Metal Casting, Welding, Press Working and Processing of Plastics.

List of Experiments

1. Design and making of pattern
   A. Single piece pattern
   B. Split pattern
2. Sand properties testing
   A. Sieve analysis (dry sand)
   B. Clay content test
   C. Moisture content test
   D. Strength test (Compression test & Shear test)
   E. Permeability test
3. Mould preparation
   A. Straight pipe
   B. Bent pipe
   C. Dumble
   D. Gear blank
4. Gas cutting and welding
5. Manual metal arc welding
   A. Lap joint
   B. Butt joint
6. Injection Molding
7. Blow Molding
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:

- 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)
- To weld and cut metals using an oxyacetylene welding setup. (https://virtual-labs.github.io/exp-gas-cutting-processes-iitkgp/index.html).
- To simulate Fused deposition modelling process (FDM) (https://3dpdei.vlabs.ac.in/exp/simulation-modelling-process) (https://altair.com/inspire-mold/

Course Outcomes:

- Make moulds for sand casting.
- Fabricate different types of components using various manufacturing techniques.
- Adapt unconventional manufacturing methods.
- Develop Different Weld joints.
- Explain different types of 3d Printing techniques.

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SOFT SKILLS

Course Objectives:

- To prepare to face global competition for employment and excellence in profession.
- To help the students understand and build interpersonal and interpersonal skills that will enable them to lead meaningful professional 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, Soft Skills vs English - Improving Techniques.

UNIT – II:

Intra-Personal:

Definition-Meaning – Importance - SWOT analysis, Johari windows - Goal Setting- quotient skills - Emotional Intelligence - Attitudinal skills - Right 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 - Improving Tips for Listening, Speaking, need - types, advantages, Importance - Improving Tips, Reading - Writing Skills, Report, Resume, statement of purpose, need - types, advantages, Importance - Improving Tips .

UNIT – V:

Non-Verbal Skills & Interview skills

Definition and Meaning – Importance - Facial Expressions - Eye Contact – Proxemics - Haptics - Posture, cross cultural body language, 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

Course Outcomes:

- Assimilate and understood the meaning and importance of soft skills and learn how to develop them.
- Understand the significance of soft skills in the working environment for professional excellence.
- Prepare to undergo the placement process with confidence and clarity.
- Ready to face any situation in life and equip themselves to handle them effectively.
- Understand and learn the importance of etiquette in both professional and personal life.

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DESIGN THINKING & INNOVATION

Course Objectives:

The objective of this course is to familiarize students with design thinking process as a tool for breakthrough innovation. It aims to equip students with design thinking skills and ignite the minds to create innovative ideas, develop solutions for real-time problems.

Course Outcomes:

- Define the concepts related to design thinking. (L1, L2)
- Explain the fundamentals of Design Thinking and innovation (L1, L2)
- Apply the design thinking techniques for solving problems in various sectors. (L3)
- Analyse to work in a multidisciplinary environment (L4)
- Evaluate the value of creativity (L5)
- Formulate specific problem statements of real time issues (L3, L6)

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 modelling, 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, Harper Bollins (2009)
2. Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons.

Reference Books:

1. David Lee, Design Thinking in the Classroom, Ulysses press
2. Shrutin N Shetty, Design the Future, Norton Press
3. William Lidwell, Universal Principles of Design- Kritinaholden, Jill Butter.
4. Chesbrough. H, The Era of Open Innovation – 2013

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

B.Tech. – III Year I Semester

B.Tech. – III Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	PC	Machine Tools and Metrology	3	0	0	3
2	PC	Thermal Engineering	3	0	0	3
3	PC	Theory of Machines	3	1	0	3
4	PCE-1	Professional Elective – I	3	0	0	3
5	OE-1	1. Sustainable Energy Technologies 2. Applied operation Research 3. Industrial safety 4. Energy Conservation Management	3	0	0	3
6	PC Lab-1	Thermal Engineering Lab	0	0	3	1.5
7	PC Lab-2	Theory of Machines Lab	0	0	3	1.5
8	SEC	Machine Tools & Metrology Lab Mechatronics Lab	0	0	4	2
9	ES	Computational Fluid Dynamics Lab	0	0	2	1.0
10	Evaluation of Community Service Internship	Community Service Internship	-	-	-	2
		Total	15	0	12	**23**

Professional Elective - I

1. Instrumentation & Control Systems
2. Nano Technology
3. Design for manufacturing
4. Thermal management of Electronic Systems
5. Joining Processes

B.Tech. – III Year II Semester

B.Tech. III Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	PC	Heat Transfer	3	0	0	3
2	PC	Artificial Intelligence and Machine Learning	3	0	0	3
3	PC	Finite Element Methods	3	0	0	3
4	PE - II	Professional Elective-II	3	0	0	3
5	PE - III	Professional Elective-III	3	0	0	3
6	OE - II	1. Electrical vehicles 2. Supply chain management 3. Design of Experiments 4. Total Quality Management 5. Industrial robotics	3	0	0	3
7	PC Lab-1	Heat Transfer Lab	0	0	3	1.5
8	PC Lab-2	Artificial Intelligence and Machine Learning Lab	0	0	3	1.5
9	SEC	Computer Aided Manufacturing Lab Robotics and Drone Technology	0	1	2	2
10	Audit Course	Technical paper writing and IPR	2	0	0	-
		Total	**20**	**01**	**08**	**23**
Mandatory Industry Internship of 08 weeks duration during summer vacation						

Professional Elective-II

1. Industrial robotics
2. Supply chain management
3. Additive manufacturing
4. UnConventional Machining Processes
5. Refrigeration and Air conditioning

Professional Elective-III

1. Automobile Engineering
2. Computer Integrated Manufacturing
3. Smart manufacturing
4. Mechanical Vibrations
5. Composite materials

B.Tech. – IV Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	PC	CAD/CAM	3	0	0	3
2	Management Course- II	Operations Research	2	0	0	2
3	PE – IV	Professional Elective-IV	3	0	0	3
4	PE - V	Professional Elective-V	3	0	0	3
5	OE - III	1. Digital marketing management 2. Product design and development 3. Introduction to Mechatronics 4. Condition Monitoring 5. Operations Management	3	0	0	3
6	OE - IV	1. Statistical Quality Control 2. Nano Materials 3. Entrepreneurship 4. Product Design & Development 5. Optimization Techniques	3	0	0	3
7	Skill Enhancement Course	Renewable Energy Simulation Lab Instrumentation and control systems lab	0	1	2	2
8	Audit Course	Constitution of India	2	0	0	-
9	Internship	Evaluation of Industry Internship	-	-	-	2
Total			**19**	**01**	**02**	**21**

Professional Elective-IV

1. Production Planning & Control
2. Nondestructive evaluation
3. Smart materials
4. Hydrogen and fuel cell technology
5. Power Plant Engineering

Professional Elective-V

1. Electric and Hybrid vehicles
2. Cryogenics
3. Automation in Manufacturing
4. Industrial Hydraulics and Pneumatics
5. Noise Control

B.Tech. – IV Year II Semester

S.No	Category	Title	L	T	P	C
1	Internship & Project Work	Full semester Internship & Project Work	**0**	**0**	**24**	**12**

For Minor degree: (18 Credits)

1. Industrial Engineering and Management
2. Materials Science
3. Design of Machine Elements
4. Manufacturing Technologies
5. Basics of Thermal Engineering
6. Material Science Lab
7. Manufacturing Technologies Lab

For Honor's degree:

1. Machine Design (18 Credits)

1. Advanced Mechanics of Solids
2. Advanced Finite Element Methods
3. Advanced Mechanisms & Robotics
4. Advanced Machine Design
5. Design for Manufacturing &Assembly
6. Computational Lab
7. Mechanisms and Robotics Lab

2. CAD/CAM (18 Credits)

1. Advanced CAD
2. Computer Integrated Manufacturing
3. Modeling & Simulation of Manufacturing systems
4. Advanced Manufacturing Processes
5. Quality & Reliability
6. Advanced CAD Lab
7. Modeling & Simulation of Manufacturing systems Lab

3. Thermal Engineering (18 Credits)

1. Advanced Thermodynamics
2. Advanced Fluid Mechanics
3. Advanced Heat Transfer
4. Advanced CFD
5. Design of Heat Transfer Equipment
6. Computational laboratory
7. Computational Fluid Dynamics Lab

4. Robotics and Automation (18 Credits)

1) Robotic Engineering
2) Basic Control system for robots
3) Fluid Power System for Automation
4) Industrial IoT and Cloud Computing
5) Autonomous Navigation and Path Planning
6) Robot Design Lab
7) IoT and Cloud Computing Lab

5. Industrial Engineering (18 Credits)

1) Operations Planning and Control
2) Work System Design
3) Facilities Planning
4) Advanced Operation Research
5) Productivity Engineering & Management
6) Industrial Engineering Lab-I
7) Industrial Engineering Lab-II

III Year I Semester	Professional Core	L	T	P	C
		3	0	0	3

MACHINE TOOLS AND METROLOGY

Course Objectives:

The students will acquire the knowledge

- To interpret the fundamental principles in material removal processes.
- To apply the fundamentals and principles of metal cutting to machining process using lathes, milling machines, grinding machines, drill presses, Computer Numerical Control machines etc
- To develop fundamental knowledge on tool materials, cutting fluids and tool wear mechanisms.
- To develop knowledge and importance of metal cutting parameters and demonstrate the fundamentals of machining processes and machine tools.
- To analyze the concepts of finishing processes and the system of limits and fits.
- To illustrate 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 of single point cutting tool, tool signature, tool angles, mechanism of metal cutting, types of chips and chip formation – built up edge and its effects, chip breakers, mechanics of orthogonal and oblique cutting – Merchant's force diagram, cutting forces, velocity ratio, cutting speeds, feed, depth of cut, tool life, Taylor's tool life equation, simple problems – Tool wear, tool wear mechanisms, heat generation in metal cutting, coolants, machinability, economics of machining, tool materials and properties

UNIT-2

LATHE MACHINES: Introduction- types of lathe – Engine lathe – principle of working – construction – specification of lathe – work holders and tool holders – accessories and attachments – lathe operations – taper turning methods and thread cutting – drilling on lathes – cutting speed and feed-depth of cut.

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 – geometry of twist drill – operations performed –cutting speed and feed – machining time calculations – Boring Machines – fine Boring Machines – jig boring machines – deep hole Drilling Machines.

MILLING MACHINES: Introduction – principle of working – specifications – milling methods – classification of Milling Machines –types of cutters – geometry of milling cutters – methods of indexing, accessories to milling machines – cutting speed and feed – machining time calculations

UNIT-4

FINISHING PROCESSES: Introduction – theory of grinding – classification of grinding machines- cylindrical and surface grinding machines- tool and cutter grinding machines- different types of abrasives- bonds, specification and selection of a grinding wheel-lapping, Honing & Broaching operations- comparison to grinding.

SYSTEMS OF LIMITS AND FITS: Introduction, nominal size, tolerance, limits, deviations, different types of fits -Unilateral and bilateral tolerance system, hole and shaft basis systems interchangeability, deterministic & statistical tolerances, selective assembly- International standard system of tolerances, selection of limits and tolerances for correct functioning, simple problems related to limits and fits, Taylor’s principle – design of go and no go gauges; plug, ring, snap, gap, taper, profile and position gauges – inspection of gauges

UNIT-5

SURFACE ROUGHNESS MEASUREMENT: Differences between surface roughness and surface waviness –Numerical assessment of surface finish-CLA, Rt., R.M.S. Rz, R10 values, simple problems – method of measurement of surface finish – Profilograph, Talysurf, ISI symbols for indication of surface finish.

OPTICAL MEASURING INSTRUMENTS: Tools maker’s microscope, Autocollimators, Optical projector, Optical flats-working principle, construction, merits, demerits and their uses. optical comparators

TEXT BOOKS:

1. Manufacturing Processes / JP Kaushish/ PHI Publishers-2 nd Edition
2. Manufacturing Technology Vol-II/P.N Rao/Tata McGraw Hill
3. Engineering Metrology – R.K. Jain/Khanna Publishers

REFERENCE BOOKS:

1. Metal cutting and machine tools /Geoffrey Boothroyd, Winston A.Knight/ Taylor & Francis
2. Production Technology / H.M.T. Hand Book (Hindustan Machine Tools).
3. Production Engineering/K.C Jain & A.K Chitaley/PHI Publishers
4. Technology of machine tools/S.F.Krar, A.R. Gill, Peter SMID/ TMH
5. Manufacturing Processes for Engineering Materials-Kalpak Jian S & Steven R Schmid/Pearson Publications 5 th Edition

Course Outcomes:

- CO1: Interpret the concepts of machining processes.
- CO2: Apply the principles of lathe, shaping, slotting and planning machines.
- CO3: Apply the principles of drilling, milling and boring processes.
- CO4: Analyze the concepts of finishing processes and the system of limits and fits.
- CO5: Illustrate the concepts of surface roughness and optical measuring instruments.

III Year I Semester	Professional Core	L	T	P	C
		3	0	0	3
THERMAL ENGINEERING					

Course Objectives:

The students will acquire the knowledge

1. To interpret the different processes in air-standard cycles and differences between Air Standard and Actual Cycles
2. To interpret the basic principles of vapour power cycles
3. To illustrate combustion phenomenon and identify the functions of boilers and draught systems and evaluate their performance.
4. To demonstrate the performance of an IC engine and gas turbine based on the performance parameters.
5. To summarize the classification and basic principles of compressors.

UNIT – I

Air standard Cycles: Power Cycles: Otto, Diesel, Dual Combustion cycles, Sterling Cycle, Atkinson Cycle, Ericcson Cycle, Lenoir Cycle – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles, 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, Valve and Port Timing Diagrams, - Engine systems – Fuel, Carburettor, Fuel Injection System, Ignition, Cooling and Lubrication, principle of Wankle engine, principles of supercharging and turbo charging.

Measurement, Testing and Performance: Parameters of performance - measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, Brake power – Determination of frictional losses and indicated power – Performance test – Heat balance sheet and chart

UNIT III

VAPOUR POWER CYCLES: Carnot, Rankine cycle - schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance – regeneration & reheating.

COMBUSTION: Fuels and combustion, concepts of heat of reaction, adiabatic flame temperature, Stoichiometry, flue gas analysis.

BOILERS: Classification – working principles of L.P & H.P boilers with sketches – mountings and accessories – working principles, boiler horse power, equivalent evaporation, efficiency and heat balance – Draught: classification – height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney – artificial draught, induced and forced.

UNIT – IV

STEAM NOZZLES: Function of a nozzle – applications - types, flow through nozzles, thermodynamic analysis – assumptions -velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity coefficient, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape.

STEAM TURBINES: Classification – impulse turbine; mechanical details – velocity diagram – effect of friction – power developed, axial thrust, blade or diagram efficiency – condition for maximum efficiency. De-laval turbine – combined velocity diagram for a velocity impulse and reaction turbine.

REACTION TURBINE: Mechanical details – principle of operation, thermodynamic analysis of a stage, degree of reaction –velocity diagram – Parson's reaction turbine – condition for maximum efficiency – calculation of blade height.

STEAM CONDENSERS: Requirements of steam condensing plant – classification of condensers – working principle of different types – vacuum efficiency and condenser efficiency – air leakage, sources and its affects, air pump, cooling water requirement

UNIT – V

COMPRESSORS – Classification – fan, blower and compressor - positive displacement and non-positive displacement type – reciprocating and rotory types.

Reciprocating: Principle of operation, work required, Isothermal efficiency, volumetric efficiency and effect of clearance, multi stage compression, saving of work, minimum work condition for two stage compression.

Rotary (Positive displacement type)

Roots Blower, vane sealed compressor, Lysholm compressor – mechanical details and principle of working – efficiency considerations.

Rotary (non positive displacement type)

Centrifugal compressors: Mechanical details and principle of operation – velocity and pressure variation. Energy transfer-impeller blade shape-losses, slip factor, power input factor, pressure coefficient and adiabatic coefficient – velocity diagrams – power.

Text Books:

1. I.C. Engines - V. Ganesan- Tata McGraw Hill Publishers

2. Gas Turbines – V.Ganesan – Tata McGraw Hill Publishers

References:

1. Thermal Engineering - Mahesh Rathore- McGraw Hill publishers

2. I.C.Engines–AppliedThermosciences–C.R.Ferguson&A.T.Kirkpatrick-2ndEdition-Wiley Publishers

3. I.C. Engines - J.B.Heywood /McGrawHIll.

4. Heat engines, Vasandani & Kumar - Thermal publications

5. Gas Turbine Theory – HIH Saravanamuttoo, Cohen, Rogers –Pearson Publishers

Course Outcomes:

The students will be able to

1. Interpret the different processes in air-standard cycles and differences between Air Standard and Actual Cycles
2. Analyze the basic principles of vapour power cycles
3. Illustrate the combustion phenomenon and identify the functions of boilers and draught systems and evaluate their performance.
4. Analyze the performance of an IC engine and gas turbine based on the performance parameters.
5. Illustrate the classification and basic principles of compressors.

<table>
<tr><td rowspan="2">III Year I Semester</td><td rowspan="2">Professional Core</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">THEORY OF MACHINES</td></tr>
</table>

Course Objectives: The students will acquire the knowledge

1. To interpret the nature and role of the kinematics of machinery, mechanisms and machines
2. The course includes velocity and acceleration diagrams, analysis of mechanisms joints, 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.
3. To analyze dynamic forces of slider, crank mechanism and design of flywheel
4. To analyze the methods of balancing reciprocating and rotary masses.
5. To illustrate the concept of vibrations and its significance on engineering design

UNIT – I

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, Degrees of freedom, Kutzbach criterion 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.

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 – II

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.

POWER TRANSMISSION (BELT, CHAIN AND GEAR):

Belt Drive: Type of belts, flat belt, V-belt & its applications, material for flat and V-belt, Selection of belts, Angle of lap, length of belt (No derivation), Slip and creep, Determination of velocity ratio of tight side and slack side tension, Power transmitted by belt. (numerical on power transmission by belt)

Chain Drives: Types of chains and sprockets, Advantages & Disadvantages of chain drive over other drives (No numerical on Chain drive).

Gear Drives: Classification of gears, Law of gearing, Concept of Conjugate profile (Involute only) Spur gear terminology. Types of gear trains, Train value & velocity ratio for simple, compound, reverted and epicyclic gear trains. (No numerical on Gear drive). Comparison between Belt drive, Chain drive and Gear drive

Unit – III

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.

TURNING MOMENT DIAGRAMS: Dynamic force analysis of slider crank mechanism, inertia torque, angular velocity and acceleration of connecting rod, crank effort and turning moment diagrams – fluctuation of energy – fly wheels and their design.

UNIT – IV

GOVERNERS: Watt, Porter and Proell governors, spring loaded governors – Hartnell and Hartung with auxiliary springs. sensitiveness, isochronism and hunting

BALANCING: Balancing of rotating masses single and multiple – single and different planes, use analytical and graphical methods. Primary, secondary, and higher balancing of reciprocating masses.

UNIT – V

VIBRATIONS: Free Vibration of spring mass system –Natural frequency-types of damping – damped free vibration, Simple problems on forced damped vibration, vibration isolation and transmissibility transverse loads, vibrations of beams with concentrated and distributed loads. Dunkerly’s methods, Raleigh’s method, whirling of shafts, critical speeds, torsional vibrations, two and three rotor systems.

TEXT BOOKS:

1. "Theory of Machines”, Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd Ed-2009

2. "Theory of Machines”, Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Ed 2006/

REFERENCE BOOKS

1. “Theory of Machines & Mechanisms", J.J. Uicker, , G.R. Pennock, J.E. Shigley, OXFORD 3rd Ed. 2009.

2. “Theory of Machines” by Thomas Bevan, CBS Publication 1984.

3. “Design of Machinery” by Robert L. Norton, McGraw Hill, 2001.

4.“Mechanisms and Dynamics” of Machinery by J. Srinivas, Scitech Publications, Chennai,2002.

5. “Dynamics of machinery” by J. B. K. Das & P. L. S. Murthy.

Course outcomes:

Upon successful completion of this course the student should be able to:

1. Interpret a mechanism for a given plane motion. analyze motion of different planar mechanisms with lower and higher pairs
2. Select a power transmission system for a given application and analyze different transmission systems.
3. Analyze dynamic forces of slider crank mechanism and design of flywheel
4. Analyze the methods of balancing reciprocating and rotary masses.
5. Illustrate the concept of vibrations and its significance on engineering design

III Year-I Semester	Professional Elective-I	L	T	P	C
		3	0	0	3
INSTRUMENTATION & CONTROL SYSTEMS					

Course Objectives:

The students will acquire the knowledge

1. To learn basic principles of measurement systems, errors occurred in measurement systems and measurement of displacement
2. To learn the operating principles and working of different instruments used for temperature and pressure measurement
3. To learn the operating principles and working of different instruments used for level, flow and speed measurement
4. To learn the operating principles and working of different instruments used for acceleration, strain and humidity measurement
5. To learn the operating principles and working of different instruments used for force, torque and power and concepts of control systems

UNIT – I

Definition–Basic principles of measurement-measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. Dynamic performance characteristics–sources of error, classification and elimination of error.

Measurement of Displacement: Theory and construction of various transducers to measure displacement – piezo electric, inductive, capacitance, resistance, ionization and photo electric transducers, calibration procedures.

UNIT – II

MEASUREMENT OF TEMPERATURE: Classification – ranges – various principles of measurement – expansion, electrical resistance – thermistor – thermocouple – pyrometers.

MEASUREMENT OF PRESSURE: Units – classification – different principles used. Manometers, bourdon pressure gauges, bellows – diaphragm gauges. Low pressure measurement – thermal conductivity gauges – ionization pressure gauges, Mcleod pressure gauge.

UNIT – III

MEASUREMENT OF LEVEL: Direct method – indirect methods – capacitive, ultrasonic, magnetic, cryogenic fuel level indicators – bubbler level indicators.

FLOW MEASUREMENT: Rotameter, magnetic, ultrasonic, turbine flow meter, hot – wire anemometer, laser Doppler anemometer (LDA).

MEASUREMENT OF SPEED: Mechanical tachometers – electrical tachometers – stroboscope, noncontact type of tachometer

UNIT – IV

Measurement of Acceleration and Vibration: Different simple instruments – principles of seismic instruments – Vibrometer and accelerometer using this principle.

STRESS STRAIN MEASUREMENTS:

Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – usage for measuring torque, strain gauge rosettes.

MEASUREMENT OF HUMIDITY – Moisture content of gases, sling psychrometer, absorption psychrometer, dew point meter.

UNIT – V

MEASUREMENT OF FORCE, TORQUE AND POWER- Elastic force meters, load cells, torsion meters, dynamometers.

ELEMENTS OF CONTROL SYSTEMS: Introduction, importance – classification – open and closed systems, servomechanisms–examples with block diagrams–temperature, speed & position control systems.

Text Books:

1. Measurement Systems: Applications & design / D.S Kumar/

2. Mechanical Measurements / BeckWith, Marangoni,Linehard, Pearson

References:

1. Measurement systems: Application and design/Doeblin Earnest. O. Adaptation/ TMH

2. Experimental Methods for Engineers / J.P.Holman/McGraw Hill

3. Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers.

4.Instrumentation, measurement & analysis / B.C.Nakra&K.K.Choudhary/TMH

Course outcomes:

Upon successful completion of this course the student should be able to:

1. Build the principles of measurement systems and construction of various transducers for displacement measurement

2. Classify and study the different types of temperature and pressure measuring devices

3. Interpret the working principles of level, flow and speed measuring instruments

4. Utilize the principles of various types of acceleration and vibration, stress and strain and humidity measuring instruments

5. Illustrate the operating principles of force, torque and power measurements and different types of control systems and application of servo mechanisms

III Year-I Semester	Professional Elective-I	L	T	P	C
		3	0	0	3
NANO TECHNOLOGY					

Course Objectives:

The students will acquire the knowledge:

1. To interpret the classification of nano structured Materials
2. To describe 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 illustrate the applications of nano materials

Unit I

Introduction: History and Scope, Classification of Nano structured Materials, Fascinating Nanostructures, applications of nanomaterials, challenges and future prospects.

Unit II

Unique Properties of Nano materials: Microstructure and Defects in Nano crystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. Effect of Nano-dimensions on Materials Behavior: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, enhanced solid solubility. Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

Unit III

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 isostatic pressing and Cold isostatic pressing Spark plasma sintering.

UNIT –IV

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

UNIT – V

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.

2. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.

3. Nano Essentials- T.Pradeep/TMH

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:

The students will be able to:

1. Interpret the classification of nano structured Materials

2. Describe the unique properties of nano materials

3. Interpret the Synthesis Routes - Bottom up and Top-down approaches

4. Identify the tools to characterize nano materials

5. Illustrate the applications of nano materials

III Year-I Semester	Professional Elective-I	L	T	P	C
		3	0	0	3
DESIGN FOR MANUFACTURING					

Course Objectives:

The students will acquire the knowledge:

1. To analyze the basic concepts of design for manual assembly
2. To interpret basic design procedure of machining processes
3. To analyze 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 – I

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, Application of the DFA Methodology.

UNIT - II

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 - III

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, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

UNIT - IV

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-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies –drop forging die design – general design recommendations.

UNIT – V

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, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

TEXT BOOKS:

1. Design for manufacture, John cobert, Adisson Wesley. 1995

1. Design for Manufacture by Boothroyd,

2. Design for manufacture, James Bralla

REFERENCE:

ASM Hand book Vol.20

Course Outcomes:

Upon successful completion of this course the student should be able to:

The students will acquire the knowledge:

1. Analyze the basic concepts of design for manual assembly

2. Interpret basic design procedure of machining processes

3. Analyze design considerations metal casting, extrusion and sheet metal work

4. Interpret the design considerations of various metal joining process.

5. Interpret the basic design concepts involved in the assembly automation

III Year-I Semester	Professional Elective-I	L	T	P	C
		3	0	0	3
THERMAL MANAGEMENT OF ELECTRONIC SYSTEMS					

Course objectives:

1) To interpret the basics of heat transfer and analyze heat transfer through fins

2) To analyze the basics of convection and radiation modes of heat transfer.

3) To illustrate concepts the thermal analysis of printed circuit boards and their cooling.

4) To analyze the principles of two-phase cooling and heat pipes.

5) To interpret knowledge about the thermoelectric coolers.

UNIT– I

Introduction of Heat Transfer and Conduction: 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 – Fin efficiency – Selection and design of fins.

UNIT– II:

Convection and Radiation: Forced and Free Convection – Heat transfer coefficient - Parameters effecting heat transfer – Thermal Properties of fluids - Combined Modes, 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– III:

Printed Circuit Boards and Cooling – 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 – Forced cooling in medium and large systems – Liquid cooling in high power modules – Case Studies.

UNIT– IV:

Two Phase Cooling and Heat pipes – 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 – Micro Heat Pipes.

UNIT– V:

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. Use of nano fluids in electronic cooling.

Text Books:

1. Thermal Analysis and Control of Electronic Equipment – Allan D. Kraus and Avram BarCohen, McGraw Hill, New York, NY, 1983.

2. Fundamentals of Microelectronics Packaging – Ed: Rao Tummala, McGraw Hill, New York, NY, 2001.

Reference Books

1) 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

1) Interpret the basics of heat transfer and analyze heat transfer through fins

2) Analyze the basics of convection and radiation modes of heat transfer.

3) Illustrate concepts the thermal analysis of printed circuit boards and their cooling.

4) Analyze the principles of two-phase cooling and heat pipes.

5) Interpret knowledge about the thermoelectric coolers.

III Year I Semester	Professional Elective-I	L	T	P	C
		3	0	0	3
JOINING PROCESSES					

Course Objectives:

The students will acquire the knowledge

1. To describe basic principles of metal joining process
2. To interpret the theory and procedure involved in the fusion welding process
3. To analyze the basic concepts of the pressure welding
4. To analyze the basic steps of soldering operational steps of brazing.
5. To illustrate the concepts of modern welding processes

Unit-I:

Metal Joining Processes: Joining process as a manufacturing route, relevance of joining process to metallurgy. Different types of joining process, classification of joining process, safety aspects in Metal joining processes, types of joints used in welding.

Unit – II:

Fusion Welding Process: Classification of welding process, gas welding, arc welding process (equipment, fluxes, electrodes, procedures, limitations and advantages of various arc welding process), relative advantages and limitations and applications of gas welding and arc welding, thermit welding.

Unit – III:

Pressure Welding: Resistance welding, cold welding, forge welding. relative advantages, limitation and applications of pressure welding. spot welding, explosion welding, flash welding.

Unit – IV: Soldering and Brazing: Basic operational steps of Soldering, Basic operational steps of Brazing, flux and its role in joining process, different types of fluxes, metallurgical aspects of soldering and brazing, applications of soldering and brazing, soldering and Brazing Alloys, adhesive joining.

Unit – V: Modern Welding Processes: Electron beam welding, Laser beam welding, Submerged arc welding, Ultrasonic welding, Under water welding, Magnetic pulse welding.

Text Books:

1. Welding Technology O.P.Khanna Dhanpat Rai Publications Ltd. New Delhi

2. Soldering, welding and brazing Lankester George Allen and Unwin, London.

3. Modern arc welding techniques S.V. Nadkarni Oxford IBH Publishers.

References:

1. Engineering Metallurgy I and II R.A.Higgins The English University Press Ltd.

2. Welding Technology R.S.Parmar Khanna Publishers, New Delhi

3. Welding Engineering Richard little Tata McGraw Hill, New Delhi

Course Outcomes

At the end of the course the students shall be able to:

1. Describe basic principles of metal joining process
2. Interpret the theory and procedure involved in the fusion welding process
3. Analyze the basic concepts of the pressure welding
4. Analyze the basic steps of soldering operational steps of brazing.
5. Discuss the concepts of modern welding processes

III Year-I Semester	Open Elective -I	L	T	P	C
		3	0	0	3

SUSTAINABLE ENERGY TECHNOLOGIES

Course Objectives:

The students will acquire the knowledge:

1. To demonstrate the importance and solar radiation, solar energy collection and storage
2. To analyze the energy sources and potential from wind energy, bio-mass, geothermal energy and ocean energy
3. To interpret energy efficient electrical and mechanical systems
4. To develop energy efficient processes
5. To illustrate features and benefits of green buildings

UNIT-I

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 radiation data, numerical problems. Photo voltaic energy conversion – types of PV cells.

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 – II

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy.

OCEAN ENERGY: OTEC, Principles of utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques.

UNIT –III

ENERGY EFFICIENT SYSTEMS:

(A) ELECTRICAL SYSTEMS: Energy efficient motors, energy efficient lighting and control, selection of luminaire, variable voltage variable frequency drives (adjustable speed drives), controls for HVAC (heating, ventilation and air conditioning), demand site management.

(**B) MECHANICAL SYSTEMS**: Fuel cells- principle, thermodynamic aspects, selection of fuels & working of various types of fuel cells, Environmental friendly and Energy efficient compressors and pumps**.**

UNIT-IV

ENERGY EFFICIENT PROCESSES: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of efficient and sustainable green production systems with examples like environmental friendly machining, vegetable based cutting fluids, alternate casting and joining techniques, zero waste manufacturing.

UNIT – V

GREEN BUILDINGS: Definition, features and benefits. Sustainable site selection and planning of buildings for maximum comfort. Environmental friendly building materials like bamboo, timber, rammed earth, hollow blocks, lime & lime pozzolana cement, agro materials and industrial waste, Ferro cement and Ferro-concrete, alternate roofing systems, paints to reduce heat gain of the buildings. Energy management.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH

2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006

3. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013

References:

1. Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New age international

2. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth& John F Kreider / Taylor &Francis

3. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd

4. Renewable Energy Technologies -Ramesh & Kumar /Narosa

5. Non-conventional Energy Source- G.D Roy/Standard Publishers

6. Renewable Energy Resources-2nd Edition/ J.Twidell and T. Weir/ BSP Books Pvt.Ltd

7. Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd

Course Outcomes:

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

1. Demonstrate the importance and solar radiation, solar energy collection and storage
2. Analyze the energy sources and potential from wind energy, bio-mass, geothermal energy and ocean energy
3. Interpret energy efficient electrical and mechanical systems
4. Develop energy efficient processes
5. Illustrate features and benefits of green buildings

III Year-I Semester	Open Elective –I	L	T	P	C
		3	0	0	3

APPLIED OPERATIONS RESEARCH

Course Objectives:

The students will acquire the knowledge:

1. To illustrate classification of optimization problem and apply classical optimization techniques
2. To apply unconstrained optimization techniques using various methods
3. To analyze the characteristics and approaches of constrained optimization techniques
4. To interpret optimized solutions using constrained and unconstrained geometric programming
5. To illustrate integer programming methods

UNIT I

INTRODUCTION TO OPTIMIZATION: Engineering applications of optimization- statement of an optimization problem- classification of optimization problem- optimization techniques.

CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization- multivariable optimization with equality constraints- multivariable optimization with inequality constraints.

UNIT-II

UNCONSTRAINED OPTIMIZATION TECHNIQUES: Pattern search method- Rosenbrock's method of rotating coordinates- Simplex method- Descent methods- Gradient of function- Steepest Descent method.

UNIT-III

CONSTRAINED OPTIMIZATION TECHNIQUES: Characteristics of constrained problem methods of feasible directions - basic approach in the penalty function method- interior penalty function method- convex programming problem- exterior penalty function method.

UNIT-IV

GEOMETRIC PROGRAMMING (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. primal dual relationship and sufficiency conditions.

Solution of a constrained geometric programming problem (G.P.P). Complimentary geometric programming (C.G.P)

UNIT-V

INTEGER PROGRAMMING (I.P): Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem. Integer nonlinear programming.

TEXT BOOK:

1. Optimization Theory and Applications/ S.S.Rao/Wiley Eastern Limited, New Delhi.

REFERENCES:

1. Engineering Optimization / Kalyanmanai Deb/Prentice Hall of India, New Delhi.

2. Optimization Techniques-Theory and applications/C.Mohan&Kusum Deep/New Age International

3. Operations Research /S.D.Sharma / MacMillan Publishers

Course Outcomes:

Upon successful completion of this course student should be able to:

1. Illustrate classification of optimization problem and apply classical optimization techniques
2. Apply unconstrained optimization techniques using various methods
3. Analyze the characteristics and approaches of constrained optimization techniques
4. Interpret optimized solutions using constrained and unconstrained geometric programming
5. Illustrate integer programming methods

III Year-I Semester	Open Elective –I	L	T	P	C
		3	0	0	3
INDUSTRIAL SAFETY					

Course Objectives:

1. To provide information regarding different elements of industrial water pollution and Methods of treatment.
2. To expose to the various industrial applications, maintenance, preventive measures taken against wear and tear.

UNIT- I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT- II

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT- III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication Side feed lubrication, Ring lubrication

Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT- IV

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like,

i. Any one machine tool,
ii. Pump
iii. Air compressor
iv. Internal combustion engine,
v. Boiler
vi. Electrical motors,

Types of faults in machine tools and their general causes.

UNIT- V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of:

i. Machine tools
ii. Pumps,
iii. Air compressors,
iv. Diesel generating (DG) sets,

Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance

REFERENCE BOOKS:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.

2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

3. Pump-hydraulic Compressors, Audels, McGraw Hill Publication.

4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Course Outcomes:

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

1. Know how to take safety measures in executing works
2. Identify the need for maintenance (or) replacement of equipment
3. Illustrate the need for periodic and preventive maintenance

III Year-I Semester	Open Elective –I	L	T	P	C
		3	0	0	3
ENERGY CONSERVATION MANAGEMENT					

Course Objectives:

- To illustrate energy efficiency, scope, conservation and technologies.
- To design energy efficient lighting systems.
- To analyze power factor of systems and propose suitable compensation techniques.
- To interpret energy conservation in HVAC systems.
- To analyze life cycle costing analysis and return on investment on energy efficient technologies.

UNIT-I

Basic Principles of Energy Audit and management Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts –Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems – Principles of energy management – Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager – Qualities and functions – Language – Questionnaire – Check list for top management.

UNIT-II

Lighting Modification of existing systems – Replacement of existing systems – Priorities: Definition of terms and units – Luminous efficiency – Polar curve – Calculation of illumination level – Illumination of inclined surface to beam – Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light LED and conducting Polymers – Energy conservation measures.

UNIT-1II

Power Factor and energy instruments Power factor – Methods of improvement – Location of capacitors – Power factor with non linear loads – Effect of harmonics on Power factor – Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters – Tong testers – Power analyzer.

UNIT-IV

Space Heating and Ventilation – Air–Conditioning (HVAC) and Water Heating: Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air–conditioning – Insulation–Cooling load – Electric water heating systems – Energy conservation methods.

UNIT-V

Economic Aspects and Financial Analysis Understanding energy cost – Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts) – Economics of energy efficient motors and system

Computation of Economic Aspects Need of investment, appraisal and criteria – Calculation of simple payback period–Return on investment – Net present value – Internal rate of return – numerical examples – Power factor correction – Lighting – Applications of life cycle costing analysis – Return on investment – Numerical examples

TEXT BOOKS:

1. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995

REFERENCE BOOKS:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
2. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
3. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
4. Energy management hand book by W.C.Turner, John wiley and sons.
5. Energy management and conservation –k v Sharma and pvenkataseshaiah-I K International Publishing House pvt.ltd,2011.
6. Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill

Course Outcomes:

- Illustrate energy efficiency, scope, conservation and technologies.
- Design energy efficient lighting systems.
- Analyze power factor of systems and propose suitable compensation techniques.
- Interpret energy conservation in HVAC systems.
- Analyze life cycle costing analysis and return on investment on energy efficient technologies.

		L	T	P	C
III Year I Semester	**Professional Core**	**0**	**0**	**3**	**1.5**
THERMAL ENGINEERING LAB					

Course Objective: To provide hands on experience in operating various types of internal combustion engines and understands their functioning and performance**.**

List of experiments:

1. I.C. Engines valve / port timing diagrams.
2. Testing of Fuels – Viscosity, flash point/fire point, carbon residue, calorific value.
3. I.C. Engines performance test and Exhaust emission measurements (4 -stroke diesel engine)
4. I.C. Engines performance test and Exhaust emission measurements (2-stroke petrol engine)
5. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine.
6. Determination of FP by retardation and motoring test on IC engine.
7. I.C. Engines heat balance at different loads and show the heat distribution curve.
8. Economical speed test of an IC engine.
9. Performance test on variable compression ratio engines.
10. Performance test on reciprocating air compressor unit.
11. Dis-assembly / assembly of different parts of two wheelers. 3 wheelers & 4 wheelers. Tractor &Heavy-duty engines covering 2-stroke and 4 stroke, SI and CI engines.
12. Study of boilers, mountings and accessories

Course outcomes:

Upon successful completion of this course the student should be able to:

1. Identify the valves and ports opening and closing of IC engines and Assembly and Dis-assembly of IC Engines. (BL-3)
2. Find the performance characteristics of an internal combustion engines (BL-1)
3. Solve the heat load by drawing the Heat Balance sheet (BL-3)
4. Demonstrate the performance of engine by economical speed tests and Study of Boilers (BL-2)
5. Analyze the performance parameters like IP, BP and FP for multi cylinder engines (BL-2)

III Year I Semester	Professional Core	L	T	P	C
		0	0	3	1.5

THEORY OF MACHINES LAB

Course objective:

The students will acquire the knowledge

To analyze gyroscope, frequency of free and forced vibration and study static and dynamic balancing.

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 analyze 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 coefficient of friction between 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:

Upon successful completion of this course the student should be able to:

1. Examine the motion of a motorized gyroscope when the couple is applied along its spin axis. (BL-4)
2. Find the frequency of undamped and damped free vibration of an equivalent spring mass system. (BL-1)
3. Find the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation (BL-1)
4. Interpret the static and dynamic balancing using rigid blocks (BL-2)
5. Interpret the moment of inertia of a flywheel and determine whirling speed of shaft theoretically and experimentally (BL-2)

		L	T	P	C
III Year-I Semester	**Skill Oriented Course**	**0**	**0**	**4**	**2**
MACHINE TOOLS AND METROLOGY LAB					

Course Objectives:

1. To interpret the working principles of various machines viz lathe, Drilling, milling, shaping.
2. To illustrate the usage of CNC in Lathe and Milling machines.
3. To learn about basic measuring instruments vernier callipers, screw gauge, vernier height gauge.
4. To learn the measurement of the angle and taper by Bevel protractor, Sine bar, etc.
5. To learn about Mechanical parameter measuring systems and different alignment techniques.

Part A -List of Experiments

1. Introduction of general-purpose machines -Lathe, drilling machine, Milling machine, Shaper,
1. Planning machine, slotting machine, Cylindrical Grinder, surface grinder and tool and cutter
2. grinder.
3. To perform Step turning and taper turning on lathe machine
4. To perform Thread cutting and knurling on lathe machine.
5. To perform spur gear cutting using milling machine.
6. To perform flat surface operation on a block using shaper.
7. To perform Drilling & Tapping operations.
8. To perform precise surface grinding operations.
9. To perform precision cylindrical grinding operations.
10. To perform splines on a block using slotting machine.
11. To perform step turning operation using CNC lathe.

Part B - List of Experiments

1. Measurement of lengths, heights, diameters by vernier callipers, micrometers etc.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. To Study the Angle and taper measurements by Bevel protractor, Sine bars, etc.
4. Measurements by Gear Tooth Vernier Callipers.
5. To study about the Tool makers microscope and its application
6. Surface Roughness Measurement

Course Outcomes:

Students get exposure to

1. Perform step, taper turning, knurling and threading operations on lathe.
2. Practical exposure on Flat Surface machining, Shaping, Slotting, Milling and grinding
3. operations.
4. Develop programs on CNC lathe and Milling machines.
5. Apply the procedures to measure length, width, depth, bore diameters, external tapers, tool angles, and surface roughness by using different instruments.
6. Demonstrate knowledge of different machine tools used in machine shops.

III Year-I Semester	Skill Oriented Course	L	T	P	C
		0	0	4	2
MECHATRONICS LAB					

Course Objectives:

The students will acquire the knowledge:

1. To measure load and temperature using analogue and digital sensors.
2. To measure displacement using analogue and digital sensors.
3. To develop PLC programs for control of traffic lights, water level, lifts and conveyor belts.
4. To simulate and analyze PID controllers for a physical system using MATLAB.
5. To develop pneumatic and hydraulic circuits using Automaton studio.

List of Experiments

1. DYNA 1750 Transducers Kit:-
   a. Characteristics of LVDT
   b. Principle & Characteristics of Strain Gauge
   c. Characteristics of Summing Amplifier
   d. Characteristics of Reflective Opto Transducer
2. PLCPROGRAMMING
   a. Ladder programming on Logic gates, Timers &counters
   b. Ladder Programming for digital & Analogy sensors
   c. Ladder programming for Traffic Light control, Water level control and Lift control Modules
3. AUTOMATION STUDIO software
   a. Introduction to Automation studio & its control
   b. Draw & Simulate the Hydraulic circuit for series & parallel cylinders connection
   c. Draw & Simulate Meter-in, Meter-out and hydraulic press and clamping.
4. MATLAB Programming
   a. Sample programmes on Matlab
   b. Simulation and analysis of PID controller using SIMULINK

Course outcomes:

Upon successful completion of this course student should be able to:

1. Measure load using analogue and digital sensors (BL-5)
2. Measure displacement using analogue and digital sensors (BL-5)
3. Develop PLC programs for control of traffic lights, water level and lift system (BL-3)
4. Analyze PID controllers for a physical system using MATLAB(BL-4)
5. Develop pneumatic and hydraulic circuits (BL-3)

III Year-I Semester	Engineering Science Course	L	T	P	C
		0	0	2	1
COMPUTATIONAL FLUID DYNAMICS LAB					

Course Objectives:

The students will acquire the knowledge

1. To solve problems of fluid mechanics and heat transfer by writing programs in C-language and MATLAB.
2. To solve ANSYS-FLUENT build geometry, mesh that geometry, Perform CFD method on the mesh, perform the calculation, and post-process the results.
3. To interpret the validation of the numerical result by comparison with known analytical results.
4. To analyze the numerical result by invoking the physical principles of fluid mechanics and heat transfer.
5. To solve Elliptical, Parabolic, Partial and Hyperbolic partial differential equations.

Using ANSYS-FLUENT solve the following problems of heat transfer analysis

1. Steady state conduction
2. Lumped heat transfer
3. Convective heat transfer – Internal flow (study both velocity and thermal boundary layers)
4. Convective heat transfer – External flow (study both velocity and thermal boundary layers)
5. Radiation heat transfer–Emissivity
6. Fluid Flow inside a bend pipe
7. Flow inside a cyclone / scrubber
8. External flow over a airfoil
9. Pressure drop analysis in a valve
10. Heat transfer analysis in heat exchanger
11. Heat transfer analysis in solar flat plate collector
12. Heat transfer analysis in solar air heater

Course Outcomes:

At the end of the course the students shall be able to:

1. Solve problems of fluid mechanics and heat transfer by writing programs in C-language and MATLAB.
2. Solve ANSYS-FLUENT build geometry, mesh that geometry, Perform CFD method on the mesh, perform the calculation, and post-process the results.
3. Intrepret the validation of the numerical result by comparison with known analytical results.
4. Analyze the numerical result by invoking the physical principles of fluid mechanics and heat transfer.
5. Solve Elliptical, Parabolic, Partial and Hyperbolic partial differential equations.

		L	T	P	C
III Year-II Semester	**Professional Core**	**3**	**0**	**0**	**3**
HEAT TRANSFER					

(Heat transfer data book allowed)

Course Objectives:

The students will acquire the knowledge

1. To interpret the different modes of heat transfer and conduction heat transfer through various solid bodies
2. To analyze the one-dimensional steady state heat conduction heat transfer and one-dimensional transient heat conduction
3. To illustrate the basic concepts of convective heat transfer and forced convection heat transfer of external flows and internal flows
4. To analyze the free convection heat transfer concepts and heat transfer processes in heat exchangers
5. To interpret the concepts of film wise condensation, drop wise condensation and radiation heat transfer

UNIT – I:
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 and Spherical coordinates – simplification and forms of the field equation – 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, Application to error measurement of Temperature.

UNIT – II:
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 – III:

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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 and annulus flow.

Free Convection:

Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.

UNIT – IV:

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 V:

Radiation Heat Transfer: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

TEXT BOOKS:

1. Heat Transfer by HOLMAN, Tata McgrawHill
2. Heat Transfer by P.K.Nag, TMH

REFERENCE BOOKS:

1. Fundamentals of Heat Transfer by Incropera& Dewitt, John wiley
2. Fundamentals of Engineering, Heat& Mass Transfer by R.C.Sachdeva, NewAge.
3. Heat& Mass Transfer by Amit Pal – Pearson Publishers
4. Heat Transfer by Ghosh dastidar, Oxford University press.
5. Heat Transfer by a Practical Approach, YunusCengel, Boles, TMH
6. Engineering Heat and Mass Transfer by Sarit K. Das, DhanpatRai Pub

Note: Heat and Mass transfer Data Book by C P Kothandaraman and Subrahmanyan is used to design and analyze various thermal processes and thermal equipment.

Course Outcomes:

At the end of the course, the student should be able to

1. Interpret the different modes of heat transfer and conduction heat transfer through various solid bodies
2. Analyze the one-dimensional steady state heat conduction heat transfer and one-dimensional transient heat conduction
3. Illustrate the basic concepts of convective heat transfer and forced convection heat transfer of external flows and internal flows
4. Analyze the free convection heat transfer concepts and heat transfer processes in heat exchangers
5. Interpret the concepts of film wise condensation, drop wise condensation and radiation heat transfer

III Year-II Semester	Professional Course	L	T	P	C
		3	0	0	3
FINITE ELEMENT METHODS					

Course Objectives:

The students will acquire the knowledge

1. To illustrate basic principles of finite element analysis procedure
2. To analyze the theory and characteristics of finite elements that represent engineering structures of trusses and beams
3. To develop finite element modeling of two-dimensional stress analysis
4. To analyze the finite modelling for high order and isoparametric elements
5. To develop the usage of finite element method for the steady state heat transfer analysis

UNIT-I

Introduction to finite element method, stress and equilibrium, strain –displacement relations, stress–strain relations, plane stress and plane strain conditions, 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 – II

Analysis of Trusses: Finite element modelling coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, 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 – III

Finite element modelling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axi-symmetric problems.

UNIT-IV

Higher order and isoparametric elements: One dimensional quadratic and cubic elements in natural coordinates, two dimensional four noded isoparametric elements and numerical integration.

UNIT – V

Steady state heat transfer analysis: one dimensional analysis of a fin and two-dimensional analysis of thin plate, analysis of a uniform shaft subjected to torsion.

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of Eigen values and Eigen vectors, free vibration analysis.

Text Books:

1. The Finite Element Methods in Engineering /SSRao/Pergamon.

References:

1. Finite Element Method with applications in Engineering / YM Desai, Eldho& Shah /Pearson publishers
2. An introduction to Finite Element Method /JNReddy/McGrawHill

3. The Finite Element Method for Engineers–KennethH.Huebner, Donald L. Dewhirst, Douglas E. Smith and TedG. Byrom/John Wiley & sons (ASIA)PteLtd.
4. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education
5. Finite Element Methods / Chen
6. Finite Element Analysis: for students & Practicing Engineers / G.Lakshmi Narasaiah / BSP Books Pvt. Ltd.

Course outcomes:

Upon successful completion of this course, you should be able to:

1. Illustrate basic principles of finite element analysis procedure
2. Analyze the theory and characteristics of finite elements that represent engineering structures of trusses and beams
3. Develop finite element modeling of two-dimensional stress analysis
4. Analyze the finite modelling for high order and isoparametric elements
5. Develop the usage of finite element method for the steady state heat transfer analysis

III Year-II Semester	Professional Elective -II	L	T	P	C
		3	0	0	3
INDUSTRIAL ROBOTICS					

Course Objectives:

The students will acquire the knowledge:

1. To illustrate various applications of robotics and classification of coordinate system and control systems
2. To build the concepts of components of industrial robotics.
3. To determine kinematic analysis with D-H notation, forward and inverse kinematics and Solve dynamic analysis with Lagrange – Euler and Newton – Euler formulations
4. To model trajectory planning for a manipulator by avoiding obstacles
5. To analyze different types of actuators and applications of robots in manufacturing

UNIT-I

INTRODUCTION: Automation and Robotics, CAD/CAM and Robotics – An over view of Robotics – present and future applications – classification by coordinate system and control system.

UNIT – II

COMPONENTS OF THE INDUSTRIAL ROBOTICS: Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices.

UNIT – III

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. Differential transformation and manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formulations – Problems.

UNIT IV

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 V

ROBOT ACTUATORS AND FEED BACK COMPONENTS:

Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors.

ROBOT APPLICATIONS IN MANUFACTURING: Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.

TEXT BOOKS:

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Robotics / John J. Craig/ Pearson

REFERENCE BOOKS:

1. Theory of Applied Robotics /Jazar/Springer.
2. Robotics / Ghosal / Oxford

Course outcomes:

Upon successful completion of this course student should be able to:

1. Illustrate various applications of robotics and classification of coordinate system and control systems
2. Build the concepts of components of industrial robotics.
3. Determine kinematic analysis with D-H notation, forward and inverse kinematics and Solve dynamic analysis with Lagrange – Euler and Newton – Euler formulations
4. Model trajectory planning for a manipulator by avoiding obstacles
5. Analyze different types of actuators and applications of robots in manufacturing

III Year-II Semester	Professional Elective-II	L	T	P	C
		3	0	0	3
SUPPLY CHAIN MANAGEMENT					

Course Objectives:
The students will acquire the knowledge:

1. To explain the importance of Supply chain management frame work in business management
2. To interpret basic concepts of Supply Chain Drivers and Metrics
3. To interpret the Design of Supply Chain Network and factors influencing distribution network design
4. To analyze role of forecasting in a supply chain
5. To analyze aggregate Planning and inventories in supply chain

Unit-I
Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope.

Unit-II
Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit.

Unit-III
Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation.

Unit-IV
Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting.

Unit-V
Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory. Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect.

Text Books:

1. Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 4th Edition, Pearson Education Asia, 2010.
2. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

Course Outcomes:

Up on completion of course students will be able to

1. Explain the importance of Supply chain management frame work in business management
2. Interpret basic concepts of Supply Chain Drivers and Metrics
3. Interpret the Design of Supply Chain Network and factors influencing distribution network design
4. Analyze role of forecasting in a supply chain
5. Analyze aggregate Planning and inventories in supply chain

III Year-II Semester	Professional Elective-II	L	T	P	C
		3	0	0	3
ADDITIVE MANUFACTURING					

Course Objectives:

1. To analyze the principles of prototyping, classification of RP processes and liquid-based RP systems
2. To illustrate and apply different types of solid-based RP systems.
3. To interpret and apply powder-based RP systems.
4. To discuss and apply various rapid tooling techniques.
5. To analyze different types of data formats and to explore the applications of AM processes in various fields.

UNIT– I:

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, case studies. Solid Ground Curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT– II:

SOLID-BASED RAPID PROTOTYPING SYSTEMS: Laminated object manufacturing (LOM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT– III:

POWDER BASED RAPID PROTOTYPING SYSTEMS: Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages and disadvantages, case studies. three-dimensional printing (3DP): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT– IV:

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– V:

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

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

1. Analyze the principles of prototyping, classification of RP processes and liquid-based RP systems
2. Illustrate and apply different types of solid-based RP systems.
3. Interpret and apply powder-based RP systems.
4. Discuss and apply various rapid tooling techniques.
5. Analyze different types of data formats and to explore the applications of AM processes in various fields.

III Year-II Semester	Professional Elective-II	L	T	P	C
		3	0	0	3

UNCONVENTIONAL MACHINING PROCESSES

Course Objectives:
The students will acquire the knowledge

1. To Analyze basic concepts of modern machining processes and ultrasonic machining.
2. To interpret the principles and procedure of principles of electro chemical machining.
3. To apply the principles and procedure of thermal metal removal processes.
4. To illustrate the principles and procedure of electron beam machining, laser beam machining and plasma machining.
5. To interpret the principles and procedure of abrasive jet machining.

UNIT – I

INTRODUCTION: Need for non-traditional machining methods-classification of modern machining processes considerations in process selection, applications.

Ultrasonic machining – Elements of the process, mechanics of material removal, MRR process parameters, economic considerations, applications and limitations.

UNIT – II

ELECTRO – CHEMICAL MACHINING: Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate, fundamentals of chemical, machining, advantages and applications.

UNIT - III

Thermal Metal Removal Processes: General principle and applications of Electric Discharge Machining, Electric Discharge Grinding and wire EDM – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface.

UNIT – IV

Electron Beam Machining, Laser Beam Machining - Basic principle and theory, mechanics of material removal, process parameters, efficiency & accuracy, applications

Plasma Machining: Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries.

UNIT – V

Abrasive jet machining, Water jet machining and abrasive water jet machining: Basic principles, equipment, process variables, mechanics of material removal, MRR, application and limitations, magnetic abrasive finishing, abrasive flow finishing, Electro stream drilling, shaped tube electrolytic machining.

Text Books:

1. Fundamentals of Machining Processes-Conventional and non – conventional processes/Hassan Abdel – Gawad El-Hafy/CRCPress-2016.

References:

1. Modern Machining Process / Pandey P.C. and Shah H.S./TMH.
2. New Technology / Bhattacharya A/ the Institution of Engineers, India1984.
3. Non-Traditional Manufacturing Processes / Benedict

Course Outcomes

At the end of the course the students shall be able to:

1. Analyze basic concepts of modern machining processes and ultrasonic machining.
2. Interpret the principles and procedure of principles of electro chemical machining.
3. Apply the principles and procedure of thermal metal removal processes.
4. Illustrate the principles and procedure of electron beam machining, laser beam machining and plasma machining.
5. Interpret the principles and procedure of abrasive jet machining.

III Year-II Semester	Professional Elective-II	L	T	P	C
		3	0	0	3
REFRIGERATION AND AIR CONDITIONING					

(Refrigeration and Psychrometric tables and charts allowed)

Course Objectives:

The students will acquire the knowledge:

1. To illustrate the operating cycles and different systems of refrigeration
2. To analyze cooling capacity and coefficient of performance of vapor compression refrigeration systems and understand the properties of refrigerants
3. To identify VCR system components and calculate coefficient of performance by conducting test on vapor absorption and steam jet refrigeration systems
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 – I

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 – II

VAPOUR COMPRESSION REFRIGERATION: Working principle and essential components of the plant – simple vapor 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.

VCR SYSTEM COMPONENTS: Compressors – general classification – comparison – advantages and disadvantages. condensers – classification – working principles evaporators – classification – working principles expansion devices – types – working principles

REFRIGERANTS – Desirable properties – classification - refrigerants used – nomenclature – ozone depletion – global warming

UNIT III

VAPOR ABSORPTION SYSTEM: Calculation of maximum COP – description and working of NH_3 – water system and Li Br –water (Two shell & four shell) System, principle of operation three fluid absorption system, salient features.

STEAM JET REFRIGERATION SYSTEM: Working Principle and basic components. Principle and operation of thermoelectric refrigerator and vortex tube.

UNIT IV

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, air-conditioning load calculations.

UNIT – V

AIR CONDITIONING SYSTEMS: Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers. heat pump – heat sources – different heat pump circuits

Text Books:

1. A Course in Refrigeration and Air conditioning / SC Arora &Domkundwar / Dhanpatrai
2. Refrigeration and Air Conditioning / CP Arora / TMH.

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:

Upon successful completion of this course the student should be able to:

1. Illustrate the operating cycles and different systems of refrigeration (BL-2)
2. Analyze cooling capacity and coefficient of performance of vapour compression refrigeration systems and understand the properties of refrigerants (BL-3)
3. Identify VCR system components and calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration systems (BL-3)
4. Solve cooling load for air conditioning systems and identify the requirements of comfort air conditioning. (BL-2)
5. Demonstrate different component of refrigeration and air conditioning systems.(BL-2)

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III Year-II Semester	Professional Elective-III	L	T	P	C
		3	0	0	3
AUTOMOBILE ENGINEERING					

Course Objectives:

The students will acquire the knowledge

1. To Illustrate basic components and functions of automobile
2. To analyze the various elements and working of transmission system of automobile
3. To Interpret the working of steering system, suspension system and braking system of automobile
4. To analyze the concepts involved in the electrical system of automobile, engine specifications and safety systems
5. To illustrate the concepts involved in the emission control and engine service of different parts

UNIT – I

INTRODUCTION: Components of four-wheeler automobile – chassis and body – power unit – power transmission – rear wheel drive, front wheel drive, 4-wheel drive – types of automobile engines, engine construction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps – crank case ventilation – engine service, reboring, decarbonization, Nitriding of crank shaft.

UNIT – II

TRANSMISSION SYSTEM: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, construct mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. propeller shaft – Hotch – Kiss drive, Torque tube drive, universal joint, differential rear axles – types – wheels and tyres.

UNIT – III

STEERING SYSTEM: Steering geometry – camber, castor, king pin rake, combined angle toein, centre point steering. types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, independent suspension system.

UNIT – IV: BRAKING SYSTEM: Mechanical brake system, hydraulic brake system, master cylinder, wheel cylinder tandem master cylinder requirement of brake fluid, pneumatic and vacuum brakes.

ELECTRICAL SYSTEM: Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.

UNIT – V

ENGINE SPECIFICATION AND SAFETY SYSTEMS: Introduction- engine specifications with regard to power, speed, torque, no. of cylinders and arrangement, lubrication and cooling etc.

SAFETY: Introduction, safety systems - seat belt, air bags, bumper, anti lock brake system (ABS), wind shield, suspension sensors, traction control, mirrors, central locking and electric windows, speed control

ENGINE EMISSION CONTROL: Introduction – types of pollutants, mechanism of formation, concentration measurement, methods of controlling-engine modification, exhaust gas treatment-thermal and catalytic converters-use of alternative fuels for emission control – National and International pollution standards

ENGINE SERVICE: Introduction, service details of engine cylinder head, valves and valve mechanism, piston-connecting rod assembly, cylinder block, crank shaft and main bearings, engine reassembly-precautions.

Text Books:

1. Automotive Mechanics – Vol. 1 & Vol. 2 / Kirpal Singh/standard publishers
2.Automobile Engineering / William Crouse/TMH Distributors
3.Automobile Engineering/P.S Gill/S.K. Kataria& Sons/New Delhi.

References:

1.Automotive Engines Theory and Servicing/James D. Halderman and Chase D. Mitchell Jr.,/ Pearson education inc.
2. Automotive Engineering / K Newton, W.Steeds& TK Garrett/SAE
3. Automotive Mechanics : Principles and Practices/ Joseph Heitner/Van Nostrand Reinhold 4. Automobile Engineering / C Srinivasan/McGrawHill

Course Outcomes:

At the end of the course the students shall be able to:

1. Illustrate basic components and functions of automobile
2. Analyze the various elements and working of transmission system of automobile
3. Interpret the working of steering system, suspension system and braking system of automobile
4. Analyze the concepts involved in the electrical system of automobile, engine specifications and safety systems
5. Illustrate the concepts involved in the emission control and engine service of different parts

III Year-II Semester	Professional Elective-III	L	T	P	C
		3	0	0	3
COMPUTER INTERGRATED MANUFACTURING					

Course Outcome

Students will be able to

1. Apply manufacturing concepts and management principles.
2. Classify and compare different manufacturing processes and systems.
3. Develop part program for manufacturing of different machine components.
4. Analyze the behavior of manufacturing system using simulation.

UNIT-I

Introduction:

Introduction, evolution of CIM, types of manufacturing system, components of CIM, CIM Wheel, role of management in CIM. Impact of CIM on personnel, Levels of Automation, Lean Production and Just-In Time Production.

UNIT-II

Group Technology & CAPP Introduction, part families, visual inspection, part classification and coding techniques – chain type, hierarchical structure, hybrid & Opitz coding, product flow analysis, rank order clustering, composite part concepts.

Introduction, Approaches to Computer Aided Process Planning – Variant, Generative and Hybrid method, applications and benefits.

UNIT-III

Flexible Manufacturing System Introduction & component of FMS, needs of FMS, general FMS consideration, objectives, types of flexibility, FMS layout and advantages. Automated material handling system: Types and Application, Automated Storage and Retrieval System, Automated Guided Vehicles, Automated Tool Management and supply system, Tool Monitoring System, Flexible Fixturing, Flexible Assembly Systems.

UNIT-IV

Robot Technology Introduction: Robot Anatomy, Laws of Robot, human System and robotics, coordinate system, specifications of robot, different configurations of robots, power sources, actuators and transducers, robotic sensors, grippers, robot safety, applications, economic considerations of robotics system. Concepts of Computer Vision and Machine Intelligence.

UNIT-V

NC/CNC Machine Tools Types, Classification, Specification and components, Construction Details, Controllers, Sensors and Actuators, CNC hardware: Re circulating ball screw, antifriction slides, step/servo motors. Axis designation, NC/CNC tooling. Fundamentals of manual Part programming, absolute and incremental dimensioning Types of formats, Part Programming for drilling, lathe and milling operations, subroutines, canned Cycles, parametric sub routines.

Software based programming cycles: • Turning Cycles Stock Removal, Groove, Undercut, Thread-OD, Cut-off, contour and plunge turning operations • Milling Cycles Face Milling, Pocket, Multi-edge spigot, slot, Thread Milling, Engraving) • Drilling Cycles Centering, Drilling, Deep Hole Drilling, Boring, Threading

Programmable Logic Controllers Introduction, Programmable controller architecture, relay device components, programming a programmable controller, tools for PLC logic design.

Textbooks:

1. Principles of Computer-integrated Manufacturing by S. Kant Vajpayee

2. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover Pearson Education

Reference Books:

1. Robotics Technology and Flexible Automation, by S R Deb, S Deb, McGraw Hill Education
2. Private Limited
3. Flexible Manufacturing Cells and System -William. W. Luggen
4. CNC Machines by B.S. Pabla
5. CNC Machines and Automation by J.S. Narang

III Year-II Semester	Professional Elective-III	L	T	P	C
		3	0	0	3
SMART MANUFACTURING					

Course Objectives:

1) To interpret the basics of smart manufacturing
2) To describe advanced automation and smart design and manufacturing technologies
3) To apply machine learning in manufacturing
4) To illustrate the applications of smart manufacturing
5) To illustrate the elements of IIoT

UNIT-I Introduction to Smart Manufacturing

Definition, objectives, benefits of Smart Manufacturing, Evolution of manufacturing systems, Key components and technologies in Smart Manufacturing, Industrial Automation and Control Systems. Basic principles and technologies of a Smart manufacturing, Digitalization and the Networked Economy, Globalization and Emerging Issues. Cyber-Physical Systems and Cyber-Physical Production Systems, smart work piece, Digital Twins in production, Assistance systems for production.

UNIT-II: Smart Design & Fabrication

Smart Design/Fabrication - Digital Tools, Product Representation and Exchange Technologies and Standards, Agile (Additive) Manufacturing Systems and Standards. Mass Customization, Smart Machine Tools, Robotics and Automation (perception, manipulation, mobility, autonomy), Smart Perception – Sensor networks and Devices. Online Predictive modelling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes; Smart Energy Management of manufacturing processes and facilities.

UNIT-III : ML in Manufacturing

ML - Concept of AI, Conceptual Learning, AI & Augmented reality in Manufacturing. ANN in Manufacturing-Biological Neuron, Artificial Neuron, Types NNs, ML Applications in Manufacturing. Human-Robot Collaboration. Communication Systems in Cloud Manufacturing, Cloud Applications in Manufacturing, and allied factory.

UNIT- IV: Application

Factories and Assembly Line, Food Industry, Medical, Power Plants, Inventory Management & Quality. Data Acquisition and Analysis

UNIT-V: Elements of IIoT

Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API’s (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

Textbooks:

1. Masoud Soroush, McKetta Michael Baldea, & Thomas Edgar (2020). “Smart Manufacturing: Concepts and Methods”, Elsevier, 2020.

2. Smart Manufacturing Innovation and Transformation: Interconnection and Intelligence Luo,

Z. ed., 2014 IGI Global.

3. Smart Manufacturing: Integrating Transformational Technologies for Competitiveness and Sustainability. Shemwell, S.M. and Quazi, H.A., CRC press

4. Gilchrist, A., “Industry 4.0: the industrial internet of things”, A press, 2016

5. Automation, Production Systems and CIM/Groover M.P./PHI/2007

Reference Books:

1. Rawat, D. B., Brecher, C., Song, H., & Jeschke, S. (2017)., “Industrial Internet of Things: Cybermanufacturing Systems”, Springer, 2017.

2. M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010,\ ISBN-10: 0123748992.

Course Outcomes:

1) Interpret the basics of smart manufacturing
2) Describe advanced automation and smart design and manufacturing technologies
3) Apply machine learning in manufacturing
4) Illustrate the applications of smart manufacturing
5) Illustrate the elements of IIoT

III Year-II Semester	Professional Elective -III	L	T	P	C
		3	0	0	3
MECHANICAL VIBRATIONS					

Course Objectives:
The students will acquire the knowledge

1. To analyze basic principles of mathematical modeling of vibrating systems
2. To illustrate the basic concepts free and forced multi degree freedom systems
3. To interpret concepts involved in the torsional vibrations
4. To analyze the principles involved in the critical speed of shafts
5. To illustrate the basic concepts of transient vibrations

UNIT-I: 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-II: 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, modal analysis.

UNIT-III: 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-IV: CRITICAL SPEEDS OF SHAFTS: 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-V: TRANSIENT VIBRATIONS:

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”, 5th Edition,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:

1. Analyze basic principles of mathematical modeling of vibrating systems
2. Illustrate the basic concepts free and forced multi degree freedom systems
3. Interpret concepts involved in the torsional vibrations
4. Analyze the principles involved in the critical speed of shafts
5. Illustrate the basic concepts of transient vibrations

III Year-II Semester	Professional Elective-III	L	T	P	C
		3	0	0	3
COMPOSITE MATERIALS					

Course Objectives

The students will acquire the knowledge:

1. To classify the composite materials and identify the applications
2. To illustrate strengthening mechanisms of fiber composites
3. To analyze Major composite classes and role of interfaces in composites
4. To interpret the Fabrication of PMC's, CMC's and MMC'S
5. To analyze applications of advanced composite materials.

UNIT-I

Introduction to Composites: Matrices, Reinforcements, Classifications, Applications, Comparison with Metals and Importance over other materials, design fabrication and economic consideration, General requirements. Classification of composites on the basis of reinforcement and matrix, Classification of Reinforcement, Form and functions of reinforcement, Functions of matrices. Dispersion strengthened, particle strengthened and fiber-reinforced composites. Fibres and resin materials.

UNIT-II

Strengthening mechanisms, Aspect Ratio, Rule of Mixture, discontinuous and continuous fiber composites and their comparison, Characteristics and materials of reinforcements and matrices. Critical Fiber Length, Short and Continuous Fibers, Fiber Orientation.

UNIT-III

Major composite classes: polymer matrix, metal matrix, ceramic matrix, carbon-carbon, and intermetallic composites. Hybrid composites, Laminated composites. Polymer composites, thermoplastics, thermosetting plastics, manufacturing of PMC, MMC & CCC and their applications.
Role of interfaces in composites, Interfacial Bonding Mechanisms. Pullout & Push-out Testing. Control of Bond Strength. Toughening mechanisms in PMCs, MMCs, and CMCs.

UNIT-IV

Fabrication of PMC's:- Fabrication of Fibers, Plastic Fiber Forms, Prepregs, Molding Compounds-Processes, Lay-Ups, Filament Winding, Pultrusion, and Recycling. ; Matrix –Reinforcement Interface, Wettability.
Fabrication of CMC's: Hot-Pressing, Infiltration, In Situ Chemical Reaction Techniques. CVD & CVI, Sol-gel.
Fabrication of MMC'S: Liquid Infiltration- Casting, Solid State Processes-Diffusion Bonding &In Situ Technique.

UNIT-V

Applications of advanced composite materials. Environmental effects in Composites, Green composites, Synthesis and Properties of Nanocomposites. Surface Composites & Surface metal matrix composites: Need, Synthesis, Properties and applications

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Text Books:

1. Nano material /A.K. Bandyopadyay/New age Publishers
2. Material science and Technology: A comprehensive treatment/Robert W.Cahn,/VCH
3. Engineering Mechanics of Composite Materials / Isaac and M Daniel/Oxford University Press

References:

1. Mechanics of Composite Materials / R. M. Jones/ Mc Graw Hill Company, New York, 1975.
2. Analysis of Laminated Composite Structures / L. R. Calcote/Van Nostrand Rainfold,NY 1969
3. Analysis and performance of fibre Composites /B. D. Agarwal and L. J. Broutman /Wiley-Interscience,New York, 1980
4. Mechanics of Composite Materials - Second Edition (Mechanical Engineering) /Autar K.Kaw / CRC Press

Course Outcomes:

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

1. Classify the composite materials and identify the applications
2. Illustrate strengthening mechanisms of fiber composites
3. Analyze Major composite classes and role of interfaces in composites
4. Interpret the Fabrication of PMC's, CMC's and MMC'S
5. Analyze applications of advanced composite materials.

III Year-II Semester	Open Elective-II	L	T	P	C
		3	0	0	3
ELECTRICAL VEHICLES					

Course Objectives: At the end of the course, the student will be able to:
1. To Illustrate electric vehicles.
2. To Interpret drive-train topologies.
3. To Classify various electrical drives
4. To Classify energy storage technologies.
5. To Classify different energy management strategies.

UNIT-I:
INTRODUCTION TO ELECTRIC VEHICLES
History of electric vehicles, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies. Comparison by efficiency of Conventional, Hybrid, Electric and Fuel cell Vehicles.

UNIT-II:
ELECTRIC DRIVE-TRAINS
Basic concept of electric traction, Introduction to various electric drive-train topologies, Power flow control in electric drive-train topologies.

UNIT-III:
ELECTRIC DRIVES & CONTROL
Introduction to electric components used in electric vehicles, Control of Induction Motor Drive, Permanent Magnet (PM) motor Drive & Switched Reluctance Motor (SRM) Drive.

UNIT-IV:
ENERGY STORAGE
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its modeling, SOC, Different Types of Batteries, Super Capacitor based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT-V:
ENERGY MANAGEMENT STRATEGIES & CHARGING INFRASTRUCTURE 10 Lectures
Introduction to energy management strategies used in electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies, Types of EV charging Infrastructure & Standardized Communication protocols for EV charging.

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, 2 nd Edition, 2017. (Unit-I, II)

2. Ali Emadi, “Advanced Electric Drive Vehicles (Energy, Power Electronics, and Machines)”, CRC Press, 2015. (Unit-III)
3. John G. Hayes and A. Goodarzi, “Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles”, Wiley, 2018. (Unit-IV & V)

References:

1.James Larminie, John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2 nd Edition 2012.

Course Outcomes:

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

1. Illustrate electric vehicles.
2. Interpret drive-train topologies.
3. Classify various electrical drives
4. Classify energy storage technologies.
5. Classify different energy management strategies.

<table>
<tr><td rowspan="2">III Year-II Semester</td><td rowspan="2">Open Elective-II</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">SUPPLY CHAIN MANAGEMENT</td></tr>
</table>

Course Objectives:
The students will acquire the knowledge:

1. To explain the importance of Supply chain management frame work in business management
2. To illustrate basic concepts of Supply Chain Drivers and Metrics
3. To interpret the Design of Supply Chain Network and factors influencing distribution network design
4. To analyze role of forecasting in a supply chain
5. To analyze aggregate Planning and inventories in supply chain

Unit-I
Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope.

Unit-II
Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit.

Unit-III
Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation.

Unit-IV
Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting.

Unit-V
Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory. Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect.

Text Books:

1. Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 4th Edition, Pearson Education Asia, 2010.
2. David Simchi-Levi, PhilpKamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

Course Outcomes:
Up on completion of course students will be able to
1. Explain the importance of Supply chain management frame work in business management
2. Illustrate basic concepts of Supply Chain Drivers and Metrics

3. Interpret the Design of Supply Chain Network and factors influencing distribution network design
4. Analyze role of forecasting in a supply chain
5. Analyze aggregate Planning and inventories in supply chain

Note: The students who already opted the subject name- Supply Chain Management in Professional elective need to opt for a different subject.

III Year-II Semester	Open Elective-II	L	T	P	C
		3	0	0	3
DESIGN OF EXPERIMENTS					

Course Objectives:

The students will acquire the knowledge:

1. To interpret Probability laws, Baye's theorem and Probability distributions.
2. To analyze normal and t-distributions and Central limit theorem.
3. To interpret randomization, blocking with paired comparisons and Analysis of variance
4. To develop analyze two-way factorial designs and understand Yate's algorithm
5. To interpret simple modeling with least squares

UNIT-I:

Introduction to probability, Probability laws, Baye's theorem, Probability distributions, Parameters and statistics.

UNIT-II:

Normal and t-distributions, Central limit theorem, Random sampling and declaration of independence significance tests.

UNIT-III:

Randomization and blocking with paired comparisons significance tests and confidence interval for means, variances, proportions and frequencies. Analysis of variance, Experiments to compare k-treatment means.

UNIT-IV:

Two-way factorial designs, blocking, Yate's algorithm Fractional factorial designs at two levels, Concept of design resolution.

UNIT-V:

Simple modeling with least squares (Regression analysis), Matrix versions of normal equations.

Text Book

1. Statistics for Experimenters, G.E.P. Box, William G. Hunter and J.S. Hunter, John Wiley & Sons.

Reference Books

1. Design and Analysis of Experiments, D.C. Montgomery, 2nd Edition John Wiley and Sons.
2. Design of Experiments in Chemical Engineering: A Practical Guide, Zivorad R. Lazic, Wiley-VCH publications.

Course Outcomes

After completing this course students will be able to:

1) Interpret Probability laws, Baye’s theorem and Probability distributions.
2) Analyze normal and t-distributions and Central limit theorem.
3) Interpret randomization, blocking with paired comparisons and Analysis of variance
4) Develop analyze two-way factorial designs and understand Yate’s algorithm
5) Interpret simple modeling with least squares

III Year-II Semester	Open Elective-II	L	T	P	C
		3	0	0	3
TOTAL QUALITY MANAGEMENT					

Course Objectives

The students will acquire the knowledge:

1. To analyze the concepts of TQM, Quality and Business performance
2. To illustrate importance of customer satisfaction and loyalty
3. To analyze Organizing for quality implementation
4. To interpret the concept of cost of quality
5. To analyze ISO 9000 universal standards of quality

UNIT – I:

INTRODUCTION: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

UNIT – II:

CUSTOMER FOCUS AND SATISFACTION: The importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

UNIT – III:

ORGANIZING FOR TQM: The systems approach, organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

UNIT – IV:

THE COST OF QUALITY: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT – V:

ISO9000: Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-Series Standards, benefits of ISO9000 certification, the third-party audit, Documentation ISO9000 and services, the cost of certification implementing the system.

TEXT BOOKS:

1. Total Quality Management / Joel E.Ross/Taylor and Franscis Limited
2. Total Quality Management/P.N.Mukherjee/PHI

REFERENCES:

1. 1 Beyond TQM / Robert L.Flood
2. 2 Statistical Quality Control / E.L. Grant / McGraw Hill.
3. 3 Total Quality Management- A Practical Approach/H. Lal
4. 4 Quality Management/KanishkaBedi/Oxford University Press/2011
5. 5 Total Engineering Quality Management/Sunil Sharma/Macmillan

Course Outcomes:
On completion of this course, the students will be able to:

1. Analyze the concepts of TQM, Quality and Business performance
2. Illustrate importance of customer satisfaction and loyalty
3. Analyze Organizing for quality implementation
4. Interpret the concept of cost of quality
5. Analyze ISO 9000 universal standards of quality

<table>
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<tr><td colspan="6">INDUSTRIAL ROBOTICS</td></tr>
</table>

Course Objectives:
The students will acquire the knowledge:

1. To Analyze various applications of robotics and classification of coordinate system and control systems
2. To interpret the concepts of components of industrial robotics.
3. To analyze kinematic analysis with D-H notation, forward and inverse kinematics and solve dynamic analysis with Lagrange – Euler and Newton – Euler formulations
4. To Interpret trajectory planning for a manipulator by avoiding obstacles
5. To analyze different types of actuators and applications of robots in manufacturing

UNIT-I
INTRODUCTION: Automation and Robotics, CAD/CAM and Robotics – An over view of Robotics – present and future applications – classification by coordinate system and control system.

UNIT – II
COMPONENTS OF THE INDUSTRIAL ROBOTICS: Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices.

UNIT – III
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. Differential transformation and manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formulations – Problems.

UNIT IV
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 V
ROBOT ACTUATORS AND FEED BACK COMPONENTS:
Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors.
ROBOT APPLICATIONS IN MANUFACTURING: Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.

TEXT BOOKS:

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Robotics / John J. Craig/ Pearson

REFERENCE BOOKS:

1. Theory of Applied Robotics /Jazar/Springer.
2. Robotics / Ghosal / Oxford

Course outcomes:

Upon successful completion of this course student should be able to:

1. Analyze various applications of robotics and classification of coordinate system and control systems
2. Interpret the concepts of components of industrial robotics.
3. Analyze kinematic analysis with D-H notation, forward and inverse kinematics and solve dynamic analysis with Lagrange – Euler and Newton – Euler formulations
4. Interpret trajectory planning for a manipulator by avoiding obstacles
5. Analyze different types of actuators and applications of robots in manufacturing

Note: The students who already opted the subject name- Industrial Robotics in Professional elective need to opt for a different subject.

III Year-II Semester	Professional Core	L	T	P	C
		0	0	3	1.5

HEAT TRANSFER LAB

Course objectives:

The student will acquire

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.

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 Boltzman 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.
13. Investigation of Lambert's cosine law.

Course Outcomes:
At the end of the course the students shall be able to:
1. Find the thermal conductivity of different materials, composite slabs and powders.
2. Solve heat transfer coefficient for free and forced convection and pin fin efficiency for forced and free convection
3. Examine the Stefan Boltzmann Constant and emissivity of grey body
4. Compare parallel and counter flow heat exchanger performance characteristics and investigation of Lambert's cosine law
5. Solve the heat transfer rate through lagged pipes and heat transfer rate in film and drop wise condensation

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III Year-II Semester	Skill Oriented Course	L	T	P	C
		0	1	2	2
ROBOTICS & DRONE TECHNOLOGY					

Course Objectives: This course aims to

1. To develop the students' knowledge in various robot and drone structures and their workspace.
2. To develop multidisciplinary robotics that have practical importance by participating in robotics Competitions
3. To develop students' skills in performing spatial transformations associated with rigid body motions, kinematic and dynamitic analysis of robot systems.
4. Through projects done in lab, increase the true hands-on student learning experience and enhance their conceptual understanding, increase students' ability, competence and teamwork skills on dealing with real life engineering problems

Lab Experiments:

1. Assembling of robot mechanical components, mounting of motors, sensors, electronic circuits to the chassis.
2. Connecting to electronic circuitry: motor drivers, incremental encoders proximity sensors, micro controller,
3. Different types of batteries, selection of suitable battery for application, safety precaution.
4. Introduction to Linux Command Line Interface: basic file and directory management and other useful commands
5. Controlling robot using Python: i) Move robot using Python code, ii) Make robot move in patterns using Python
6. Robot programming with Sensor inputs: i) Read sensor data using Python, ii) Visualize sensor data using Python, iii) Code robot to avoid obstacles by using sensor data
7. Open CV: i) Create an Image and display an image; ii) Read and change pixel values; iii) Create colored shapes and save image; iv) Extract the RGB values of a pixel; v) Reading and Writing Videos
8. Open CV: i) Extraction of Regions of Interest; ii) Extraction of RGB values of a pixel
9. Coding robot to work with colors, follow colored objects, identifying shape of the object-oriented
10. Projects: i) Making a line follower robot using a Camera; ii) Writing code for a complex function
11. Assembly of a drone

Course Outcomes: After completion of this course, students will be able to

1. Demonstrate knowledge of the relationship between mechanical structures of robotics and their operational workspace characteristics
2. Interpret mechanical components, motors, sensors and electronic circuits of robots and build robots.
3. Demonstrate knowledge of robot controllers.
4. Use Linux environment for robotic programming.
5. Write Python scripts to control robots using Python and Open CV

III Year-II Semester	Skill Oriented Course	L	T	P	C
		0	1	2	2
COMPUTER AIDED MANUFACTURING LAB					

Course Objectives:
The students will acquire the knowledge

- To model of simple machine parts and assemblies from the part drawings using standard CAM packages.
- To generate CNC Turning codes for different operations using standard CAM packages.
- To generate CNC Milling codes for different operations using standard CAM packages.
- To learn various fields of engineering where these tools can be effectively used to improve the output of a product.
- To impart knowledge on how these tools are used in Industries by solving some real time problems using 3-D printing equipment.

List of Experiments:

1. Study and prepare the Manual Part program for CNC Turn machine
2. Study and prepare the Manual Part program for CNC Mill machine
3. Study of various post processors used in NC Machines.
4. Machining of simple components on NC lathe by transferring NC Code / from a CAM package through RS 232.
5. Machining of simple components on NC Mill by transferring NC Code / from a CAM package through RS 232.
6. Automated CNC Tool path, G-Code & M-Code generation using CAM.
7. Study and prepare the Computer Aided Part-program for CNC Milling machine with APT (Automatically programmed Tools) language
8. Study and prepare the Computer Aided Part-program for CNC Turning machine with APT (Automatically programmed Tools) language
9. Study on 3-D printing equipment and prepare 3D Model to print using Idea maker software on 3-D printing equipment.
10. Prepare and create a simple box using 3-D printing equipment.

Course Outcomes:
Upon successful completion of this course student should be able to:

1. Intrerpret the concepts of simple machine parts and assemblies from the part drawings using standard CAM packages. (BL-2)
2. Illustrate the concepts of CNC Turning codes for different operations using standard CAM packages. (BL-2)
3. Solve CNC Milling codes for different operations using standard CAM packages. (BL-3)
4. Analyze the concepts of CNC programming for various operations of milling (BL-4)
5. Interpret the study of tools that are used in Industries by solving some real time problems using 3- D printing equipment. (BL-5)

		L	T	P	C
IV Year-I Semester	**Professional Course**	**3**	**0**	**0**	**3**
CAD/CAM					

Course Objectives:

The students will acquire the knowledge

1. To interpret the basic fundamentals of computer aided design and manufacturing.
2. To analyze 2D & 3D transformations of the basic entities like line, circle, ellipse etc
3. To interpret the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication.
4. To interpret the part programming, importance of group technology, computer aided process planning, computer aided quality control
5. To illustrate the overall configuration and elements of computer integrated manufacturing systems.

UNIT – I

Computers in industrial manufacturing, product cycle, CAD / CAM Hardware, basic structure, CPU, memory types, input devices, display devices, hard copy devices, storage devices.

COMPUTER GRAPHICS: Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections, clipping, hidden surface removal.

UNIT – II

GEOMETRIC MODELING: Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modeling facilities desired.

DRAFTING AND MODELING SYSTEMS: Basic geometric commands, layers, display control commands, editing, dimensioning, solid modelling.

UNIT – III

PART PROGRAMMING FOR NC MACHINES: NC, NC modes, NC elements, CNC machine tools, structure of CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming. Direct Numerical Control, Adaptive Control

UNIT – IV

GROUP TECHNOLOGY: Part family, coding and classification, production flow analysis, types and advantages. Computer aided processes planning – importance, types. FMS-Introduction, Equipment, Tool management systems, Layouts, FMS Control.

UNIT – V

COMPUTER AIDED QUALITY CONTROL: Terminology used in quality control, use of computers in Quality control. Inspection methods- contact and noncontact types, computer aided testing, integration of CAQC with CAD/CAM.

COMPUTER INTEGRATED MANUFACTURING SYSTEMS: Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, computer control systems, human labor in manufacturing systems, CIMS benefits.

Text Books:

1. CAD / CAM Principles and Applications/PN Rao / McGraw-Hill
2. Automation, Production systems & Computer integrated Manufacturing/ M.P. Groover/Pearson Education

References:

1. Mastering CAD / CAM / Ibrahim Zeid / McGraw-Hill
2. Principles of Computer Aided Design and Manufacturing / FaridAmirouche / Pearson
3. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson learning, Inc
4. Product manufacturing and cost estimation using CAD/CAE/ Kuang Hua Chang/Elsevier Publishers

Course Outcome:

At the end of the course the students shall be able to:

1. Interpret the basic fundamentals of computer aided design and manufacturing.
2. Analyze 2D & 3D transformations of the basic entities like line, circle, ellipse etc
3. Interpret the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication.
4. Interpret the part programming, importance of group technology, computer aided process planning, computer aided quality control
5. Illustrate the overall configuration and elements of computer integrated manufacturing systems.

IV Year-I Semester	Professional Course	L	T	P	C
		3	0	0	3
Operations Research					

Course Objectives: The students will acquire the knowledge

1. To Analyze Linear Programming models

2. To Interpret Transportation and sequencing problems

3. To Solve replacement problems and analyze queuing models

4. To Analyze game theory and inventory problems

5. To Interpret dynamic programming and simulation.

UNIT – I

Development – definition– characteristics and phases – types of operation research models – applications. ALLOCATION: Linear programming problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT – II

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 – III

REPLACEMENT: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement. THEORY OF GAMES: 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 – IV

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 poison arrivals.

INVENTORY: Introduction – single item – deterministic models – purchase inventory models with one price break and multiple price breaks – shortages are not allowed – stochastic models – demand may be discrete variable or continuous variable – instantaneous production. Instantaneous demand and continuous demand and no set up cost. ABC & VED Analysis.

UNIT – V

DYNAMIC PROGRAMMING: Introduction – Bellman's principle of optimality – applications of dynamic programming- capital budgeting problem – 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 – simulation languages.

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, Arhur Yaspan & Lawrence Friedman/Wiley

4. Operations Research / R.Pannerselvam/ PHI Publications.

5. Operations Research / Wagner/ PHI Publications.

6. Operation Research /J.K.Sharma/MacMilan 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: Upon successful completion of this course the student should be able to:

1. Analyze Linear Programming models

2. Interpret Transportation and sequencing problems

3. Solve replacement problems and analyze queuing models

4. Analyze game theory and inventory problems

5. Interpret dynamic programming and simulation.

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
PRODUCTION PLANNING AND CONTROL					

Course objectives:

The students will acquire the knowledge:

1. To Illustrate the different types of production systems and the internal organization of production planning and control
2. To estimate forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques
3. To Analyze the importance and function of inventory and to be able to apply for its control and management
4. To apply routing procedures and differentiate schedule and loading and interpret scheduling policies and aggregate planning
5. To interpret dispatching procedure and applications of computers in production planning and control

UNIT – I

Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department – internal organization of department.

UNIT – II

Forecasting – Importance of forecasting –types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitative methods.

UNIT – III

Inventory management – functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems Introduction to MRP I, MRP II, ERP, LOB (Line of Balance), JIT and KANBAN system.

UNIT – IV

Routing –definition – routing procedure –route sheets – bill of material – factors affecting routing procedure, schedule –definition – difference with loading. Scheduling policies – techniques, standard scheduling methods.

Line Balancing, aggregate planning, chase planning, expediting, controlling aspects.

UNIT – V

Dispatching – activities of dispatcher – dispatching procedure – follow up – definition – reason for existence of functions – types of follow up, applications of computer in production planning and control.

Text Books:

1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
2. Manufacturing, Planning and Control/Partik Jonsson Stig- ArneMattsson/ TataMc GrawHill

References:

1. Inventory Control Theory and Practice / Martin K. Starr and David W.Miller/Prentice-Hall
2. Production Planning and Control/Mukhopadyay/PHI.
3. Production Control A Quantitative Approach / John E.Biegel/Prentice-Hall
4. Production Control / Franklin G Moore & Ronald Jablonski/Mc-GrawHill
5. Production and Operations Management/Shailendra Kale/McGraw-Hill
6. Production and Operations Management/Ajay K Garg/McGraw-Hill

.TEXT BOOKS:

1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.

2. Manufacturing, Planning and Control/Partik Jonsson Stig-Arne Mattsson/Tata McGraw Hill

REFERENCES:

1. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller/Prentice-Hall

2. Production Planning and Control/Mukhopadyay/PHI.

3. Production Control A Quantitative Approach / John E. Biegel/Prentice-Hall

4. Production Control / Franklin G Moore & Ronald Jablonski/ Mc-Graw Hill

5. Production and Operations Management/Shailendra Kale/McGraw Hill

6. Production and Operations Management/Ajay K Garg/McGraw Hill

Course Outcomes:

1. Illustrate the different types of production systems and the internal organization of production planning and control
2. Estimate forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques
3. Analyze the importance and function of inventory and to be able to apply for its control and management
4. Apply routing procedures and differentiate schedule and loading and interpret scheduling policies and aggregate planning
5. Interpret dispatching procedure and applications of computers in production planning and control

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
NON-DESTRUCTIVE EVALUATION					

Course Objectives:

The students will acquire the knowledge

1. To Illustrate basic concepts of non-destructive testing and industrial applications
2. To analyze the elements of ultrasonic test and limitations of ultrasonic test
3. To Illustrate the concepts involved in the liquid penetrant test and eddy current test
4. To analyze the basic principles and operating procedures of magnetic particle testing
5. To interpret the basic concepts involved in the infrared and thermal testing
   (At least, two equipment on Non-destructive evaluation process are to be demonstrated)

UNIT–I

Introduction to non-destructive testing and industrial Applications of NDE: 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, NDE of pressure vessels, castings, welded constructions.

Radiographic test**,** Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography

UNIT–II

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–III

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness and 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–IV

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–V

Infrared And Thermal Testing: Introduction and fundamentals to infrared and thermal testing–Heat transfer –Active and passive techniques –Lock in and pulse thermography–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 behaviour of materials–IR imaging in aerospace applications, electronic components, Honey comb and sandwich structures–Case studies.

Text Books:

1. Non destructive test and evaluation of Materials/J Prasad, GCK Nair/TMH Publishers
2. Ultrasonic testing of materials/ H Krautkramer/Springer
3. Non destructive testing/Warren, J Mc Gonnagle / Godan and Breach Science publishers
4. Nondestructive 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/PrometheusPress,
2. ASTM Standards,Vol3.01,Metals and alloys
3. Non-destructive, Hand Book – R. Hamchand

Course Outcomes

At the end of the course the students shall be able to:

1. Illustrate basic concepts of non-destructive testing and industrial applications
2. Analyze the elements of ultrasonic test and limitations of ultrasonic test
3. Illustrate the concepts involved in the liquid penetrant test and eddy current test
4. Analyze the basic principles and operating procedures of magnetic particle testing
5. Interpret the basic concepts involved in the infrared and thermal testing

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
SMART MATERIALS					

Course Objectives

The students will acquire the knowledge:

1. To classify the composite materials and identify the applications
2. To illustrate manufacturing methods of PMC, MMC & CCC and their applications
3. To analyze macro-mechanical analysis of a lamina
4. To interpret the functionally graded materials and their properties
5. To analyze types of nano materials and their properties

UNIT-I

INTRODUCTION TO COMPOSITE MATERIALS: Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber- reinforced composites and nature-made composites, and applications

REINFORCEMENTS: Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and boron carbide fibres.

UNIT-II

AEROSPACE MATERIALS: Metallic materials- super alloys, Aluminium, Magnesium, titanium and Nickel based alloys and intermetallics, High temperature polymers, Materials for cryogenic application, Materials for space environment, Evaluation of materials for extreme environment, Materials processing and manufacturing in zero gravity.

UNIT-III

MACROMECHANICAL ANALYSIS OF A LAMINA: Introduction, generalized Hooke's law, reduction of Hooke's law in three dimensions to two dimensions, relationship of compliance and stiffness matrix to engineering elastic constants of an orthotropic lamina, laminate-laminate code.

UNIT-IV

FUNCTIONALLY GRADED MATERIALS: Types of functionally graded materials-classification different systems-preparation-properties and applications of functionally graded materials.

SHAPE MEMORY ALLOYS: Introduction-shape memory effect-classification of shape memory alloys-composition-properties and applications of shape memory alloys.

UNIT-V

NANO MATERIALS: Introduction-properties at nano scales-advantages & disadvantages applications in comparison with bulk materials (nano – structure, wires, tubes, composites). state of art nano advanced- topic delivered by student.

Text Books:

1. Nano material /A.K. Bandyopadyay/New age Publishers

2. Material science and Technology: A comprehensive treatment/Robert W.Cahn,/VCH

3. Engineering Mechanics of Composite Materials / Isaac and M Daniel/Oxford University Press

References:

1. Mechanics of Composite Materials / R. M. Jones/ Mc Graw Hill Company, New York, 1975.

2. Analysis of Laminated Composite Structures / L. R. Calcote/Van Nostrand Rainfold,NY 1969

3. Analysis and performance of fibre Composites /B. D. Agarwal and L. J. Broutman /Wiley-

Interscience, New York, 1980

4. Mechanics of Composite Materials - Second Edition (Mechanical Engineering) /Autar K.Kaw /CRC Press

Course Outcomes

After learning the course, the students should be able to

1. Classify the composite materials and identify the applications
2. Illustrate manufacturing methods of PMC, MMC & CCC and their applications
3. Analyze macro-mechanical analysis of a lamina
4. Interpret the functionally graded materials and their properties
5. Analyze types of nano materials and their properties

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
HYDROGEN & FUEL CELL TECHNOLOGY					

Course Objective: To gain insight about hydrogen energy, fuel cells, their working principle, types of fuel cells and performance analysis.

UNIT-I

Introduction to hydrogen energy systems: Current scenario of hydrogen production, general introduction to infrastructure requirement for hydrogen production, dispensing and utilization. Hydrogen production pathways: Thermal: Steam reformation, Thermo chemical water splitting, Gasification, Pyrolysis and Partial oxidation methods. Electrochemical: Electrolysis, Photo-electro chemical. Biological: Anaerobic Digestion, Fermentative Micro-organisms

UNIT-II

Hydrogen Storage: General storage methods, compressed storage, Zeolites, Metal hydride storage, chemical hydride storage and cryogenic storage. Hydrogen Utilization: Overview of hydrogen utilization, I.C. Engines, gas turbines, hydrogen burners, power plant, refineries, domestic, marine applications, fuel cell.

UNIT-III

Introduction to Fuel Cell: A simple fuel cell, fuel cell advantages, fuel cell disadvantages, fuel cell types basic fuel cell operation, fuel cell performance characterization and modeling, fuel cell technology, fuel cells and the environment. Fuel Cell Thermodynamics: Thermodynamics review, Heat potential of a fuel: enthalpy of reaction, Work potential of a fuel: Gibbs Free Energy, Predicting eversible voltage of a fuel cell under non-Standard state conditions, fuel cell efficiency, Thermal and Mass balances in fuel cells, Thermodynamics of reversible fuel cells.

UNIT-IV

Fuel Cell Reaction Kinetics: Introduction to electrode kinetics, activation energy of charge transfer reactions, activation energy determines reaction rate, net rate of a reaction calculation, rate of reaction at equilibrium: exchange current density, potential of a reaction at equilibrium: Galvani potential, potential and rate: Butler–Volmer equation, exchange currents and electrocatalysis: Improving kinetic performance, simplified activation kinetics: Tafel equation.

UNIT-V

Fuel Cell Charge Transport: Charges move in response to forces, charge transport results in a voltage loss, characteristics of fuel cell charge transport resistance, physical meaning of conductivity, review of fuel cell electrolyte classes. Fuel Cell Mass Transport: Transport in electrode versus flow structure, transport in electrode: diffusive transport, transport in flow Structures: convective transport. Overview of Fuel Cell Types: introduction, phosphoric acid fuel cell, polymer electrolyte membrane fuel cell, alkaline fuel cell, molten carbonate fuel cell, solid-oxide fuel cell, other fuel cells.

Text Books

1 O'Hayre, Ryan/ Colella, Whitney/ Cha, Suk-Won, Fuel Cell Fundamentals (3rd Ed.) by Wiley Publications. 2016 (B) Reference Books

2. James Larminie and Andrew Dicks, Fuel Cell Systems Explained, 2ndEd., John Wiley & Sons Inc. 2000

2 .Supramaniam Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer. 2010

3. Frano Barbir, PEM Fuel Cells Theory and Practice, Elsevier Academic Press. 2005

Course Outcome: Upon completion of this course, the students will be able to:

i. Gain knowledge on fuel cell working principle, types of fuel cell, voltage loss and its reason

ii. Interpret the role of fluid dynamics, reaction kinetics and mass transfer principles in fuel cell operation.

iii. Illustrate the stacking of fuel cell and fuel processing for fuel cell.

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
POWER PLANT ENGINEERING					

Course Objectives:

The students will acquire the knowledge:

1. To illustrate the working of different circuits of the steam power plant.
2. To analyze the layout and auxiliaries of the diesel and gas power plants.
3. To interpret the different elements in the hydroelectric and nuclear power plants.
4. To illustrate the basic concepts for power production in combined plants and usage of different instrument to measure the operating parameters of the power plant.
5. To analyze the concepts of power plant economics and pollution standards to be observed in the power plants.

UNIT – I
Introduction to the sources of energy – resources and development of power in India.

STEAM POWER PLANT: Plant layout, working of different circuits, fuel and handling equipment, types of coals, coal handling, choice of handling equipment, coal storage, ash handling systems. Combustion: properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, dust collectors, cooling towers and heat rejection. corrosion and feed water treatment.

UNIT – II
INTERNAL COMBUSTION AND GAS TURBINE POWER PLANTS:
DIESEL POWER PLANT: Plant layout with auxiliaries – fuel supply system, air starting equipment, super charging.
GAS TURBINE PLANT: Introduction – classification - construction – layout with auxiliaries, combined cycle power plants and comparison.

UNIT – III
HYDRO ELECTRIC POWER PLANT: Water power – hydrological cycle / flow measurement – drainage area characteristics – hydrographs – storage and pondage – classification of dams and spill ways.
HYDRO PROJECTS AND PLANT: Classification – typical layouts – plant auxiliaries – plant operation pumped storage plants.

NUCLEAR POWER STATION: Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation.

TYPES OF REACTORS: Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous reactor, gas cooled reactor, radiation hazards and shielding – radioactive waste disposal.

UNIT – IV

COMBINED OPERATIONS OF DIFFERENT POWER PLANTS: Introduction, advantages of combined working, load division between power stations, storage type hydro-electric plant in combination with steam plant, run-of-river plant in combination with steam plant, pump storage plant in combination with steam or nuclear power plant, co-ordination of hydro-electric and gas turbine stations, co-ordination of hydro-electric and nuclear power stations, co-ordination of different types of power plants.

POWER PLANT INSTRUMENTATION AND CONTROL: Importance of measurement and instrumentation in power plant, measurement of water purity, gas analysis, O2 and CO2 measurements, measurement of smoke and dust, measurement of moisture in carbon dioxide circuit, nuclear measurements.

UNIT – V

POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATIONS: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor – related exercises. effluents from power plants and Impact on environment – pollutants and pollution standards – methods of pollution control.

Text Books:

1. A course in Power Plant Engineering /Arora and Domkundwar/Dhanpatrai & Co.
2. Power Plant Engineering /P.C.Sharma / S.K.Kataria Pub

References:

1. Power Plant Engineering: P.K.Nag/ II Edition /TMH.
2. Power station Engineering – ElWakil / McGrawHill.
3. An Introduction to Power Plant Technology / G.D. Rai/Khanna Publishers

Course outcomes:

Upon successful completion of this course the student should be able to:

1. Illustrate the working of different circuits of the steam power plant.
2. Analyze the layout and auxiliaries of the diesel and gas power plants.
3. Interpret the different elements in the hydroelectric and nuclear power plants.
4. Illustrate the basic concepts for power production in combined plants and usage of different instrument to measure the operating parameters of the power plant.
5. Analyze the concepts of power plant economics and pollution standards to be observed in the power plants.

IV Year-I Semester	Professional Elective - V	L	T	P	C
		3	0	0	3
ELECTRIC AND HYBRID VEHICLES					

Course Objectives: To present a comprehensive overview of Electric and Hybrid Electric Vehicles.

UNIT – I

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

UNIT – II

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT-III

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT-IV

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

UNIT-V

Communications, supporting subsystems: In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies.

Text Book:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

References:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Course outcome:

The students will be able to

i. Illustrate a suitable drive scheme for developing an electric hybrid vehicle depending on resources (BL-1)

ii. Design and develop basic schemes of electric vehicles and hybrid electric vehicles. (BL-6)

iii. Select proper energy storage systems for vehicle applications (BL-1)

iv. Identify various communication protocols and technologies used in vehicle networks. (BL-1)

IV Year-I Semester	Professional Elective - V	L	T	P	C
		3	0	0	3
CRYOGENICS					

Course Objectives

1 To interpret the scope and history of cryogenicsm, the properties of materials at low temperature applying fundamental knowledge.

2 To apply the knowledge of low temperature production methods to interpret and analyse different liquefaction systems. To gain knowledge about the critical components involved in liquefaction.

3 To apply the knowledge of ideal refrigeration techniques, to interpret and analyse common cryogenic refrigeration systems. To apply some of the novel cryogenic refrigeration methods.

4 To illustrate various cryogenic fluid storage and transport systems and to evaluate their performance applying fundamental concepts

5 To interpret the different cryogenic instrumentation and to illustrate cryo pumping.

UNIT-I

Introduction to Cryogenic Systems: Historical development, Applications of Cryogenics (Space, Food Processing, Super conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry). Low Temperature Properties: Properties of Engineering Materials (Mechanical properties, Thermal properties, Electric and Magnetic properties), Properties of Cryogenic fluids.

UNIT-II

Introduction to Liquefaction Systems: Ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System. Introduction to Cryogenic Refrigeration Systems: Magnetic Cooling, Stirling Cycle Cryo Coolers.

UNIT-III

Gas Liquefaction Systems: General liquefaction systems. Liquefaction systems for Neon, Hydrogen and Helium. Critical components of liquefaction systems.

UNIT-IV

Cryogenic Refrigeration Systems: Ideal refrigeration systems, Refrigeration using liquids and gases as refrigerant, Refrigerators using solids as working media.

UNIT-V

Cryogenic Fluid Storage and Transfer Systems: Cryogenic storage vessels and transportation. Thermal insulation and their performance at cryogenic temperatures, Super insulations, Vacuum insulation, Powder insulation. Cryogenic fluid transfer systems. Cryogenic Instrumentation: Pressure, flow-rate, liquid-level and temperature measurements. Types of Heat Exchangers used in cryogenic systems (only description with figure). Cryo Pumping Applications.

Text books

1. J. H. Boll Jr, Cryogenic Engineering

2. R. B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959

References

1. Randal F.Barron, Cryogenic systems, McGraw Hill, 1986 R1 Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.

Course Outcomes

1. interpret the scope and history of cryogenics, the properties of materials at low temperature applying fundamental knowledge.
2. Apply the knowledge of low temperature production methods to interpret and analyse different liquefaction systems. To gain knowledge about the critical components involved in liquefaction.
3. Apply the knowledge of ideal refrigeration techniques, to analyse common cryogenic refrigeration systems. To interpret some of the novel cryogenic refrigeration methods.
4. Illustrate various cryogenic fluid storage and transport systems and to evaluate their performance applying fundamental concepts
5. Interpret the different cryogenic instrumentation and cryo pumping.

IV Year-I Semester	Professional Elective - V	L	T	P	C
		3	0	0	3
AUTOMATION IN MANUFACTURING					

Course Objectives:

The students will acquire the knowledge:

1.To analyze the types and strategies and various components in Automated Systems
2.To classify the types of automated flow lines and analyze automated flow lines
3.To solve the line balancing problems in the various flow line systems with and without buffer storage
4. To interpret different automated material handling systems, storage and retrieval systems and automated inspection systems
5.To illustrate the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications

UNIT-I

INTRODUCTION: Types and strategies of automation, pneumatic and hydraulic components, circuits, automation in machine tools, mechanical feeding and tool changing and machine tool control.

UNIT – II

AUTOMATED FLOW LINES: Methods of part transport, transfer mechanism, buffer storage, control function, design and fabrication considerations. Analysis of automated flow lines - General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

UNIT – III

ASSEMBLY SYSTEM AND LINE BALANCING: Assembly process and systems, assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

UNIT – IV

AUTOMATED MATERIAL HANDLING and STORAGE SYSTEMS:

Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems. Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

UNIT – V

ADAPTIVE CONTROL SYSTEMS: Introduction, adaptive control with optimization, adaptive control with constraints, application of adaptive control in machining operations. Consideration of various parameters such as cutting force, temperatures, vibration and acoustic emission in the adaptive controls systems.

AUTOMATED INSPECTION: Fundamentals, types of inspection methods and equipment, Coordinate Measuring Machines, Machine Vision

TEXT BOOK:

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover./ PE/PHI.

REFERENCES:

1. Computer Control of Manufacturing Systems by YoramCoren.
2. CAD / CAM/ CIM by Radhakrishnan.
3. Automation by W. Buekinsham.

Course outcomes:

Upon successful completion of this course student should be able to :

1. Analyze the types and strategies and various components in Automated Systems
2. Classify the types of automated flow lines and analyze automated flow lines
3. Solve the line balancing problems in the various flow line systems with and without buffer storage
4. Interpret different automated material handling systems, storage and retrieval systems and automated inspection systems
5. Illustrate the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications

<table>
<tr><td rowspan="2">IV Year-I Semester</td><td rowspan="2">Professional Elective - V</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">INDUSTRIAL HYDRAULICS AND PNEUMATICS</td></tr>
</table>

Course Objectives:

The students will acquire the knowledge:
1. To explain the basic concepts of fluid power
2. To illustrate the functions of elements of Hydraulic and Pneumatic systems
3. To analyze the functions of hydraulic and Pneumatic circuits
4. To illustrate the working of various hydraulic and pneumatic devices.
5. To interpret the procedure of installation, maintenance and troubleshooting of hydraulic and Pneumatic systems

UNIT – I:

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– II:

Hydraulic and Pneumatic Elements:
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, 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– III:

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-IV

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-V

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, 2013

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:

Upon successful completion of this course the student should be able to:

1. Explain the basic concepts of fluid power

2. Illustrate the functions of elements of Hydraulic and Pneumatic systems

3. Analyze the functions of hydraulic and Pneumatic circuits

4. Illustrate the working of various hydraulic and pneumatic devices.

5. Interpret the procedure of installation, maintenance and troubleshooting of hydraulic and Pneumatic systems

IV Year-I Semester	Professional Elective - V	L	T	P	C
		3	0	0	3
NOISE CONTROL					

Course Objectives:

The students will acquire the knowledge:

1. To interpret the fundamental principles of sound and acoustics.
2. To measure and analyze noise and vibration signals.
3. To identify and characterize various noise sources.
4. To apply different noise control techniques to reduce noise at the source, along the path, or at the receiver.
5. To apply relevant noise standards and regulations.

Unit-1

Fundamentals of Acoustics:

Nature of Sound: Sound waves, propagation, frequency, wavelength, speed of sound, simple harmonic motion., **Sound Pressure, Power, and Intensity:** Definitions, units, and relationships., **Decibel Scale:** Sound pressure level (SPL), sound power level (SWL), sound intensity level (SIL), dB arithmetic, combining sound levels., **Frequency Analysis:** Octave bands, 1/3 octave bands, narrow band analysis, frequency weighting (A, C, etc.).,**Human Hearing:** Anatomy of the ear, hearing mechanisms, psychoacoustics, loudness, pitch, masking, human response to noise, hearing loss, noise-induced hearing loss., **Sound Fields:** Free field, reverberant field, near field, far field., **Acoustic Impedance and Admittance.**

UNIT II. Noise Measurement and Instrumentation:

Sound Level Meters: Types, components, standards, and usage., **Microphones:** Types, characteristics, and selection., **Noise Dosimeters:** Principles and applications for personal noise exposure assessment., **Frequency Analyzers:** Real-time analyzers (RTA), Fast Fourier Transform (FFT) analyzers., **Calibration and Measurement Techniques:** Standards and best practices for noise measurements in various environments., **Measurement of Sound Power Level:** Different methods (e.g., ISO standards),**Vibration Measurement:** Displacement, velocity, and acceleration; transducers.

UNIT III. Noise Sources and Characteristics:

Types of Noise Sources: Point, line, and area sources., **Noise from Machinery:** Motors, pumps, compressors, fans, HVAC systems, industrial equipment., **Flow-Induced Noise:** Turbulence, jet noise, cavitation, aerodynamic noise., **Noise from Vibrating Structures:** Sound radiation, structural vibration as a noise source., **Transportation Noise:** Road traffic, railway, aircraft noise, **Environmental Noise Sources:** Construction, community noise., **Source Characterization:** Sound power estimation, directivity.

UNIT IV. Principles and Methods of Noise Control:

Source-Path-Receiver Model: Understanding the elements of noise problems., **Noise Control Strategies:** Control at the source, control along the path, protection of the receiver., **Passive Noise Control: Sound Absorption:** Materials, mechanisms, absorption coefficient, room acoustics treatment. **Sound Isolation/Transmission Loss:** Barriers, enclosures, walls, floors, transmission loss coefficient, mass law, coincidence effect, double-leaf partitions. **Vibration Isolation:** Isolators, resilient mounts, damping. **Damping Treatments:** Application and effectiveness. **Silencers and Mufflers:** Reactive and dissipative types, design principles.

Unit V. Environmental Noise and Regulations:

Outdoor Sound Propagation: Geometric spreading, ground effects, atmospheric absorption, meteorological effects, barriers. **Environmental Noise Standards and Regulations:** National and international guidelines, noise limits for different environments.

Course Out comes:

Upon successful completion of this course student should be able to:

1. Interpret the fundamental principles of sound and acoustics.
2. Measure and analyze noise and vibration signals.
3. Identify and characterize various noise sources.
4. Apply different noise control techniques to reduce noise at the source, along the path, or at the receiver.
5. Apply relevant noise standards and regulations.

<table>
<tr><td rowspan="2">IV Year-I Semester</td><td rowspan="2">Open Elective - III</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">DIGITAL MARKETING MANAGEMENT</td></tr>
</table>

Course Objectives:

This course aims at enabling students,

1. To describe the basic concept of Digital Marketing.

2. To explain the basics of Mobile Marketing.

3. To summarize the concept of Online Marketing.

4. To illustrate with the knowledge of E-mail Marketing.

UNIT I

Introduction to Digital marketing

The Concept, Need & Evolution of Digital Marketing, Reason for growing importance of Digital Marketing in India, Digital Marketing: Types & Examples.

Case Study on Digital Marketing

UNIT II

Mobile Marketing

Meaning, types & Evolution, Mobile – market size and rate of growth, Mobile applications, Types of Mobile Marketing, Advantages and Disadvantages of Mobile marketing, Performance marketing: definition, benefits.

Case Study on Mobile Marketing

UNIT III

Online Marketing

The concept of Digital Marketing Mix, 7 P’s of Online Marketing: Product, Price, Promotion, Place People, Process, Physical evidence, Methods of Online Marketing promotion.

Case Study on Online Marketing

UNIT IV

Email Marketing

Email Marketing: Need for Emails, Types of Emails, options in Email advertising, Do's and Don'ts of an email marketing campaign, Introduction to E-mail marketing tool- Mailchimp.

Case Study on Email Marketing

UNIT V

Social Media Marketing with Twitter and Linkedin Twitter Usage Stats and Interesting Facts, Twitter Terminology and Account Security, Advertising on Twitter, Twitter for Marketing. Linkedin for Business, Linkedin for Advertising, Linkedin for Recruiters

Text Books:

1. Damian Ryan& Calvin Jones. Understanding DIGITAL Marketing, 2009, ISBN 9780749453893

2. Vandana Ahuja, Digital Marketing, Oxford University Press, New Delhi, 2015, ISBN: 9780199455447.

3. Jodie the Mom (2023) Email Marketing Planner: Organize and Track Your Emails, 2023, ASIN :B0C5KNF1BM

Reference Books:

1. Dave Evans., Susan Bratton, Social Media Marketing: The Next Generation of Business Engagement. Wiley ,

2010, ISBN: 978-0-470-63403-5

2. George Pain(2019). Marketing Automation and Online Marketing: Automate Your Business through Marketing

Best Practices such as Email Marketing and Search Engine Optimization, 2019, ISBN-10 1922301132 :

E-sources:

1. https://www.coursera.org/learn/foundations-of-digital-marketing-and-e-commerce

2. https://open.umn.edu/opentextbooks/textbooks/1602

Course Outcomes:

After learning the course, the students should be able to:

1. Describe the core concepts of Digital Marketing. (BL-2)

2. Explain the basics of Mobile Marketing. (BL-2)

3. Summarize the core concepts of Online Marketing. (BL-2)

4. Discuss E-mail marketing techniques. (BL-6)

IV Year-I Semester	Open Elective - III	L	T	P	C
		3	0	0	3
PRODUCT DESIGN AND DEVELOPMENT					

COURSE OBJECTIVES:

The students will acquire the knowledge:

1. Apply the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development.

2. Generate, select, screen, and test concepts for new product design and development.

3. Apply the principles of product architecture and industrial design to design and develop new products.

4. Apply the principles of DFMA and Prototyping to design and develop new product.

5. Apply the concepts of economics principles sustainable product development and life cycle assessment.

UNIT I

INTRODUCTION – A Generic Development Process – Adapting the Generic Product Development Process - Product Development Process Flows- Digital tools for product design– Identifying Customer Needs - Product Specifications: Establishing Target Specifications; Setting the Final Specifications.

UNIT II

CONCEPT GENERATION

Concept Generation: The Activity of Concept Generation - Concept Selection: Concept Screening; Concept Scoring – Concept Testing – Concept innovation using TRI

UNIT III

PRODUCT ARCHITECTURE

Implications of the Architecture; Establishing the Architecture; Delayed Differentiation;

Platform Planning; Related System-Level Design Issues – Industrial Design: Assessing the Need for Industrial Design; Impact of Industrial Design; The Industrial Design Process; Management of the Industrial Design Process; Assessing the Quality of Industrial Design.

UNIT IV

DFM AND PROTOTYPING

Design for Manufacturing: Estimate the Manufacturing Costs; Reduce the Costs of Components; Reduce the Costs of Assembly; Reduce the Costs of Supporting Production; Consider the Impact of DFMA– Prototyping: Type; Uses; Principles; Technologies; Planning for Prototypes.

UNIT V

PRODUCT DEVELOPMENT ECONOMICS

Elements of Economic Analysis; Economic Analysis Process – sustainable product development: framework and metrics – life cycle assessment of a product: stages and impact.

Text Books:

1. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

2. Karl, T. Ulrich and Steven, D. Eppinger, “Product Design and Development”, McGraw Hill, 2003.

References:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.

2. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.

3. Pugh S., “Total Design – Integrated Methods for successful Product Engineering”, Addison Wesley Publishing, 1991.

4. Rosenthal S., “Effective Product Design and Development”, Business One, 1992.

5. Silva, A., Handbook of Research on Trends in Product Design and Development:

Technological and Organizational Perspectives: Technological and Organizational

Perspectives, IGI Global, 2010.

6. Devdas Shetty, “Product design for Engineers”, Cengage Learning

Course Outcomes:

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

1. Apply the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development.

2. Select, screen, and test concepts for new product design and development.

3. Apply the principles of product architecture and industrial design to design and develop new products.

4. Apply the principles of DFMA and Prototyping to design and develop new product.

5. Apply the concepts of economics principles sustainable product development and life cycle assessment.

<table>
<tr><td rowspan="2">IV Year-I Semester</td><td rowspan="2">Open Elective - III</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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<tr><td colspan="6">INTRODUCTION TO MECHATRONICS</td></tr>
</table>

Course Objectives:

The students will acquire the knowledge

1. To illustrate the use the various mechatronics systems, measurement systems, sensors and transducers.

2. To apply the concepts of solid-state electronic devices.

3. To identify the components in the design of electro mechanical systems.

4. To apply the concepts of digital electronics and applications of PLCs for control.

5. To analyze system interfacing, data acquisition and design of mechatronics systems.

UNIT-I

Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT-II

Solid state electronic devices - PN junction diode, BJT, FET, DIAC, TRIAC and LEDs. Analog signal conditioning, operational amplifiers, noise reduction, filtering.

UNIT-III

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

UNIT-IV

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT-V

System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives. Design of mechatronics systems & future trends.

Text Books:

1. Mechatronics: Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition

References

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford UniversityPress

2. Mechatronics Source Book / Newton C Braga/ThomsonPublications,Chennai.

3. Mechatronics – N. Shanmugam / Anuradha AgenciesPublishers.

4. Mechatronics System Design / Devdasshetty/Richard/Thomson.

5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.

6. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W.Bolton/ Pearson,2012

7. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print

Course Outcomes:

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

1. Illustrate the use the various mechatronics systems, measurement systems, sensors and transducers.

2. Apply the concepts of solid-state electronic devices.

3. Identify the components in the design of electro mechanical systems.

4. Apply the concepts of digital electronics and applications of PLCs for control.

5. Analyze system interfacing, data acquisition and design of mechatronics systems.

IV Year-I Semester	Open Elective - III	L	T	P	C
		3	0	0	3
CONDITION MONITORING					

COURSE OBJECTIVE:

- Provide an overview of the fundamental principles of maintenance and condition
- monitoring techniques
- Acquire knowledge of data acquisition and signal processing techniques
- Explain about diagnosis of machinery faults and methods to correct faults
- Describe oil analysis and other NDT techniques

UNIT-I

Predictive Maintenance Techniques:

Basics, maintenance philosophies, Bath tub curve, Classification of maintenance, advantages and disadvantages of maintenance, plant machinery classifications and recommendations.

Condition Monitoring Techniques:

Introduction to Condition monitoring, definition, Types of condition monitoring, advantages and limitations of different condition monitoring techniques like wear derbies monitoring, oil monitoring, performance monitoring, vibration monitoring, thermography, corrosion monitoring.

UNIT-II

Data Acquisition:

Introduction, collection of vibration signal, vibration transducers, characteristics and mountings, conversion of vibrations to electrical signal.

Signal Processing, Applications and Representations:

The Fast Fourier Transform (FFT) analysis, Time waveform analysis, Phase signal analysis, special signal processes.

UNIT-III

Machinery Fault Diagnosis Using Vibration Analysis:

Unbalance, bent shaft, Eccentricity, Misalignment, looseness, Belt drive problems, gear defects, bearing defects, Electrical faults, Cavitation Shaft cracks, Rotor rubs, Resonance, Hydraulic and aerodynamic forces.

Correcting Faults That Cause Vibration:

Introduction, Balancing Alignment, Resonance vibration control with dynamic absorbers.

UNIT-IV

Oil and Practical Analysis:

Introduction, oil fundamentals, oil analysis sampling methods, lubricant properties, contaminants in lubricants, practical analysis techniques.

Other Predictive Maintenance Techniques:

Ultrasound, Infrared thermography applications of IR thermography, ISO 2372 standards for vibrations.

Text books

1. Machinery vibration Analysis & Predictive Maintenance by Paresh Girdhar, Elsevier publishers.

2. Mechanical Fault diagnosis and condition monitoring by R. A. Collacott.

References

1. Vibration monitoring and diagnosis by R. A. Collacott.

2. First course on condition monitoring in the process industries, by M.J.Neale, Nov 1979, Manchester.

3. Management of Industrial Maintenance by Newman-Butterworth, March 1978.

4. Condition Monitoring Manual by National Productivity council, New Delhi

Course Outcomes:

At the end of the course student can be able to

1.Apply maintenance and condition monitoring techniques to machineries and industries (BL-3)

2. Apply data acquisition and signal processing techniques to all mechanical components and plants

3. Illustrate Machinery faults and apply methods to correct faults

4. Analyze machinery faults and using oil analysis and other NDT techniques (BL-3)

IV Year-I Semester	Open Elective - III	L	T	P	C
		3	0	0	3
OPERATIONS MANAGEMENT					

Course Objectives:

The students will acquire the knowledge:

1. To identify types of forecasting techniques and their principles
2. To analyze plant and process layout
3. To interpret about material management and MRP logic
4. To apply the concepts of aggregate planning and scheduling
5. To analyze the concepts of inventory control, MRP-II, JIT, ERP and supply chain Management

UNIT-I

Forecasting: Introduction, types of forecasting and their uses, General principles of forecasting, forecasting techniques: qualitative and quantitative methods of Forecasting.

Production Systems: Types of production systems: job, batch, mass and flow type production.

UNIT-II

Plant Location: Factors affecting the plant location, comparison of rural and urban sites.

Plant Layout: Introduction, principles of plant layout, types of plant layouts

UNIT-III

Materials Management: Introduction, functions of materials management, inventory, inventory management, types of inventories, Selective inventory control techniques: ABC analysis, VED analysis. Material Requirement Planning: Introduction, Inputs, outputs and MRP logic

UNIT-IV

Aggregate Planning: Introduction, aggregate planning strategies, aggregate planning methods

mathematical planning models, heuristic and computer search models, problems. Scheduling:

Introduction, difference with loading, scheduling policies, techniques, standard scheduling methods.

UNIT-V

Inventory Control: Deterministic models, safety stock inventory control systems Contemporary management techniques: Introduction to MRP-II, JIT, ERP and Supply chain management

TEXT BOOKS:

1. Operations Management /Joseph. G.Monks, International (3rd) Edition

2. Elements of Production Planning and Control / Samuel Eilon.

3. Modern Production/ operation managements / Baffa& Rakesh Sarin

REFERENCES:

1. Operations Management – S.N. Chary.

2. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.

3. Production And Operation Management / Martand Telsang

4. Production Control A Quantitative Approach / John E. Biegel.

5. Production Control / Moore.

Course Out comes:

Upon successful completion of this course student should be able to:

1. Identify types of forecasting techniques and their principles
2. Analyze plant and process layout
3. Interpret about material management and MRP logic
4. Apply the concepts of aggregate planning and scheduling
5. Analyze the concepts of inventory control, MRP-II, JIT, ERP and supply chain Management

<table>
<tr><td rowspan="2">IV Year-I Semester</td><td rowspan="2">Open Elective - IV</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">STATISTICAL QUALITY CONTROL</td></tr>
</table>

Course objectives:

The students will acquire the knowledge:

1. To analyze the approaches and techniques of quality value and engineering
2. To interpret statistical process control with $\overline{X}$, R, p, c charts and other types of control charts.
3. To illustrate tolerance design and quality function deployment
4. To interpret techniques of modern reliability engineering tools.
5. To interpret the concepts of complex system and reliability techniques

UNIT-I

Quality value and engineering – quality systems – quality engineering in product design and production process – system design – parameter design – tolerance design, quality costs – quality improvement.

UNIT-II

Statistical process control $\overline{X}$, R, p, c charts, other types of control charts, process capability, process capability analysis, process capability index. (SQC tables can be used in the examination)

Acceptance sampling by variables and attributes, design of sampling plans, single, double, sequential and continuous sampling plans, design of various sampling plans

UNIT-III

Loss function, tolerance design – N type, L type, S type; determination of tolerance for these types. Online quality control – variable characteristics, attribute characteristics, parameter design.

Quality function deployment – house of quality, QFD matrix, total quality management concepts. Quality information systems, quality circles, introduction to ISO 9000 standards.

UNIT-IV

Reliability – Evaluation of design by tests - Hazard Models, Linear, Raleigh, Weibull. Failure Data Analysis, reliability prediction based on Weibull distribution, Reliability improvement.

UNIT-V

Complex system, reliability, reliability of series, parallel & standby systems & complex systems & reliability prediction and system effectiveness.

Maintainability, availability, economics of reliability engineering, replacement of items, maintenance costing and budgeting, reliability testing.

Text Books:

1. Quality Engineering in Production Systems / G Taguchi /McGraw Hill
2. Reliability Engineering/ E.Bala Guruswamy/Tata McGraw Hill,
3. Statistical Quality Control : A Modern Introduction/ Montgomery/Wiley

References:

1. Jurans Quality planning & Analysis/ Frank.M.Gryna Jr. / McGraw Hill.
2. Taguchi Techniques for Quality Engineering/ Philipposs/ McGraw Hill,
3. Reliability Engineering / LS Srinath / Affiliated East West Pvt. Ltd.,
4. Statistical Process Control/ Eugene Grant, Richard Leavenworth / McGraw Hill.
5. Optimization & Variation Reduction in Quality / W.A. Taylor / Tata McGraw Hill
6. Quality and Performance Excellence/ James R Evans/ Cengage learning

Course Outcomes:

Upon successful completion of this course the student should be able to:

The students will acquire the knowledge:

1. Analyze the approaches and techniques of quality value and engineering
2. Interpret statistical process control with $\overline{X}$, R, p, c charts and other types of control charts.
3. Illustrate tolerance design and quality function deployment
4. Interpret techniques of modern reliability engineering tools.
5. Interpret the concepts of complex system and reliability techniques

		L	T	P	C
IV Year-I Semester	**Open Elective - IV**	**3**	**0**	**0**	**3**
NANO MATERIALS					

Course Objectives:

The students will acquire the knowledge:

1. To analyze historical development and classification of nano materials

2. To interpret structure and bonding in nano materials

3. To analyze the size dependence of properties

3. To illustrate nano material Synthesis techniques

5. To interpret nano material characterization techniques

UNIT-I

Introduction: Definitions, historical development of nano materials, classification of nano materials, Size & Scale Units Scaling Atoms, Molecules, Clusters and Supramolecules

UNIT-II

Structure and Bonding in Nano materials

Chemical Bonds (types and strength), intermolecular forces, molecular and crystalline structures, hierarchical structures, bulk to surface transition, surface reconstruction

UNIT-III

Properties and Size dependence of properties: Chemical Optical, vibrational, thermal, Electrical, Magnetic, Mechanical, Theoretical Aspects-e.g. density functional theory

UNIT-IV

Nano material Synthesis: Chemical routes, Electrochemical methods, Vapour growth, Thin films methods: chemical vapour deposition, physical vapor deposition (sputtering, laser ablation), Langmuir-Blodgett growth Mechanical methods: ball milling, mechanical attrition Sol-gel methods, Special nanomaterials: carbon nanotubes, fullerenes, nanowires, porous silicon, Bio-inspired synthesis, Nanocomposite fabrication, Nanolithography

UNIT-V

Nano material characterization techniques: Scanning and Transmission Electron Microscopy, Scanning Probe Microscopies: Atomic Force, scanning tunneling microscopy, Diffraction and scattering techniques, Vibrational spectroscopy, Surface techniques

Applications: Nano-electronics, Nano optics, Nanoscale chemical- and bio-sensing, Biological/bio-medical applications, Photovoltaic, fuel cells, batteries and energy-related applications, High strength nanocomposites, Nano energetic materials

Textbook

1.The Physics and Chemistry of Nanosolids by Frank J. Owens and Charles P. Poole Jr, Wiley-Interscience, 2008.

Reference Books

1.Nanomaterials- Synthesis, Properties and Applications, Edited by A.S. Edelstein and R.C. Cammarata, Institute of Physics Publishing, London, 1998 (paper back edition)

2.Nanochemistry: A Chemical Approach to Nanomaterials, by G. Ozin and A. Arsenault, RSC Publishing, 2005

3.Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Edward L. Wolf, Wiley-VCH, 2nd Reprint (2005)

Course Outcomes:

Upon successful completion of this course the student should be able to:

1. Analyze historical development and classification of nano materials

2. Interpret structure and bonding in nano materials

3. Analyze the size dependence of properties

4. Illustrate nano material Synthesis techniques

5. Interpret nano material characterization techniques

IV Year-I Semester	Open Elective - IV	L	T	P	C
		3	0	0	3
ENTREPRENEURSHIP					

COURSE OBJECTIVE:

The students will acquire the knowledge:

1. To analyze concept of entrepreneurship and its characteristics
2. To recognize entrepreneurial environment and policies
3. To illustrate business plan preparation
4. To interpret finance and Human Resource mobilization and operations planning
5. To analyze management of small business

UNIT- I
ENTREPRENEURAL COMPETENCE

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality -

Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.

UNIT- II
ENTREPRENEURAL ENVIRONMENT AND POLICIES

Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organizational Services – Central and State Government Industrial Policies and Regulations - International Business.

UNIT- III
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- IV
LAUNCHING OF SMALL BUSINESS

Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection -Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

UNIT- V
MANAGEMENT OF SMALL BUSINESS

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business

Units- Effective Management of small Business.

Text Books:

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.

2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001.

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.

Course Outcome:

Up on completing this course, students are able to

1. Analyze concept of entrepreneurship and its characteristics
2. Recognize entrepreneurial environment and policies
3. Illustrate business plan preparation
4. Interpret finance and Human Resource mobilization and operations planning
5. Analyze management of small business

		L	T	P	C
IV Year-I Semester	**Open Elective - IV**	**3**	**0**	**0**	**3**
PRODUCT DESIGN AND DEVELOPMENT					

COURSE OBJECTIVES:

The students will acquire the knowledge:

1. To interpret the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development.

2. To generate, select, screen, and test concepts for new product design and development.

3. To interpret the principles of product architecture and industrial design to design and develop new products.

4. To apply the principles of DFMA and Prototyping to design and develop new product.

5. To apply the concepts of economics principles sustainable product development and life cycle

assessment.

UNIT I

INTRODUCTION – A Generic Development Process – Adapting the Generic Product Development Process - Product Development Process Flows- Digital tools for product design– Identifying Customer Needs - Product Specifications: Establishing Target Specifications; Setting the Final Specifications.

UNIT II

CONCEPT GENERATION

Concept Generation: The Activity of Concept Generation - Concept Selection: Concept Screening; Concept Scoring – Concept Testing – Concept innovation using TRI

UNIT III

PRODUCT ARCHITECTURE

Implications of the Architecture; Establishing the Architecture; Delayed Differentiation;

Platform Planning; Related System-Level Design Issues – Industrial Design: Assessing the Need for Industrial Design; Impact of Industrial Design; The Industrial Design Process; Management of the Industrial Design Process; Assessing the Quality of Industrial Design.

UNIT IV

DFM AND PROTOTYPING

Design for Manufacturing: Estimate the Manufacturing Costs; Reduce the Costs of Components; Reduce the Costs of Assembly; Reduce the Costs of Supporting Production; Consider the Impact of DFMA– Prototyping: Type; Uses; Principles; Technologies; Planning for Prototypes.

UNIT V

PRODUCT DEVELOPMENT ECONOMICS

Elements of Economic Analysis; Economic Analysis Process – sustainable product development: framework and metrics – life cycle assessment of a product: stages and impact.

TEXT BOOK:

1. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

2. Karl, T. Ulrich and Steven, D. Eppinger, “Product Design and Development”, McGraw Hill, 2003.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.

2. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.

3. Pugh S., “Total Design – Integrated Methods for successful Product Engineering”, Addison Wesley Publishing, 1991.

4. Rosenthal S., “Effective Product Design and Development”, Business One, 1992.

5. Silva, A., Handbook of Research on Trends in Product Design and Development:

Technological and Organizational Perspectives: Technological and Organizational

Perspectives,IGI Global, 2010.

6. Devdas Shetty, “Product design for Engineers”, Cengage Learning

Course Outcomes:

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

1. Interpret the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development

2. Select, screen, and test concepts for new product design and development.

3. Interpret the principles of product architecture and industrial design to design and develop new products.

4. Apply the principles of DFMA and Prototyping to design and develop new product.

5. Apply the concepts of economics principles sustainable product development and life cycle

assessment.

<table>
<tr><td rowspan="2">IV Year-I Semester</td><td rowspan="2">Open Elective - IV</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">OPTIMIZATION TECHNIQUES</td></tr>
</table>

Course Objectives:

The students will acquire the knowledge:

1. To classify of optimization problem and apply classical optimization techniques
2. To apply unconstrained optimization techniques using various methods
3. To analyze the characteristics and approaches of constrained optimization techniques
4. To illustrate optimized solutions using constrained and unconstrained geometric programming
5. To analyze integer programming methods

UNIT I

INTRODUCTION TO OPTIMIZATION: Engineering applications of optimization-statement of an optimization problem- classification of optimization problem- optimization techniques.

CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization- multivariable optimization with equality constraints- multivariable optimization with inequality constraints.

UNIT-II

UNCONSTRAINED OPTIMIZATION TECHNIQUES: Pattern search method-Rosenbrock's method of rotating coordinates- Simplex method- Descent methods- Gradient of function- Steepest Descent method.

UNIT-III

CONSTRAINED OPTIMIZATION TECHNIQUES: Characteristics of constrained problem methods of feasible directions - basic approach in the penalty function method- interior penalty function method- convex programming problem- exterior penalty function method.

UNIT-IV

GEOMETRIC PROGRAMMING (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. primal dual relationship and sufficiency conditions.

Solution of a constrained geometric programming problem (G.P.P). Complimentary geometric programming (C.G.P)

UNIT-V

INTEGER PROGRAMMING (I.P): Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem.Integer non linear programming.

Text Books:

1. Optimization Theory and Applications/ S.S.Rao/Wiley Eastern Limited, New Delhi.

References:

1. Engineering Optimization / Kalyanmanai Deb/Prentice Hall of India, New Delhi.

2. Optimization Techniques-Theory and applications/C.Mohan&Kusum Deep/New Age International

3. Operations Research /S.D.Sharma / MacMillan Publishers

Course Outcomes:

Upon successful completion of this course student should be able to:

1. Classify of optimization problem and apply classical optimization techniques
2. Apply unconstrained optimization techniques using various methods
3. Analyze the characteristics and approaches of constrained optimization techniques
4. Illustrate optimized solutions using constrained and unconstrained geometric programming
5. Analyze integer programming methods

IV Year-I Semester	Skill oriented Course- III	L	T	P	C
		2	0	0	2
RENEWABLE ENERGY					

Course Objectives:

The students will acquire the knowledge:

1. To demonstrate the importance and solar radiation, solar energy collection and storage
2. To illustrate the energy sources and potential from wind energy, bio-mass, geothermal energy and ocean energy
3. To interpret energy efficient electrical and mechanical systems
4. To develop energy efficient processes
5. To analyze features and benefits of green buildings

UNIT-I

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 radiation data, numerical problems. Photo voltaic energy conversion – types of PV cells.

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 – II

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy.

OCEAN ENERGY: OTEC, Principles of utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques.

UNIT –III

ENERGY EFFICIENT SYSTEMS:

(A) ELECTRICAL SYSTEMS: Energy efficient motors, energy efficient lighting and control, selection of luminaire, variable voltage variable frequency drives (adjustable speed drives), controls for HVAC (heating, ventilation and air conditioning), demand site management.

(**B) MECHANICAL SYSTEMS**: Fuel cells- principle, thermodynamic aspects, selection of fuels & working of various types of fuel cells, Environmental friendly and Energy efficient compressors and pumps**.**

UNIT-IV

ENERGY EFFICIENT PROCESSES: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of efficient and sustainable green production systems with examples like environmental friendly machining, vegetable based cutting fluids, alternate casting and joining techniques, zero waste manufacturing.

UNIT – V

GREEN BUILDINGS: Definition, features and benefits. Sustainable site selection and planning of buildings for maximum comfort. Environmental friendly building materials like bamboo, timber, rammed earth, hollow blocks, lime & lime pozzolana cement, agro materials and industrial waste, Ferro cement and Ferro-concrete, alternate roofing systems, paints to reduce heat gain of the buildings. Energy management.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH

2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006

3. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013

References:

1. Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New age international

2. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth & John F Kreider / Taylor &Francis

3. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd

4. Renewable Energy Technologies -Ramesh & Kumar /Narosa

5. Non conventional Energy Source- G.D Roy/Standard Publishers

6. Renewable Energy Resources-2nd Edition/ J.Twidell and T. Weir/ BSP Books Pvt.Ltd

7. Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd

Course Outcomes:

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

1. Demonstrate the importance and solar radiation, solar energy collection and storage
2. Illustrate the energy sources and potential from wind energy, bio-mass, geothermal energy and ocean energy
3. Interpret energy efficient electrical and mechanical systems
4. Develop energy efficient processes
5. Analyze features and benefits of green buildings

IV Year-I Semester	Skill oriented Course- III	L	T	P	C
		0	1	2	2
SIMULATION LAB					

Course Objectives:

The students will acquire the knowledge:

1. To impart the fundamental knowledge on using various analytical tools like ANSYS, FLUENT, etc., for Engineering Simulation
2. To know various fields of engineering where these tools can be effectively used to improve the output of a product.
3. To impart knowledge on how these tools are used in Industries by solving some real time problems using these tools.

1. **PART MODELING:** Generation of various 3D models through protrusion, revolve, shell sweep. creation of various features. study of parent child relation. feature based and Boolean based modelling surface and assembly modelling. study of various standard translators. design simple components.
2. **ANALYSIS:**
   a) Determination of deflection and stresses in 2D and 3D trusses and beams.
   b) Determination of deflections component and principal and Von-mises stresses in plane stress, plane strain and Axisymmetric components.
   c) Determination of stresses in 3D and shell structures (at least one example in each case)
   d) Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
   e) Steady state heat transfer Analysis of plane and Axisymmetric components.

Packages to be provided to cater to drafting, modelling & analysis from the following:

CATIA, Pro-E, I-DEAS, ANSYS, NISA, etc

Course outcomes:

Upon successful completion of this course student should be able to:

1. Explain the concepts of part drawings and assembly of various mechanical parts
2. Interpret the concepts of surface and assembly modeling
3. Solve displacements, stress and reactions in a the 2D bar, beam and truss elements
4. Solve displacements, stress and reactions in the 3D bar, beam and truss elements
5. Describe the steady state heat transfer analysis of plane and Axisymmetric components.

IV Year-I Semester	Skill oriented Course- III	L	T	P	C
		0	1	2	2
INSTRUMENTATION AND CONTROL SYSTEMS LAB					

Course Objectives:

To study and calibrate displacement, temperature, speed, capacitance and pressure measuring instruments

List of Experiments

1. Calibration of pressure gauge.
2. Calibration of transducer for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Calibration of strain gauge.
5. Calibration of thermocouple.
6. Calibration of capacitive transducer.
7. Study and calibration of photo and magnetic speed pickups.
8. Calibration of resistance temperature detector.
9. Study and calibration of a rotameter.
10. Study and use of a seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.
11. Study and calibration of Mcleod gauge for low pressure.

Course Outcomes:

At the end of the course the students shall be able to:

1. Explain the usage of pressure gauge, Mcleod gauge and temperature measurement transducer
2. Analyze the usage of LVDT transducer and strain gauge
3. Illustrate concept of applications of thermo couple and capacitive transducer
4. Explain the usage of photo and magnetic speed pickups and resistance temperature detector.
5. Interpret the calibration of Rotameter and seismic pickup for measurement of vibrational amplitude.

<table>
<tr><td rowspan="2">IV Year-I Semester</td><td rowspan="2">Audit Course- III</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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<tr><td colspan="6">CONSTITUTION OF INDIA</td></tr>
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<table>
<tr><td rowspan="2">Honors Course</td><td rowspan="2">MACHINE DESIGN</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">ADVANCED MECHANICS OF SOLIDS</td></tr>
</table>

Prerequisite: Mechanics of solids

Course Objectives:
The main objectives of the course are
1. To impart concepts of stress and strain analyses in a solid.
2. To study the methodologies in theory of elasticity at a basic level.
3. To acquaint with the solution of advanced bending problems.
4. To get familiar with energy methods for solving structural mechanics problems.

UNIT-I
Introduction to stress analysis in elastic solids - stress at a point – stress tensor – stress components in rectangular and polar coordinate systems - Cauchy's equations – stress transformation – principal stresses and planes - hydrostatic and deviatoric stress components, octahedral shear stress - equations of equilibrium. Displacement field – engineering strain - strain tensor (basics only) – analogy between stress and strain tensors - strain-displacement relations (small-strain only) – compatibility conditions.

UNIT-II
Constitutive equations – generalized Hooke's law – equations for linear elastic isotropic solids - relation among elastic constants – Boundary conditions – St. Venant's principle for end effects – uniqueness theorem. 2-D problems in elasticity - Plane stress and plane strain problems – stress compatibility equation - Airy's stress function and equation – polynomial method of solution – solution for bending of a cantilever with an end load

UNIT-III
Equations in polar coordinates (2D) – equilibrium equations, strain displacement relations, Airy's equation, stress function and stress components (only short derivations for examination). Application of stress function to Lame's problem and stress concentration problem of a small hole in a large plate (only stress distribution). Axisymmetric problems – governing equations – application to thick cylinders,, rotating discs.

UNIT-IV
Unsymmetrical bending of straight beams (problems having c/s with one axis of symmetry only) – curved beams (rectangular c/s only) - shear center of thin-walled open sections (c/s with one axis of symmetry only). Strain energy of deformation – special cases of a body subjected to concentrated loads, moment or torque - reciprocal relation – strain energy of a bar subjected to axial force, shear force, bending moment and torque.

UNIT-V

Maxwell reciprocal theorem – Castigliano's first and second theorems – virtual work principle – minimum potential energy theorem. Torsion of non-circular bars: Saint Venant's theory - solutions for circular and elliptical cross-sections. Prandtl's method - solutions for circular and elliptical cross-sections - membrane analogy. Torsion of thin-walled tubes, thin rectangular sections, rolled sections and multiply connected sections.

Text Books:

1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill,2008
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill,2008
3. S. Jose, Advanced Mechanics of Materials, Pentagon Educational Services,2013
4. L. Govindaraju ,TG Sitharaman, Applied elasticity for Engineers, NPTEL
5. U. Saravanan, Advanced Solid Mechanics, NPTEL
6. S. Anil Lal, Advanced Mechanics of Solids, Siva Publications and Distributions, 2017

References Books:

1. S. P. Timoshenko, J. N. Goodier, Theory of elasticity, McGraw Hill,1970
2. R.J. Atkin, and N. Fox, An introduction the theory of elasticity, Longman,1980
3. J. P. Den Hartog, Advanced Strength of Materials, McGraw Hill,1987
4. C. K. Wang, Applied Elasticity, McGraw Hill,1983
5. www.solidmechanics.org/contents.htm - Free web book on Applied Mechanics of Solids by A.F. Bower.

Course Outcomes: At the end of the course students will be able to

1. Apply concepts of stress and strain analyses in solids.
2. Use the procedures in theory of elasticity at a basic level.
3. Solve general bending problems.
4. Apply energy methods in structural mechanics problems.

Honors Course	MACHINE DESIGN	L	T	P	C
		3	0	0	3
ADVANCED FINITE ELEMENT METHODS					

Prerequisite: Finite Element Methods

Course Objectives: The main objectives of the course are

1. To provide a strong foundation in the mathematical formulation of finite element methods using variational principles.
2. To develop the ability to model and analyze complex 1D, 2D, and axisymmetric problems using various finite elements.
3. To impart knowledge on isoparametric formulation and numerical integration techniques in FEM.
4. To introduce solution strategies for structural and heat transfer problems using FEM.
5. To enable students to apply commercial FEM tools for static and dynamic structural analysis.

UNIT-I

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-II

One-dimensional elements: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT-III

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-IV

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.

UNIT-V

Finite elements in Structural Analysis: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

Text Books:
1. Finite element methods by Chandrubatla & Belagondu.

References Books:
1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994.
2. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996.

Course Outcomes: At the end of the course students will be able to
1. Formulate finite element equations using variational methods and weighted residual methods.
2. Analyze 1D and 2D structural and thermal problems using appropriate finite elements.
3. Apply isoparametric concepts and evaluate convergence of FEM solutions.
4. Solve structural and heat transfer problems using FEM techniques and validate with numerical tools.
5. Use commercial FEM software to perform structural simulations and interpret the results critically.

		L	T	P	C
Honors Course	**MACHINE DESIGN**	**3**	**0**	**0**	**3**
ADVANCED MECHANISMS & ROBOTICS					

Prerequisite: Engineering Mechanics and Kinematics of Machinery

Course Objectives: The main objectives of the course are

1. To provide an in-depth understanding of advanced planar and spatial mechanism analysis.
2. To introduce analytical synthesis methods for mechanism design.
3. To impart knowledge on robotic manipulators and their kinematic modeling.
4. To understand robot actuators and sensors used in industrial and research applications.
5. To develop skills in forward and inverse kinematics for robotic systems.

UNIT-I

Introduction: Elements of Mechanisms; Mobility Criterion for Planar mechanisms and manipulators; Mobility Criterion for spatial mechanisms and manipulators. Spherical mechanisms spherical trigonometry.

Advanced Kinematics of plane motion- I: The Inflection circle; Euler – Savary Equation; Analytical and graphical determination of di; Bobillier's Construction; Collineastion axis; Hartmann's Construction; Inflection circle for the relative motion of two moving planes; Application of the Inflection circle to kinematic analysis.

UNIT-II

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; Determination of the output angular acceleration and its Rate of change; Freudenstein's collineation –axis theorem; Carter –Hall circle; The circling – point curve for the Coupler of of a four-bar mechanism.

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-III

Manipulator Kinematics: D-H transformation matrix; Direct and Inverse kinematic analysis of Serial manipulators: Articulated, spherical & industrial robot manipulators- PUMA, SCARA, STANFORD ARM, MICROBOT.

Fundamentals of Robots: Introduction, definition of robot, classification of robots, History of robotics, robot components, degree of freedom, robot joints, robot coordinates, reference frames, programming modes, robot characteristics, robot work space, robot languages, advantages, disadvantages and applications of robots.

UNIT-IV

Robot kinematics: Forward and inverse kinematics of robots-forward and inverse kinematic equations for position, forward and inverse kinematic equations for orientation, forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg(D-H) representation of forward kinematic equations of robots, The inverse kinematic solution and programming of robots, Degeneracy and Dexterity, simple problems with D-H representation.

UNIT-V

Robot Actuators: Introduction, characteristics of Actuating systems-weight, power to weight ratio, operating pressure, stiffness Vs compliance, comparision of actuating systems, hydraulic devices, pneumatic devices, Electric motors-DC motorcar motors, Brushless DC motors, direct Drive electric motors, servomotors, stepped motors.

Robot sensors: Introduction, sensor characteristics, Position sensors-potentiometers, encoders, LVDT, Resolvers, time of travel displacement sensor, Velocity sensors-Encoders, Tachometers, differentiation of position signal, Accelerating sensors, force and pressure sensors-piezoelectric, force sensing resistor, strain gauges, Torque sensors, light and infrared sensors, touch and tactile sensors, proximity sensors-magnetic proximity sensors, optical proximity sensors, Ultrasonic proximity sensors, inductive proximity sensors, capacitive proximity sensors, eddy current proximity sensors, sniff sensors.

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.
4. Introduction to Robotics – Analysis, System, Applications by Saeed B. Niku,PHI Publications.
5. Industrial Robotics – Mikell P. Groover & Mitchell Weiss, Roger N. Nagel, Nicholas G.Odrey – Mc Graw Hill, 1986

References Books:

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.
4. Robot Modeling and Kinematics – Rachid Manseur, Firewall Media Publishers (An imprint of Laxmi Publications Pvt. Ltd., New Delhi).
5. Robot Analysis and Control - H. Asada and J.J.E. Slotine John Willey & Sons.
6. Fundamentals of Robotics: Analysis and control, Robert J. Schilling, Prentice Hall, 1990.
7. A robot Engineering text book – Mohsen shahinpoor, Harper & Row Publishers,1987.
8. Introduction to Robotics: Mechanics and Control, John.J.Craig, Addison- Wesley, 1999.
9. Robotics: Control, sensing, vision, and intelligence – K.S. FU, R.C. Gonzalez and C.S.G Lee. Mc Graw Hill, 1987.
10. Modeling and control of Robot manipulators, L. sciavicco and b. Siciliano,Springer.
11. ROBOTICS (Fundamental concepts and analysis) Ashitava Ghosal. Oxford university press.

Course Outcomes: At the end of the course students will be able to

1. Analyze advanced kinematic behavior of planar and spatial mechanisms.
2. Apply graphical and analytical methods for mechanism synthesis and motion analysis.
3. Perform kinematic modeling and analysis of robot manipulators using D-H conventions.
4. Develop and solve forward and inverse kinematic equations of robot arms.
5. Identify and select appropriate actuators and sensors for robotic systems based on performance criteria

Honors Course	MACHINE DESIGN	L	T	P	C
		3	0	0	3
ADVANCED MACHINE DESIGN					

Prerequisite: Mechanics of Solids and Machine Design

Course Objectives: The main objectives of the course are
1. To understand the philosophical and structured approach to modern machine design.
2. To analyze components under static and dynamic loads using advanced failure theories.
3. To evaluate the effects of fatigue, creep, and surface failure on mechanical components.
4. To integrate human, economic, and ethical considerations into the design process.
5. To apply advanced design concepts like value engineering and ergonomics for optimized product development.

UNIT-I
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-II
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-III
Fatigue failure theories: cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation

UNIT-IV
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-V
Economic factors influencing design: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design. Team work and Ethics in engineering design: Team formation, functioning, discharge, team dynamics, 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 McGrawHill International Book Company, New Delhi.

References Books:

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 /McGrawHill International edition.

Course Outcomes: At the end of the course students will be able to

1. Apply a structured and philosophical approach to product and machine design.
2. Analyze failure under complex loading using static and fatigue failure theories.
3. Evaluate the impact of thermal effects, residual stresses, and cumulative damage on machine elements.
4. Design components to prevent surface failures and improve durability.
5. Incorporate economic, ergonomic, and ethical considerations into the engineering design process.

Honors Course	MACHINE DESIGN	L	T	P	C
		3	0	0	3
DESIGN FOR MANUFACTURING & ASSEMBLY					

Prerequisite: Mechanics of Solids, Manufacturing Processes, Materials Science and Metallurgy, Engineering Drawing / Machine Drawing.

Course Objectives:

The main objectives of the course are

1. To introduce the principles and significance of Design for Manufacturing (DFM) and Design for Assembly (DFA) in product development.
2. To enable students to integrate manufacturing considerations into the design process to reduce production costs and time.
3. To familiarize students with different manufacturing processes and their impact on design.
4. To teach systematic approaches to designing parts for ease of assembly and automation.
5. To develop analytical skills to evaluate and improve design efficiency in real-world manufacturing scenarios.

UNIT-I

Introduction to DFM, **DFMA:** Reasons for Not Implementing DFMA, 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, Application of the DFA Methodology.

UNIT-II

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-III

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, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

UNIT-IV

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-design of brazed joints.

Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.

UNIT-V

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, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

Text Books:

1. Design for manufacture, John cobert, Adisson Wesley. 1995.
2. Design for Manufacture by Boothroyd.
3. Design for manufacture, James Bralla.

References Books:

1. ASM Hand book Vol.20

Course Outcomes: At the end of the course students will be able to

1. Apply DFM and DFA principles to optimize product designs for cost-effective manufacturing and ease of assembly.
2. Analyze and redesign components considering various manufacturing processes like machining, casting, welding, forging, and sheet metal working.
3. Evaluate and recommend suitable manufacturing methods based on design requirements and product constraints.
4. Incorporate automation and assembly system configurations in design to improve production efficiency.
5. Use systematic design methodologies to create manufacturable and assemblable components, ensuring higher product reliability and performance.

<table>
<tr><td rowspan="2">Honors Course</td><td rowspan="2">MACHINE DESIGN</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="6">COMPUTATIONAL LAB</td></tr>
</table>

Prerequisite: Linear Algebra, Calculus and Differential Equations, Programming Fundamentals.
Course Objectives: The main objectives of the course are
1. To provide hands-on experience in implementing numerical methods using MATLAB and Python.
2. To enhance understanding of solving mathematical problems such as systems of equations, curve fitting, transformations, and differential equations through computational approaches.
3. To develop computational thinking and problem-solving skills applicable to engineering and research problems.

List of Experiments/Programs:
1. Solution of algebraic and transcendental equations using:
   i. Bisection Method
   ii. Newton-Raphson Method
2. Solution of linear system of equations using:
   i. Gauss Elimination Method
   ii. Gauss-Seidel Iterative Method
3. Interpolation techniques:
   i. Newton’s Forward and Backward Interpolation
   ii. Lagrange’s Interpolation
4. Numerical differentiation using:
   i. Forward, Backward, and Central Difference Methods
5. Numerical integration using:
   i. Trapezoidal Rule
   ii. Simpson’s 1/3 and 3/8 Rules
6. Solving ordinary differential equations (ODEs) using:
   i. Euler’s Method
   ii. Runge-Kutta 2nd and 4th Order Methods
7. Fitting a curve to a given data set:
   i. Linear and Nonlinear Curve Fitting (Least Squares Method)
8. Fourier Series approximation of periodic functions (if included in course)
9. Partial Differential Equation Solvers (Optional/Advanced):
   i. Finite Difference Method for Laplace/Poisson Equation
10. Matrix operations and eigen value problems using computational tools

Software Tools (suggested):
- Python (with NumPy, SciPy, Matplotlib)
- MATLAB / Octave
- Scilab (open-source alternative)
- Jupyter Notebook or any IDE

Text Books:
1. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, McGraw-Hill.
2. Amos Gilat, MATLAB: An Introduction with Applications, Wiley.

References Books:
1. Saumyen Guha and Rajesh Srivastava, Numerical Methods, Oxford University Press.
2. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI Learning.
3. V. Sundarapandian, Numerical Methods, Vikas Publishing.
4. Hans Petter Langtangen, A Primer on Scientific Programming with Python, Springer.

Course Outcomes: At the end of the course students will be able to
1. Develop and implement numerical algorithms using MATLAB and Python.
2. Solve linear and nonlinear systems, curve fitting, and transform-based problems computationally.
3. Apply numerical methods to solve ordinary and partial differential equations.
4. Interpret the results of numerical simulations to support engineering analysis and research.

Honors Course	MACHINE DESIGN	L	T	P	C
		0	0	3	1.5
MECHANISMS & ROBOTICS LAB					

Prerequisite: Kinematics of Machinery, Robotics

Course Objectives: The main objectives of the course are
1. To provide hands-on experience in analyzing the motion of mechanisms.
2. To demonstrate working principles of gear trains, cams, and linkages.
3. To introduce basic robotic configurations and programming.

List of Experiments:

Mechanisms Experiments:
1. Study of four-bar mechanism and its inversions
2. Study of single and double slider crank mechanism
3. Study and analysis of Geneva mechanism
4. Study of quick return mechanism (Whitworth / Slotted Link)
5. Study and plotting of cam profile for different followers
6. Study of different gear trains – simple, compound, and epicyclic
7. Determination of coefficient of friction using friction models (e.g., inclined plane)
8. Experiment on Hooke’s Joint – Angular speed and velocity ratio

Robotics Experiments:
9. Study of robotic arm configuration (2R/3R planar arm)
10. Simulation of a SCARA / Cartesian robot using software tools
11. Forward kinematics of a 2R or 3R robot using MATLAB / Python / RoboDK
12. Inverse kinematics simulation using appropriate software
13. Path planning and trajectory generation for robot manipulator
14. Pick and place programming using a robotic kit or simulator

Software Tools (Optional / As Per Availability):
- MATLAB / Simulink
- RoboAnalyzer / RoboDK / V-REP
- Python with Robotics Toolbox
- SolidWorks / Fusion 360 (for linkage simulation)

Text Books:
1. J. Uicker, G. Pennock, and J. Shigley, Theory of Machines and Mechanisms, Oxford University Press.
2. M. P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson.

References Books:

1. R.L. Norton, Design of Machinery, McGraw-Hill.
2. Ashitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Wiley.

Course Outcomes: At the end of the course students will be able to

1. Analyze and demonstrate the working of various mechanisms.
2. Design and simulate motion paths for mechanisms and robotic arms.
3. Interpret and implement kinematic solutions for basic robot arms.
4. Use simulation tools to validate robot behavior and motion planning.

Honors Course	CAD/CAM	L	T	P	C
		3	0	0	3
ADVANCED CAD					

Course Objectives: Student will be able to

1. Model the 3D geometric information of machine components including assemblies, and automatically generate 2- D production drawings, interpret the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.
2. Interpret visualization ability of machine components and assemblies before their actual fabrication through modeling, animation, shading, rendering, lighting and coloring.
3. Model complex shapes including freeform curves and surfaces,
4. Integrate the CAD system and the CAM system by using the CAD system for modelling design Information and converting the CAD model into a CAM model for modelling the manufacturing Information.
5. Use full scale CAD/CAM software systems designed for geometric modeling of machine Components and automatic generation of manufacturing information.

UNIT - I PRINCIPLES OF COMPUTER GRAPHICS

Introduction, graphic primitives, point plotting, lines, Bresenham's circle algorithm, ellipse, transformation in graphics, coordinate systems, view port, 2D and 3D transformation, hidden surface removal, reflection, shading and generation of characters.CAD –modeling of curves, surfaces and solids manipulation of CAD models, features based modelling, product data exchange standards.

UNIT - II CAD TOOLS & GEOMETRIC MODELLING

CAD TOOLS: Definition of CAD Tools, Types of system CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software.

GEOMETRICMODELLING: Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic sp lines Bezier curves B-sp lines rational curves.

UNIT - III SURFACE MODELING

Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder

UNIT - IV PARAMETRIC REPRESENTATION OF SYNTHETIC SURFACES

Hermite Bicubic surface, Bezier surface, B- Spline surface, COONs surface, Blending surface Sculptured surface, Surface manipulation — Displaying, Segmentation, Trimming, Intersection, Transformations (both 2D and 3D).

UNIT - V GEOMETRICMODELLING

GEOMETRICMODELLING: Solid modeling, Solid Representation, Boundary Representation (13-rep), Constructive Solid Geometry (CSG).

CAD/CAM Exchange: Evaluation of data - exchange format, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF. Design Applications: Mechanical tolerances, Mass property calculations, Finite Element Modeling and Analysis and Mechanical Assembly.

Collaborative Engineering: Collaborative Design, Principles, Approaches, Tools, Design Systems.

Textbooks:

1. Mastering CAD/CAM / IbrhimZeid / McGraw Hill International.
2. CAD/CAM Principles and Applications/ P.N.Rao/TMH/3rd Edition

Reference Books:

3. CAD/CAM /Groover M.P./ Pearson education
4. CAD/CAM Concepts and Applications/ Alavala/ PHI
5. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
6. Principles of Computer Aided Design and Manufacturing/ FaridAmirouche/ Pearson
7. Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson

Online Learning Resources:

1. https://nptel.ac.in/courses/112/102/112102101/
2. https://nptel.ac.in/courses/112/102/112102102/
3. https://www.youtube.com/watch?v=EgKc9L7cbKc
4. https://www.youtube.com/watch?v=0IgOapAtauM

Course Outcomes (CO): Student will be able to

1. Interpret the concepts of wireframe, surface and solid modelling
2. Describe part modelling and part data exchange standards (VDA,IGES and STEP)
3. Develop knowledge in 2D-Transformations, 3D Transformations.
4. Illustrate the Assembly Modelling, Assembly tree, and Assembly Methods.
5. Interpret visualization and computer animation Techniques.

<table>
<tr><td rowspan="2">Honors Course</td><td rowspan="2">CAD/CAM</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COMPUTER INTEGRATED MANUFACTURING</td></tr>
</table>

Course Objectives

1. To apply manufacturing concepts and management principles.
2. To classify and compare different manufacturing processes and systems.
3. To develop part program for manufacturing of different machine components.
4. To analyze the behavior of manufacturing system using simulation.

UNIT I

INTRODUCTION:

Introduction to CAD and CAM – Manufacturing Planning, Manufacturing control Introduction to CAD/CAM – Concurrent Engineering - CIM concepts – Computerized elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In Time Production.

UNIT II

PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING: Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

UNIT III

CELLULAR MANUFACTURING Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT IV

FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT V

INDUSTRIAL ROBOTICS Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

Text Books:

1.Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.

2.Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000

Reference Books:

1. Principles of Computer-integrated Manufacturing by S. Kant Vajpayee
2. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover Pearson Education
3. Robotics Technology and Flexible Automation, by S R Deb, S Deb, McGraw Hill Education Private Limited
4. Flexible Manufacturing Cells and System -William. W. Luggen
5. CNC Machines by B.S. Pabla
6. CNC Machines and Automation by J.S. Narang

Course Outcomes (CO): Student will be able to
1. Apply manufacturing concepts and management principles.
2. Classify and compare different manufacturing processes and systems.
3. Determine part parts classification and coding.
4. Illustrate flexible manufacturing system and automated guided vehicle system.
5. Summarize robot anatomy and related attributes

		L	T	P	C
Honors Course	**CAD/CAM**	**3**	**0**	**0**	**3**
MODELING & SIMULATION OF MANUFACTURING SYSTEMS					

Course Objectives:

- Learn way of analyzing the systems.
- Classification of systems based nature of dynamics and knowledge of elements.
- To develop simulation model for dynamic discrete – event stochastic system.
- To run the model and collect the data.
- To analyze the output data of simulation for specified for performance measures bases on type of simulation and method of output data analysis.

UNIT - I:

System – ways to analyze the system – Model - types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages & Disadvantages. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1& 2 errors – Framing – strong law of large numbers.

UNIT - II:

Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modeling – Techniques for verification – statistical procedures for developing credible model. Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling.

UNIT - III:

Generation of random variates – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – weibull – normal Bernoullie – Binomial – uniform – poison. Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs Simulators – software features – statistical capabilities – G P S S – SIMAN-SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages.

UNIT - IV:

Output data analysis – Types of Simulation with respect to output data analysis – warm up periodWelch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons

UNIT –V:

Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – New boy paper problem.

Text Books:

1. Simulation Modelling and Analysis by Law, A.M. & Kelton, McGraw Hill, 2nd Edition, New York, 1991.
2. Discrete Event System Simulation by Banks J. & Carson J.S., PH, Englewood Cliffs, NJ, 1984.

Reference Books:

1. Simulation of Manufacturing Systems by Carrie A., Wiley, NY, 1990.
2. A Course in Simulation by Ross, S.M., McMillan, NY, 1990.
3. Simulation Modelling and SIMNET by Taha H.A., PH, Englewood Cliffs, NJ, 1987

Course Outcomes:

At the end of course, student should able to

- Define the state of system W.R.T specified performance measures.
- Identify Dynamic Discrete- event stochastic system.
- Develop simulation model for the said system
- Analyze the model and present the results to specified confidence level.

		L	T	P	C
Honors Course	**CAD/CAM**	**3**	**0**	**0**	**3**
ADVANCED MANUFACTURING PROCESSES					

Course Objectives:

- To make acquainted the various unconventional manufacturing processes
- To know about the applications of advanced manufacturing processes (which are exceptional)
- To encourage the students for developing the models of Advanced Manufacturing Processes

UNIT-I:

Surface treatment: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT-II:

Non-Traditional Machining: Introduction, need, AJM, Parametric Analysis, Process capabilities, USM –Mechanics of cutting, models, Parametric Analysis, WJM –principle, equipment, process characteristics, performance, EDM – principles, equipment, generators, analysis of R-C circuits, MRR, Surface finish, WEDM.

UNIT-III:

Laser Beam Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
Electron Beam Machining - Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
Electro Chemical Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.

UNIT-IV:

Processing of ceramics: Applications, characteristics, classification. Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics.
Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT-V:

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 microelectronics, surface mount technology, Integrated circuit economics. E-Manufacturing, nanotechnology, micromachining and High-speed Machining, basic principles, working, applications, advantages.

Text Books:

1. Manufacturing Engineering and Technology by Kalpakijian, Addison Wesley, 1995.
2. Foundation of MEMS by Chang Liu, Pearson, 2012.
3. Advanced Machining Processes by V. K. Jain, Allied Publications.

Reference Books:

1. Process and Materials of Manufacturing by R. A. Lindburg, 4th edition, PHI 1990.
2. Introduction to Manufacturing Processes by John A Schey, Mc Graw Hill.
3. Micro Machining of Engineering Materials by J. Mc Geough, CRC Press.
4. Non-Traditional Manufacturing Processes by Gary F Benedict, CRC Press.
5. Advanced Methods of Machining by J. A Mc Geough, Springer.

Course Outcomes:

At the end of the course, the student will be

- Summarize various surface treatment methods
- Distinguish various unconventional manufacturing processes
- Interpret the working principle of Electron beam, laser beam and laser beam processes.
- Able to interpret different types of composite material characteristics, types of micro & macro machining processes.
- Explain the fabrication of microelectronic devices, e-manufacturing & nano materials.

		L	T	P	C
Honors Course	**CAD/CAM**	**3**	**0**	**0**	**3**
QUALITY & RELIABILITY					

UNIT-1:
Partially redundant systems-Standby redundant systems-redundancy concepts-perfect switching imperfect switching-standby redundancy calculations-Component versus unit redundancy-Weakest Link Technique-Mixed Redundancy-Redundancy Optimization-Double Failures and Redundancy.

UNIT-II:
Systems Model-Statement of the various optimization problems- Heuristic Methods applied to optimal systems reliability-A heuristic method: Sharma And Venkateswran's Approach, Aggrawal's Approach, Mishra's Approach, Ushakov's Approach, Nakagawa and Nakashima's Approach.

UNIT-III:
Dynamic programming applied to optimal systems reliability-Basic dynamic programming approach-Dynamic programming approach using Lagrange multipliers-The discrete maximum principle applied to optimal systems reliability-Sequential unconstrained minimization technique (SUMT) applied to optimal systems reliability-Generalized reduced gradient method (GRG) applied to optimal Systems reliability.

UNIT-IV:
Method of Lagrange multipliers-single constraint problem-single linear constraint problem-two linear constraint problem-Generalized Lagrangian function method applied to optimal systems reliability-Generalized Lagrangian problem-computational procedures- KUHN-TUCKER conditions in optimal systems reliability and for the two linear constraint problem. The geometric programming applied to optimal systems reliability- Examples.

UNIT-V:
Integer programming applied to optimal systems reliability-Introduction-The partial Enumeration method-The Gomory Cutting plane method-The branch and bound method-The Geoffrion Implicit Enumeration Method-Parametric Method-Linear Programming-Separable Programming Methods Examples.

Text Books:

1. F. A. Tillman, C. V. Hwang & W. Kuo, Optimization of Systems Reliability, Marcel Dekker Inc.
2. S. S Rao, Engineering Optimization Theory and Practice, New Age International Publications, Third edition.

Reference Books:

1. E. Balagurusamy, Reliability Engineering, Tata McGraw-Hill Publishing Company Limited.
2. J. K. Sharma, Operations Research Theory and Appliactions, Macmillan Publications, 4th Edition.

		L	T	P	C
Honors Course	**CAD/CAM**	**0**	**0**	**3**	**1.5**
ADVANCED CAD LAB					

Course Objectives: Student will be able to

- Model the 3D geometric information of machine components including assemblies, and automatically generate 2- D production drawings, interpret the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.
- Improve visualization ability of machine components and assemblies before their actual fabrication through modeling, animation, shading, rendering, lighting and coloring.
- Model complex shapes including freeform curves and surfaces,
- Integrate the CAD system and the CAM system by using the CAD system for modeling design
- Information and converting the CAD model into a CAM model for modeling the manufacturing
- Information.
- Use full scale CAD/CAM software systems designed for geometric modeling of machine Components and automatic generation of manufacturing information

List of Experiments:

1. Features and selection of CNC turning and milling centers.
2. Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles.
3. Practice in part programming and operating a machining center, tool panning and selection of sequences of operations, tool setting on machine, practice in APT based NC programming.
4. Practice in Robot programming and its languages.
5. Robotic simulation using software. Robo path control, preparation of various reports and route sheets, Simulation of manufacturing system using CAM software, controller operating system commands.

Course Outcomes (CO): Student will be able

- Interpret the concepts of wire frame, surface and modeling
- Apply part modeling and part data exchange standards (VDA, IGES and STEP)
- Develop knowledge in 2D-Transformations, 3D Transformations.
- Illustrate the Assembly Modeling, Assembly tree, and Assembly Methods.
- Describe Visualization and computer animation Techniques.

<table>
<tr><td rowspan="2">Honors Course</td><td rowspan="2">CAD/CAM</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="6">MODELING AND SIMULATION OF MANUFACTURING SYSTEMS LAB</td></tr>
</table>

Course Objectives: Student will be able
• To interpret various manufacturing processes
• To illustrate the various Simulation Processes

List of Experiments:
A. MANUFACTURING SIMULATION:
The students will be given training on the use and application of the following software to manufacturing problems:
1. Auto MOD Software.
2. PROMODEL
3. SLAM-II
4. CAFIMS
5. Flexsim
They also learn how to write sub routines in C-language and interlinking with the above packages.

Problems for modelling and simulation experiments:
1. AGV planning
2. ASRS simulation and performance evaluation
3. Machines, AGVs and AS/RS integrated problems
4. JIT system
5. Kanban flow
6. Material handling systems
7. M.R.P. Problems
8. Shop floor scheduling etc.

Course Outcomes (CO): Student will be able
• To apply various softwares for simulation of manufacturing processes.

<table>
<tr><td rowspan="2">Honors Course</td><td rowspan="2">THERMAL ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">ADVANCED THERMODYNAMICS</td></tr>
</table>

Course Objectives: Student will be able

- To interpret of thermodynamic laws and corollaries
- To analyze the Real gas behavior using P.V.T surface
- To analyze the Combustion Reactions and Chemical equilibrium of ideal gases
- To interpret various power cycles and thermodynamics off irreversible processes
- To describe fuel cells and Photovoltaic cells

UNIT -I

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-II

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, Clapeyro equation. Throttling, Joule. Thompson coefficient. Non-reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air conditioning processes, cooling towers. Real gas mixture.

UNIT-III

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. The chemical potential and phase equilibrium. The Gibbs phase rule.

UNIT-IV

POWER CYCLES: Review binary vapour cycle, co-generation and combined cycles, Second law analysts of cycles. Refrigeration cycles. Thermodynamics off irreversible processes. Introduction, Phenomenological laws, Onsaga Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

UNIT-V

DIRECT ENERGY CONVERSION INTRODUCTION: Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydronamic generations, Photovoltaic cells.

Text Books:

1. Basic and Applied Thermodynamics/ P.K.Nag/ TMH

2. Thermodynamics/Holman/ Me Graw Hill.

References

1. Engg. Thermodynamics/PL.Dhar / Elsevier
2. Thermodynamics/Sonnatag & 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: Student will be able

- Interpret thermodynamic laws and corollaries
- Analyze the Real gas behavior using P.V.T surface
- Analyze the Combustion Reactions and Chemical equilibrium of ideal gases
- Interpret various power cycles and thermodynamics off irreversible processes
- To describe fuel cells and Photovoltaic cells

		L	T	P	C
Honors Course	**THERMAL ENGINEERING**	**3**	**0**	**0**	**3**
ADVANCED FLUID MECHANICS					

Course Objectives

By the end of this course, students will:

1. **Develop a deep enumeration of the fundamental principles** governing fluid motion, including both inviscid and viscous flows.
2. **Apply analytical techniques** to solve fluid flow problems using the Navier-Stokes and Euler equations.
3. **Analyze boundary layer behavior** and predict separation in practical flow systems.
4. **Interpret the basic mechanisms of turbulence** and become familiar with modeling approaches.
5. **Explore specialized and real-world fluid mechanics applications**, including compressible flow, surface tension effects, and rotating systems.
6. **Gain exposure to computational and experimental tools** for fluid flow analysis.

UNIT 1: Fundamentals of Fluid Mechanics

- Continuum hypothesis and properties of fluids
- Conservation laws: mass, momentum, energy
- Navier-Stokes equations: derivation and physical interpretation
- Stress tensors and constitutive relations

UNIT 2: Inviscid and Potential Flow

- Euler's equations and Bernoulli's principle
- Potential flow theory and superposition methods
- Vorticity, circulation, and lift generation (Kelvin's and Helmholtz's theorems)

UNIT 3: Viscous and Laminar Flows

- Exact solutions to Navier-Stokes: Couette and Poiseuille flow
- Boundary layer theory: laminar, turbulent, separation
- Introduction to dimensional analysis and similarity (Buckingham Pi theorem, Reynolds number)

UNIT 4: Turbulence and Advanced Flow Phenomena

- Turbulent flows: characteristics, Reynolds averaging, energy spectrum
- Turbulence models: k-ε, k-ω basics
- Introduction to compressible flow: Mach number, isentropic relations, shock waves

UNIT 5: Special Topics and Applications

- Surface tension and capillarity (capillary rise, Marangoni effect)
- Rotating and stratified flows: Coriolis effect, Ekman layers
- Computational and experimental methods in fluid mechanics

Textbooks

1. **An Introduction to Fluid Dynamics** – G.K. Batchelor
   - A classic and rigorous text that covers theoretical fluid mechanics in depth, especially inviscid and viscous flows.
2. **Viscous Fluid Flow** – Frank M. White
   - Excellent for understanding viscous flows, boundary layers, and practical analytical solutions to the Navier-Stokes equations.
3. **Fluid Mechanics** – Pijush K. Kundu, Ira M. Cohen, and David Dowling
   - Comprehensive and accessible; includes detailed mathematical derivations and discussions on turbulence and compressible flow.

References

1. **Fundamentals of Fluid Mechanics** – Munson, Young, Okiishi, and Huebsch
   - Good for foundational understanding; well-illustrated and student-friendly.
2. **Turbulent Flows** – Stephen B. Pope
   - In-depth and advanced coverage of turbulence theory and modeling techniques.
3. **Fluid Mechanics** – L.D. Landau and E.M. Lifshitz
   - Theoretical and concise; part of the Course of Theoretical Physics series, suitable for mathematically advanced readers.
4. **Computational Fluid Dynamics: The Basics with Applications** – John D. Anderson
   - For those integrating CFD into their study of fluid mechanics.

Course Outcomes

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

1. **Formulate and derive conservation equations** (mass, momentum, energy) for fluid systems.
2. **Solve classic fluid mechanics problems analytically**, including laminar flows and potential flows.
3. **Apply dimensional analysis and similarity principles** to scale and interpret fluid flow behavior.
4. **Identify and characterize flow regimes** such as laminar vs. turbulent and incompressible vs. compressible.
5. **Predict boundary layer development and separation** in internal and external flows.
6. **Interpret the fundamentals of turbulence** and interpret basic turbulent flow models.
7. **Simulate fluid flows** using computational tools (e.g., CFD) and validate them with theoretical/experimental results.
8. **Apply advanced concepts** to real-world systems such as aerospace, HVAC, and biomedical applications.

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<tr><td colspan="6">ADVANCED HEAT TRANSFER</td></tr>
</table>

Course Objectives

By the end of this course, students will:

1. Interpret the fundamental modes of heat transfer: conduction, convection, and radiation.
2. Apply analytical and numerical methods to solve complex heat transfer problems in various geometries and conditions.
3. Analyze phase change phenomena, including boiling and condensation, in engineering systems.
4. Develop computational tools to model and simulate heat transfer processes.
5. Explore advanced topics such as multi-mode heat transfer and heat transfer in micro/nanoscale systems.

UNIT 1: Multidimensional Heat Conduction

- General heat conduction equation (Cartesian, cylindrical, spherical coordinates)
- Steady and unsteady conduction in multiple dimensions
- Analytical methods (separation of variables, integral transforms)
- Heat conduction with internal heat generation
- Extended surfaces and fin efficiency

UNIT 2: Convective Heat Transfer

- Forced convection in internal and external flows (laminar and turbulent)
- Natural (free) convection in enclosures and around bodies
- Thermal boundary layers and similarity solutions
- Dimensional analysis and empirical correlations (Nusselt number, Grashof number)
- Heat transfer in compact heat exchangers

UNIT 3: Thermal Radiation

- Fundamental laws: Planck’s law, Stefan–Boltzmann law, Wien’s displacement law
- Blackbody and gray body radiation
- View factors and radiation exchange between surfaces
- Radiation shields and enclosures
- Radiative transfer in absorbing, emitting, and scattering media

UNIT 4: Phase Change Heat Transfer

- Boiling: nucleate and film boiling, critical heat flux

- Condensation: filmwise and dropwise
- Melting and solidification processes
- Applications in power plants, refrigeration, and electronic cooling

UNIT 5: Advanced Topics and Computational Methods

- Conjugate heat transfer and multi-mode interactions
- Heat transfer in porous media
- Microscale and nanoscale heat transfer phenomena
- Introduction to numerical techniques: Finite Difference, Finite Volume
- Use of software tools (e.g., ANSYS Fluent, COMSOL, MATLAB) for heat transfer simulations

Text books

1. **Fundamentals of Heat and Mass Transfer** by F.P. Incropera and D.P. DeWitt
   - A foundational text covering all modes of heat transfer with practical examples.
2. **Conduction Heat Transfer** by Vedat S. Arpaci
   - Focuses on analytical methods for solving conduction problems.
3. **Convective Heat and Mass Transfer** by W.M. Kays, M.E. Crawford, and B. Weigand
   - Provides in-depth coverage of convection processes and applications.(sites.uml.edu)
4. **Thermal Radiation Heat Transfer** by Robert Siegel and John R. Howell
   - Comprehensive resource on radiative heat transfer principles and calculations.

References

1. **Advanced Heat and Mass Transfer** by Amir Faghri, Yuwen Zhang, and John R. Howell
   - Integrates advanced topics and modern applications in heat and mass transfer.
2. **Heat Transfer: Thermal Management of Electronics** by Younes Shabany
   - Addresses heat transfer challenges in electronic systems.
3. **Heat Conduction** by M. Necati Özışık
   - Offers detailed analytical solutions for conduction problems.
4. **Convection Heat Transfer** by Adrian Bejan
   - Explores both fundamental and advanced concepts in convective heat transfer.
5. **Introduction to Heat Transfer** by F.P. Incropera and D.P. DeWitt
   - An accessible introduction to heat transfer, suitable for reinforcing foundational knowledge.
6. **Heat Transfer** by J.P. Holman
   - Provides a practical approach to heat transfer with numerous examples and problems.

Course Outcomes

Upon successful completion, students will be able to:

1. **Formulate and solve** multidimensional, steady, and transient heat conduction problems.
2. **Analyze convective heat transfer** in both laminar and turbulent flows, considering internal and external configurations.
3. **Evaluate radiative heat transfer** between surfaces, including gray and non-gray bodies.

4. **Model phase change processes**, such as boiling and condensation, using appropriate correlations and methods.
5. **Utilize computational methods** to simulate and analyze complex heat transfer scenarios.
6. **Design and assess** thermal systems incorporating multiple modes of heat transfer.

Honors Course	THERMAL ENGINEERING	L	T	P	C
		3	0	0	3
ADVANCED CFD					

Course Objectives

By the end of this course, students will:

1. **Understand the theoretical foundation** of fluid dynamics and its numerical solutions.
2. **Develop expertise in discretization methods** (finite difference, finite volume, finite element) and their applications to fluid flow and heat transfer problems.
3. **Analyze and implement turbulence models** including RANS, LES, and DNS for practical applications.
4. **Use modern computational tools** (commercial and open-source CFD codes like ANSYS Fluent, Open FOAM to solve real-world fluid mechanics problems.
5. **Evaluate the stability, accuracy, and convergence** of CFD methods and their implementation.
6. **Understand the role of numerical errors** and the importance of mesh independence, boundary conditions, and solution verification.

UNIT 1: Introduction to Computational Fluid Dynamics

- **Fundamental CFD Principles**: Overview of CFD; relationship to fluid mechanics and numerical methods.
- **Governing Equations**: Navier-Stokes, energy, and species transport equations.
- **Discretization Methods**: Finite difference, finite volume, finite element methods.
- **Numerical Stability**: Stability, consistency, and convergence criteria.
- **Error Analysis**: Sources of error and error reduction techniques.

UNIT 2: Mesh Generation and Grid Independence

- **Mesh Generation**: Structured vs. unstructured grids, mesh refinement techniques.
- **Grid Independence Study**: Influence of grid resolution on solution accuracy.
- **Types of Meshes**: Cartesian, polar, and general unstructured meshes.
- **Advanced Mesh Techniques**: Adaptive mesh refinement (AMR), multigrid methods.

UNIT 3: Solving the Navier-Stokes Equations & Turbulence Modeling

- **Steady and Unsteady Flows**: Time-stepping methods, implicit and explicit schemes.
- **Pressure-Velocity Coupling**: SIMPLE, PISO, and other solution algorithms.
- **Boundary Conditions**: Treatment of boundary layers, wall functions, and external flow simulations.
- **Flow in Complex Geometries**: Handling complex boundary conditions in CFD solvers.

- **Turbulence Models**: Reynolds-Averaged Navier-Stokes (RANS) models, k-ε, k-ω, and more.
- **Large Eddy Simulation (LES)**: Principles and implementation.
- **Direct Numerical Simulation (DNS)**: Overview and applications.
- **Turbulence in Engineering Applications**: Flow over bodies, heat transfer, etc.

UNIT 4: Advanced CFD Techniques

- **Multiphase Flows**: Modeling free surface flows, boiling, and condensation.
- **Heat Transfer in CFD**: Conjugate heat transfer and multi-mode heat transfer.
- **Optimization and Sensitivity Analysis**: Using CFD for optimization, design studies, and parametric simulations.
- **CFD in Engineering Applications**: Aerospace, automotive, HVAC, biomedical systems, etc.

UNIT 5: Practical CFD Applications and Tools

- **Introduction to CFD Software**: OpenFOAM, ANSYS Fluent, COMSOL.
- **Hands-on Practice**: Setting up CFD simulations, running cases, interpreting results.
- **Post-Processing**: Visualization techniques, data analysis, and interpretation of CFD results.
- **Verification and Validation of CFD Simulations**: Benchmark cases, comparison with experimental data.

Text books

1. **Computational Fluid Dynamics: The Basics with Applications** – John D. Anderson
   - Excellent introductory book that covers both fundamental and advanced CFD techniques with practical examples.
2. **Numerical Heat Transfer and Fluid Flow** – Suhas V. Patankar
   - Focuses on the finite volume method and its applications in heat transfer and fluid flow problems.
3. **Computational Fluid Dynamics: Principles and Applications** – Jiri Blazek
   - Comprehensive guide to CFD principles with a focus on practical applications and computational algorithms.
4. **Computational Fluid Dynamics** – John D. Anderson
   - An authoritative text for understanding the theory and practice of CFD, covering a range of numerical methods and applications.

References

1. **Introduction to Computational Fluid Dynamics** – Atul Sharma
   - A beginner-friendly approach to CFD, including discretization methods, grid generation, and solving the Navier-Stokes equations.
2. **Turbulent Flow Computation** – Richard W. Johnson
   - Focuses on turbulence models and their computational implementation.
3. **Computational Methods for Fluid Dynamics** – Joel H. Ferziger & Milovan Peric
   - A great resource for learning numerical methods specifically for fluid dynamics applications, with a focus on both theory and implementation.

Software and Tools

- **OpenFOAM** (Open-source CFD software)
- **ANSYS Fluent** (Industry-standard CFD software)
- **COMSOL Multiphysics** (For multi physics simulations, including CFD)
- **MATLAB/Simulink** (For custom simulations and post-processing)

Course Outcomes

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

1. **Discretize fluid flow and heat transfer equations** (Navier-Stokes, energy, species transport) using finite difference, finite volume, and finite element methods.
2. **Apply boundary conditions and initial conditions** in practical fluid dynamics problems.
3. **Implement and apply turbulence models** (RANS, LES, DNS) to simulate real-world turbulent flow.
4. **Generate computational meshes** for complex geometries and perform grid independence studies.
5. **Perform numerical simulations** for steady and unsteady fluid flow, heat transfer, and species transport.
6. **Validate CFD results** with analytical, experimental, or benchmark data to ensure the accuracy and reliability of simulations.
7. **Interpret and analyze CFD simulation results** critically, identifying sources of error and optimizing designs.
8. **Use CFD software tools** to perform parametric studies, optimize systems, and simulate engineering applications (e.g., aerodynamic, thermodynamic, or fluidic designs).

<table>
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<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">DESIGN OF HEAT TRANSFER EQUIPMENT</td></tr>
</table>

Course Objectives

By the end of this course, students will:

1. **Understand the principles and mechanisms** of heat transfer in various heat exchangers and thermal systems.
2. **Design and optimize heat exchangers** (shell-and-tube, plate, finned, etc.) for different applications.
3. **Analyze heat transfer and fluid flow** through equipment, considering both thermal and hydraulic performance.
4. **Integrate material selection, cost, and environmental considerations** in the design of heat transfer equipment.
5. **Apply computational tools and simulations** to model heat transfer equipment and predict their performance.
6. **Design systems for various thermal processes**, including cooling, heating, and waste heat recovery.

UNIT 1: Introduction to Heat Transfer Equipment Design & Selection Criteria

- **Overview of Heat Exchangers**: Types, applications, and selection criteria.
- **Heat Exchanger Design Basics**: Heat exchanger duty, temperature change, and flow arrangement.
- **Thermal Design of Heat Exchangers**: General principles for designing heat exchangers and thermal sizing.

- **Shell-and-Tube Heat Exchangers**: Design, sizing, and analysis.
- **Plate Heat Exchangers**: Design principles and applications.
- **Air Cooled Heat Exchangers**: Design considerations for air-cooled systems.
- **Double Pipe Heat Exchangers**: Basic design principles and applications.

UNIT 2: Heat Transfer and Fluid Flow in Heat Exchangers

- **Convective Heat Transfer**: Understanding heat transfer in different fluid flow regimes.
- **Heat Transfer Coefficients**: Estimation methods for both laminar and turbulent flows.
- **Pressure Drop and Flow Distribution**: Determining pressure drops and optimizing flow paths.
- **Fouling and its Effects**: Analyzing fouling factors and their impact on heat exchanger performance.

UNIT 3: Advanced Heat Exchanger Design

- **Compact Heat Exchangers**: Design, materials, and applications.
- **Boiling and Condensation Heat Transfer**: Designing equipment for phase change applications.
- **Multi-stream Heat Exchangers**: Design considerations for multi-stream exchangers and complex thermal systems.
- **Heat Recovery and Waste Heat Utilization**: Designing systems for maximum heat recovery efficiency.

UNIT 4: Computational Methods and Simulation in Heat Transfer Equipment Design

- **Computational Fluid Dynamics (CFD) in Heat Exchanger Design**: Simulation of fluid flow and heat transfer.
- **Optimization Techniques**: Using optimization methods to improve heat exchanger design (e.g., genetic algorithms, gradient-based optimization).
- **Cost-Effective Design**: Integrating cost constraints, energy efficiency, and environmental concerns in the design process.
- **Case Studies**: Practical applications of heat exchanger design in industries such as power plants, chemical plants, and HVAC systems.

UNIT 5: Practical Applications and Design Projects

- **Design Project**: Students work on a design project to design a heat exchanger for a given set of conditions.
- **Real-World Case Studies**: Application of course concepts to actual industry problems, including cooling systems for electronics, automotive applications, and industrial heat recovery systems.

Text books References

1. **Heat Exchanger Design Handbook** – K.K. Saha
   - A comprehensive guide to the design and analysis of heat exchangers, covering thermal design, mechanical design, and operational issues.
2. **Process Heat Transfer** – D.Q. Kern
   - A widely used textbook that discusses heat exchanger design along with the necessary theory behind heat transfer and fluid flow.
3. **Heat Exchanger Design** – A. F. Mills
   - Focuses on the practical aspects of heat exchanger design with a strong emphasis on engineering principles and case studies.
4. **Fundamentals of Heat and Mass Transfer** – Incropera & DeWitt
   - Covers fundamental concepts of heat and mass transfer, which are essential for designing and optimizing heat transfer equipment.
5. **Introduction to Heat Transfer** – Frank P. Incropera
   - A standard textbook on heat transfer with practical applications in the design of heat transfer equipment.

References

1. **Compact Heat Exchangers** – J. R. Thome
   - Provides a detailed analysis of compact heat exchangers and their applications in energy systems, air-conditioning, and refrigeration.
2. **Advanced Heat Exchanger Design** – B.E. Polley, A. F. Mills
   - A specialized textbook focusing on advanced topics and emerging trends in heat exchanger technology.
3. **Thermal-Fluid Systems Design** – Richard A. R. McManus
   - Covers the design of thermal-fluid systems, integrating heat transfer, fluid mechanics, and thermodynamics in the context of engineering design.

Software and Tools

- **MATLAB/Simulink** (for modeling, optimization, and simulations)
- **ANSYS Fluent** (CFD simulations for heat exchanger design)
- **HYSYS or Aspen Plus** (for process simulations, including heat exchanger design)
- **COMSOL Multiphysics** (for thermal simulations and multi-physics problems)

Course Outcomes

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

1. **Design and size heat exchangers** (e.g., shell-and-tube, plate, air-cooled) based on operational requirements (thermal load, heat duty, etc.).
2. **Evaluate the thermal performance** of heat exchangers under different conditions using fundamental heat transfer equations.
3. **Apply advanced heat transfer correlations** to predict performance in special cases (e.g., boiling, condensation, or phase change).
4. **Select suitable materials** and equipment for heat transfer applications based on thermal conductivity, mechanical properties, and cost.
5. **Analyze the overall system design**, including thermal efficiency, pressure drop, and pump/heat transfer area optimization.
6. **Use computational software** (e.g., MATLAB, Aspen Plus, ANSYS) to simulate, optimize, and analyze the performance of heat transfer systems.

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<tr><td colspan="6">COMPUTATIONAL LAB</td></tr>
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Course Objectives

By the end of this course, students will be able to:

1. **Develop computational models** for solving complex engineering problems, especially in heat transfer, fluid dynamics, and related fields.
2. **Implement numerical methods** for solving differential equations, particularly in heat conduction, fluid flow, and mass transfer problems.
3. **Use simulation software** such as MATLAB, COMSOL, OpenFOAM, and ANSYS Fluent to model and solve practical engineering problems.
4. **Analyze simulation results** and perform data post-processing to visualize and interpret the results.
5. **Understand the principles of model validation**, comparing computational results with analytical or experimental data.
6. **Work with advanced techniques** like turbulence modeling, multiphase flows, and computational fluid dynamics (CFD) simulations.

Unit 1: Introduction to Computational Tools and Programming

- **MATLAB Basics**: Programming, matrix operations, data plotting, and analysis.
- **COMSOL Multiphysics Overview**: Basic setup, defining materials, boundary conditions, and solving multiphysics problems.
- **Introduction to OpenFOAM & ANSYS Fluent**: Setting up and running basic CFD simulations.
- **Fundamentals of Numerical Methods**: Introduction to Finite Difference, Finite Volume, and Finite Element methods.

Unit 2: Numerical Methods for Engineering Simulations

- **Finite Difference Method (FDM)**: Solving heat conduction and fluid flow problems (steady-state & transient).
- **Finite Element Method (FEM)**: Meshing, solving heat conduction and structural problems.
- **Finite Volume Method (FVM)**: Solving fluid dynamics and heat transfer using FVM.
- **Error Analysis**: Stability, convergence, and accuracy of numerical methods.

Unit 3: Heat Transfer and Fluid Flow Simulations

- **Heat Conduction**: Solving steady and transient heat conduction problems in solids.
- **Convection Simulations**: Modeling natural and forced convection using FVM or CFD.

- **Navier-Stokes Equations**: Solving incompressible flow (laminar and turbulent) and boundary layers.
- **Phase Change and Heat Exchanger Modeling**: Using computational methods for boiling, condensation, and heat exchanger design.

Unit 4: Advanced Computational Techniques

- **Turbulence Modeling**: Applying k-ε, k-ω, and LES models in CFD for turbulent flow.
- **Multiphase Flow**: Introduction to modeling two-phase flows and droplet dynamics.
- **Optimization**: Using CFD simulations to optimize designs, such as minimizing drag or improving heat exchanger efficiency.
- **Data Visualization and Post-Processing**: Analyzing simulation results through visualization tools (contour plots, vector fields).

Unit 5: Model Validation and Practical Applications

- **Model Validation**: Comparing numerical results with analytical and experimental data.
- **Industry Projects**: Solving real-world engineering problems (e.g., cooling systems, aerodynamics, heat exchangers).
- **Final Project**: Students complete a project involving simulation, analysis, and optimization of an engineering problem.
- **Presentation**: Reporting results using visualizations, error analysis, and conclusions.

Recommended Software Tools

- **MATLAB/Simulink** for numerical methods and simulations.
- **COMSOL Multiphysics** for multiphysics modeling.
- **OpenFOAM** for CFD simulations.
- **ANSYS Fluent** for commercial CFD analysis.
- **Python** for scripting, data processing, and visualization.

Text books

1. **Computational Fluid Dynamics: The Basics with Applications** – John D. Anderson
   - A foundational textbook on CFD, providing a clear introduction to solving fluid dynamics problems.
2. **Introduction to Finite Element Analysis and Design** – Nam-Ho Kim, Bhavani V. Sankar
   - Covers the basics of the finite element method, applicable to heat transfer, fluid flow, and other engineering applications.
3. **Computational Methods for Fluid Dynamics** – Joel H. Ferziger, Milovan Peric
   - A detailed text on the computational methods used in fluid dynamics and the fundamentals of CFD.
4. **MATLAB for Engineers** – H. S. Kim, D. M. Etter
   - Provides a comprehensive introduction to MATLAB programming with an emphasis on solving engineering problems.

References

1. **Introduction to Computational Fluid Dynamics: The Finite Volume Method** – H. Versteeg, W. Malalasekera
   - Covers the finite volume method (FVM), one of the most commonly used methods in CFD solvers.
2. **ANSYS Fluent Tutorial** – Sandeep K. Joshi
   - A guide to using ANSYS Fluent for practical CFD applications, covering the setup and solution of real-world problems.
3. **Computational Methods for Heat Transfer** – J. R. Howell, R. Siegel
   - Focuses on computational methods for solving heat transfer problems, particularly in the context of engineering design.
4. **Applied Computational Fluid Dynamics** – Vincent H. D. Tran
   - A practical guide to applying computational fluid dynamics in various engineering fields.

Course Outcomes

Upon successful completion of this course, students will:

1. **Implement numerical methods** (Finite Difference, Finite Element, Finite Volume) to solve heat transfer and fluid mechanics problems.
2. **Use computational software tools** such as MATLAB, COMSOL, OpenFOAM, and ANSYS Fluent to simulate engineering systems.
3. **Analyze complex systems** by performing simulations and extracting key parameters (e.g., temperature profiles, velocity fields, pressure drop).
4. **Compare computational results** with theoretical or experimental data for validation and error estimation.
5. **Optimize engineering designs** based on simulation results (e.g., reducing pressure drop, optimizing heat exchanger design).
6. **Present results effectively**, using graphs, tables, and visualizations to interpret and communicate findings.

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<tr><td colspan="6">COMPUTATIONAL FLUID DYNAMICS LAB</td></tr>
</table>

Course Objectives:
The students will acquire the knowledge

1. To solve problems of fluid mechanics and heat transfer by writing programs in C-language and MATLAB.
2. To solve 1-D and 2-D heat conduction problems with (Finite Difference method)
3. To interpret the validation of the numerical result by comparison with known analytical results.
4. To analyze the numerical result by invoking the physical principles of fluid mechanics and heat transfer.
5. To solve Elliptical, Parabolic, Partial and Hyperbolic partial differential equations

Writing Programs in C and MATLAB for the following:
1. Solution of Transcendental equations
2. Solution of Simultaneous algebraic equations
3. Numerical differentiation and Integration
4. Solution of Ordinary Differential Equation
5. Solution of a Tri-diagonal matrix using Thomas Algorithm.
6. Solution of Partial differential equations related to
    i) Elliptical Partial differential equations
    ii) Parabolic Partial differential equations
    iii) Hyperbolic Partial differential equations
7. Solution of 1-D and 2-D heat conduction with (Finite Difference method)
    i) Constant temperature boundary conditions
    ii) Constant heat flux boundary conditions
    iii) Convective boundary conditions
8. Solution of Incompressible Navier-Stokes equations (Finite difference and Finite Volume methods)
9. Solution of Inviscid incompressible fluid flows (Finite difference and Finite Volume methods)
10. Solution of Flow over a circular cylinder Flow over a circular cylinder at different Reynolds numbers, observe the properties at separation region and wake region.
11. Solution of Flow over a flat plate Flow over a flat plate at low Reynolds numbers, observe the boundary layer phenomena, no slip condition and velocity profile inside the boundary layer.
12. Solution of Flow over a wedge Flow over wedge body at supersonic Mach number; observe the shock wave phenomena and change of properties across the shock wave.
13. Solution of Flow over a cone Flow over a cone at supersonic Mach number; observe the shock waves and 3D relieving effect

Course Outcomes:
At the end of the course the students shall be able to:

1. Solve problems of fluid mechanics and heat transfer by writing programs in C-language and MATLAB.

2. Solve 1-D and 2-D heat conduction problems with (Finite Difference method)
3. Interpret the validation of the numerical result by comparison with known analytical results.
4. Analyze the numerical result by invoking the physical principles of fluid mechanics and heat transfer.
5. Solve Elliptical, Parabolic, Partial and Hyperbolic partial differential equations

		L	T	P	C
Honors Course	**Robotics And Automation**	**3**	**0**	**0**	**3**
ROBOTIC ENGINEERING					

Course Objectives

The students will acquire the knowledge

1. To explain the functional elements of Robotics
2. To analyse the direct and inverse kinematics
3. To interpret the manipulator differential motion and control
4. To analyse on various path planning techniques
5. To determine the dynamics and control of manipulators

UNIT I: BASIC CONCEPTS

Brief history-Types of Robots–Technology-Robot classifications and specifications-Design and control issues- Various manipulators – Sensors - work cell - Programming languages.

UNIT II: DIRECT AND INVERSE KINEMATICS

Mathematical representation of Robots - Position and orientation – Homogeneous Transformation-Various joints- Representation using the Denavit Hattenberg parameters - Degrees of freedom-Direct Kinematics-Inverse kinematics- SCARA robots- Solvability – Solution Methods-Closed form solution.

UNIT III: MANIPULATOR DIFFERENTIAL MOTION AND STATICS

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints -Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.

UNIT IV: PATH PLANNING

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

UNIT V: DYNAMICS AND CONTROL

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler Formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

Text Books:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, NewDelhi,4th Reprint, 2005.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGrawHill Singapore, 1996.

References

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis‘, OxfordUniversity Press, Sixth impression, 2010.
2. K. K.AppuKuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An IntegratedApproach, Prentice Hall of India, New Delhi, 1994.
5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
4. S.Ghoshal, ― Embedded Systems & Robotics‖ – Projects using the 8051Microcontroller‖, Cengage Learning, 2009.

Course Outcomes

On successful completion of the module students will be able to:

1. Explain the functional elements of Robotics
2. Analyse the direct and inverse kinematics
3. Interpret the manipulator differential motion and control
4. Analyse on various path planning techniques
5. Determine the dynamics and control of manipulators

		L	T	P	C
Honors Course	**Robotics and Automation**	**3**	**0**	**0**	**3**
BASIC CONTROL SYSTEM FOR ROBOTS					

Course objective:

This course aims to develop the understanding of control systems, its designing and application

UNIT 1: MATLAB for Control system

Basics, Language Fundamentals, Mathematical Operations, Graphics, Programming

UNIT 2: Basics of Control

Control Systems: Types of Controllers, Introduction to closed loop control, Differential Equation, Transfer function, Block diagram, Signal Flow Graph

UNIT 3: Time Response and Frequency Response

Time Response, Routh-Hurwitz test, relative stability, Root locus design, construction of root loci, phase lead and phase-lag design, lag-lead design, Frequency response, Bode, polar, Nyquist plot.

UNIT 4: Linear Control

Concept of states, state space model, different form, controllability, observability; pole placement by state feedback, observer design, P, PI &PID Controller, control law partitioning, modelling and control of a single joint.

UNIT 5: Non-Linear Control System

Common physical non-linear system, phase plane method, system analysis by phase plane method, stability of non-linear system, Liapunov‟s stability criterion, the control problems for manipulators.

Text Books:

1. M. Gopal, Control Systems, McGraw-Hill (2012)
2. K. Ogata, “Modern Control Engineering”, Prentice Hall India (2009).
3. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons,(2005).

References:

1. J. J. Craig, “Introduction to Robotics: Mechanics and Control”, 3rd edition, AddisonWesley (2003).
2. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014).
3. Thomas Kailath, “Linear Systems”, Prentice Hall (1980). 7. AlokSinha, “Linear Systems:Optimal and Robust Control”, Taylor & Francis (2007).

Course Outcomes (CO):

1. Interpret the fundamentals of MATLAB software
2. Illustrate the transfer function, signal flow graph representation of linear systems & their controlling actions
3. Analyze concept of time, frequency response as well as concept of state-space models and their relation to frequency domain models
4. Apply the methodology for modelling dynamic systems with concept of stability

		L	T	P	C
Honors Course	**Robotics and Automation**	**3**	**0**	**0**	**3**
FLUID POWER SYSTEM FOR AUTOMATION					

Course Objectives: The students will acquire the knowledge

1.To identify and describe the key components of fluid power systems.

2. To explain the underlying scientific principles behind the operation of fluid power systems.

3.To demonstrate knowledge of different types of fluid power systems and their applications.

4.To design and analyze fluid power systems for automation.

5.To develop innovative and practical applications of fluid power systems in automation.

UNIT I

Introduction to Fluid Power Systems, Definition of fluid power systems; Components of fluid power systems, Advantages and disadvantages of fluid power systems; Properties of fluids used in fluid power systems, Basic laws of fluid mechanics and their application in fluid power systems

UNIT II

Hydraulic Systems & Pneumatic Systems, Introduction to hydraulic systems; Components of hydraulic systems, Hydraulic fluids and their properties; Principles of hydraulic press operation, Applications of hydraulic systems in automation

Introduction to pneumatic systems; Components of pneumatic systems, Pneumatic fluids and their properties; Principles of pneumatic press operation, Applications of pneumatic systems in automation.

UNIT III

Design and Analysis of Fluid Power Systems for Automation, Design considerations for fluid power systems, Calculation of hydraulic and pneumatic system parameters, Analysis of fluid power systems, Troubleshooting methods for fluid power systems.

UNIT IV

Industrial Automation - Programmable Logic Controller, Functions of PLCs - Features of PLC - Selection of PLC - Architecture – IEC61131-3 programming standard and types - Basics of PLC Programming – Ladder Logic Diagrams, Communication in PLC – Programming Timers and Counters – Data Handling - PLC modules – Advanced motion controlled Multi Axis PLC.

UNIT V:

Industrial Robotics through Fluid Power - Subsystem in the robotics – Architecture, Communication and Control

Innovative and Practical Applications of Fluid Power Systems in Automation - Case studies of innovative applications of fluid power systems in automation, Practical applications of fluid power systems in automation, Applications in the Industry 4.0, Group projects on designing and implementing a fluid power system for automation.

Text Book

1. Hydraulic and Pneumatic Power for Production by Harry L.Stewart.

References:

1. Fluid Power with Applications by Anthony Esposito.

2. Fundamentals of Fluid Power Control by John Watton

Course Outcomes: At the end of the course the students will be able to:

1.Identify and describe the key components of fluid power systems.

2. Explain the underlying scientific principles behind the operation of fluid power systems.

3.Demonstrate knowledge of different types of fluid power systems and their applications.

4.Design and analyze fluid power systems for automation.

5.Develop innovative and practical applications of fluid power systems in automation.

<table>
<tr><td rowspan="2">**Honors Course**</td><td rowspan="2">**Robotics and Automation**</td><td>**L**</td><td>**T**</td><td>**P**</td><td>**C**</td></tr>
<tr><td>**3**</td><td>**0**</td><td>**0**</td><td>**3**</td></tr>
<tr><td colspan="6">**INDUSTRIAL IoT & CLOUD COMPUTING**</td></tr>
</table>

Course Objectives: The students will acquire the knowledge

1. To understand the association of Internet of Things with Secure Cloud Computing
2. To develop skills required for using Cloud computing Platforms
3. To impart knowledge of components of Internet of Things
4. To impart knowledge on wireless communication technologies
5. To develop skills required to build real-life IoT based projects using Cloud Platforms

UNIT – I

Cloud Computing: Definition, roots of cloud computing, characteristics, cloud architecture, deployment models, service models.

Virtualization: Benefits & drawbacks of virtualization, server virtualization, virtualization of - operating system, platform, CPU, network, application, memory and I/O devices etc.

UNIT – II

Cloud Computing Service Platforms, Compute services, storage services, database services, application services, queuing services, e-mail services, notification services, media services, content delivery services, analytics services, deployment & management services, identity & access management services and their case studies. Security in cloud computing: issues, threats, data security and information security

UNIT – III

Internet of Thing (IoT): Overview, conceptual framework, architecture, major components, common applications Design principles for connected devices: Modified OSI Model for IoT/M2M systems, ETSI M2M Domains and High-level capabilities,

UNIT – IV

wireless communication technologies - NFC, RFID, Bluetooth BR/EDR and Bluetooth low energy, ZigBee, WiFi, RF transceiver and RF modules. Data enrichment, data consolidation & device management at gateway.

UNIT – V

Design principles for web connectivity: web communication protocols for connected devices: constrained application protocol, CoAP Client web connectivity, client authentication, lightweight M2M communication protocol. Message communication protocols for connected devices - CoAP-SMS, CoAP-MQ, MQTT, XMPP. IoT privacy, security and vulnerabilities and their solutions.

Text Books:

1. Internet of Things, “A Hands-on Approach”, by Vijay Madisetti, Arshdeep Bahga, University Press

2. “Internet of Things for Architects: Architecting IoT solutions by implementing sensors,

communication infrastructure, edge computing, analytics, and security”, by Perry Lea, Packt

Publishing Ltd., 2018

3. Internet of Things with Raspberry Pi and Arduino. Boca Raton, by Singh, R., Gehlot, A., Gupta, L.,Singh, B., Swain, M, CRC Press, 2020

4. Embedded Systems - SoC, IoT, AI and Real-Time Systems, 4th Edition Kindle Edition by Raj Kamal

References:

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, by Pethuru Raj andAnupama C. Raman (CRC Press)

Course Outcomes:

CO-1: Identify the need of cloud computing for IoT

CO-2: Apply Machine Learning techniques for IoT Data

CO-3: Interpret the Data Analytics with IoT Data

CO-4: Identify the Vulnerability in Cloud – IoT

Honors Course	Robotics and Automation	L	T	P	C
		3	0	0	3
AUTONOMOUS NAVIGATION AND PATH PLANNING					

Course Objectives: The students will acquire the knowledge

1. To describe the basic concepts of autonomous navigation and path planning.
2. To analyze and design autonomous navigation and path planning algorithms.
3. To evaluate the effectiveness of different autonomous navigation and path planning algorithms in different situations.
4. To implement these algorithms in real-world applications.

UNIT I

Introduction to Autonomous Navigation and Path Planning,Definition and basic concepts of autonomous navigation and path planning,Applications of autonomous navigation and path planning,Sensors and odometry.

UNIT II

Introduction to various techniques and algorithms used for navigation and path planning, State estimation methods (Kalman filter, unscented Kalman filter, particle filtering), Camera modelling and calibration, structure from motion, visual motion estimation.

UNIT III

Navigation Techniques and Algorithms, Sensor-based navigation, Deadreckoning, Beacon-based navigation, Landmark-based navigation

Obstacle Avoidance Techniques, Potential field method, Virtual force field method, Artificial potential fields method

UNIT IV

Optimal Path Planning Techniques and Trajectory Planning, Dijkstra'salgorithm, A* algorithm, Probabilistic Road map method, Trajectory planning for Mobile Robots and Unmanned Aircraft System (UAS).

UNIT V

Case Studies and Examples

Introduction to Robot Operating System (ROS), ROS2, and GAZEBO, Real-world case studies and examples of autonomous navigation and path planning, Analysis and evaluation of different techniques and algorithms used in different situations, Performing at least two experiments each with ROS and GAZEBO

Implementation of Autonomous Navigation and Path Planning Algorithms

Implementation of various algorithms in real-world applications, Hands-on exercises and projects to develop an autonomous navigation and path planning system

Text Books

1. Steven M. LaValle, Planning Algorithms Hardcover – Illustrated, 29 May 2006

2. J.-P. Laumond, Robot Motion Planning and Control, 1998

3. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, Introduction toAutonomous Mobile Robots", Bradford Company Scituate, USA, 2004.

4. J. J. Graig, "Introduction to Robotics – Mechanics and Control", 2nd edition, PearsonEducation, Inc.

References

1. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, "ROBOTICS – Control, Sensing, Vision, and

Intelligence", McGraw-Hill Book Company.

2. Mohsen Shahinpoor, Harper and Row, "A Robot Engineering Textbook", New York.

Course Outcomes:

1. Describe the basic concepts of autonomous navigation and path planning.
2. Analyze and design autonomous navigation and path planning algorithms.
3. Evaluate the effectiveness of different autonomous navigation and path planning algorithms in different situations.
4. Apply these algorithms in real-world applications

		L	T	P	C
Honors Course	**Robotics and Automation**	**0**	**0**	**3**	**1.5**
ROBOT DESIGN LAB					

Course Objectives:

1. Understand the importance and application of robots in virtual environment
2. Design the robot system for point-to-point operation
3. Design the robot program for drilling operation
4. Design robot programming for continuous path operation

List of Experiments

1. Design robot program for drilling operation using single cubes
2. Design robot program for drilling operation using double cubes
3. Design robot programming for continuous path operation on cylinder
4. Design a robot system for point-to-point operation on a square
5. Design a robot system for circular path operation
6. Design a robot system for point-to-point operation on a triangle
7. Design a robot system for continuous path operation for any 3 objects (cubecircle, triangle)
8. Design robot program for drilling operation using cubes and cylinder
9. Design a robot program for multi-move operation
10. Design a robot program using smart components
11. Design a robot system for pick and place operation
12. Design a robot program for conveyer tracking system

Course outcomes (Course Skill Set):

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

CO1. Interpret the importance and application of robots in virtual environment

CO2. Design the robot system for point to point and continuous operation

CO3. Design the robot program for drilling operation

		L	T	P	C
Honors Course	**Robotics and Automation**	**0**	**0**	**3**	**1.5**
IoT and Cloud Computing Lab					

Course Objectives:

At the end of this course the students will understand;

1. Overview and various real time usage scenarios of ESP8266 NodeMCU.

2. Various approaches for Controlling devices remotely through cloud.

3. Glimpse of cloud-based sensor data processing and usage.

4. Practical oriented basics of MS Azure, AWS & IBM Watson IoT services.

List of Experiments:

1. Discuss ESP8266 NodeMCU Pinout with respective Arduino IDE compatibility.

2. Write an Arduino sketch in Arduino IDE to blink on-board LED and externally connected LED of ESP8266 NodeMCU.

3. Write an Arduino sketch to control on-board LED of ESP8266 NodeMCU from the Web Server.

4. Define functionality and pinout of relay and write an Arduino sketch to control AC Bulb using ESP8266 NodeMCU.

5. Write an Arduino sketch to control 2 AC Devices from the Web Server, using ESP8266 NodeMCU.

6. Connect ESP8266 NodeMCU to Arduino IoT Cloud and write an Arduino sketch to read sensor data.

7. Connect ESP8266 NodeMCU to Blynk Cloud platform and write an Arduino sketch to

control on-board LED of ESP8266 NodeMCU.

8. Write an Arduino sketch for ESP8266 NodeMCU to monitor temperature and humidity using DHT11 sensor through Blynk cloud platform.

9. Write an Arduino sketch for of ESP8266 NodeMCU to implement Live Water Tank monitoring using Ultrasonic sensor through Blynk cloud platform.

10. Create a MicrodoŌ Azure account and send sensor data from ESP8266NodeMCU to Microsoft Azure IoT Analytics.

11. Setup ESP8266 NodeMCU with IBM Watson IoT Cloud Services and process the sensor data in cloud.

12. Setup ESP8266 NodeMCU with AWS IoT Cloud Services and process the sensor data in cloud.

Course Outcomes:

On completion of this course, students will be able to;

CO1 - Create real-time automation applications with ESP8266 NodeMCU.

CO2 - Controlling sensors through cloud.

CO3 - Process data efficiently through various clous based services.

CO4 - Creating live data instances and visualization of analytics.

<table>
<tr><td rowspan="2">Honors Course</td><td rowspan="2">INDUSTRIAL ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">OPERATIONS PLANNING AND CONTROL</td></tr>
</table>

Course Objectives

1. To understand the role and significance of operations planning and control in manufacturing and service organizations.
2. To study the principles of production planning, forecasting, and scheduling.
3. To familiarize students with inventory control techniques and material requirement planning (MRP).
4. To develop skills in optimizing resource utilization and improving productivity through effective planning.
5. To introduce methods for evaluating and improving operational efficiency in systems.

UNIT I: Introduction & Forecasting

Production Planning and Control: Definition, objectives, functions, and types of production systems. **Organization**: Structure of the production planning and control department. **Forecasting**: Definition, uses, factors affecting forecasts, types (quantitative and qualitative), and general principles. **Forecasting Techniques**: Quantitative and qualitative methods, measures of forecasting errors.

UNIT II: Inventory Management & Aggregate Planning

Inventory Management: Functions of inventories, relevant costs, ABC and VED analysis, Basic EOQ model. **Inventory Control Systems**: Continuous and periodic review systems, MRP I, MRP II, ERP, JIT systems. **Aggregate Planning**: Definition, strategies, methods, and transportation model.

UNIT III: Line Balancing & Routing

Line Balancing: Terminology, methods (RPW, Largest Candidate, Heuristic).**Routing**: Definition, procedure, factors affecting routing, and route sheets.

UNIT IV: Scheduling

Scheduling: Definition, policies, types of methods, differences with loading. **Scheduling Types**: Flow shop and job shop scheduling. **Line of Balance (LOB)**: Objectives and steps involved.

UNIT V: Dispatching & Follow-Up

Dispatching: Definition, activities, procedures, and various forms used. **Follow-Up**: Definition, types, expediting procedures. **Applications**: Use of computers in planning and control.

Textbooks:

1. *Operations Management* by Heizer – Pearson
2. *Production and Operations Management* by Ajay K. Garg – McGraw Hill

References:

3. *Production Planning and Control: Text & Cases* by S.K. Mukhopadhyaya – PHI
4. *Production Planning and Control* by Jain & Jain – Khanna Publications

Course Outcomes

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

1. Analyze and interpret production systems and their components.
2. Develop production and operations strategies for effective decision-making.
3. Apply forecasting methods for demand prediction.
4. Design and implement effective scheduling, sequencing, and loading strategies.
5. Implement inventory control and material requirement planning techniques.
6. Evaluate system performance and recommend improvements for efficiency and productivity.

Honors Course	INDUSTRIAL ENGINEERING	L	T	P	C
		3	0	0	3
WORK SYSTEM DESIGN					

Course Objectives:

1. Analyze and improve work methods to enhance productivity.
2. Apply ergonomic principles to design efficient and safe work environments.
3. Interpret various production systems and their planning and control mechanisms.
4. Design effective facility layouts and material handling systems.

Unit I: Introduction to Work System Design and Human Factors

Introduction to Work System Design, Human performance in physical work, Fundamentals of ergonomics, Anthropometry and its applications in workstation design, Design of displays and controls

Unit II: Job Design and Motivation

Principles of motion economy, Job enrichment and job enlargement, Work measurement techniques overview (Time study, Work sampling – brief)

Unit III: Types of Production Systems and Planning

Types of production systems: Mass, Batch, Job Order, Characteristics and applications, Functions of production planning and control, Capacity planning and scheduling (basic concepts)

Unit IV: Facility Layout Design

Introduction to facility layout Types: Line (product-focused), Functional (process-focused), Fixed position, Design principles and layout planning, Introduction to computerized layout techniques.

Unit V: Material Handling Systems

Objectives and principles of material handling, Unit load concept, Types of material handling equipment, Criteria for equipment selection and system design.

Textbooks:

1. Introduction to Work Study by International Labour Organization (ILO), Geneva.
2. Motion and Time Study by R.M. Barnes

Course Outcomes

By the end of this course, students will be able to:

1. Interpret and apply the principles of ergonomics and human factors in system design.

2. Analyze work systems using time and motion study techniques to improve productivity.
3. Design efficient workplace layouts based on anthropometric and biomechanical data.
4. Apply work measurement techniques such as stopwatch time study, work sampling, and predetermined motion time systems (PMTS).
5. Identify and eliminate wasteful motions using principles of motion economy.
6. Evaluate job design alternatives for improving worker satisfaction and system performance.
7. Implement methods for improving work methods and ensuring occupational health and safety.

<table>
<tr><td rowspan="2">Honors Course</td><td rowspan="2">INDUSTRIAL ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">FACILITIES PLANNING</td></tr>
</table>

Course Objectives:

1. Intrepret the principles and methodologies involved in planning industrial facilities.
2. Analyze and design efficient facility layouts to enhance operational efficiency.
3. Evaluate material handling systems and their impact on facility design.
4. Apply quantitative techniques for facility location and layout optimization

UNIT I: Introduction to Facilities Planning

Definition and scope of facilities planning, Objectives and importance in manufacturing and service industries, Strategic role in achieving organizational goals, Relationship between facilities planning and productivity

UNIT II: Facility Location Analysis

Factors influencing location decisions, **Quantitative techniques**: Center of gravity method, Break-even analysis, Load-distance method, multi-facility location problems, Case examples.

UNIT III: Facility Layout Planning

Types of layouts: Product layout, Process layout, Fixed-position layout, Cellular layout, Systematic Layout Planning (SLP), Introduction to computerized layout planning tools

UNIT IV: Material Handling Systems

Objectives and principles of material handling, Material handling equipment: types and applications, Factors affecting equipment selection, Integration of material handling with facility layout, Unit load concept and system design.

UNIT V: Workplace Design and Facility Implementation

Ergonomics and human factors in facility design, Safety, comfort, and regulatory standards, Project management for facility implementation, Budgeting and cost estimation, Case studies on successful facility design.

Text books

1. **“**Facilities Planning” by James A. Tompkins, John A. White, Yavuz A. Bozer, and J. M. A. Tanchoco Publisher: Wiley Widely regarded as the definitive text on the subject, covering layout planning, material handling, and facility location.
2. “Plant Layout and Material Handling” by James M. Apple Publisher: Krieger Publishing Offers foundational and practical insights into layout techniques and handling systems.
3. “Production and Operations Analysis” by Steven Nahmias Publisher: Waveland Press While broader, it includes relevant chapters on facilities and capacity planning.

References

1. “Manufacturing Facilities Design and Material Handling” by Matthew P. Stephens and Fred E. Meyers Focuses on modern manufacturing layouts and lean facility design principles.
2. “Facilities Design” by Sunderesh Heragu Covers computational tools, simulation, and advanced planning methods.
3. “Operations Management” by Jay Heizer and Barry Render Includes relevant sections on facility strategy, capacity planning, and location decisions.

Course Outcomes:

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

1. Analyze and determine optimal facility locations based on various factors and models.
2. Design efficient facility layouts tailored to specific production requirements.
3. Select appropriate material handling systems that complement the facility design.
4. Incorporate ergonomic principles into facility and workplace design.
5. Manage the implementation process of facility planning projects effectively.

		L	T	P	C
Honors Course	**INDUSTRIAL ENGINEERING**	**3**	**0**	**0**	**3**
ADVANCED OPERATIONS RESEARCH					

Course Objectives:

1. To intrepret and apply advanced optimization techniques.
2. To model and solve complex decision-making problems.
3. To analyze and interpret the results of advanced operations research models.

UNIT I: Advanced Linear Programming

Revised Simplex Method, Dual Simplex Method, Sensitivity Analysis, Parametric Programming.

UNIT II: Integer Programming

Branch and Bound Technique, Cutting Plane Method, Zero-One Programming, Applications in capital budgeting and resource allocation.

UNIT III: Dynamic Programming

Bellman's Principle of Optimality, Multistage Decision Processes, Applications in inventory control and equipment replacement.

UNIT IV: Non-Linear Programming

Unconstrained Optimization Techniques: Gradient and Newton-Raphson Methods, Constrained Optimization: Lagrange Multipliers and Kuhn-Tucker Conditions, Quadratic Programming.

UNIT V: Simulation and Heuristic Methods

Monte Carlo Simulation, Simulation of Queuing and Inventory Systems, Heuristic Techniques: Genetic Algorithms and Simulated Annealing, Applications in complex system optimization.

Text books:

1. *Operations Research: An Introduction* by Hamdy A. Taha.
2. *Introduction to Operations Research* by Hillier and Lieberman.
3. *Operations Research* by P.K. Gupta and D.S. Hira.

Course Outcomes:

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

1. Apply advanced linear programming techniques to solve optimization problems.
2. Model and solve integer and dynamic programming problems.
3. Analyze non-linear programming problems using appropriate methods.
4. Utilize simulation and heuristic methods for complex system optimization.
5. Interpret and validate the results obtained from advanced operations research models.

Honors Course	INDUSTRIAL ENGINEERING	L	T	P	C
		3	0	0	3
PRODUCTIVITY ENGINEERING & MANAGEMENT					

Course Objectives:

1. Interpret the principles and techniques of productivity improvement.
2. Apply work study methods to analyze and enhance work efficiency.
3. Implement quality management practices to ensure product and process excellence.
4. Manage resources effectively to optimize organizational performance.

UNIT I: Introduction to Productivity Engineering

Definition and scope of productivity engineering, Factors influencing productivity, Productivity measurement and indices, Productivity improvement techniques.

UNIT II: Work Study and Ergonomics

Method study: Procedure, tools, and techniques, Work measurement: Time study, work sampling, and standard data, Principles of motion economy, Ergonomics: Human factors in workplace design.

UNIT III: Quality Management

Introduction to quality and quality control, Statistical quality control: Control charts for variables and attributes, Total Quality Management (TQM) principles, Six Sigma methodology.

UNIT IV: Resource Management

Human resource management: Recruitment, training, and performance appraisal, Financial management basics: Costing, budgeting, and financial analysis, Material management: Inventory control and procurement, Maintenance management: Preventive and predictive maintenance strategies.

UNIT V: Productivity Improvement Techniques

Lean manufacturing principles, Just-In-Time (JIT) production, Kaizen and continuous improvement, Benchmarking and best practices.

Text books:

1. Industrial Engineering and Management by O.P. Khanna.
2. Work Study by International Labour Organization (ILO).
3. Total Quality Management by Dale H. Besterfield

Course Outcomes:

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

1. Analyze factors affecting productivity and implement improvement strategies.

2. Apply work study techniques to optimize work processes.
3. Implement quality management tools to enhance product and process quality.
4. Manage organizational resources effectively for improved performance.
5. Adopt continuous improvement methodologies to sustain productivity gains.

		L	T	P	C
Honors Course	**INDUSTRIAL ENGINEERING**	**0**	**0**	**3**	**1.5**
INDUSTRIAL ENGINEERING LAB-I					

Course Objective: To familiarize students with the practical aspects of industrial engineering, focusing on work study, time study, and motion study techniques.

Experiments:

1. **Time Study:** Conducting time measurements for various tasks to establish standard times.
2. **Motion Study:** Analyzing and improving the motion patterns of workers to enhance efficiency.
3. **Method Study:** Evaluating and improving work methods to optimize productivity.
4. **Work Sampling:** Estimating the proportion of time spent on different activities.
5. **Ergonomics:** Assessing and designing workstations to improve comfort and reduce strain.

Course Outcomes – Industrial Engineering Lab-I

By the end of this lab course, students will be able to:

1. Apply time study techniques to analyze and improve work performance.
2. Conduct method study using process charts and diagrams.
3. Use work sampling techniques to measure and enhance efficiency.
4. Apply principles of motion economy to eliminate unnecessary motions.
5. Develop standard time data using time study tools and software.
6. Demonstrate improved observation of workplace ergonomics and safety measures.

		L	T	P	C
Honors Course	**INDUSTRIAL ENGINEERING**	**0**	**0**	**3**	**1.5**
INDUSTRIAL ENGINEERING LAB-II					

Objective: To provide students with practical knowledge and skills in quality control, inventory management, and production planning techniques.

Experiments:

1. **Statistical Quality Control:** Applying control charts and process capability analysis to monitor and improve quality.
2. **Inventory Management:** Implementing models like EOQ and ABC analysis for effective inventory control.
3. **Production Planning:** Developing production schedules and capacity planning to meet demand efficiently.
4. **Simulation Techniques:** Using simulation tools to model and analyze manufacturing systems.
5. **Lean Manufacturing:** Applying lean principles to eliminate waste and improve process flow.

Course Outcomes – Industrial Engineering Lab-II

Upon successful completion, students will be able to:

1. Use simulation tools or software (e.g., Arena, FlexSim) for analyzing industrial systems.
2. Evaluate plant layouts and suggest improvements using systematic layout planning (SLP).
3. Analyze material handling systems and recommend optimal solutions.
4. Apply productivity measurement techniques in industrial scenarios.
5. Conduct feasibility and performance analysis for different manufacturing systems.
6. Interpret and present lab findings with a focus on decision-making in industrial environments.

Minors Course	Mechanical Engineering	L	T	P	C
		3	0	0	3
INDUSTRIAL ENGINEERING AND MANAGEMENT					

Course Objectives:

1. To understand the principles and techniques of industrial engineering.
2. To apply management concepts to engineering practices.
3. To analyze and improve production processes for efficiency and effectiveness.
4. To manage resources effectively to meet organizational goals.

UNIT I: Introduction to Industrial Engineering

Definition and scope of industrial engineering, Evolution and role of industrial engineers in organizations, Industrial engineering functions and responsibilities, Relationship between industrial engineering and other engineering disciplines.

UNIT II: Work Study

Method study: Procedure, tools, and techniques, **Work measurement**: Time study, work sampling, and standard data, Principles of motion economy, **Ergonomics**: Human factors in workplace design.

UNIT III: Production Planning and Control

Production planning: Objectives, types, and techniques, Aggregate planning and master production scheduling, Inventory control: EOQ, ABC analysis, and JIT, Materials requirement planning (MRP) and enterprise resource planning (ERP)

UNIT IV: Quality Control and Assurance

Quality management principles and practices, **Statistical quality control**: Control charts, process capability analysis, **Acceptance sampling**: Single and double sampling plans, Total Quality Management (TQM) and Six Sigma.

UNIT V: Human Resource and Financial Management

Human resource management: Recruitment, training, and performance appraisal, **Financial management**: Costing, budgeting, and financial analysis, **Project management**: Planning, scheduling, and control techniques, **Maintenance management**: Preventive and predictive maintenance strategies.

Text books:

1. Industrial Engineering and Management by O.P. Khanna.
2. Industrial Engineering and Management by Buffa.
3. Operations Management by Heizer and Render.
4. Introduction to Work Study by ILO.

Course Outcomes:

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

1. Interpret the role and functions of industrial engineers in organizations.
2. Apply work study techniques to improve productivity.
3. Develop production plans and control systems to meet organizational goals.
4. Implement quality control measures to ensure product excellence.
5. Manage human and financial resources effectively in industrial settings

<table>
<tr><td rowspan="2">Minors Course</td><td rowspan="2">Mechanical Engineering</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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<tr><td colspan="6">MATERIAL SCIENCE</td></tr>
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Course Objectives:

1. To understand the relationship between the structure and properties of materials.
2. To classify materials based on their properties and applications.
3. To study the phase diagrams and heat treatment processes.
4. To explore the mechanical properties and testing methods of materials.

UNIT I: Introduction to Materials Science

Classification of materials: Metals, ceramics, polymers, and composites, Atomic structure and bonding in materials, **Crystallography**: Unit cells, crystal systems, and Miller indices, **Defects in solids**: Point, line, and surface defects.

UNIT II: Phase Diagrams and Phase Transformations

Binary phase diagrams: Isomorphous and eutectic systems, Lever rule and phase fraction calculations, Solidification and solid-state transformations, T-T-T diagrams and continuous cooling transformation diagrams.

UNIT III: Mechanical Properties of Materials

Stress-strain behavior and elastic properties, Plastic deformation and dislocation theory, Hardness, toughness, and fatigue, Creep and impact testing.

UNIT IV: Heat Treatment of Materials

Annealing, normalizing, hardening, and tempering, **Surface hardening techniques**: Carburizing, nitriding, and induction hardening. Heat treatment of non-ferrous alloys. Effect of heat treatment on microstructure and properties.

UNIT V: Materials Characterization and Selection

Microscopy techniques: Optical and electron microscopy, X-ray diffraction and spectroscopy, Materials selection criteria for engineering applications, Environmental considerations in material selection.

Text books:

1. Materials Science and Engineering: An Introduction by William D. Callister.
2. Materials Science and Engineering by V. Raghavan.
3. Materials Science and Engineering: A First Course by J.C. Anderson.

Course Outcomes:

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

1. Interpret the fundamental concepts of materials science and engineering.
2. Analyze the structure-property relationships in materials.
3. Apply phase diagrams to predict material behavior.
4. Evaluate the mechanical properties of materials through testing.
5. Select appropriate materials for specific engineering applications.

Minors Course	Mechanical Engineering	L	T	P	C
		3	0	0	3
DESIGN OF MACHINE ELEMENTS					

Course Objectives:

1. To understand the fundamental principles of machine design.
2. To apply these principles to design various machine elements.
3. To analyze and select materials suitable for different machine components.
4. To evaluate the performance of designed elements under various loading conditions.

UNIT I: Introduction to Machine Design

Basic concepts and definitions in machine design, Design process and methodology, Factors influencing design decisions, Selection of materials based on mechanical properties.

UNIT II: Design for Static Loading

Analysis of stresses and strains in machine components, Design of components subjected to axial, bending, and torsional loads, Factor of safety and its application in design, Design of shafts, keys, couplings, and joints.

UNIT III: Design for Variable Loading

Fatigue failure and S-N curve, Design for fluctuating loads, Cumulative damage and fatigue life estimation, Design of components subjected to impact and shock loads.

UNIT IV: Design of Machine Elements

Design of springs: Helical, leaf, and torsion springs, Design of fasteners: Bolts, nuts, and rivets, Design of welded and brazed joints, Design of bearings: Sliding and rolling contact bearings.

UNIT V: Design of Power Transmission Elements

Design of gears: Spur, helical, bevel, and worm gears, Design of clutches and brakes, Design of belt and chain drives, Selection of power transmission elements based on design requirements.

Textbooks:

1. V.Bhandari, "Design of Machine Elements", Tata McGraw Hill.
2. M.F.Spotts, "Design of Machine Elements", Pearson Education.
3. R.L.Norton, "Machine Design: An Integrated Approach", Pearson Education.

References

1. J.E.Shigley, "Mechanical Engineering Design", McGraw-Hill.

Course Outcomes:

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

1. Interpret the principles and methodologies involved in machine design.
2. Apply these principles to design various machine elements.
3. Analyze and select materials suitable for different machine components.
4. Evaluate the performance of designed elements under various loading conditions.
5. Use design standards and codes to ensure the reliability and safety of machine components

Minors Course	Mechanical Engineering	L	T	P	C
		3	0	0	3
MANUFACTURING TECHNOLOGIES					

Course Objectives:

1. To introduce students to various manufacturing processes and their applications.
2. To provide knowledge about the principles and operations of machine tools.
3. To understand the selection criteria for manufacturing processes based on product design and material.
4. To impart practical skills through laboratory sessions and hands-on training.

UNIT I: Introduction to Manufacturing Processes

Overview of manufacturing processes, **Classification of manufacturing processes**: Casting, forming, machining, joining, and additive manufacturing, Selection of manufacturing processes based on material, design, and production requirements, Recent advancements in manufacturing technologies.

UNIT II: Metal Casting Processes

Sand casting: Molding materials, pattern making, and core making, **Die casting**: Types of die casting, applications, and advantages, **Investment casting**: Process steps, materials used, and applications, **Centrifugal casting**: Types and applications, Gating system design and solidification of casting.

UNIT III: Forming Processes

Bulk deformation processes: Rolling, forging, extrusion, and drawing, **Sheet metal forming processes:** Bending, deep drawing, and spinning, Processing of polymers and composites, Analysis of forming processes and their applications.

UNIT IV: Machining Processes

Introduction to machining: Principles and operations, **Machine tools:** Lathe, milling machine, drilling machine, and grinding machine, **Cutting tools:** Materials, geometry, and selection,
Machining parameters: Cutting speed, feed, depth of cut, and their effects on machining performance, Surface finish and tolerances in machining.

UNIT V: Joining Processes

Welding: Types of welding processes (arc welding, MIG, TIG, resistance welding), welding defects, and inspection, **Brazing and soldering:** Processes, applications, and advantages, **Mechanical fastening:** Riveting, bolting, and clinching, **Adhesive bonding:** Types of adhesives, applications, and advantages.

Text books:

1. *Manufacturing Engineering and Technology* by Serope Kalpakjian and Steven R. Schmid.
2. *Fundamentals of Modern Manufacturing* by Mikell P. Groover.
3. *Manufacturing Processes for Engineering Materials* by Serope Kalpakjian.

Course Outcomes:

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

1. Interpret the principles and applications of various manufacturing processes.
2. Select appropriate manufacturing processes based on material, design, and production requirements.
3. Analyze the advantages and limitations of different manufacturing processes.
4. Apply knowledge of manufacturing processes to solve engineering problems.
5. Demonstrate practical skills in manufacturing processes through laboratory sessions.

Minors Course	Mechanical Engineering	L	T	P	C
		3	0	0	3
BASICS OF THERMAL ENGINEERING					

Course Objectives:

1. To introduce the fundamental concepts of thermodynamics and heat transfer.
2. To understand the behavior of fluids and gases in thermal systems.
3. To analyze and design basic thermal systems and components.
4. To apply the principles of thermal engineering in real-world applications.

UNIT I: Introduction to Thermodynamics

Basic concepts: System, surroundings, state, process, and cycle, **Laws of thermodynamics:** Zeroth, first, second, and third laws, Thermodynamic properties of pure substances, **Energy transfer:** Heat and work.

UNIT II: Properties of Pure Substances

Phase change processes: Sensible and latent heat, P-v, and T-s diagrams, Steam tables and Mollier diagrams, Thermodynamic cycles: Rankine cycle.

UNIT III: Heat Transfer

Modes of heat transfer: Conduction, convection, and radiation, Fourier's law of heat conduction, Newton's law of cooling, Stefan-Boltzmann law.

UNIT IV: Fluid Mechanics

Properties of fluids. **Fluid statics**: Pressure variation, buoyancy, **Fluid dynamics:** Continuity equation, Bernoulli's equation, **Flow in pipes:** Darcy-Weisbach equation, Reynolds number.

UNIT V: Applications of Thermal Engineering

Heat exchangers: Types, effectiveness, and design considerations, **Boilers:** Types, components, and performance, **Internal combustion engines:** Working principles, efficiency, **Refrigeration and air conditioning:** Basic cycles and applications.

Textbooks:

1. *Thermal Engineering* by M.L. Mathur and R.P. Mehta.
2. *Fundamentals of Thermodynamics* by Richard E. Sonntag and Claus Borgnakke.
3. *Introduction to Heat Transfer* by Frank P. Incropera and David P. DeWitt.

Course Outcomes:

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

1. Interpret the fundamental principles of thermodynamics and heat transfer.
2. Analyze and solve problems related to thermal systems.
3. Design basic thermal systems and components.
4. Apply thermal engineering principles in real-world applications.

Minors Course	Mechanical Engineering	L	T	P	C
		0	0	3	1.5
MATERIAL SCIENCE LAB					

Course Objectives

- To understand the mechanical behavior of materials under various loading conditions.
- To study the microstructure of different engineering materials.
- To correlate the mechanical properties with microstructural features.
- To familiarize with standard testing procedures and equipment.

List of Experiments

Part A: Mechanics of Solids

1. Tension test on mild steel specimen.
2. Compression test on wood or concrete specimen.
3. Torsion test on mild steel specimen.
4. Hardness test using Brinell and Rockwell methods.
5. Impact test (Charpy and Izod).
6. Bending test on simply supported beam.
7. Spring test (open and close coiled springs).

Part B: Metallurgy

1. Preparation and study of microstructure of plain carbon steels.
2. Preparation and study of microstructure of cast irons.
3. Preparation and study of microstructure of non-ferrous alloys (e.g., brass, bronze).
4. Heat treatment studies: Annealing, normalizing, hardening, and tempering of steels.
5. Jominy end-quench test for hardenability.
6. Study of microstructure of heat-treated steels.
7. Grain size measurement using comparison method

Course Outcomes

Upon successful completion of this lab course, students will be able to:

1. Conduct standard mechanical tests to determine material properties.
2. Prepare and analyze metallographic specimens to study microstructures.
3. Interpret the effects of heat treatment on microstructure and mechanical properties.
4. Correlate theoretical concepts with practical observations.
5. Develop proficiency in using laboratory equipment and interpreting experimental data.

Minors Course	Mechanical Engineering	L	T	P	C
		0	0	3	1.5
MANUFACTURING TECHNOLOGY LAB					

Course Objectives

- To familiarize students with the construction and working of various machine tools.
- To teach the selection of parameters for different machining processes.
- To impart practical knowledge on manufacturing processes like casting, welding, and machining.
- To develop skills in operating manufacturing equipment and interpreting results.

List of Experiments

1. Design and making of patterns:
    a. Single piece pattern
    b. Split pattern
2. Sand properties testing:
    a. Sieve analysis (dry sand)
    b. Clay content test
    c. Moisture content test
    d. Strength test (Compression test & Shear test)
    e. Permeability test
3. Mould preparation:
    a. Straight pipe
    b. Bent pipe
    c. Dumbbell
    d. Gear blank
4. Gas cutting and welding
5. Manual metal arc welding:
    a. Lap joint
    b. Butt joint
6. Lathe operations:
    a. Turning
    b. Facing
    c. Taper turning
    d. Thread cutting
7. Drilling and tapping operations
8. Milling operations:
    a. Plain milling
    b. Slot milling
9. Grinding operations:
    a. Surface grinding
    b. Cylindrical grinding
10. Demonstration of CNC machine operations

Course Outcomes

Upon successful completion of this lab course, students will be able to:

1. Interpret the working principles of various manufacturing machines and tools.
2. Select appropriate manufacturing processes for specific applications.
3. Perform basic manufacturing operations with precision.
4. Analyze the quality of manufactured components.
5. Demonstrate safety practices in a manufacturing environment.