DEPARTMENT OF MECHANICAL ENGINEERING

ACADEMIC REGULATIONS (R23)

FOR

B. Tech Four Year Degree Programme

(Applicable for the batches admitted from the A.Y. 2023-24)

PACE INSTITUTE OF TECHNOLOGY AND SCIENCES
(Autonomous)
Approved by AICTE and Govt. of Andhra Pradesh, Accredited by NAAC (A Grade)
Recognized under 2(f) & 12(B) of UGC, Permanently Affiliated to JNTUK, Kakinada
NH-16, Near Valluramma Temple, Ongole-523272
Andhra Pradesh, India.

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. **Courses of study:**
   The following courses of study are offered at Pace Institute of Technology and Sciences,Ongole

Sl No	Branch	Short name	Code
1	Civil Engineering	CE	01
2	Electrical and Electronics Engineering	EEE	02
3	Mechanical Engineering	ME	03
4	Electronics & Communication Engineering	ECE	04
5	Computer Science and Engineering	CSE	05
6	Computer Science and Information Technology	CSIT	07
7	Information Technology	IT	12
8	Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)	CSE(IoT&CSBT)	47
9	Artificial Intelligence and Data Science	AIDS	54
10	Artificial Intelligence and Machine Learning	AIML	61
11	Computer Science and Engineering (Indian Language)	CSE-R	63
12	Electronics Engineering (VLSI Design & Technology)	EE(VLSID&T)	66

4. **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.

5. **Program related terms**

   (a) **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.

   (b) **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

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

   (d) **Choice Based Credit System (CBCS):** The CBCS provides a choice for students to select from the prescribed courses.

6. **Semester/Credits:**

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

   (b) 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.

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

7. **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	-

8. **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

9. **Programme Pattern**

(a) Total duration of the of B. Tech (Regular) Programme is four academic years.

(b) Each academic year of study is divided into two semesters.

(c) Minimum number of instruction days in each semester is 90 days.

(d) 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.

(e) Health/wellness/yoga/sports and NSS /NCC /Scouts & Guides / Community service activities are made mandatory as credit courses for all the undergraduate students.

(f) Courses like Environmental Sciences, Indian Constitution, Technical Paper Writing & IPR are offered as non-credit mandatory courses for all the undergraduate students.

(g) Design Thinking for Innovation & Tinkering Labs are made mandatory as credit courses for all the undergraduate students.

(h) Increased flexibility for students through an increase in the elective component of the curriculum, with 05 Professional Elective courses and 04 Open Elective courses.

(i) 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.

(j) 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.

(k) While choosing the electives, students shall ensure that they do not opt for the courses with syllabus contents similar to courses already pursued.

(l) 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.

(m) 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.

(n) There shall also be mandatory full internship in the final semester of the programme along with the project work.

(o) Undergraduate degree with Honors is introduced by the University for the students having good academic record.

(p) 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.

(q) 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.

(r) Preferably 25% of course work for the theory courses in every semester shall be conducted in the blended mode of learning.

10. **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.

(A) **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) **Semester 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 20 marks such that each question carries 2 marks.

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

◇ 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.

(B) **Practical Courses**

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

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

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

(c) 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.

i. Procedure: 20 marks

ii. Experimental work & Results: 30 marks

iii. 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.

(d) For the subject having design and/or drawing, such as Engineering Drawing, the distribution of marks shall be 30 for mid semester evaluation and 70 for end examination. Day-to-day work shall be evaluated for 15 marks

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

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.

(e) 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.

(f) 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.

11. **Skill oriented Courses**

(a) There shall be five skill-oriented courses offered during III to VII semesters.

(b) 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.

(c) 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.

(d) 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.

(e) 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.

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

(g) If a student prefers to take a certificate course offered by external agency, the department shall mark attendance of the student for the remaining courses in that semester excluding the skill course in all the calculations of mandatory attendance requirements upon producing a valid certificate as approved by the principal.

12. **Massive Open Online Courses (MOOCs):**

A Student has to pursue and complete one course compulsorily through MOOCs approved by the principal. 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 college.

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

13. **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 institute 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.

(a) The institute shall offer credit mobility for MOOCs and give the equivalent credit weightage to the students for the credits earned through online

learning courses.

(b) 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.

(c) Credit transfer policy will be applicable to the Professional & Open Elective courses only.

(d) The concerned department shall identify the courses permitted for credit transfer.

(e) The institution shall notify at the beginning of semester the list of the online learning courses eligible for credit transfer.

(f) The department shall designate a faculty member as a Mentor for each course to guide the students from registration till completion of the credit course.

(g) The institution shall ensure no overlap of MOOC exams with that of the semester end examination schedule. In case of delay in results, the institution will re-issue the marks sheet for such students.

(h) 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.

(i) The department shall submit the following to the examination cell & systems:

  i. List of students who have passed MOOC courses in the current semester along with the certificate of completion.

  ii. Undertaking form filled by the students for credit transfer.

(j) The institution 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.

14. **Academic Bank of Credits (ABC)**

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

(a) provide option of mobility for learners across the universities of their choice

(b) provide option to gain the credits through MOOCs from approved digital platforms.

(c) facilitate award of certificate/diploma/degree in line with the accumulated credits in ABC

(d) execute Multiple Entry and Exit system with credit count, credit transfer and credit acceptance from students' account.

15. **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 institution.

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 Exami-

nation conducted in the presence of internal examiner and external examiner appointed by the principal 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.

16. **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.

(a) The Minor program requires the completion of 12 credits in Minor stream chosen.

(b) 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.

(c) 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.

17. **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.

(a) 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.

(b) 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).

(c) 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.

(d) The concerned Head of The Department shall arrange separate class work and timetable of the courses offered under Honors program.

(e) 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.

(f) 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.

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

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

(i) **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.

(j) 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.

(k) 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:

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

(b) 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.

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

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

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

Registration for Honors:

(a) 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.

(b) 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.

(c) 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.

(d) There is no fee for registration of subjects for Honors program offered in offline at the respective institutions.

18. **Attendance Requirements:**

(a) A student shall be eligible to appear for the semester end examinations if he/she acquires a minimum of 40% attendance in each subject and 75% of attendance in aggregate of all the subjects. 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.

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

(c) A stipulated fee shall be payable towards condonation of shortage of attendance to the University.

(d) 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.

(e) 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.

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

(g) 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.

(h) For induction programme attendance shall be maintained as per AICTE norms.

19. **Promotion Rules:**

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

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

(b) 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.

(c) 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.

(d) 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.

20. **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	S (Superior)	10
80 - 89	A (Excellent)	9
70 - 79	B (Very Good)	8
60 - 69	C (Good)	7
50 - 59	D (Average)	6
40 - 49	E (Pass)	5
<40	F (Fail)	0
Absent	Ab (Absent)	0

(a) 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.

(b) 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 Grade Point 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.,

$$SGPA = \frac{\sum(C_i \times G_i)}{\sum(C_i)}$$

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.,

$$CGPA = \frac{\sum(C_i \times S_i)}{\sum(C_i)}$$

where "S_i" is the SGPA of the i^{th} semester and C_i is the total number of 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	$\geq$ 7.5
First Class	$\geq$ 6.5 <7.5
Second Class	$\geq$ 5.5 <6.5
Pass Class	$\geq$ 5.0 <5.5

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

21. **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.

22. **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.

23. **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 Head of The Department shall forward such proposals submitted by the students to the principal. An evaluation committee constituted by the principal shall evaluate the proposal submitted by the student and the committee shall decide whether to permit the student(s) to avail the Gap Year or not

24. **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.

25. **Minimum Instruction Days for a Semester:**

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

26. **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. Similarly, the medium of instruction and examinations in AICTE approved Indian language B.Tech programme are in Telugu and English.

27. **Student Transfers:**

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

28. **General Instructions:**

(a) The academic regulations should be read as a whole for purpose of any interpretation.

(b) Malpractices rules-nature and punishments are appended.

(c) Where the words “he”, “him”, “his”, occur in the regulations, they also include “she”, “her”, “hers”, respectively.

(d) In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the competent authorities of institution is final.

(e) The institution 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 institute.

(f) In the case of any doubt or ambiguity in the interpretation of the guidelines given, the decision of the 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

   (a) 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.

   (b) 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**

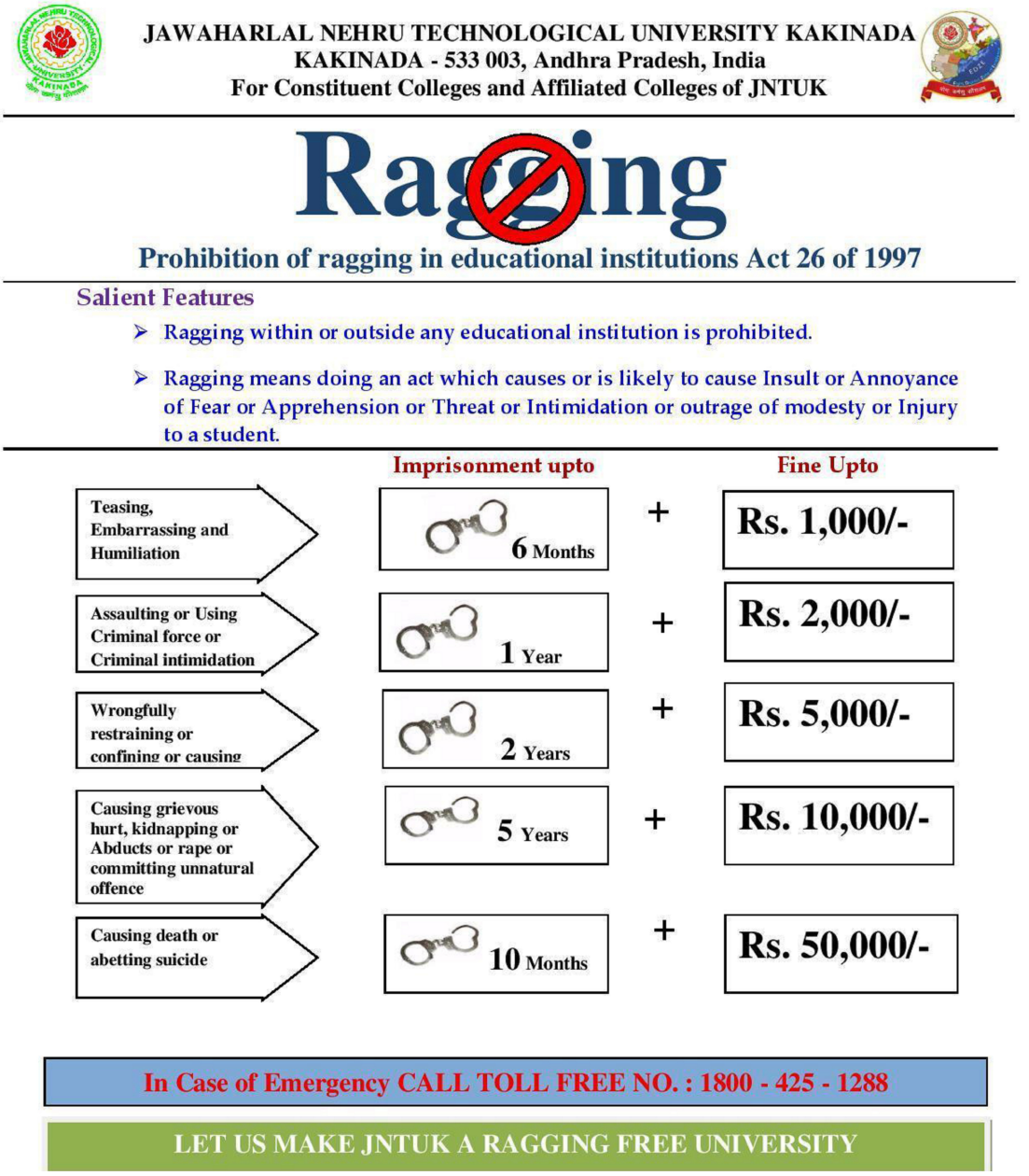
   (a) The entire course of study is three academic years on semester pattern.

(b) 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.

(c) 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).

Annexure-I


JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India
For Constituent Colleges and Affiliated Colleges of JNTUK
Ragging
Prohibition of ragging in educational institutions Act 26 of 1997
Salient Features
Ragging within or outside any educational institution is prohibited.
Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student.
Imprisonment upto
Fine Upto
Teasing, Embarrassing and Humiliation
6 Months
+
Rs. 1,000/-
Assaulting or Using Criminal force or Criminal intimidation
1 Year
+
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Wrongfully restraining or confining or causing
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+
Rs. 5,000/-
Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence
5 Years
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KAKINADA - 533 003, Andhra Pradesh, India
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

ABSOLUTELY NO TO RAGGING

1. **Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.**
2. **Ragging entails heavy fines and/or imprisonment.**
3. **Ragging invokes suspension and dismissal from the College.**
4. **Outsiders are prohibited from entering the College and Hostel without permission.**
5. **Girl students must be in their hostel rooms by 7.00 p.m.**
6. **All the students must carry their Identity Cards and show them when demanded**
7. **The Principal and the Wardens may visit the Hostels and inspect the rooms any time.**

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DEPARTMENT OF MECHANICAL ENGINEERING

R-23 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

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

DEPARTMENT OF MECHANICAL ENGINEERING

R-23 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

I Year - I Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P23BST04	Engineering Physics	3	0	0	3
2	P23BST02	Linear Algebra & Calculus	3	0	0	3
3	P23EST03	Basic Electrical and Electronics Engineering	3	0	0	3
4	P23EST04	Engineering Graphics	1	0	4	3
5	P23EST02	Introduction to Programming	3	0	0	3
6	P23ESL04	IT Workshop	0	0	2	1
7	P23BSL02	Engineering Physics Lab	0	0	2	1
8	P23ESL03	Electrical and Electronics Engineering Workshop	0	0	3	1.5
9	P23ESL02	Computer Programming Lab	0	0	3	1.5
10	P23BST08	NSS/NCC/Scouts & Guides/Community Service	-	-	1	0.5
Total Credits						20.5

I Year - II Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P23BST01	Communicative English	2	0	0	2
2	P23BST05	Engineering Chemistry	3	0	0	3
3	P23BST03	Differential Equations & Vector Calculus	3	0	0	3
4	P23EST01	Basic Civil & Mechanical Engineering	3	0	0	3
5	P23MET01	Engineering Mechanics	3	0	0	3
6	P23BSL01	Communicative English Lab	0	0	2	1
7	P23BSL03	Engineering Chemistry Lab	0	0	2	1
8	P23ESL01	Engineering Workshop	0	0	3	1.5
9	P23MELO1	Engineering Mechanics Lab	0	0	3	1.5
10	P23BSL05	Health and wellness, Yoga and sports	-	-	1	0.5
Total Credits						19.5

DEPARTMENT OF MECHANICAL ENGINEERING

R-23 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

II Year - I Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P23BST09	Numerical Methods and Transform Techniques	3	0	0	3
2	P23BST12	Universal Human Values – Understanding Harmony	2	1	0	3
3	P23EST07	Thermodynamics	2	0	0	2
4	P23MET02	Mechanics of Solids	3	0	0	3
5	P23MET03	Material Science and Metallurgy	3	0	0	3
6	P23MEL02	Mechanics of Solids and Materials Science Lab	0	0	3	1.5
7	P23MEL03	Computer-Aided Machine Drawing Lab	0	0	3	1.5
8	P23ESL05	Python Programming Lab	0	0	2	1
9	P23MES01	Python Programming	0	1	2	2
10	P23ACT01	Environmental Science	2	0	0	-
Total Credits						**20**

II Year - II Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P23MBT02	Industrial Management	2	0	0	2
2	P23BST13	Complex Variables, Probability and Statistics	3	0	0	3
3	P23MET04	Fluid Mechanics and Hydraulic Machines	3	0	0	3
4	P23MET05	Manufacturing Processes	3	0	0	3
5	P23MET06	Theory of Machines	3	0	0	3
6	P23MEL04	Fluid Mechanics and Hydraulic Machines Lab	0	0	3	1.5
7	P23MEL05	Manufacturing Processes Lab	0	0	3	1.5
8	P23MES02	Soft Skills	0	1	2	2
9	P23BST17	Design Thinking and Innovation	1	0	2	2
Total Credits						**21**
Note: Mandatory Community Service Project Internship of 08 weeks duration during summer vacation						

DEPARTMENT OF MECHANICAL ENGINEERING

R-23 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

III Year - I Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P23MET07	Machine Tools and Metrology	3	0	0	3
2	P23MET08	Thermal Engineering	3	0	0	3
3	P23MET09	Design of Machine Elements	3	0	0	3
4	P23MEEXX	Professional Elective – I	3	0	0	3
5	P23XXOXX	Open Elective – I	3	0	0	3
6	P23MEL06	Thermal Engineering Lab	0	0	3	1.5
7	P23MEL07	Theory of Machines Lab	0	0	3	1.5
8	P23MES03	Machine Tools and Metrology Lab	0	0	4	2
9	P23BSL04	Tinkering Lab	0	0	2	1
10	P23MEI01	Community Service Internship (Evaluation)	-	-	-	2
Total Credits						**23**

III Year - II Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P23MET10	Heat Transfer	3	0	0	3
2	P23MET11	Artificial Intelligence and Machine Learning	3	0	0	3
3	P23MET12	Finite Element Methods	3	0	0	3
4	P23MEEXX	Professional Elective – II	3	0	0	3
5	P23MEEXX	Professional Elective – III	3	0	0	3
6	P23XXOXX	Open Elective – II	3	0	0	3
7	P23MEL08	Heat Transfer Lab	0	0	3	1.5
8	P23MEL09	Artificial Intelligence and Machine Learning Lab	0	0	3	1.5
9	P23MES04	Robotics and Drone Technologies Lab	0	0	4	2
10	P23ACT02	Technical Paper Writing and IPR (Audit Course)	2	0	0	-
Total Credits						**23**
Mandatory Industry Internship of 08 weeks duration during summer vacation.						

DEPARTMENT OF MECHANICAL ENGINEERING

R-23 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

IV Year I Semester						
S.No.	**Category**	**Title**	**L**	**T**	**P**	**C**
1	Professional Core		3	0	0	3
2	Professional Core		3	0	0	3
3	Management Course - II		2	0	0	2
4	Professional Elective - IV		3	0	0	3
5	Professional Elective - V		3	0	0	3
6	Open Elective - IV		3	0	0	3
7	Professional Core		0	0	2	1
8	Professional Core		0	0	2	1
9	Skill Enhancement Course		0	1	2	2
10	Audit Course	Constitution of India	2	0	0	-
11	Internship	Evaluation of Industry Internship	-	-	-	2
Total Credits			19	1	6	23

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

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
R-21 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

Professional Elective – I		
S.No	**Course Code**	**Course Title**
1	P23MEE01	Design for Manufacturing
2	P23MEE02	Conventional and Futuristic Vehicle Technology
3	P23MEE03	Renewable Energy Technologies
4	P23MEE04	Non-destructive Evaluation

Professional Elective – II		
S.No	**Course Code**	**Course Title**
1	P23MEE05	Mechanical Vibrations
2	P23MEE06	Advanced Manufacturing Processes
3	P23MEE07	Micro Electro Mechanical Systems
4	P23MEE08	Sensors and Instrumentation

Professional Elective – III		
S.No	**Course Code**	**Course Title**
1	P23MEE09	Energy Storage Technologies
2	P23MEE10	Industrial Hydraulics and Pneumatics
3	P23MEE11	Industrial Robotics
4	P23MEE12	Refrigeration & Air-Conditioning

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BST04	Engineering Physics (Common to All Branches of Engineering)	3	0	0	3

Internal Marks: 30 External Marks: 70

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

CO1: Analyze the intensity variation of light due to interference, diffraction and polarization.

CO2: Familiarize with the basics of crystals and their structures.

CO3: Summarize various types of polarization of dielectrics and classify the magnetic materials.

CO4: Explain the basic concepts of Quantum Mechanics, free electron theory.

CO5: Apply the band theory of solids and Hall Effect to study the semiconductors.

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.

Text Books:

1. A Text book of Engineering Physics, M. N. Avadhanulu, P.G.Kshirsagar & TVS Arun Murthy, S. Chand Publications, 11^{th} 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:

1. `https://www.loc.gov/rr/scitech/selected-internet/physics.html`

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BST02	Linear Algebra & Calculus (Common to All Branches of Engineering)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives: To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and their applications.

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

CO1: Demonstrate the understanding of rank of a matrix. Analyze the solutions of the system of linear equations.

CO2: Find the Eigen values and Eigen vectors of a matrix, apply Cayley-Hamilton theorem to determine inverse and power of a matrix and identify the nature of quadratic form.

CO3: Utilize mean value theorems to real life problems.

CO4: Familiarize with functions of several variables which are useful in optimization.

CO5: Familiarize with double and triple integrals of functions of several variables in two dimensions using Cartesian and polar coordinates and in three dimensions using cylindrical and spherical coordinates.

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, Jacobi and Gauss Seidel Iteration Methods.

UNIT–II: Eigenvalues, Eigenvectors and Orthogonal Transformation

Eigenvalues, Eigenvectors and their properties, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem, Quadratic 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)

Functions of several variables: Continuity and Differentiability, Partial derivatives, total derivatives, chain rule, Taylor's and Maclaurin's series expansion of functions

of two variables. Jacobians, Functional dependence, maxima and minima of functions of two variables, method of Lagrange multipliers.

UNIT–V: Multiple Integrals (Multi variable Calculus)

Double integrals, triple integrals, change of order of integration, change of variables to polar, cylindrical and spherical coordinates. Finding areas by double integrals and volumes by double integrals and triple integrals.

Text Books:

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

Reference Books:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23EST03	Basic Electrical & Electronics Engineering (Common to All branches of Engineering)	3	0	0	3

Internal Marks: 30 External Marks: 70

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

CO1: Describe fundamental laws, operating principles of motors/generators, MC/MI instruments (L2)

CO2: Demonstrate the working of electrical machines, measuring instruments and power generation stations. (L2)

CO3: Apply mathematical tools and fundamental concepts to derive various equations related to electrical circuits and machines. (L3)

CO4: Calculate electrical load and electricity bill of residential and commercial buildings. (L4)

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, Applications.

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, 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.

Text 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

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.

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

CO1: Compare the operation and characteristics of various semiconductor devices and their utilization.

CO2: Implement various power supply circuits using diodes and amplifier circuits using BJT.

CO3: Categorize various types of Logic gates and implement simple combinational logic circuits.

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.

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.

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.

Text Books:

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.

Semester end examination pattern:

1. Question paper shall be in two parts viz., Part A and Part B with equal weightage of 35 marks each.
2. In each part, question 1 shall contain 5 compulsory short answer questions for a total of 5 marks such that each question carries 1 mark.
3. 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.
4. The questions from 2 to 4 shall be set by covering one unit of the syllabus for each question.

Course Code	Course Name	Course Structure			
		L	T	P	C
P23EST04	Engineering Graphics (Common to All branches of Engineering)	1	0	4	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To enable the students with various concepts like dimensioning, conventions and standards related to Engineering Drawing
2. To impart knowledge on the projection of points, lines and plane surfaces
3. To improve the visualization skills for better understanding of projection of solids
4. To develop the imaginative skills of the students required to understand Section of solids and Developments of surfaces.
5. To make the students understand the viewing perception of a solid object in Isometric and orthographic projections.

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

CO1: Understand the principles of engineering drawing, including polygons, engineering curves, scales.
CO2: Draw and interpret orthographic projections of points, lines, planes.
CO3: Understand and draw projection of solids in various positions in first quadrant.
CO4: Explain principles behind sections of solids and development of surfaces.
CO5: Convert the isometric view into orthographic view and vice versa.

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: Semiconductors

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).

Text Books:

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.

Course Code	Course Name	Course Structure			
		L	T	P	C
P23EST02	Introduction To Programming (Common to All branches of Engineering)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Understand basics of computers, the concept of algorithm, flowcharts and algorithmic thinking.

CO2: Analyse a problem and develop programs involving decision structures and loops.

CO3: Implement different operations on arrays and solve problems using Strings.

CO4: Design the programs by applying the features of pointers, structures and unions.

CO5: Develop problem-solving skills and the ability to debug and optimize the code by using functions and files.

UNIT–I: Introduction to Programming and Problem Solving

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

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

UNIT–II: Control Structures

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

UNIT–III: Arrays and Strings

Arrays indexing, memory model, programs with array of integers, two dimensional arrays, Introduction to Strings.

UNIT–IV: Pointers & User Defined Data types

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

UNIT–V: Functions & File Handling

Introduction to Functions, Function Declaration and Definition, Function call Return Types and Arguments, modifying parameters inside functions using pointers, arrays as parameters. Scope and Lifetime of Variables, Basics of File Handling

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

Text Books:

1. "The C Programming Language", Brian W. Kernighan and Dennis M. Ritchie, Prentice- Hall, 1988
2. Schaum's Outline of Programming with C, Byron S Gottfried, McGraw-Hill Education, 1996

Reference Books:

1. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education, 2008.
2. Programming in C, Rema Theraja, Oxford, 2016, 2^{nd} edition
3. C Programming, A Problem Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE, 3rd edition

Course Code	Course Name	Course Structure			
		L	T	P	C
P23ESL04	IT Workshop (Common to All branches of Engineering)	0	0	2	1

Internal Marks: 30 External Marks: 70

Course Objectives:

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

Course Outcomes:

CO1: Understand the fundamental principles of computer hardware components and their interconnections.

CO2: Analyze the historical development of the Internet and its impact on global communication.

CO3: Analyze the underlying principles and structure of LaTeX and Word documents.

CO4: Implement essential toolbars and ribbons for common spreadsheet tasks.

CO5: Understand the principles of effective content organization in presentations.

CO6: Implement AI tools like ChatGPT into their professional workflows for content creation and translation.

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 LaTeX and Microsoft (MS) office or equivalent (FOSS) tool word: Importance of LaTeX 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 LaTeX and word – Accessing, overview of toolbars, saving files, Using help and resources, rulers, format painter in word.

Task 2: Using LaTeX 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 LaTeX 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:

1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream tech, 2003
2. The Complete Computer upgrade and repair book, Cheryl A Schmidt, WILEY Dream tech, 2013, 3^{rd} edition
3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education, 2012, 2^{nd} edition

4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft)
5. LaTeX Companion, Leslie Lamport, PHI/Pearson.
6. IT Essentials PC Hardware and Software Companion Guide, David Anfins on and Ken Quamme. – CISCO Press, Pearson Education, 3^{rd} edition
7. IT Essentials PC Hardware and Software Labs and Study Guide, Patrick Regan– CISCO Press, Pearson Education, 3^{rd} edition

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BSL02	Engineering Physics Lab (Common to All Branches of Engineering)	0	0	2	1

Internal Marks: 30 External Marks: 70

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

CO1: Apply the concepts of wave optics to get wavelength of light.

CO2: Apply the concept of resonance in sonometer and melde's experiments for getting frequency.

CO3: Study the earth's gravity and rigidity modulus of material.

CO4: Study electrostatics and magnetism to determine its dependent properties.

CO5: Determine the properties of semiconductors and Planks constant.

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:

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

Web Resources:

1. www.vlab.co.in
2. https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype

Course Code	Course Name	Course Structure			
		L	T	P	C
P23ESL03	Electrical & Electronics Engineering Workshop (Common to All branches of Engineering)	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Measure voltage, current and power in an electrical circuit. (L3)

CO2: **CO2:** Measure of Resistance using Wheat stone bridge (L4)

CO3: Discover critical field resistance and critical speed of DC shunt generators. (L4)

CO4: Investigate the effect of reactive power and power factor in electrical loads. (L5)

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 Device & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4^{th} 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.

Course Code	Course Name	Course Structure			
		L	T	P	C
P23ESL02	Computer Programming Lab (Common to All branches of Engineering)	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

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

CO2: Analyze the right control structure for solving the problem.

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

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

1. Basic Linux environment and its editors like Vi, Vim & Emacs etc.
2. Exposure to Turbo C, gcc
3. 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.

Lab2: Converting algorithms/flow charts into C Source code.

Developing the algorithms/flowcharts for the following sample programs

1. Sum and average of 3 numbers
2. Conversion of Fahrenheit to Celsius and vice versa
3. 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:
Lab3: Simple computational problems using arithmetic expressions.

1. Finding the square root of a given number
2. Finding compound interest
3. Area of a triangle using heron's formulae
4. 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

1. 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)
2. Find the maximum of three numbers using conditional operator
3. 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:
Lab5: Problems involving if-then-else structures.

1. Write a C program to find the max and min of four numbers using if-else.

2. Write a C program to generate electricity bill.
3. TFind the roots of the quadratic equation.
4. Write a C program to simulate a calculator using switch case.
5. 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
Lab6: Iterative problems e.g., the sum of series

1. Find the factorial of given number using any loop.
2. Find the given number is a prime or not.
3. Compute sine and cos series
4. Checking a number palindrome
5. 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.
Lab7: 1D Array manipulation, linear search

1. Find the min and max of a 1-D integer array.
2. Perform linear search on1D array.
3. The reverse of a 1D integer array
4. Find 2's complement of the given binary number.
5. 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

1. Addition of two matrices
2. Multiplication two matrices
3. Sort array elements using bubble sort
4. Concatenate two strings without built-in functions
5. 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.

1. Write a C program to find the sum of a 1D array using malloc()
2. Write a C program to find the total, average of n students using structures
3. Enter n students data using calloc() and display failed students list
4. Read student name and marks from the command line and display the student details along with the total.
5. 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

1. Create and display a singly linked list using self-referential structure.
2. Demonstrate the differences between structures and unions using a C program.
3. Write a C program to shift/rotate using bitfields.
4. 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.

1. Write a C function to calculate NCR value.
2. Write a C function to find the length of a string.
3. Write a C function to transpose of a matrix.
4. 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

1. Write a recursive function to generate Fibonacci series.
2. Write a recursive function to find the lcm of two numbers.
3. Write a recursive function to find the factorial of a number.
4. Write a C Program to implement Ackermann function using recursion.
5. 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.

1. Write a C program to swap two numbers using call by reference.
2. Demonstrate Dangling pointer problem using a C program.
3. Write a C program to copy one string into another using pointer.
4. Write a C program to find no of lowercase, uppercase, digits and other characters using pointers.

WEEK 14

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 12: Recursion, the structure of recursive calls
Lab 14: File operations

1. Write a C program to write and read text into a file.
2. Write a C program to write and read text into a binary file using fread() and fwrite()
3. Copy the contents of one file to another file.
4. Write a C program to merge two files into the third file using command-line arguments.
5. Find no. of lines, words and characters in a file
6. Write a C program to print last n characters of a given file.

Text Books:

1. Ajay Mittal, Programming in C: A practical approach, Pearson.
2. Byron Gottfried, Schaum & 39; 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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BST08	NSS/NCC/SCOUTS & Guides/Community Service (Common to All branches of Engineering)	0	0	1	0.5

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: At the end of the course, the student 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:

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

UNIT–II: Nature & Care :

Activities:

1. Best out of waste competition.
2. Poster and signs making competition to spread environmental awareness.
3. Recycling and environmental pollution article writing competition.
4. Organising Zero-waste day.
5. Digital Environmental awareness activity via various social media platforms.
6. Virtual demonstration of different eco-friendly approaches for sustainable living.

7. Write a summary on any book related to environmental issues.

UNIT–III: Community Service
Activities:

1. 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.
2. Conducting awareness programs on Health-related issues such as General Health, Mental health, Spiritual Health, HIV/AIDS,
3. Conducting consumer Awareness. Explaining various legal provisions etc.
4. Women Empowerment Programmes- Sexual Abuse, Adolescent Health and Population Education.
5. Any other programmes in collaboration with local charities, NGOs etc.

Reference Books:

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

General Guidelines:

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

Evaluation Guidelines:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BST01	Communicative English (Common to All Branches of Engineering)	2	0	0	2

Internal Marks: 30 External Marks: 70

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

Course Outcomes:

CO1: Understand the context, topic, and pieces of specific information from social or Transactional dialogues.

CO2: Apply grammatical structures to formulate sentences and correct word forms.

CO3: Analyze discourse markers to speak clearly on a specific topic in informal discussions.

CO4: Evaluate reading / listening texts and to write summaries based on global comprehension of these texts.

CO5: Create a coherent paragraph, essay, and resume

UNIT I

Lesson: HUMAN VALUES: Gift of Magi **(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.

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

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

UNIT II

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

Listening: Answering a series of questions about main ideas and supporting ideas 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.

UNIT III

Lesson: BIOGRAPHY: Elon Musk

Listening: Listening for global comprehension and summarizing what is listened to.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed
Reading: Readinga text in detail by making basic inferences -recognizing and interpreting specific context clues; strategies to use text clues for comprehension.
Writing: Summarizing, Note-making, paraphrasing
Grammar: Verbs - tenses; subject-verb agreement; Compound words, Collocations
Vocabulary: Compound words, Collocations

UNIT IV

Lesson: INSPIRATION: The Toys of Peace by Saki

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

UNIT V

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

Text Books:

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

Reference Books:

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

Web Resources:

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
7. https://www.youtube.com/c/DailyVideoVocabulary/videos

VOCABULARY

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BST05	Engineering Chemistry (Common to Civil, Chemical, Mechanical Engineering and allied branches)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives: At the end of the course the student can be able

1. To impart the concept of soft and hard waters, softening methods of hard water
2. To train the students on the principles and applications of eiectrochemistry
3. To train the students on the principles and applications of polymers, calorific values, octane number, refining of petroleum and cracking of oils.
4. To Illustrate the commonly used industrial materials
5. To Summarize the concepts of colloids, micelle and nanomaterials.

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

CO1: Explain the concept of soft and hard waters, softening methods of hard water

CO2: Explain the principles and applications of eiectrochemistry.

CO3: Explain the principles and applications of polymers, calorific values, octane number, refining of petroleum and cracking of oils.

CO4: Explain the commonly used industrial materials

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: Semiconductors

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.

Text Books:

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, 3^{rd} Edition

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BST03	Differential Equations and Vector Calculus (Common to All Branches of Engineering)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Solve the differential equations related to various engineering fields.

CO2: Find the complete solution to the higher order linear differential equations and apply these methods to find the current in complex electrical circuits.

CO3: Identify solution methods for partial differential equations that model physical processes.

CO3: Interpret the physical meaning of different operators such as gradient, curl and divergence.

CO4: Estimate the work done against a field, circulation and flux using vector calculus.

UNIT–I: Differential equations of first order and first degree

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

UNIT–II: Linear differential equations of higher order (Constant Coefficients)

Definitions, homogenous and non-homogenous, complimentary function, particular integral, general solution, Wronskian, Method of variation of parameters, Applications to L-C-R Circuit problems and Simple Harmonic motion.

UNIT–III: Partial Differential Equations

Introduction, Formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations using Lagrange's method and non-linear(standard types) equations, Second order PDE: solution of linear PDE with constant coefficients- RHS term of the type $e^{ax+by}, sin(ax+by), cos(ax+by), x^m y^n$

UNIT–IV: Vector differentiation

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

UNIT–V: Vector integration

LWithoutegral-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 related problems.

Text Books:

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

Reference Books:

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14^{th} Edition.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha ScienceInternational Ltd., 2021 5^{th} Edition(9^{th} reprint).
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5^{th} Edition.
4. Advanced Engineering Mathematics, Micheael Greenberg, , Pearson publishers, 9^{th} edition
5. Higher Engineering Mathematics, B. V. Ramana, McGraw Hill Education, 2017

Course Code	Course Name	Course Structure			
		L	T	P	C
P23EST01	Basic Civil and Mechanical Engineering (Common to All branches of Engineering)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

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

CO2: Identity 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.

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: Polymers and Fuel Chemistry

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).

Text Books:

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. 38^{th} Edition.
4. Highway Engineering, S.K.Khanna, C.E.G. Justo and Veeraraghavan, Nemchand and Brothers Publications 2019. 10^{th} 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

1. Get familiarized with the scope and importance of Mechanical Engineering in different sectors and industries.
2. Explain different engineering materials and different manufacturing processes.
3. Provide an overview of different thermal and mechanical transmission systems and introduce basics of robotics and its applications.

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

CO1: Understand the role of mechnical engineering and different engineering materials.

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

CO3: Describe the working of different mechanical power transmission systems,power plants, 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 their applications.

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

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

Text Books:

1. Internal Combustion Engines by V.Ganesan, By Tata McGraw Hill publications (India) Pvt.
2. A text 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, Cengage learning India Pvt.

Reference Books:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET01	Engineering Mechanics (Common to Civil, Mechanical Engineering & Allied branches)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Define the fundamental concepts in mechanics and determine the frictional forces for bodies in contact.

CO2: Analyze different force systems such as concurrent, coplanar and spatial systems and calculate their resultant forces and moments.

CO3: Calculate the centroids, center of gravity and moment of inertia of different geometrical shapes.

CO4: Apply the principles of work-energy and impulse-momentum to solve the problems of rectilinear 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 – Moment of 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 for Spatial 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 gravity of 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.

Text Books:

1. Engineering Mechanics, S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., , McGraw Hill Education 2017. 5^{th} 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. 4^{th} Edition.
4. A Textbook of Engineering Mechanics, Dr.R.K.Bansal. Laxmi publications 2015. 6^{th} 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. 4^{th} Edition.
3. Engineering Mechanics, Volume-I: Statics, Volume-II: Dynamics, J. L. Meriam and L.
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, 14^{th} Edition

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BSL01	Communicative English Lab (Common to All Branches of Engineering)	0	0	2	1

Internal Marks: 30 External Marks: 70

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:

1. Walden Infotech
2. 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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BSL03	Engineering Chemistry Lab (Common to Civil, Chemical, Mechanical Engineering and allied branches)	0	0	2	1

Internal Marks: 30 External Marks: 70

Course Objectives:

- To verify the fundamental concepts with experiments

Course Outcomes: At the end of the course, the student 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

References:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23ESL01	Engineering Workshop (Common to All branches of Engineering)	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objectives:

To familiarize students with wood working, sheet metal operations, fitting, electrical house wiring skills, and basic repairs of two-wheeler vehicle.

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

CO1: Identify workshop tools and their operational capabilities.

CO2: Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry, welding and plumbing.

CO3: Apply sheet metal working operations in various applications and basic repairs of two weeler vehicle.

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.

9. **Basic repairs of Two-wheeler vehicle** – Demonstration of working of two-wheeler vehicle and its repairs.

Text Books:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published, 2019.

2. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5^{th} Edn. 2015.

3. A Course in Workshop Technology Vol I. & II, B.S. Raghuwanshi, Dhanpath Rai & Co., 2015 & 2017.

Reference Books:

1. Wiring Estimating, Costing and Contracting; Soni P.M. & Upadhyay P.A.; Atul Prakashan, 2021-22.

2. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.

3. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14^{th} edition

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEL01	Engineering Mechanics Lab (Mechanical Engineering & allied branches)	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objectives: The students completing the course are expected to:

1. Verify the Law of Parallelogram of Forces and Lami's theorem.
2. Determine the coefficients of friction of Static and Rolling friction and Centre of gravity of different plane Lamina.
3. Analyse the system of Pulleys and Moment of Inertia of Compound Pendulum and Flywheel.

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

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 to the plane of oscillation and passing through its centre of mass.
10. Determine the Moment of Inertia of a Flywheel.
11. Verification of Law of Moment using Rotation Disc Apparatus and Bell Crank Lever.

References:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BSL05	Health and Wellness, Yoga and Sports (Common to All branches of Engineering)	0	0	1	0.5

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: At the end 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:

1. Organizing health awareness programmes in community
2. Preparation of health profile
3. 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:

1. 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

2. Practicing cardiorespiratory fitness, treadmill, run test, 9 min walk, skipping and running.

Reference Books:

1. Gordon Edlin, Eric Golanty. Health and Wellness, 14^{th} 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. – 3^{rd} ed. Human Kinetics, Inc.2014

General Guidelines:

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

Evaluation Guidelines:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BST09	Numerical Methods and Transform Techniques (Common to All Branches of Engineering)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Evaluate the approximate roots of polynomial and transcendental equations by different algorithms. Apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals. (L3)

CO2: Apply numerical integral techniques to different engineering problems. Apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations. (L3)

CO3: Apply the Laplace transform for solving differential equations. (L3)

CO4: Find or compute the Fourier series of periodic signals. (L3)

CO5: Apply integral expressions for the forward and inverse Fourier transform to a range of non-periodic waveforms. (L3)

UNIT–I: Iterative Methods and Interpolation (10 Lectures)

Solutions of algebraic and transcendental equations: Bisection method, Secant method, Method of false position, Iteration method, Newton-Raphson method (Simultaneous Equations). Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula.

UNIT–II: Numerical Integration and ODEs (8 Lectures)

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

UNIT–III: Laplace Transforms (10 Lectures)

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

equations (initial value problems) and integro-differential equations using Laplace transforms.

UNIT–IV: Fourier Series (8 Lectures)

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

UNIT–V: Fourier Transforms (9 Lectures)

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

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44^{th} Edition, Khanna Publishers.
2. B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata McGraw Hill Education.

Reference Books:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MBO03	Universal Human Values – Understanding Harmony & Ethical Human Conduct	2	1	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To help the students appreciate the essential complementarity between 'Values' and 'Skills' to ensure sustained happiness and prosperity.
2. To facilitate the development of a holistic perspective among students towards life, profession, happiness and prosperity based on correct understanding of human reality and existence.
3. To highlight implications of such holistic understanding in terms of ethical human conduct, trustful behaviour, and mutually enriching interaction with Nature.

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

CO1: Define Natural Acceptance, Happiness and Prosperity.
CO2: Identify one's self and surroundings (family, society, nature).
CO3: Apply the concepts learnt in day-to-day real-life settings.
CO4: Relate human values with human relationship and society.
CO5: Justify the need for universal human values and harmony in existence.
CO6: Develop as socially and ecologically responsible engineers.

UNIT–I: Introduction to Value Education

Right Understanding, Relationship and Physical Facility – Role of Education; Value Education; Self-exploration; Continuous Happiness and Prosperity as basic human aspirations; Method to fulfill aspirations; Practice sessions on Natural Acceptance and Human Consciousness.

UNIT–II: Harmony in the Human Being

Understanding human being as co-existence of self and body; Needs of self and body; Body as an instrument of self; Harmony in self; Harmony of self with the body; Self-regulation and Health; Practice sessions on harmony and imagination.

UNIT–III: Harmony in the Family and Society

Family as basic unit of interaction; Trust as foundational value; Respect as right evaluation; Justice in relationships; Harmony in society; Vision for Universal Human Order; Practice sessions on Trust, Respect and Human Goal fulfillment.

UNIT–IV: Harmony in Nature/Existence

Harmony in nature; Interconnectedness and mutual fulfilment among the four orders of nature; Existence as co-existence; Holistic perception of harmony; Practice sessions on exploring four orders of nature and coexistence.

UNIT–V: Implications of Holistic Understanding – Professional Ethics

Natural acceptance of human values; Ethical human conduct; Humanistic education, constitution and universal order; Competence in professional ethics; Holistic technologies and management models; Transition strategies towards value-based living; Practice sessions on ethical conduct and transition.

Text Books:

1. R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, 2019.

Reference Books:

1. A. Nagaraj, *Jeevan Vidya: Ek Parichaya*, Jeevan Vidya Prakashan, 1999.
2. A.N. Tripathi, *Human Values*, New Age International, 2004.
3. M.K. Gandhi, *The Story of My Experiments with Truth*.
4. E.F. Schumacher, *Small is Beautiful*.
5. Cecile Andrews, *Slow is Beautiful*.
6. J.C. Kumarappa, *Economy of Permanence*.
7. Dharampal, *Rediscovering India*.

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-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf
5. https://swayam2.ac.in/aic22_ge23/preview

Course Code	Course Name	Course Structure			
		L	T	P	C
P23EST07	THERMODYNAMICS	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Explain the importance of thermodynamic properties related to conversion of heat energy into work. (L3)

CO2: Apply the Zeroeth and First Law of Thermodynamics. (L3)

CO3: Understand Second Law of Thermodynamics. (L2)

CO4: Analyze the Mollier charts, T-S and h-s diagrams, Steam calorimetry, Phase Transformations. (L4)

CO5: Evaluate the COP of refrigerating systems and properties, processes of psychrometry and sensible and latent heat loads. (L5)

UNIT–I: Basic Concepts (9 Lectures)

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: First Law of Thermodynamics (9 Lectures)

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

UNIT–III: Second Law of Thermodynamics (9 Lectures)

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: Properties of Pure Substances (9 Lectures)

Pure Substances, P-V-T surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point and 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: Refrigeration & Air Conditioning (9 Lectures)

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. C.P. Arora, *Refrigeration and Air-conditioning*, 4/e, McGraw Hill, 2021.

Online Learning Resources:

1. https://www.edx.org/learn/thermodynamics
2. https://archive.nptel.ac.in/courses/112/106/112106310
3. https://www.youtube.com/watch?v=7NI5P4KqrAs&t=1s
4. https://kp.kiit.ac.in/pdf_files/02/Study-Material_3rd-Semester_Winter_2021_Mechanical-Engg.-_Thermal-Engineering-1_Abhijit-Samant.pdf
5. https://www.coursera.org/learn/thermodynamics-intro

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET02	MECHANICS OF SOLIDS	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Extend knowledge of various stresses and strains in members under different loadings and principal stresses on inclined planes.
2. Describe and analyze the shear force and bending moment diagrams of various beams subjected to different loads.
3. Analyze flexural stresses, section modulus and shear stress distribution in beams of various sections.
4. Determine slope and deflection for different support arrangements using Double Integration, Macaulay's method and Moment-Area method.
5. Analyze stresses and strains induced in thin & thick cylinders and estimate shear stresses in shafts.

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

CO1: Apply the fundamental concepts of stress, strain and analyze the stresses on inclined planes for solids. (L3)

CO2: Analyze and construct the shear force and bending moment diagrams for various types of beams under different loads. (L4)

CO3: Compute the bending stress and shear stress induced in beams of various cross sections. (L3)

CO4: Interpret the slope and deflection of beams by Double Integration method, Macaulay's method and Moment-Area method. (L4)

CO5: Evaluate the stresses and strains in thin and thick cylinders and spherical shells, and calculate torsional effects in shafts. (L5)

UNIT–I: Simple Stresses & Strains (9 Lectures)

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 inclined planes under uniaxial and biaxial conditions – Principal planes and stresses – Mohr's circle – Relation between elastic constants – Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT–II: Shear Force and Bending Moment (9 Lectures)

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, UDL, UVL and combinations – Point of contra flexure – Relation between S.F., B.M. and rate of loading.

UNIT–III: Flexural and Shear Stresses (9 Lectures)

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 – Distribution across rectangular, circular, triangular, I and T sections.

UNIT–IV: Deflection of Beams (9 Lectures)

Bending into a circular arc – slope, deflection and radius of curvature – Differential equation of elastic line – Double Integration and Macaulay's methods – Slope and deflection of cantilever and simply supported beams subjected to point loads, UDL and UVL – Mohr's theorem and Moment-Area method.

UNIT–V: Thin and Thick Cylinders & Torsion (9 Lectures)

Thin seamless cylindrical shells – Longitudinal and circumferential stresses – Hoop, longitudinal and volumetric strains – Change in diameter and volume – Thin spherical shells – Wire wound cylinders. Lame's equation – Cylinders under internal & external pressure – Compound cylinders. Torsion: Derivation – Torsion of circular shafts – Pure shear – Transmission of power – Shafts in series and parallel.

Text Books:

1. S.S. Rattan, *Strength of Materials*, Tata McGraw-Hill Education, 2011.
2. R.K. Bansal, *A Textbook of Strength of Materials*, Laxmi Publications, 2010.
3. G.H. Ryder, *Strength of Materials*, Macmillan, 1961.

Reference Books:

1. J.M. Gere, B.J. Goodno, *Mechanics of Materials*, 8/e, Cengage Learning, 2012.
2. R.C. Hibbeler, *Mechanics of Materials*, Pearson Education, 2007.
3. R.S. Khurmi, *Strength of Materials*, S. Chand & Co., 2005.

Online Learning Resources:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET03	MATERIAL SCIENCE & METALLURGY	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Understand the crystalline structure of different metals and study the stability of phases in different alloy systems.
2. Study the behavior of ferrous and non-ferrous metals and alloys and their applications in different domains.
3. Understand the effect of heat treatment and addition of alloying elements on the properties of ferrous metals.
4. Grasp the methods of making metal powders and applications of powder metallurgy.
5. Comprehend the properties and applications of ceramics, composites and other advanced materials.

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

CO1: Understand the crystalline structure of different metals and study the stability of phases in different alloy systems. (L2)

CO2: Study the behavior of ferrous and non-ferrous metals and alloys and their application in different domains. (L1)

CO3: Understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals. (L2)

CO4: Grasp the methods of making metal powders and applications of powder metallurgy. (L3)

CO5: Comprehend the properties and applications of ceramics, composites and other advanced methods. (L4)

UNIT–I: Structure of Metals and Constitution of Alloys (9 Lectures)

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 – Electron compounds. Equilibrium Diagrams: Experimental methods of construction – Isomorphous systems – Equilibrium cooling/heating of alloys – Lever rule – Coring – Miscibility gaps – Eutectic systems – Congruent melting phases – Peritectic reaction – Solid state transformations (allotropy, eutectoid, peritectoid) – Phase rule – Relationship of diagrams with properties – Binary phase diagrams: Cu–Ni and Fe–Fe_3C.

UNIT–II: Ferrous & Non-Ferrous Metals and Alloys (9 Lectures)

Ferrous metals: Structure and properties of White cast iron, Malleable cast iron, Grey cast iron, Spheroidal graphite cast iron, Alloy cast iron. Steels: Classification, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, Tool and die steels. Non-ferrous: Structure and properties of Copper, Aluminium, Titanium, Magnesium and their alloys – Super alloys.

UNIT–III: Heat Treatment of Steels (9 Lectures)

Effect of alloying elements on Fe–Fe_3C system – Annealing – Normalizing – Hardening – TTT diagrams – Tempering – Hardenability – Surface-hardening methods – Age hardening – Cryogenic treatment.

UNIT–IV: Powder Metallurgy (9 Lectures)

Basic processes – Methods of producing metal powders (Milling, Atomization, Granulation, Reduction, Electrolytic deposition). Compacting methods – Sintering – Manufacturing of sintered parts – Secondary operations – Applications of powder metallurgy products.

UNIT–V: Ceramics and Advanced Materials (9 Lectures)

Crystalline ceramics – Glasses – Cermets – Abrasives. Composites: Classification – Manufacturing methods – Particle-reinforced – Fiber-reinforced – PMC, MMC, CMC, CCCs. Introduction to Nano materials 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, Cengage Learning, 2018.

Reference Books:

1. 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 & 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:

1. https://archive.nptel.ac.in/courses/113/106/113106032/

2. https://www.edx.org/learn/mechanics/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-3-time-dependent-behavior
3. https://www.youtube.com/watch?v=9Sf278j1GTU
4. https://www.coursera.org/learn/fundamentals-of-materials-science
5. https://www.coursera.org/learn/material-behavior

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEL02	MECHANICS OF SOLIDS & MATERIALS SCIENCE LAB	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Evaluate the values of yield stress, ultimate stress and bending stress of a specimen under tension test and bending test.
2. Conduct the torsion test to determine the modulus of rigidity of a given specimen.
3. Justify the Rockwell hardness test over Brinell hardness test and measure the hardness of a specimen.
4. Examine the stiffness of open coil and closed coil springs and grade them.
5. Analyze the microstructure and characteristics of ferrous and non-ferrous alloy specimens.

Laboratory Experiments:

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 Experiments:

1. Investigate the principal stresses σ_a and σ_b at any given point of a structural element in a state of plane stress. https://virtual-labs.github.io/exp-rockwell-hardness-experiment-iiith/objective.html
2. Find the impact resistance of mild steel and cast iron. https://sm-nitk.vlabs.ac.in/exp/izod-impact-test
3. Find the impact resistance of mild steel. https://sm-nitk.vlabs.ac.in/exp/charpy-impact-test/index.html
4. Find the Rockwell hardness number of mild steel, cast iron, brass, aluminum and spring steel. https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test
5. Determine the indentation hardness of mild steel, brass, aluminum etc. using Vickers hardness test. https://sm-nitk.vlabs.ac.in/exp/vickers-hardness-test

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

CO1: Understand the stress-strain behavior of different materials. (L2)
CO2: Evaluate the hardness of different materials. (L4)
CO3: Explain the relation between elastic constants and hardness of materials. (L1)
CO4: Identify various microstructures of steels and cast irons. (L3)
CO5: Evaluate hardness of treated and untreated steels. (L4)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEL03	COMPUTER-AIDED MACHINE DRAWING	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objectives:

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

Syllabus:

Conventional Representation of Materials and Components

Detachable joints: Thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut, stud joint, screw joint and foundation bolts. Riveted joints: 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.

3D Modeling Exercises

Sectional views: Creating solid models of complex machine parts and sectional views. Assembly drawings: (Any four) – 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 assemblies to prepare manufacturing drawing with dimensional and geometric tolerances.

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

CO1: Demonstrate the conventional representations of materials and machine components. (L3)

CO2: Model riveted, welded and key joints using CAD system. (L6)

CO3: Create solid models and sectional views of machine components. (L6)

CO4: Generate solid models of machine parts and assemble them. (L5)

CO5: Translate 3D assemblies into 2D drawings. (L6)

Text Books:

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

Reference Books:

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

Online Learning Resources:

1. https://eeedocs.wordpress.com/wp-content/uploads/2014/02/machinedrawing.pdf
2. https://archive.nptel.ac.in/courses/112/105/112105294/
3. https://www.edx.org/learn/engineering/dassault-systemes-solidworks-solidworks-cad-fundamentals
4. https://www.youtube.com/watch?v=0bQkS3_3Fq4

Course Code	Course Name	Course Structure			
		L	T	P	C
P23ESL05	Python Programming Lab	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Develop a solid foundation in Python programming, covering essential syntax, semantics, and constructs.
2. Equip students with skills to handle and manipulate data using Python libraries like Pandas and NumPy.
3. Enhance problem-solving abilities by implementing various algorithms and data structures in Python.
4. Foster software development skills, including version control, package management, and project documentation.
5. Introduce advanced Python topics such as web scraping, API interaction, and database management.

List of Experiments:

1. **Introduction to Python:** Install Python and IDE, write a simple "Hello, World!" program, demonstrate basic syntax.
2. **Basic Python Programming:** Programs using variables, data types, operators, input/output, control structures.
3. **Functions and Modules:** Define and call functions, explore built-in modules, use at least two standard library modules.
4. **Lists and Tuples:** Create, modify, iterate lists/tuples, perform list comprehensions, show immutability of tuples.
5. **Dictionaries and Sets:** Create and manipulate dictionaries/sets, use comprehensions, perform set operations.
6. **Strings and File I/O:** String methods, read/write text files, work with CSV and JSON files.
7. **Error Handling:** Use try-except-else-finally, handle specific and custom exceptions.
8. **Object-Oriented Programming:** Define classes, objects, inheritance, polymorphism, class and instance variables.
9. **Libraries and Packages:** Use NumPy and Pandas, create a Python package, work with virtual environments.
10. **Working with Data:** Load, manipulate, analyze data using Pandas, visualize with Matplotlib/Seaborn, summarize findings.
11. **Web Scraping and APIs:** Access REST APIs, parse JSON data, extract and analyze web data.

12. **Databases:** Connect with SQLite/SQLAlchemy, perform CRUD operations, write SQL queries.

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

CO1: Install Python, configure environments, and write basic programs.
CO2: Apply programming constructs, functions, and data structures in problem-solving.
CO3: Work with files, handle exceptions, and develop modular Python programs.
CO4: Implement OOP concepts, libraries, and data analysis techniques.
CO5: Perform web scraping, interact with APIs, and manage databases using Python.

Suggested Online Resources:

1. https://www.w3schools.com/python/python_intro.asp
2. https://www.youtube.com/watch?v=eWRfhZUzrAc
3. https://onlinecourses.nptel.ac.in/noc20_cs83/preview
4. https://www.edx.org/learn/python
5. Virtual Labs - https://python-iitk.vlabs.ac.in/
6. Virtual Labs - https://virtual-labs.github.io/exp-arithmetic-operations-iitk/
7. Virtual Labs - https://cse02-iiith.vlabs.ac.in/
8. https://mlritm.ac.in/assets/cse/cse_lab_manuals/R20_cse_manuals/Python%20Lab%20Manual.pdf

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MES01	Python Programming	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Introduce core programming concepts of Python programming language.
2. Demonstrate Python data structures such as Lists, Tuples, Sets, and Dictionaries.
3. Implement Functions, Modules, and Regular Expressions in Python.
4. Enable students to create practical and contemporary applications using Python.

Unit-I:

History of Python Programming Language, Thrust Areas of Python, Installing Anaconda Python Distribution, Installing and Using Jupyter Notebook. Parts of Python Programming Language: Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and Associativity, Data Types, Indentation, Comments, Reading Input, Print Output, Type Conversions, the `type()` Function and `is` Operator, Dynamic and Strongly Typed Language. Control Flow Statements: if, if-else, if...elif. . . else, Nested if, while Loop, for Loop, continue and break, Exception handling with try-except.

Sample Experiments:

1. Program to find the largest element among three numbers.
2. Program to display all prime numbers within an interval.
3. Program to swap two numbers without using a temporary variable.
4. Demonstration of Python Operators (Arithmetic, Relational, Assignment, Logical, Bitwise, Ternary, Membership, Identity).
5. Program to add and multiply complex numbers.
6. Program to print multiplication table of a given number.

Unit-II:

Functions: Built-In Functions, Modules, Function Definition and Calls, Return Statement, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments. Strings: Creation, Access, Slicing, Joining, Methods, Formatting. Lists: Creation, Indexing, Slicing, Built-In Functions, Methods, `del` Statement.

Sample Experiments:

1. Function with multiple return values.

2. Function with default arguments.
3. Program to find the length of a string without using library functions.
4. Program to check if a substring is present in a string.
5. List operations: addition, insertion, slicing.
6. Demonstration of 5 built-in functions on lists.

Unit-III:

Dictionaries: Creation, Access, Modification, Built-In Functions, Methods, `del` Statement. Tuples and Sets: Creation, Operations, Indexing, Slicing, Conversion with `tuple()`, Relation with Lists and Dictionaries, `zip()` Function, Sets, Methods, Frozenset.

Sample Experiments:

1. Program to create and concatenate tuples.
2. Program to count vowels in a string (without control flow).
3. Program to check if a key exists in a dictionary.
4. Program to add a new key-value pair to a dictionary.
5. Program to sum all dictionary items.

Unit-IV:

Files: Types, Creation, Reading/Writing Text, Binary, Pickle, CSV, OS and `os.path` Modules. OOP in Python: Classes, Objects, Constructors, Class Attributes vs Data Attributes, Encapsulation, Inheritance, Polymorphism.

Sample Experiments:

1. Program to sort words in a file and write to another file.
2. Program to print each line of a file in reverse order.
3. Program to count characters, words, and lines in a file.
4. Program to perform array operations (create, display, append, insert, reverse).
5. Program to add, transpose, and multiply matrices.
6. Program to create a class hierarchy for shapes with area and perimeter.

Unit-V:

Introduction to Data Science: Functional Programming, JSON and XML in Python, NumPy, Pandas.

Sample Experiments:

1. Program to check whether JSON string contains a complex object.
2. NumPy array creation using `array()` function.
3. Demonstration of `ndim`, `shape`, `size`, `dtype`.
4. NumPy slicing, integer and Boolean indexing.
5. Program to compute min, max, sum, cumulative sum of an array.

6. Dictionary-to-Pandas DataFrame operations (`head()`, selection).
7. Data visualization using scatter plots in Matplotlib.

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

CO1: Understand the fundamentals of Python programming and control structures.

CO2: Apply concepts of functions, strings, lists, and modules in problem-solving.

CO3: Work with tuples, sets, and dictionaries in real-world applications.

CO4: Implement file handling and object-oriented programming concepts.

CO5: Use Python libraries for data science and perform data analysis with NumPy and Pandas.

Reference Books:

1. Gowrishankar S, Veena A., *Introduction to Python Programming*, CRC Press.
2. S. Sridhar, J. Indumathi, V. M. Hariharan, *Python Programming*, 2nd Edition, Pearson, 2024.
3. Y. Daniel Liang, *Introduction to Programming Using Python*, Pearson.

Suggested Online Resources:

1. `https://www.coursera.org/learn/python-for-applied-data-science-ai`
2. `https://www.coursera.org/learn/python?specialization=python#syllabus`

Course Code	Course Name	Course Structure			
		L	T	P	C
P23ACT01	Environmental Science (Common to All branches of Engineering)	2	0	0	0

Course Objectives:

1. To make the students get awareness on environment.
2. 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.
3. To save earth from the inventions by the engineers.

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

CO1: Appreciate multidisciplinary nature of environmental studies and various renewable and non-renewable resources. (L2)

CO2: Understand flow and bio-geo-chemical cycles and ecological pyramids. (L2)

CO3: Understand various causes of pollution and solid waste management and related preventive measures. (L2)

CO4: Understand rainwater harvesting, watershed management, ozone layer depletion and wasteland reclamation. (L2)

CO5: Illustrate the causes of population explosion, value education and welfare programmes. (L3)

UNIT–I: (6 Lectures)

Multidisciplinary Nature of Environmental Studies: Definition, Scope and Importance – Need for Public Awareness. Natural Resources: Renewable and non-renewable resources – Forest resources – Use and over–exploitation, deforestation, case studies – Mining, dams and other effects on forest and tribal people – Water resources: utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: use and exploitation, case studies – Food resources: world food problems, modern agriculture, fertilizer-pesticide problems, water logging, salinity – Energy resources.

UNIT–II: (6 Lectures)

Ecosystems: Concept, structure, function – Producers, consumers, decomposers – Energy flow – Ecological succession – Food chains, webs and pyramids. Ecosystems types: Forest, Grassland, Desert, Aquatic (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity: Definition – Genetic, species and ecosystem diversity – Bio-geographical classification of India – Values of biodiversity – India as a mega-diversity nation – Hot-spots – Threats: habitat loss, poaching, conflicts – Endangered and endemic species – Conservation: In-situ and Ex-situ.

UNIT–III: (6 Lectures)

Environmental Pollution: Definition, causes, effects and control of Air, Water, Soil, Marine, Noise, Thermal pollution and Nuclear hazards. Solid Waste Management:

Causes, effects and control of urban and industrial wastes – Role of individual – Pollution case studies – Disaster management: floods, earthquake, cyclone, landslides.

UNIT–IV: (6 Lectures)

Social Issues and Environment: Sustainable development – Urban problems and energy – Water conservation, rainwater harvesting, watershed management – Resettlement and rehabilitation – Environmental ethics – Climate change, global warming, acid rain, ozone depletion, nuclear accidents – Case studies – Wasteland reclamation – Consumerism – Environmental legislation: Environment Protection Act, Air Act, Water Act, Wildlife Protection Act, Forest Conservation Act – Enforcement issues – Public awareness.

UNIT–V: (6 Lectures)

Human Population and Environment: Population growth, explosion, variations – Family Welfare Programmes – Human rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of IT in environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets, polluted sites, study of common plants, insects, birds, etc.

Text Books:

1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, Universities Press, 2019.
2. Palaniswamy, Environmental Studies, 2/e, Pearson, 2014.
3. S. Azeem Unnisa, Environmental Studies, Academic Publishing, 2021.
4. K. Raghavan Nambiar, Textbook of Environmental Studies as per UGC syllabus, SciTech Publications, 2010.

Reference Books:

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

Online Learning Resources:

1. https://onlinecourses.nptel.ac.in/noc23_hs155/preview
2. http://ecoursesonline.iasri.res.in/Courses/Environmental%20Science-I/Data%20Files/pdf/lec07.pdf
3. https://www.youtube.com/watch?v=5QxxaVfgQ3k

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MBT02	INDUSTRIAL MANAGEMENT	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Learn about how to design the optimal layout. (L1)
CO2: Demonstrate work study methods. (L3)
CO3: Explain Quality Control techniques. (L2)
CO4: Discuss the financial management aspects. (L2)
CO5: Understand the human resource management methods. (L2)

UNIT–I: Introduction & Plant Layout (9 Lectures)

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 (9 Lectures)

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 & TQM (9 Lectures)

Quality control, Quality assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – X and R charts, X and S charts and their applications, numerical examples. Total Quality Management: Zero defect concept, quality circles, implementation, applications, ISO quality systems. Six Sigma – definition, basic concepts.

UNIT–IV: Financial Management (9 Lectures)

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 & Value Analysis (9 Lectures)

Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job evaluation – 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 D.K., *Industrial Management*, S. Chand Publishers, 2010.
2. J.G. Monks, *Operations Management*, 3/e, McGraw Hill Publishers, 1987.
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. N.V.S. Raju, *Industrial Engineering and Management*, 1/e, Cengage India Pvt Ltd, 2013.

Online Learning Resources:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BST11	COMPLEX VARIABLES, PROBABILITY AND STATISTICS	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic. (L3)

CO2: Apply Cauchy residue theorem to evaluate certain integrals. (L3)

CO3: Apply discrete and continuous probability distributions. (L3)

CO4: Apply the various sampling distributions and estimation using small sample distributions. (L3)

CO5: Analyze the statistical inferential methods based on small and large sampling tests. (L4)

UNIT–I: Functions of a complex variable and Complex integration (10 Lectures)

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

UNIT–II: Series Expansions and Residue Theorem (8 Lectures)

Radius of convergence, Expansion of function in Taylor's series, Maclaurin's series and Laurent series. Types of Singularities: Isolated, Essential singularities, Pole of order m, Residues, Residue theorem (without proof). Evaluation of real integrals of the types $\int_0^{2\pi} f(\sin\theta, \cos\theta)d\theta$ and $\int_{-\infty}^{\infty} f(x)dx$.

UNIT–III: Probability and Distributions (10 Lectures)

Random variables, Discrete and Continuous random variables. Distribution functions: Probability mass function, Probability density function and Cumulative distribution functions, Mathematical Expectation and Variance. Binomial, Poisson, Uniform and Normal distributions.

UNIT–IV: Sampling Theory (8 Lectures)

Introduction, Population and Samples, Sampling distribution of Means and Variance (definition only), Central limit theorem (without proof). Representation of the

normal theory distribution, Point and interval estimations, Maximum error of estimate.

UNIT–V: Tests of Hypothesis (10 Lectures)

Introduction, Hypothesis, Null and Alternative Hypothesis, Type I and Type II errors, Level of significance, One tail and two-tail tests. Tests concerning one mean and two means (Large and small samples), Tests on proportions.

Text Books:

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

Reference Books:

1. J. W. Brown and R. V. Churchill, *Complex Variables and Applications*, 9/e, McGraw Hill, 2013.
2. S.C. Gupta and V.K. Kapoor, *Fundamentals of Mathematical Statistics*, 11/e, Sultan Chand & Sons Publications, 2012.
3. Jay L. Devore, *Probability and Statistics for Engineering and the Sciences*, 8/e, Cengage Publishers.
4. Shron L. Myers, Keying Ye, Ronald E. Walpole, *Probability and Statistics for Engineers and the Scientists*, 8/e, Pearson Publishers, 2007.
5. Sheldon M. Ross, *Introduction to Probability and Statistics for Engineers and the Scientists*, 4/e, Academic Foundation, 2011.

Online Learning Resources:

1. `http://tutorial.math.lamar.edu/Classes/DE/DE.aspx`
2. `http://mathworld.wolfram.com/topics`
3. `http://www.nptel.ac.in/course.php`

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET04	FLUID MECHANICS & HYDRAULIC MACHINES	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Understand the basic concepts of fluid properties. (L2)

CO2: Estimate the mechanics of fluids in static and dynamic conditions. (L5)

CO3: Apply the boundary layer theory, flow separation and dimensional analysis. (L3)

CO4: Estimate the hydrodynamic forces of jet on vanes in different positions. (L5)

CO5: Understand the working principles and performance evaluation of hydraulic pumps and turbines. (L2)

UNIT–I: Fluid Statics (9 Lectures)

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: Metacenter, stability of floating body, submerged bodies, calculation of metacenter height, stability analysis and applications.

UNIT–II: Fluid Kinematics and Dynamics (9 Lectures)

Fluid Kinematics: Introduction, flow types. Equation of continuity for one-dimensional flow, circulation and vorticity, streamline, path line, streak line and stream tube. Stream function and velocity potential function – relation and differences, condition for irrotational flow, flow net, source and sink, doublet and vortex flow. Fluid Dynamics: Surface and body forces, Euler's and Bernoulli's equations for flow along a streamline, momentum equation and its applications, force on pipe bend. Closed conduit flow: Reynold's experiment, Darcy–Weisbach equation, minor losses in pipes, pipes in series and parallel, total energy line and hydraulic gradient line.

UNIT–III: Boundary Layer Theory and Dimensional Analysis (9 Lectures)

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness. Separation of boundary layer, control of flow separation. Streamlined and bluff bodies, velocity profiles. Dimensional Analysis: Dimensions and Units, Dimensional Homogeneity, Non-dimensionalization of equations, Method of Repeating Variables, Buckingham π Theorem.

UNIT–IV: Basics of Turbomachinery and Hydraulic Turbines (9 Lectures)

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 – 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 Turbines and Pumps (9 Lectures)

Performance of hydraulic turbines: Geometric similarity, unit and specific quantities, characteristic curves, governing of turbines, selection of turbine type, cavitation, surge tank, water hammer. Hydraulic systems: hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics – amplifiers, sensors and oscillators. 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 and 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 Hydraulic Machines*, Standard Book House, 2017.
2. R.K. Bansal, *Fluid Mechanics and Hydraulic Machines*, 10/e, Laxmi Publications (P) Ltd, 2019.
3. R.K. 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:

1. https://archive.nptel.ac.in/courses/112/105/112105206/
2. https://archive.nptel.ac.in/courses/112/104/112104118/

3. https://www.edx.org/learn/fluid-mechanics
4. https://onlinecourses.nptel.ac.in/noc20_ce30/preview
5. https://www.coursera.org/learn/fluid-power

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET05	MANUFACTURING PROCESSES	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Design the patterns and core boxes for metal casting processes. (L6)
CO2: Understand the different welding processes. (L2)
CO3: Demonstrate the different types of bulk forming processes. (L3)
CO4: Understand sheet metal forming processes. (L2)
CO5: Learn about the different types of additive manufacturing processes. (L2)

UNIT–I: Casting **(9 Lectures)**

Steps involved in making a casting – Advantages 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 **(9 Lectures)**

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 **(9 Lectures)**

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 and High Energy Rate Forming (9 Lectures)

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 (9 Lectures)

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

Text Books:

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

Reference Books:

1. A. Ghosh & A. K. Malik, *Manufacturing Science*, East West Press Pvt. Ltd, 2010.
2. Lindberg and Roy, *Processes and Materials of Manufacture*, 4/e, Prentice Hall India, 1990.
3. R. K. Jain, *Production Technology*, Khanna Publishers, 2022.
4. P. C. Sharma, *A Textbook of Production Technology*, 8/e, S Chand Publishing, 2014.
5. H. S. Shaun, *Manufacturing Processes*, 1/e, Pearson Publishers, 2012.
6. W. A. J. 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:

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

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET06	THEORY OF MACHINES	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

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

CO1: Understand different mechanisms and their inversions. (L2)
CO2: Calculate velocity and acceleration of different links in a mechanism. (L4)
CO3: Apply the effects of gyroscopic couple in ships, aeroplanes and road vehicles. (L3)
CO4: Evaluate unbalance mass in rotating machines. (L5)
CO5: Analyze free and forced vibrations of single degree freedom systems. (L4)

UNIT–I: Simple Mechanisms (9 Lectures)

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

UNIT–II: Plane and Motion Analysis (9 Lectures)

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations – kinematic analysis of simple mechanisms – slider crank mechanism dynamics – Coincident points – Coriolis component of acceleration.

UNIT–III: Gyroscope and Gear Trains (9 Lectures)

Principle of gyroscope, gyroscopic effect in an aeroplane, ship, car and two wheeler, simple problems. Gear Profile: Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting – helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

UNIT–IV: Balancing and Cams (9 Lectures)

Balancing of rotating masses: Need for balancing, balancing of single mass and several masses in different planes, using analytical and graphical methods. Cams:

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

UNIT–V: Vibrations and Flywheels (9 Lectures)

Vibrations: Introduction, degree of freedom, types of vibrations, free natural vibrations, Newton method and energy method for single degree of freedom. Damped vibrations – under damped, critically damped, and over damped systems, forced vibrations with and without damping in single degree of freedom; Vibration isolation and transmissibility. Turning Moment Diagrams and Flywheels: Turning moment diagrams for steam engine, I.C. engine and multi cylinder engine. Crank effort – coefficient of fluctuation of energy, coefficient of fluctuation of speed – Flywheel and their design, flywheels for punching press.

Text Books:

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

Reference Books:

1. F. Haidery, *Dynamics of Machines*, 5/e, Nirali Prakashan, Pune, 2003.
2. J.E. Shigley, *Theory of Machines and Mechanisms*, 4/e, Oxford, 2014.
3. G.K. Groover, *Mechanical Vibrations*, 8/e, Nemchand Bros, 2009.
4. R.L. Norton, *Design of Machinery – An Introduction to Synthesis and Analysis of Mechanisms and Machines*, 2/e, McGraw Hill, 2000.
5. William T. Thomson, *Theory of Vibration with Applications*, 4/e, Prentice Hall, 1993.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/112/106/112106137/
2. https://archive.nptel.ac.in/courses/112/105/112105234/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/
4. https://www.coursera.org/learn/machine-design

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEL04	FLUID MECHANICS & HYDRAULIC MACHINES LAB	0	0	3	1.5

Internal Marks: 50 External Marks: 50

Course Objective:

To impart practical exposure on the performance evaluation methods of various flow 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 Orificemeter.
10. Determination of friction factor for a given pipeline.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Turbine flow meter.

Virtual Lab:

1. To study different patterns of a flow through a pipe and correlate them with the Reynolds number of the flow. https://me.iitp.ac.in/Virtual-Fluid-Laboratory/reynolds/introduction.html
2. To calculate Total Energy at different points of venturimeter. 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: At the end of the course, the student will be able to

CO1: Demonstrate the devices used for measuring flow. (L3)
CO2: Compute major losses in pipes. (L5)
CO3: Illustrate the operating parameters of turbines. (L2)
CO4: Explain the working of different types of pumps. (L2)
CO5: Explain the devices used for measuring flow. (L2)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEL05	MANUFACTURING PROCESSES LAB	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Acquire practical knowledge on metal casting processes.
2. Gain hands-on skills in welding techniques.
3. Understand press working and sheet metal forming operations.
4. Learn processing of plastics through molding operations.
5. Familiarize with modern manufacturing techniques like 3D printing.

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

CO1: Make moulds for sand casting. (L2)

CO2: Fabricate different types of components using various manufacturing techniques. (L5)

CO3: Adapt unconventional manufacturing methods. (L3)

CO4: Develop different weld joints. (L6)

CO5: Explain different types of 3D printing techniques. (L2)

List of Experiments:

1. Design and making of pattern
   (i) Single piece pattern
   (ii) Split pattern
2. Sand properties testing
   (i) Sieve analysis (dry sand)
   (ii) Clay content test
   (iii) Moisture content test
   (iv) Strength test (Compression test & Shear test)
   (v) Permeability test
3. Mould preparation
   (i) Straight pipe
   (ii) Bent pipe
   (iii) Dumble
   (iv) Gear blank
4. Gas cutting and welding
5. Manual metal arc welding
   (i) Lap joint

(ii) Butt joint

6. Injection 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:

1. To study and observe various stages of casting through demonstration of casting process. https://virtual-labs.github.io/exp-sand-casting-process-dei/theory.html
2. To weld and cut metals using an oxyacetylene welding setup. https://virtual-labs.github.io/exp-gas-cutting-processes-iitkgp/index.html
3. To simulate Fused Deposition Modelling process (FDM). https://3dpdei.vlabs.ac.in/exp/simulation-modelling-process
4. https://altair.com/inspire-mold/
5. https://virtual-labs.github.io/exp-simulation-cartesian-system-dei/theory.html

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MES02	SOFT SKILLS (Common to ECE, EE(VLSI DT), Mechanical)	2	0	0	2

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To prepare students to face global competition for employment and excellence in profession.
2. To help students understand and build interpersonal and intrapersonal skills that will enable them to lead a meaningful professional life.

UNIT–I: Introduction (6 Lectures)

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 development, improving techniques.

UNIT–II: Intra-Personal (6 Lectures)

Definition, meaning, importance – SWOT analysis, Johari window, goal setting, quotient skills, emotional intelligence, attitudinal skills, right thinking, problem solving, time management, stress management.

UNIT–III: Inter-Personal (6 Lectures)

Definition, meaning, importance – communication skills, teamwork, managerial skills, negotiation skills, leadership skills, corporate etiquettes.

UNIT–IV: Verbal Skills (6 Lectures)

Definition and meaning – listening skills (need, types, advantages, importance, improving tips), 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 (6 Lectures)

Definition and meaning, importance – facial expressions, eye contact, proxemics, haptics, posture, cross-cultural body language, body language in interview room, appearance and dress code, kinesics, paralanguage (tone, pitch, pause, neutralization of accent, use of appropriate language), interview skills, interview methods and questions.

Text Books:

1. Sherfield, M. Robert et al., *Cornerstone: Developing Soft Skills*, 4/e, Pearson Publication, New Delhi, 2014.
2. Alka Wadkar, *Life Skills for Success*, 1/e, Sage Publications India Pvt. Ltd, 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: Principles 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:

1. https://onlinecourses.nptel.ac.in/noc20_hs60/preview
2. http://www.youtube.com/@softskillsdevelopment6210
3. https://youtube.com/playlist?list=PLLy_2iUCG87CQhELCytvXh0E_y-bOO1_q&si=Fs05Xh8ZrOPsR8F4
4. https://www.coursera.org/learn/people-soft-skills-assessment?language=English
5. https://www.edx.org/learn/soft-skills

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

CO1: Assimilate and understand the meaning and importance of soft skills and learn how to develop them. (L1)

CO2: Understand the significance of soft skills in the working environment for professional excellence. (L2)

CO3: Prepare to undergo the placement process with confidence and clarity. (L3)

CO4: Face any situation in life and equip themselves to handle them effectively. (L6)

CO5: Understand and learn the importance of etiquette in both professional and personal life. (L2)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BST17	DESIGN THINKING & INNOVATION	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Bring awareness on innovative design and new product development.
2. Explain the basics of design thinking.
3. Familiarize the role of reverse engineering in product development.
4. Train how to identify the needs of society and convert into demand.
5. Introduce product planning and product development process.

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

CO1: Define the concepts related to design thinking. (L1)
CO2: Explain the fundamentals of Design Thinking and innovation. (L2)
CO3: Apply the design thinking techniques for solving problems in various sectors. (L3)
CO4: Analyse to work in a multidisciplinary environment. (L4)
CO5: Evaluate the value of creativity. (L5)

Course Content:

1. **UNIT I – Introduction to Design Thinking (6 Lectures)** 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.
2. **UNIT II – Design Thinking Process (6 Lectures)** Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking – persona, customer journey map, brainstorming, product development.
   Activity: Student presentations (idea in 3 minutes, design process as flow chart, product development explanation).
3. **UNIT III – Innovation (6 Lectures)** 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 vs creativity, planning from idea to innovation, debate on value-based innovation.
4. **UNIT IV – Product Design (6 Lectures)** Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design. Case studies.
   Activity: Importance of modeling, setting specifications, explaining own product design.

5. **UNIT V – Design Thinking in Business Processes (6 Lectures)** Design Thinking applied in Business & Strategic Innovation, 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 & testing Business Models and Business Cases. Developing & testing prototypes.
   Activity: Marketing own product, maintenance, reliability, and planning for startup.

Text Books:

1. Tim Brown, *Change by Design*, 1/e, Harper Collins, 2009.
2. Idris Mootee, *Design Thinking for Strategic Innovation*, 1/e, Adams Media, 2014.

Reference Books:

1. David Lee, *Design Thinking in the Classroom*, Ulysses Press, 2018.
2. Shrrutin N Shetty, *Design the Future*, 1/e, Norton Press, 2018.
3. William Lidwell, Kritina Holden & Jill Butler, *Universal Principles of Design*, 2/e, Rockport Publishers, 2010.
4. Chesbrough H., *The Era of Open Innovation*, 2003.

Online Learning Resources:

1. https://nptel.ac.in/courses/110/106/110106124/
2. https://nptel.ac.in/courses/109/104/109104109/
3. https://swayam.gov.in/nd1_noc19_mg60/preview
4. https://onlinecourses.nptel.ac.in/noc22_de16/preview

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET07	MACHINE TOOLS & METROLOGY	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To learn the fundamental knowledge and principles of material removal processes.
2. To understand the basic principles of lathe, shaping, slotting and planning machines.
3. To demonstrate the fundamentals of drilling, milling and boring processes.
4. To discuss the concepts of super finishing processes and limits and fits.
5. To understand the concepts of surface roughness and optical measuring instruments.

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

CO1: Learn the fundamental knowledge and principles in material removal process. (L2)

CO2: Acquire the knowledge on operations in conventional, automatic, Capstan and turret lathes. (L3)

CO3: Understand the working principles and operations of shaping, slotting, planning, drilling and boring machines. (L2)

CO4: Perform gear cutting and keyway operations in milling machines and understand the indexing mechanisms. (L3)

CO5: Understand the different types of surface roughness and optical measuring instruments. (L2)

UNIT–I: Fundamentals of Machining (9 Lectures)

Elementary treatment of metal cutting theory – Elements of cutting process – Single point cutting tools, nomenclature, tool signature – Mechanism of metal cutting – Types of chips – Mechanics of orthogonal and oblique cutting – Merchant's force diagram – Cutting forces – Taylor's tool life equation, simple problems – Tool wear, tool wear mechanisms – Machinability – Economics of machining – Coolants – Tool materials and properties.

UNIT–II: Lathe, Shaping, Slotting and Planning Machines (9 Lectures)

Lathe Machines: Introduction – Types of lathe – Engine lathe – Principle of working – Construction – Specification of lathe – Accessories and attachments – Lathe operations – Taper turning methods and thread cutting – Drilling on lathes. Shaping, Slotting and Planning Machines: Introduction – Principle of working – Principal parts – Specifications – Operations performed – Slider crank mechanism – Machining time calculations.

UNIT–III: Drilling, Boring and Milling Machines (9 Lectures)

Drilling & Boring Machines: Introduction – Construction of drilling machines – Types of drilling machines – Principle of working – Specifications – Types of drills – Operations performed – Machining time calculations – Boring Machines – Types. Milling Machines: Introduction – Principle of working – Specifications – Milling methods – Classification of milling machines – Types of cutters – Methods of indexing – Machining time calculations.

UNIT–IV: Finishing Processes, Limits and Fits, Linear Measurement (9 Lectures)

Finishing Processes: Classification of grinding machines – Types of abrasives – Bonds – Specification and selection of a grinding wheel – Lapping, Honing & Broaching operations – Comparison with grinding. Systems of Limits and Fits: Types of fits – Unilateral and bilateral tolerance system – Hole and shaft basis systems – Interchangeability & selective assembly – International standard system of tolerances – Simple problems related to limits and fits – Taylor's principle – Design of go and no-go gauges: plug, ring, snap, gap, taper, profile and position gauges. Linear Measurement: Length standards, end standards, slip gauges – Calibration of slip gauges – Dial indicators – Micrometers.

UNIT–V: Angular Measurement, Surface Roughness and Optical Instruments (9 Lectures)

Angular Measurement: Bevel protractor – Angle slip gauges – Angle dekkor – Spirit levels – Sine bar – Sine table. Surface Roughness Measurement: Differences between surface roughness and waviness – Numerical assessment of surface finish – Profilograph – Talysurf – ISI symbols. Optical Measuring Instruments: Tool maker's microscope – Autocollimators – Optical projector – Optical flats – Working principle, construction, merits, demerits and uses – Optical comparators.

Text Books:

1. J.P. Kaushish, *Manufacturing Processes*, 2/e, PHI Publishers.
2. P.N. Rao, *Manufacturing Technology, Vol-II*, Tata McGraw Hill.
3. R.K. Jain, *Engineering Metrology*, Khanna Publishers.

Reference Books:

1. Geoffrey Boothroyd, Winston A. Knight, *Metal Cutting and Machine Tools*, Taylor & Francis.
2. *Production Technology*, HMT Hand Book, Hindustan Machine Tools.
3. K.C. Jain & A.K. Chitaley, *Production Engineering*, PHI Publishers.
4. S.F. Krar, A.R. Gill, Peter Smid, *Technology of Machine Tools*, TMH.
5. Kalpakjian S., Steven R. Schmid, *Manufacturing Processes for Engineering Materials*, 5/e, Pearson.

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET08	THERMAL ENGINEERING	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To give insight into basic principles of air standard cycles.
2. To impart knowledge about IC engines and boilers.
3. To make the students learn the working principles of steam nozzles, turbines and compressors.
4. To impart the knowledge about the various types of compressors and gas turbines.
5. To make the students gain insights about rockets, jet propulsion and solar engineering.

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

CO1: Explain the basic concepts of air standard cycles. (L2)
CO2: Gain knowledge about IC Engines and Boilers. (L3)
CO3: Discuss the concepts of steam nozzles, steam turbines and steam condensers. (L2)
CO4: Gain knowledge about the concepts of compressors and gas turbines. (L3)
CO5: Acquire insights about jet propulsion, rockets and solar engineering. (L2)

UNIT–I: Air Standard and Actual Cycles (9 Lectures)

Air standard cycles: Otto, Diesel and Dual cycles, comparison, Brayton cycle. Actual Cycles and their Analysis: Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blowdown – Loss due to gas exchange process, Volumetric Efficiency, Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines.

UNIT–II: IC Engines and Boilers (9 Lectures)

IC Engines: Classification, working principles of SI and CI engines – Valve and Port Timing Diagrams – Engine systems: Fuel, Carburetor, Fuel Injection System, Ignition, Cooling and Lubrication – Principles of supercharging and turbocharging – Measurement, Testing and Performance. Boilers: Principles of LP & HP boilers, mountings and accessories, draught – induced and forced.

UNIT–III: Steam Nozzles, Turbines and Condensers (9 Lectures)

Steam Nozzles: Functions, applications, types – Flow through nozzles – Condition for maximum discharge – Critical pressure ratio – Criteria to decide nozzle shape – Wilson line. Steam Turbines: Classification – Impulse turbine: velocity diagram, effect of friction, diagram efficiency – De-Laval turbine, methods to reduce rotor speed, combined velocity diagram. Reaction Turbine: Principle, velocity diagram,

Parson's reaction turbine – Condition for maximum efficiency. Steam Condensers: Classification, working principles of different types – Vacuum efficiency and condenser efficiency.

UNIT–IV: Compressors and Gas Turbines (9 Lectures)

Compressors: Classification – Reciprocating type: Principle, multi-stage compression – Rotary type: Lysholm compressor, principle and efficiency considerations. Centrifugal Compressors: Principle, velocity and pressure variation, velocity diagrams. Axial Flow Compressors: Principle, pressure rise and efficiency calculations. Gas Turbines: Simple gas turbine plant – Ideal cycle, components – Regeneration, inter-cooling and reheating.

UNIT–V: Jet Propulsion, Rockets and Solar Engineering (9 Lectures)

Jet Propulsion: Principle, classification, T-S diagram, turbojet engines – Thermodynamic cycle, performance evaluation. Rockets: Principle, solid and liquid propellant rocket engines. Solar Engineering: Solar radiation, solar collectors, PV cells, storage methods and applications.

Text Books:

1. Mahesh Rathore, *Thermal Engineering*, McGraw Hill Publishers.
2. V.P. Vasandani, D.S. Kumar, *Heat Engineering*, Metropolitan Book Company, New Delhi.

Reference Books:

1. V. Ganesan, *IC Engines*, Tata McGraw Hill Publishers.
2. M.L. Mathur, Mehta, *Thermal Engineering*, Jain Bros. Publishers.
3. P.L. Ballaney, *Thermal Engineering*, Khanna Publishers.
4. R.K. Rajput, *Thermal Engineering*, Lakshmi Publications.
5. R.S. Khurmi, J.S. Gupta, *Thermal Engineering*, S. Chand.

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET09	DESIGN OF MACHINE ELEMENTS	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Familiarize with fundamental approaches to failure prevention for static and dynamic loading.
2. Provide an introduction to design of bolted and welded joints.
3. Explain design procedures for shafts and couplings.
4. Discuss the principles of design for clutches, brakes and springs.
5. Explain design procedures for bearings and gears.

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

CO1: Design machine members subjected to static and dynamic loads. (L3)
CO2: Design shafts and couplings for power transmission. (L3)
CO3: Learn how to design bolted and welded joints. (L2)
CO4: Know the design procedures of clutches, brakes and springs. (L3)
CO5: Design bearings and gears. (L3)

UNIT–I: Introduction, Design for Static and Dynamic Loads (9 Lectures)
Mechanical Engineering Design: Design process, design considerations, codes and standards, 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 (9 Lectures)
Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in bolts, torque requirement for bolt tightening, gasketed joints. Welded Joints: Strength of lap and butt welds, joints subjected to bending and torsion.

UNIT–III: Power Transmission Shafts and Couplings (9 Lectures)
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 (9 Lectures)
Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches – Uniform wear 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 (9 Lectures)

Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing, bearing failures. 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. Gears: Spur gears – Beam strength, Lewis equation, design for dynamic and wear loads.

Note: Data book is not allowed.

Text Books:

1. R.L. Norton, *Machine Design – An Integrated Approach*, 2/e, Pearson Education, 2004.
2. V.B. Bhandari, *Design of Machine Elements*, 3/e, Tata McGraw Hill, 2010.
3. N.C. Pandya, C.S. Shah, *Machine Design*, 17/e, Charotar Publishing House, 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, T.E. Shoup, *Design of Machine Elements*, 3/e, Prentice Hall (Pearson), 2013.

Online Learning Resources:

1. https://www.yumpu.com/en/document/view/18818306/lesson-3-course-name-design-ofmachine-elements-1-npte
2. https://www.digimat.in/nptel/courses/video/112105124/L01.html
3. https://dokumen.tips/documents/nptel-design-of-machine-elements-1.html
4. http://www.nitttrc.edu.in/nptel/courses/video/112105124/L25.html

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEL06	THERMAL ENGINEERING LAB	0	0	3	1.5

Internal Marks: 50 External Marks: 50

Course Objectives:

1. Demonstrate the characteristics of two stroke and four stroke compression and spark ignition engines.
2. Determine flash point, fire point, calorific value of different fuels using various apparatus.
3. Find out engine friction, and conduct load test of petrol and diesel engines.
4. Demonstrate performance test on petrol and diesel engines.
5. Conduct performance test and determine efficiency of air compressor.

List of Experiments:

1. Determination of actual valve timing diagram of a four stroke Compression/Spark Ignition Engine.
2. Determination of actual port timing diagram of a two stroke Compression/Spark Ignition Engine.
3. Determination of flash & fire points of liquid fuels / lubricants using (i) Abel's apparatus, (ii) Pensky Martin's apparatus, and (iii) Cleveland's apparatus.
4. Determination of viscosity of liquid lubricants/fuels using (i) Saybolt Viscometer and (ii) Redwood Viscometer.
5. Evaluation of engine friction by conducting Morse test on 4-stroke multicylinder petrol/diesel engine.
6. Heat Balance Test on single cylinder four stroke petrol/diesel engine.
7. Load test on single cylinder petrol/diesel engine to study its performance under various loads.
8. Performance test on a VCR engine under different compression ratios and determination of heat balance sheet.
9. Performance test on an air compressor and determination of different efficiencies.
10. Study of boilers with accessories and mountings.
11. Experimentation on installation of Solar PV cells.
12. Demonstration of electronic controls in an automobile.

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

CO1: Experiment with two stroke and four stroke compression and spark ignition engines for various characteristics. (L3)

CO2: Determine flash point, fire point, calorific value of different fuels using various apparatus. (L3)

CO3: Perform engine friction, heat balance test, load test of petrol and diesel engines. (L3)

CO4: Conduct performance test on petrol and diesel engines. (L3)

CO5: Perform test and determine efficiency of air compressor. (L3)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEL07	THEORY OF MACHINES LAB	0	0	3	1.5

Internal Marks: 50 External Marks: 50

Course Objectives:

1. Demonstrate the motion of a gyroscope.
2. Study the characteristics of governors.
3. Find the frequencies of damped and undamped free and forced vibrations.
4. Analyze different mechanisms.
5. Demonstrate various types of gears.

List of Experiments:

1. Determination of whirling speed of shaft theoretically and experimentally.
2. Determination of sleeve position against controlling force and speed of a Hartnell governor and plotting the characteristic curve of radius of rotation.
3. Analysis of motion of a motorized gyroscope when couple is applied along its spin axis.
4. Determination of frequency of undamped free vibration of an equivalent spring mass system.
5. Determination of frequency of damped forced vibration of a spring mass system.
6. Study of static and dynamic balancing using rigid blocks.
7. Determination of moment of inertia of a flywheel.
8. Plotting of follower displacement vs cam rotation for various cam follower systems.
9. Plotting of slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/four bar mechanism.
10. Determination of coefficient of friction between belt and pulley.
11. Study of simple and compound screw jack and determination of mechanical advantage, velocity ratio, and efficiency.
12. Study of various types of gears – Spur, Helical, Worm and Bevel Gears.

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

CO1: Explain the motion of a gyroscope. (L2)

CO2: Discuss the characteristics of governors. (L3)

CO3: Find the frequencies of damped and undamped free and forced vibrations. (L3)

CO4: Analyze different mechanisms. (L3)

CO5: Demonstrate various types of gears. (L3)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MES03	MACHINE TOOLS & METROLOGY LAB	0	0	4	2

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To understand the parts of various machine tools and about different shapes of products that can be produced on them.
2. To measure bores, angles and tapers.
3. To perform alignment tests on various machines.

Note: The students have to conduct at least 6 experiments from each lab.

Machine Tools Lab:

1. Introduction of general purpose machines - Lathe, Drilling machine, Milling machine, Shaper, Planing machine, Slotting machine, Cylindrical grinder, Surface grinder and Tool and cutter grinder.
2. Operations on Lathe machines - Step turning, Knurling, Taper turning, Thread cutting and Drilling.
3. Operations on Drilling machine - Drilling, Reaming, Tapping, Rectangular drilling, Circumferential drilling.
4. Operations on Shaping machine - (i) Round to square (ii) Round to Hexagonal.
5. Operations on Slotter - (i) Keyway (T–slot) (ii) Keyway cutting.
6. Operations on Milling machines - (i) Indexing (ii) Gear manufacturing.

Metrology Lab:

1. Calibration of vernier calipers, micrometers, vernier height gauge and dial gauges.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier caliper for tooth thickness inspection and flange micrometer for checking the chordal thickness of spur gear.
4. Machine tool alignment test on the lathe.
5. Machine tool alignment test on drilling machine.
6. Machine tool alignment test on milling machine.
7. Angle and taper measurements with bevel protractor, sine bar, rollers and balls.
8. Use of spirit level in finding the straightness of a bed and flatness of a surface.
9. Thread inspection with two wire/three wire method & tool makers microscope.
10. Surface roughness measurement with roughness measuring instrument.

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

1. Gain knowledge about the parts of various machine tools and about different shapes of products that can be produced on them.
2. Learn to measure bores, angles and tapers.
3. Perform alignment tests on various machines.

Course Code	Course Name	Course Structure			
		L	T	P	C
P23BSL04	TINKERING LAB	0	0	2	1

Internal Marks: 30 External Marks: 70

Course Objectives: To

1. Encourage Innovation and Creativity.
2. Provide Hands-on Learning.
3. Impart Skill Development.
4. Foster Collaboration and Teamwork.
5. Enable Interdisciplinary Learning.
6. Impart Problem-Solving mind-set.
7. Prepare for Industry and Entrepreneurship.

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

List of Experiments:

1. Make your own parallel and series circuits using breadboard for any application of your choice.
2. Demonstrate a traffic light circuit using breadboard.
3. Build and demonstrate automatic Street Light using LDR.
4. Simulate the Arduino LED blinking activity in Tinkercad.
5. Build and demonstrate an Arduino LED blinking activity using Arduino IDE.
6. Interfacing IR Sensor and Servo Motor with Arduino.
7. Blink LED using ESP32.
8. LDR Interfacing with ESP32.
9. Control an LED using Mobile App.
10. Design and 3D print a Walking Robot.
11. Design and 3D Print a Rocket.
12. Build a live soil moisture monitoring project, and monitor soil moisture levels of a remote plant in your computer dashboard.
13. Demonstrate all the steps in design thinking to redesign a motor bike.

Online Learning Resources:

1. `https://aim.gov.in/pdf/equipment-manual-pdf.pdf`
2. `https://atl.aim.gov.in/ATL-Equipment-Manual/`

3. https://aim.gov.in/pdf/Level-1.pdf
4. https://aim.gov.in/pdf/Level-2.pdf
5. https://aim.gov.in/pdf/Level-3.pdf

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

1. Experiment, innovate, and solve real-world challenges.

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE01	DESIGN FOR MANUFACTURING (Professional Elective–I)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives: The students will acquire the knowledge

1. To understand the basic concepts of design for manual assembly.
2. To interpret basic design procedure of machining processes.
3. To understand design considerations in metal casting, extrusion and sheet metal work.
4. To interpret the design considerations of various metal joining processes.
5. To interpret the basic design concepts involved in the assembly automation.

UNIT–I: Introduction to DFM, DFMA and Design for Manual Assembly (9 Lectures)

Introduction to DFM, DFMA: How Does DFMA Work? 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: Design for Machining (9 Lectures)

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: Design for Casting, Extrusion and Sheet Metal Work (9 Lectures)

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 guidelines for extruded sections, Design principles for punching, blanking, bending, deep drawing. Keeler–Goodman forging line diagram, Component design for blanking.

UNIT–IV: Design for Metal Joining and Forging (9 Lectures)

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 and Additive Manufacturing (9 Lectures)

Assembly Automation: Fundamentals of automated assembly systems, System configurations, Parts delivery systems at workstations, Escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi-station assembly systems, Single-station assembly lines. Design for Additive Manufacturing (AM): Introduction to AM, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part orientation, Removal of supports, Hollowing out parts, Inclusion of undercuts and other manufacturing constraining features, Interlocking features, Reduction of part count in an assembly, Identification of markings/numbers.

Text Books:

1. John Cobert, *Design for Manufacture*, Addison Wesley, 1995.
2. Boothroyd, *Design for Manufacture*.
3. James Bralla, *Design for Manufacture*.

Reference Books:

1. Molloy, E.A., Warman, S., Tilley, *Design for Manufacturing and Assembly: Concepts, Architectures and Implementation*, Springer, 1998.
2. ASM Handbook, Vol. 20.

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

CO1: Understand the basic concepts of design for manual assembly. (L2)
CO2: Identify basic design procedure of various machining processes. (L3)
CO3: Illustrate the design considerations in metal casting, extrusion and sheet metal work. (L3)
CO4: Interpret the design considerations of various metal joining processes. (L3)
CO5: Understand the basic design concepts involved in the assembly automation. (L2)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE02	CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY (Professional Elective–I)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To study the advanced engine technologies.
2. To learn various advanced combustion technologies and their benefits.
3. To learn the methods of using low carbon fuels and their significance.
4. To learn and understand the hybrid and electric vehicle configurations.
5. To study the application of fuel cell technology in automotive.

UNIT–I: Advanced Engine Technology (9 Lectures)

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder Deactivation, After Treatment Technologies, Electric EGR, Current EMS Architecture.

UNIT–II: Combustion Technology (9 Lectures)

Spark Ignition Combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion. Low Temperature Combustion Concepts – Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT–III: Low Carbon Fuel Technology (9 Lectures)

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges and Way Forward.

UNIT–IV: Hybrid and Electric Vehicles (9 Lectures)

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery). Pure Electric Vehicle Technology – Challenges and Way Forward.

UNIT–V: Fuel Cell Technology (9 Lectures)

Fuel Cells for Automotive Applications – Technology advances in fuel cell vehicle systems. Onboard Hydrogen Storage – Liquid hydrogen and compressed hydrogen – Metal hydrides. Fuel Cell Control System – Alkaline fuel cell – Road map to market.

Text Books:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 2004.

2. Rakesh Kumar Maurya, *Characteristics and Control of Low Temperature Combustion Engines*, Springer, ISBN 978-3-319-68507-6.

Reference Books:

1. Iqbal Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.
2. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003.
3. Rand D.A.J, Woods, R & Dell RM, *Batteries for Electric Vehicles*, John Wiley & Sons, 1998.

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

CO1: Discuss the latest trends in engine technology. (L2)
CO2: Discuss the need for advanced combustion technologies and their impact on reducing carbon footprint. (L2)
CO3: Analyze the characteristics of low carbon fuels and their role in sustainable development. (L3)
CO4: Discuss the working and energy flow in various hybrid and electric vehicle configurations. (L2)
CO5: Analyze the need for fuel cell technology in automotive applications. (L3)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE03	RENEWABLE ENERGY TECHNOLOGIES (Professional Elective–I)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To demonstrate the importance and impact of solar radiation and solar PV modules.
2. To understand the principles of storage in PV systems.
3. To discuss solar energy storage systems and their applications.
4. To gain knowledge in wind energy and biomass.
5. To gain insights into geothermal energy, ocean energy and fuel cells.

UNIT–I: Solar Radiation and Solar PV Systems (9 Lectures)

Solar Radiation: Role and potential of renewable sources, solar energy option, environmental impact of solar power, structure of the sun, solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sunshine, solar radiation data, numerical problems.

Solar PV Modules and PV Systems: PV module circuit design, module structure, packing density, interconnections, mismatch and temperature effects, electrical and mechanical insulation, lifetime of PV modules, degradation and failure, PV module parameters, efficiency, design of off-grid solar power plant, installation and maintenance.

UNIT–II: Storage in PV Systems (9 Lectures)

Battery operation, types of batteries, battery parameters, application and selection of batteries for solar PV system, battery maintenance and measurements, battery installation for PV system.

UNIT–III: Solar Energy Collection, Storage and Applications (9 Lectures)

Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation. **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, solar chimney.

UNIT–IV: Wind and Biomass Energy (9 Lectures)

Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criterion, types of winds, wind data measurement.

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

UNIT–V: Geothermal, Ocean and Fuel Cell Technologies (9 Lectures)

Geothermal Energy: Origin, applications, types of geothermal resources, relative merits. **Ocean Energy:** Ocean Thermal Energy – Open cycle and closed cycle OTEC plants, environmental impacts, challenges. **Fuel Cells:** Introduction, applications, classification, types of fuel cells – phosphoric acid, alkaline, PEM, molten carbonate fuel cells.

Text Books:

1. Sukhatme S.P. and J.K. Nayak, *Solar Energy – Principles of Thermal Collection and Storage*, TMH.
2. Khan B.H, *Non-Conventional Energy Resources*, Tata McGraw Hill, 2006.
3. J. Paulo Davim, *Green Manufacturing Processes and Systems*, Springer, 2013.

Reference Books:

1. D. Yogi Goswami, Frank Kreith & John F. Kreider, *Principles of Solar Engineering*, Taylor & Francis.
2. Ashok V. Desai, *Non-Conventional Energy*, New Age International (P) Ltd.
3. Ramesh & Kumar, *Renewable Energy Technologies*, Narosa.
4. G.D. Roy, *Non-Conventional Energy Sources*, Standard Publishers.

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

CO1: Illustrate the importance of solar radiation and solar PV modules. (L2)
CO2: Discuss the storage methods in PV systems. (L2)
CO3: Explain the solar energy storage methods and applications. (L2)
CO4: Understand the principles of wind energy and biomass energy. (L2)
CO5: Gain knowledge of geothermal, ocean and fuel cell technologies. (L2)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE04	NON-DESTRUCTIVE EVALUATION (Professional Elective–I)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

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

UNIT–I: Introduction to NDE and Radiographic Test (9 Lectures)

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, neutron ray radiography.

UNIT–II: Ultrasonic Test (9 Lectures)

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 and Eddy Current Test (9 Lectures)

Liquid Penetrant Test: Basic concepts, liquid penetrant system, test procedure, effectiveness, DPI, FPI, limitations of liquid penetrant testing. **Eddy Current Test:** Principle of eddy current, eddy current test system, applications of eddy current testing, effectiveness of eddy current testing.

UNIT–IV: Magnetic Particle Test (9 Lectures)

Magnetic materials, magnetization of materials, demagnetization of materials. Principle of magnetic particle test, magnetic particle test equipment, test procedure, standardization and calibration, interpretation and evaluation, effective applications and limitations of magnetic particle test.

UNIT–V: Infrared and Thermal Testing (9 Lectures)

Introduction and fundamentals of infrared and thermal testing. Heat transfer – active and passive techniques – lock-in and pulse thermography, tomography. Contact and non-contact thermal inspection methods, heat sensitive paints, papers, thermally quenched phosphors, liquid crystals. Techniques for applying liquid crystals, temperature sensitive coatings, inspection methods, infrared radiation and infrared detectors. Thermo-mechanical behaviour of materials, IR imaging in aerospace applications, electronic components, honeycomb and sandwich structures – case studies.

Text Books:

1. J. Prasad, G.C.K. Nair, *Nondestructive Test and Evaluation of Materials*, TMH Publishers.
2. H. KrautKramer, *Ultrasonic Testing of Materials*, Springer.
3. Warren J. McGonnagle, *Nondestructive Testing*, Gordon and Breach Science Publishers.
4. X.P.V. Maldague, *Nondestructive Evaluation of Materials by Infrared Thermography*, Springer-Verlag, 1993.

Reference Books:

1. E.A. Gingel, *Ultrasonic Inspection Training for NDT*, Prometheus Press.
2. ASTM Standards, Vol. 3.01, Metals and Alloys.
3. R. Ham Chand, *Non-Destructive Evaluation Handbook*.

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

CO1: Understand the concepts of various NDE techniques and requirements of radiography techniques including safety aspects. (L2)
CO2: Interpret the principles and procedure of ultrasonic testing. (L2)
CO3: Understand the principles and procedure of liquid penetrant and eddy current testing. (L2)
CO4: Illustrate the principles and procedure of magnetic particle testing. (L3)
CO5: Interpret the principles and procedure of infrared and thermal testing. (L2)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET10	HEAT TRANSFER	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives: The students will acquire the knowledge

1. To learn the different modes of heat transfer and conduction heat transfer through various solid bodies.
2. To learn the one dimensional steady state conduction heat transfer and one dimensional transient heat conduction.
3. To learn the basic concepts of convective heat transfer and forced convection heat transfer of external flows and internal flows.
4. To learn the free convection heat transfer concepts and heat transfer processes in heat exchangers.
5. To learn the concepts of radiation heat transfer.

UNIT–I: Introduction and Conduction Heat Transfer (9 Lectures)

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: Transient Conduction and Convective Heat Transfer (9 Lectures)

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: Forced and Free Convection (9 Lectures)

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 and Heat Exchangers (9 Lectures)

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 (9 Lectures)

Emission characteristics and laws of black-body radiation – Irradiation – Total and monochromatic quantities – Laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann – Heat exchange between two black bodies – Concepts of shape factor – Emissivity – Heat exchange between grey bodies – Radiation shields – Electrical analogy for radiation networks.

Note: Heat transfer data book by C.P. Kothandaraman and Subrahmanyan is allowed.

Text Books:

1. HOLMAN, *Heat Transfer*, Tata McGraw-Hill.
2. P.K. Nag, *Heat Transfer*, TMH.

Reference Books:

1. Incropera & Dewitt, *Fundamentals of Heat Transfer*, John Wiley.
2. R.C. Sachdeva, *Fundamentals of Engineering Heat & Mass Transfer*, New Age.
3. Amit Pal, *Heat & Mass Transfer*, Pearson Publishers.
4. Ghosh A. Dastidar, *Heat Transfer*, Oxford University Press.
5. Yunus Cengel, Boles, *Heat Transfer: A Practical Approach*, TMH.
6. Sarit K. Das, *Engineering Heat and Mass Transfer*, Dhanpat Rai Publishers.

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

CO1: Find heat transfer rate for 1D, steady state composite systems with heat generation and performance of fins. (L3)

CO2: Understand the concepts of transient heat conduction and basic laws involved in convection heat transfer. (L2)

CO3: Apply the empirical equations for forced convection and free convection problems. (L3)

CO4: Examine the rate of heat transfer with phase change and in the heat exchangers. (L4)

CO5: Illustrate the concepts of radiation heat transfer. (L2)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET11	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives: The students will acquire knowledge

1. To impart the basic concepts of artificial intelligence and the principles of knowledge representation and reasoning.
2. To introduce the machine learning concepts and supervised learning methods.
3. To enable the students gain knowledge in unsupervised learning method and Bayesian algorithms.
4. To make the students learn about neural networks and genetic algorithms.
5. To understand the machine learning analytics and deep learning techniques.

UNIT–I: Introduction and Knowledge Representation (9 Lectures)

Introduction: Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and Environments; Good Behaviour – concept of rationality, the nature of environments, structure of agents. Knowledge Representation and Reasoning: Logical Agents: Knowledge-based agents, the Wumpus world, logic. Patterns in Propositional Logic, Inference in First-Order Logic – Propositional vs First Order inference, unification.

UNIT–II: Machine Learning and Supervised Learning (9 Lectures)

Introduction to Machine Learning (ML): Definition, Evolution, Need, applications of ML in industry and real world, regression and classification problems, performance metrics, differences between supervised and unsupervised learning paradigms, bias, variance, overfitting and underfitting. Supervised Learning: Linear regression, logistic regression, Distance-based methods, Nearest-Neighbours, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods.

UNIT–III: Unsupervised Learning and Bayesian Learning (9 Lectures)

Unsupervised Learning: Clustering, K-means, Dimensionality Reduction, PCA and Kernel methods. Bayesian and Computational Learning: Bayes theorem, concept learning, maximum likelihood of normal, binomial, exponential, and Poisson distributions, minimum description length principle, Naïve Bayes Classifier, Instance-based Learning – K-Nearest neighbour learning.

UNIT–IV: Neural Networks and Genetic Algorithms (9 Lectures)

Neural Networks: Representation, problems, perceptron, multilayer networks and backpropagation, steepest descent method, Convolutional Neural Networks (CNNs) and their applications, Recurrent Neural Networks (RNNs) and their applications, Local vs Global optima. Genetic Algorithms: Binary coded GA, operators, convergence criteria.

UNIT–V: Deep Learning and Machine Learning Analytics (9 Lectures)

Deep Learning: Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks. Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model Selection, Ensemble Methods – Boosting, Bagging, and Random Forests.

Text Books:

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 2/e, Pearson Education, 2010.
2. Tom M. Mitchell, *Machine Learning*, McGraw Hill, 2013.
3. Ethem Alpaydin, *Introduction to Machine Learning (Adaptive Computation and Machine Learning)*, MIT Press, 2004.

Reference Books:

1. Elaine Rich, Kevin Knight and Shivashankar B. Nair, *Artificial Intelligence*, 3/e, McGraw Hill Education, 2008.
2. Dan W. Patterson, *Introduction to Artificial Intelligence and Expert Systems*, PHI Learning, 2012.

Online Resources:

1. `https://www.tpointtech.com/artificial-intelligence-ai`
2. `https://www.geeksforgeeks.org/`

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

CO1: Explain the basic concepts of artificial intelligence. (L2)
CO2: Apply principles of supervised learning methods. (L3)
CO3: Analyze unsupervised learning methods and Bayesian algorithms. (L4)
CO4: Examine the concepts of neural networks and genetic algorithms. (L4)
CO5: Evaluate machine learning analytics and apply deep learning techniques. (L5)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MET12	FINITE ELEMENT METHODS	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives: The students will acquire knowledge

1. To learn basic principles of finite element analysis procedure.
2. To learn how to solve the bar and truss problems.
3. To learn how to solve beam problems.
4. To understand the formulation of 2D problems.
5. To get knowledge in heat transfer analysis and dynamic analysis.

UNIT–I: Introduction to FEM (9 Lectures)

Introduction to finite element method – stress and equilibrium, strain–displacement relations, stress–strain relations, plane stress and plane strain conditions – variational and weighted residual methods – concept of potential energy – one-dimensional problems.

UNIT–II: Bar Elements and Trusses (9 Lectures)

Bar element formulation – Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation – interpolation functions – local and global coordinates – convergence requirements – treatment of boundary conditions. Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

UNIT–III: Beams (9 Lectures)

Analysis of Beams: Element stiffness matrix for Hermite beam element – derivation of load vector for concentrated and uniformly distributed loads (UDL) – simple problems on beams.

UNIT–IV: Two-Dimensional Problems and Higher-Order Elements (9 Lectures)

Finite element modeling of two-dimensional stress analysis with constant strain triangles – treatment of boundary conditions – formulation of axisymmetric problems. Higher order and iso-parametric elements: One dimensional quadratic and cubic elements in natural coordinates, two-dimensional four-node iso-parametric elements, and numerical integration.

UNIT–V: Heat Transfer and Dynamics (9 Lectures)

Steady state heat transfer analysis: one-dimensional analysis of a fin. Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

Text Books:

1. Tirupati Reddy Chandrupatla, *Introduction to Finite Elements in Engineering*, 2/e, Prentice-Hall.
2. S.S. Rao, *The Finite Element Method in Engineering*, Pergamon.

Reference Books:

1. Y.M. Desai, Eldho & Shah, *Finite Element Method with Applications in Engineering*, Pearson Publishers.
2. J.N. Reddy, *An Introduction to Finite Element Method*, McGraw-Hill.
3. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom, *The Finite Element Method for Engineers*, John Wiley & Sons.
4. Saeed Moaveni, *Finite Element Analysis: Theory and Application with ANSYS*, Pearson Education.
5. G. Lakshmi Narasaiah, *Finite Element Analysis: For Students & Practicing Engineers*.

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

CO1: Understand the concepts behind variational methods and weighted residual methods in FEM. (L2)
CO2: Apply FEM to solve bar and truss problems. (L3)
CO3: Apply FEM to solve beam problems. (L3)
CO4: Analyze 2D stress analysis problems, axisymmetric problems, and higher order iso-parametric elements. (L4)
CO5: Evaluate steady state heat transfer and dynamic analysis using FEM. (L5)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEL08	HEAT TRANSFER LAB	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objective: The laboratory course is aimed to provide practical exposure to the students in determining the amount of heat exchange in various modes of heat transfer including conduction, convection, radiation, condensation and boiling for different geometries.

PART–A: Experiments

1. Determination of overall heat transfer coefficient of a composite slab.
2. Determination of heat transfer rate through a lagged pipe.
3. Determination of heat transfer rate through a concentric sphere.
4. Determination of thermal conductivity of a metal rod.
5. Determination of efficiency of a pin-fin.
6. Determination of heat transfer coefficient in natural and forced convection.
7. Determination of effectiveness of parallel and counter flow heat exchangers.
8. Determination of emissivity of a given surface.
9. Determination of Stefan–Boltzmann constant.
10. Determination of heat transfer rate in dropwise and filmwise condensation.
11. Determination of critical heat flux.
12. Determination of thermal conductivity of liquids and gases.
13. Investigation of Lambert's cosine law.

PART–B: Virtual Labs (https://mfts-iitg.vlabs.ac.in/)

1. Conduction analysis of a single material slab.
2. Conduction analysis of a single material sphere.
3. Conduction analysis of a single material cylinder.
4. Conduction analysis of a double material slab.
5. Conduction analysis of a double material sphere.
6. Conduction analysis of a double material cylinder.
7. Determination of overall heat transfer coefficient (U) in (i) parallel flow heat exchanger and (ii) counter flow heat exchanger.
8. Investigation of Lambert's distance law.
9. Investigation of Lambert's direction law (cosine law).

Note: Virtual labs are only for learning purpose, and are not for external examination.

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

CO1: Determine heat transfer coefficients and thermal conductivities experimentally. (L3)

CO2: Analyze performance of fins, heat exchangers, and boiling/condensation systems. (L4)

CO3: Evaluate emissivity, Stefan–Boltzmann constant and verify radiation laws. (L5)

CO4: Use virtual lab simulations to reinforce theoretical and experimental concepts. (L3)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEL09	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB	0	0	3	1.5

Internal Marks: 30 External Marks: 70

Course Objectives: The laboratory course is aimed to provide practical exposure to artificial intelligence and machine learning models using various software tools, and to enable the students to write programs for different algorithms.

List of Experiments

1. Learning of Python libraries – NumPy, Pandas, Matplotlib, Seaborn and TensorFlow.
2. Numerical examples on Python libraries.
3. Data preprocessing and data cleaning using Python.
4. Write a program for Linear Regression.
5. Write a program for Logistic Regression.
6. Write a program for Artificial Neural Network (ANN).
7. Write a program for Convolutional Neural Network (CNN).
8. Write a program for Recurrent Neural Network (RNN).
9. Write a program to build a Decision Tree.
10. Write a program to build a Naïve Bayes Classifier.
11. Write a program for Support Vector Machine (SVM).
12. Write a program for Auto-encoder.

Note: Datasets can be taken from `https://www.kaggle.com/datasets`.

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

CO1: Learn and use various Python libraries for AI/ML applications. (L2)

CO2: Implement regression models using Python. (L3)

CO3: Develop programs for different types of neural networks (ANN, CNN, RNN). (L4)

CO4: Build machine learning models using Decision Tree, Naïve Bayes and SVM. (L4)

CO5: Implement Auto-encoders for feature extraction and dimensionality reduction. (L5)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MES04	ROBOTICS AND DRONE TECHNOLOGIES LAB	0	0	4	2

Internal Marks: 30 External Marks: 70

Course Objective: Robotics and Drone Technologies Laboratory offers the students hands-on experience in robotics and unmanned aerial systems, enabling them to design, build and control robots and drones for diverse applications.

List of Experiments:

Robotics

1. Simulation of Mathematical Model of a Robot.
2. Forward and Inverse Dynamic Analysis of a 2-DOF Robotic Manipulator using Software Tools.
3. Building and Programming a Simple Arduino-Based Robot for basic movement.
4. Build a robot that can navigate through a maze or environment using sensors for obstacle detection and avoidance.
5. Construct a robotic arm using servo/stepper motors and program it for tasks such as pick-and-place, colour sorting, or drawing shapes.
6. Build a line-following robot using appropriate sensors.
7. Design a 3D Model of a Robotic Arm and Grippers using CAD software.
8. Implement a PID controller for a robotic arm or mobile robot and simulate trajectory tracking.

Drone Technologies

1. Demonstration of parts and functions of a drone.
2. Demonstration of effects of forces and manoeuvres of a drone (roll, pitch, yaw).
3. Demonstration of various sensors and battery management systems used in drones.
4. Build a prototype drone to capture videos and photos.
5. Design and fabricate a drone for carrying a specified payload.

Suggested Online Resources:

1. https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2. https://atl.aim.gov.in/ATL-Equipment-Manual/
3. https://aim.gov.in/pdf/Level-1.pdf
4. https://aim.gov.in/pdf/Level-2.pdf
5. https://aim.gov.in/pdf/Level-3.pdf

6. https://aim.gov.in/pdf/ATL_Drone_Module.pdf

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

CO1: Simulate and analyze robotic systems using software tools. (L3)

CO2: Design, build and program mobile robots and robotic arms for various tasks. (L4)

CO3: Implement control strategies such as PID for robotics applications. (L4)

CO4: Demonstrate working principles of drones, their manoeuvres, and sensor systems. (L2)

CO5: Build and test drones for imaging and payload applications. (L5)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23xxxxx	Technical Paper Writing and IPR	2	0	0	–

Internal Marks: 30 External Marks: 70

Course Objectives: The students will acquire knowledge

1. To understand the structure of the technical paper and its components.
2. To review the literature and acquire the skills to write a technical paper for first submission.
3. To understand the process and development of IPR.
4. To create awareness about the scope of patent rights.
5. To analyze the new developments in IPR include latest software.

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

CO1: Understand the structure of the technical paper and its components.

CO2: Review the literature and acquire the skills to write a technical paper for first submission.

CO3: Understand the process and development of IPR.

CO4: Create awareness about the scope of patent rights.

CO5: Analyze the new developments in IPR include latest software.

UNIT–I: Planning and preparation (9 Lectures)

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness. Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT–II: Literature review (9 Lectures)

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. Key skills needed when writing a Title, Abstract, Introduction, a Review of the Literature, the Methods, the Results, the Discussion, and the Conclusions. Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission

UNIT–III: Process and Development (9 Lectures)

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

UNIT–IV: Patent Rights (9 Lectures)

Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases, Geographical Indications.

UNIT–V: New Developments In IPR (9 Lectures)

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies.

Text Books:

1. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
3. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age" 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE05	MECHANICAL VIBRATIONS (Professional Elective-II)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To learn basic principles of mathematical modeling of vibrating systems.
2. To understand the basic concepts of free and forced multi-degree freedom systems.
3. To get concepts involved in torsional vibrations.
4. To learn the principles involved in the critical speed of shafts.
5. To understand the basic concepts of Laplace transformations response to different inputs.

UNIT – I 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 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 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 Vibration Measuring Instruments and Critical Speeds of Shafts: Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Critical speed of a light shaft having a single disc without damping and with damping – Critical speeds of shaft having multiple discs – Secondary critical speed – Critical speeds of light cantilever shaft with a large heavy disc at its end.

UNIT – V 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”, John Wiley and Sons, 2006.
4. Randall F. Barron, “Industrial Noise Control and Acoustics”, Marcel Dekker, Inc., 2003.

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

CO1: Understand the concepts of vibrational analysis. (L2)

CO2: Understand the concepts of free and forced multi-degree freedom systems. (L2)

CO3: Summarize the concepts of torsional vibrations. (L2)

CO4: Solve problems on critical speed of shafts. (L3)

CO5: Apply and analyze the systems subjected to Laplace transformation response for different inputs. (L3, L4)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE06	ADVANCED MANUFACTURING PROCESSES (Professional Elective-II)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To learn the basic principle of advanced machining processes.
2. To know about the various additive manufacturing processes.
3. To understand the principles of coating and processing of ceramics.
4. To get insights about processing of composites and nanomaterials.
5. To know the fabrication of microelectronic components.

UNIT – I Advanced Machining Processes: Introduction, Need, AJM, WJM, Wire-EDM, ECM, LBM, EBM, PAM – Principle, working, advantages, limitations, process parameters & capabilities and applications.

UNIT – II Additive Manufacturing: Working principles, Methods, Stereo Lithography, LENS, LOM, Laser Sintering, Fused Deposition Method, 3DP Applications and Limitations, Direct and Indirect Rapid tooling techniques.

UNIT – III Surface Treatment: Scope, Cleaners, Methods of cleaning, Surface coating types, Electroforming, Chemical vapour deposition, Physical vapour deposition, thermal spraying methods, Ion implantation, diffusion coating, ceramic and organic methods of coating, and cladding methods.
Processing of Ceramics: Applications, characteristics, classification, Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application.

UNIT – IV Processing of Composites: Composite layers, particulate and fiber reinforced composites, elastomers, reinforced plastics, processing methods for MMC, CMC, Polymer matrix composites.
Processing of Nanomaterials: Introduction, Top down Vs Bottom up techniques – Ball milling, Lithography, Plasma Arc Discharge, Pulsed Laser Deposition, Sputtering, Sol-Gel, Molecular Beam Epitaxy.

UNIT – V Fabrication of Microelectronic Devices: Crystal growth and wafer preparation, film deposition, oxidation, lithography, bonding and packaging, reliability and yield, printed circuit boards, surface mount technology, integrated circuit economics.

Text Books:

1. Kalpakjian, "Manufacturing Engineering and Technology", Addison Wesley, 1995.
2. R.A. Lindberg, "Process and Materials of Manufacturing", 11th Edition, PHI, 1990.

References:

1. Rao R. Thummala and Eugene J. Rymaszewski, "Microelectronic Packaging Handbook", Van Nostrand Reinhold.
2. Tai-Ran Hsu, "MEMS & Microsystems Design and Manufacture", TMGH.
3. V.K. Jain, "Advanced Machining Processes", Allied Publications.
4. John A. Schey, "Introduction to Manufacturing Processes", McGraw Hill.
5. K.K. Chattopadhyay and A.N. Banerjee, "Introduction to Nanoscience and Nanotechnology", PHI Learning.

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

CO1: Explain the working principle of various nonconventional machining processes and their applications. (L2)

CO2: Explain the working principles of additive manufacturing methods. (L2)

CO3: Understand various laser material processing techniques. (L2)

CO4: Gain knowledge on advanced coating processes. (L3)

CO5: Describe various fabrication methods for microelectronic devices. (L2)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE07	MICRO ELECTRO MECHANICAL SYSTEMS (Professional Elective-II)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators.
2. To illustrate thermal sensors and actuators used in MEMS.
3. To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.
4. To analyze applications and considerations on micro fluidic systems.
5. To illustrate the principles of chemical and biomedical microsystems.

UNIT – I Introduction: Definition of MEMS, MEMS history and development, micromachining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micromachining, wafer bonding, LIGA.
Mechanical Sensors and Actuators: Principles of sensing and actuation: beam and cantilever, capacitive, piezo-electric, strain, pressure, flow, pressure measurement by microphone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, inch worm technology.

UNIT – II Thermal Sensors and Actuators: Thermal energy basics and heat transfer processes, thermistors, thermo devices, thermocouple, micro machined thermocouple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

UNIT – III Micro-Opto-Electro-Mechanical Systems (MOEMS): Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.
Magnetic Sensors and Actuators: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, bi-directional micro actuator, feedback circuit

integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

UNIT – IV Micro Fluidic Systems: Applications, considerations on micro scale fluid, fluid actuation methods, dielectro-phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, micro fluid dispenser, micro needle, molecular gate, micro pumps.
Radio Frequency (RF) MEMS: RF-based communication systems, RF MEMS, MEMS inductors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

UNIT – V Chemical and Biomedical Microsystems: Sensing mechanism & principle, membrane-transducer materials, chem-lab-on-a-chip (CLOC), chemo-resistors, chemo-capacitors, chemo-transistors, electronic nose (E-nose), mass sensitive chemo-sensors, fluorescence detection, calorimetric spectroscopy.

Text Book:

1. Nitaigour Premchand Mahalik, “MEMS”, TMH.

Reference Books:

1. Chang Liu, “Foundations of MEMS”, Prentice Hall Ltd.
2. Sergey Edward Lyshevski, “MEMS and NEMS”, CRC Press, Indian Edition.
3. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture”, TMH Publishers.
4. Thomas M. Adams, Richard A. Layton, “Introductory MEMS”, Springer International Publishers.

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

CO1: Understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators. (L2)

CO2: Illustrate thermal sensors and actuators used in MEMS. (L2)

CO3: Apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators. (L3)

CO4: Analyze applications and considerations on micro fluidic systems. (L4)

CO5: Illustrate the principles of chemical and biomedical microsystems. (L2)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE08	SENSORS AND INSTRUMENTATION (Professional Elective-III)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To understand the concepts of measurement technology.
2. To learn the various sensors used to measure various physical parameters.
3. To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.
4. To learn about the optical, pressure and temperature sensors.
5. To understand the signal conditioning and DAQ systems.

UNIT – I Introduction: Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT – II Motion, Proximity and Ranging Sensors: Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT – III Force, Magnetic and Heading Sensors: Strain Gage, Load Cell, Magnetic Sensors – types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor. Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT – IV Optical, Pressure and Temperature Sensors: Photo conductive cell, photovoltaic, photo resistive, LDR – Fiber optic sensors – Pressure: Diaphragm, Bellows, Piezoelectric – Tactile sensors. Temperature: IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – Flow and Level Measurement – Radiation Sensors – Smart Sensors – Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT – V Signal Conditioning and DAQ Systems: Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging – Applications: Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

Text Books:

1. Ernest O. Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2. Sawney A. K. and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition, New Delhi, 2013.

References:

1. C. Sujatha, S.A. Dyer, “Survey of Instrumentation and Measurement”, John Wiley & Sons, Canada, 2001.
2. Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing”, Volume 1, Wiley-VCH, April 2001.
3. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
4. Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, “Industrial Communication Technology Handbook”, 2nd edition, CRC Press, 2015.

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1: Recognize various calibration techniques and signal types for sensors. (L1)

CO2: Describe the working principle and characteristics of force, magnetic, heading, pressure, temperature, smart and other sensors and transducers. (L2)

CO3: Apply the various sensors and transducers in different applications. (L3)

CO4: Select the appropriate sensor for different applications. (L4)

CO5: Acquire signals from different sensors using Data Acquisition Systems. (L3)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE09	ENERGY STORAGE TECHNOLOGIES (Professional Elective-III)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Get the insights into importance of energy storage systems.
2. Understand the chemical and electromagnetic storage systems.
3. Know the principles of electrochemical storage systems.
4. Learn the working of supercapacitors and fuel cells.
5. Know how to design batteries for transportation.

UNIT – I Energy Storage Systems Overview: Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market.
Thermal Storage System: Heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage – organic and inorganic materials, efficiencies, and economic evaluation of thermal energy storage systems.

UNIT – II Chemical Storage System: Hydrogen, methane etc., concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and future prospects of chemical storage systems.
Electromagnetic Storage Systems: Double layer capacitors with electrostatically charge storage, superconducting magnetic energy storage (SMES), concepts, advantages and limitations of electromagnetic energy storage systems, and future prospects of electrochemical storage systems.

UNIT – III Electrochemical Storage System: Batteries – Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages – Li-ion battery & Metal hydride battery vs Lead-acid battery.

UNIT – IV Supercapacitors: Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, difference between battery and supercapacitors, Introduction to Hybrid electrochemical supercapacitors.

Fuel Cells: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems.

UNIT – V Battery Design for Transportation: Mechanical design and packaging of battery packs for electric vehicles, Advanced battery, Assisted quick charger for electric vehicles, Charging optimization methods for Lithium-Ion batteries, Thermal run-away for battery systems, Thermal management of battery systems, State of charge and State of health estimation over the battery lifespan, Recycling of batteries from electric vehicles.

Text Books:

1. Frank S. Barnes and Jonah G. Levine, "Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series)", CRC Press, 2011.
2. Ralph Zito, "Energy Storage: A New Approach", Wiley, 2010.

References:

1. Pistoia, Gianfranco, and Boryann Liaw, "Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost", Springer International Publishing AG, 2018.
2. Robert A. Huggins, "Energy Storage", Springer Science & Business Media, 2010.

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1: Learn the importance of energy storage systems. (L1)

CO2: Gain knowledge on chemical and electromagnetic storage systems. (L2)

CO3: Understand the principles of electrochemical storage systems. (L2)

CO4: Know the working of supercapacitors and fuel cells. (L3)

CO5: Learn how to design batteries for transportation. (L4)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE10	INDUSTRIAL HYDRAULICS AND PNEUMATICS (Professional Elective-III)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. To learn basic concepts of fluid power.
2. To understand the functions and working of basic elements of Hydraulic and Pneumatic systems.
3. To get knowledge about the basic components and their functions of Hydraulic and Pneumatic circuits.
4. To learn the operating principles and working of hydraulic and pneumatic devices.
5. To gain knowledge about the procedures of installation, maintenance and trouble shooting of Hydraulic and Pneumatic systems.

UNIT – 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-Lussac's 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): types, construction, working, specifications and selection criteria of 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 (intensifier, regenerative, synchronizing, sequencing, speed control, safety), circuit diagram, components, working and applications. Basic Pneumatic Circuits – types (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: 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.

Text Books:

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, 2/e, 2008.
2. Jagadeesha, T., "Fluid Power Generation, Transmission and Control", Universities Press (India) Private Limited, New Delhi, 1/e, 2014.
3. Jagadeesha, T., "Pneumatics Concepts, Design and Applications", Universities Press (India) Private Limited, New Delhi, 1/e, 2014.
4. Parr, Andrew, "Hydraulic and Pneumatics, A Technician's and Engineer's Guide", Jaico Publishing House, New Delhi, 2/e, 2013.
5. Shanmuga Sundaram, K., "Hydraulic and Pneumatics Controls - Understanding Made Easy", S. Chand Company Ltd., New Delhi, 1/e, 2006.

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

CO1: Illustrate the basic concepts of fluid power. (L1)

CO2: Understand the functions of elements of Hydraulic and Pneumatic systems. (L2)

CO3: Analyze the functions of hydraulic and Pneumatic circuits. (L3)

CO4: Illustrate the working of various hydraulic and pneumatic devices. (L2)

CO5: Interpret the procedure of installation and maintenance of hydraulic and pneumatic systems. (L3)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE11	INDUSTRIAL ROBOTICS (Professional Elective-III)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives: The students will acquire the knowledge to:

1. Discuss various applications and components of industrial robot systems.
2. Learn about the types of actuators used in robotics.
3. Calculate the forward kinematics and inverse kinematics.
4. Learn about programming principles and languages for a robot control system.
5. Discuss the applications of image processing and machine vision in robotics.

UNIT – I Introduction: Automation and Robotics, CAD/CAM and Robotics – An overview of Robotics – present and future applications – classification by coordinate system and control system. **Components of the Industrial Robotics:** Robot anatomy, work volume, components, number of degrees of freedom – robot drive systems, function line diagram representation of robot arms, common types of arms – requirements and challenges of end effectors, determination of the end effectors.

UNIT – II Robot Actuators and Feedback Components: Actuators – Pneumatic, Hydraulic actuators, Electric and Stepper motors. Comparison of Electric, Hydraulic and Pneumatic types of actuation devices. Feedback components: position sensors – potentiometers, resolvers, encoders; Velocity sensors.

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.

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 Image Processing and Machine Vision: Introduction to Machine Vision, sensing and digitizing function in Machine Vision, training and vision system, robotic applications.

Text Books:

1. M.P. Groover, “Industrial Robotics”, Pearson Education.
2. R.K. Mittal and J. Nagrathi, “Robotics and Control”, TMH.

References:

1. K.S. Fu, “Robotics”, McGraw Hill.
2. Richard D. Klafter, “Robotic Engineering”, Prentice Hall.
3. H. Asada and J.J.E. Slotine, “Robot Analysis and Control”, BSP Books Pvt. Ltd.
4. John J. Craig, “Introduction to Robotics”, Pearson Education.

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

CO1: Discuss various applications and components of industrial robot systems. (L2)

CO2: Explain the types of actuators used in robotics. (L2)

CO3: Calculate forward and inverse kinematics of manipulators. (L3)

CO4: Apply programming principles and languages for robot control systems. (L3)

CO5: Analyze the applications of image processing and machine vision in robotics. (L4)

Course Code	Course Name	Course Structure			
		L	T	P	C
P23MEE12	REFRIGERATION & AIR-CONDITIONING (Professional Elective-III)	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. Illustrate the operating cycles and different systems of refrigeration.
2. Analyze cooling capacity and coefficient of performance of vapour compression refrigeration systems and understand the fundamentals of cryogenics.
3. Calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration system and understand the properties of refrigerants.
4. Calculate cooling load for air conditioning systems and identify the requirements of comfort air conditioning.
5. Describe different components 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 aircrafts and problems.

UNIT – II Vapour Compression Refrigeration System & Components: Working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems. **Introduction to Cryogenics:** Joule-Thomson expansion, refrigerant mixtures, multi-stage vapour compression refrigeration.

UNIT – III Refrigerants: Desirable properties – classification – refrigerants – green refrigerants – nomenclature – ozone depletion – global warming. **Vapour Absorption System:** Calculation of maximum COP – description and working of NH_3–water system and LiBr–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.
Note: Refrigeration and Psychrometric tables and charts are allowed.

Text Books:

1. S.C. Arora & Domkundwar, "A Course in Refrigeration and Air Conditioning", Dhanpat Rai.
2. C.P. Arora, "Refrigeration and Air Conditioning", TMH.

References:

1. Manohar Prasad, "Refrigeration and Air Conditioning", New Age.
2. Dossat, "Principles of Refrigeration", Pearson Education.
3. Ananthanarayanan, "Basic Refrigeration and Air-Conditioning", TMH.

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

CO1: Illustrate the operating cycles and different systems of refrigeration. (L2)

CO2: Analyze cooling capacity and COP of vapour compression refrigeration systems and explain the fundamentals of cryogenics. (L3)

CO3: Calculate COP of vapour absorption and steam jet refrigeration systems and explain refrigerant properties. (L3)

CO4: Solve cooling load problems for air conditioning systems and identify comfort requirements. (L4)

CO5: Demonstrate knowledge of components of refrigeration and air conditioning systems. (L2)