ANNAMALAI UNIVERSITY

Annamalainagar - 608002

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

B.E. Mechanical Engineering
Choice Based Credit System

2022-23

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

The Mechanical Engineering Department endeavors to be recognized globally for outstanding education and research leading to well qualified engineers, who are innovative, entrepreneurial and successful in advanced fields of mechanical engineering to cater the ever changing industrial demands and social needs.

MISSION

The Mechanical Engineering program makes available a high quality, relevant engineering education. The Program dedicates itself to providing students with a set of skills, knowledge and attitudes that will permit its graduates to succeed and thrive as engineers and leaders. The Program strives to:

- **Prepare the graduates to pursue life-long learning, serve the profession and meet intellectual, ethical and career challenges.**
- **Extend a vital, state-of-the-art infrastructure to the students and faculty with opportunities to create, interpret, apply and disseminate knowledge.**
- **Develop the student community with wider knowledge in the emerging fields of Mechanical Engineering.**
- **Provide set of skills, knowledge and attitude that will permit the graduates to succeed and thrive as engineers and leaders.**
- **Create a conducive and supportive environment for all round growth of the students, faculty & staff.**

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1.	**Prepare the graduates with a solid foundation in Engineering, Science and Technology for a successful career in Mechanical Engineering.**
2.	**Train the students to solve problems in Mechanical Engineering and related areas by engineering analysis, computation and experimentation, including understanding basic mathematical and scientific principles.**
3.	**Inculcate students with professional and ethical attitude, effective communication skills, team work skills and multidisciplinary approach**
4.	**Provide opportunity to the students to expand their horizon beyond mechanical engineering**
5.	**Develop the students to adapt to the rapidly changing environment in the areas of mechanical engineering and scale new heights in their profession through lifelong learning**

B.E. MECHANICAL ENGINEERING

PROGRAM OUTCOMES (POs)

After the successful completion of the B.E. Mechanical Engineering degree programme, the students will be able to:

PO1: Engineering Knowledge: Graduates will be able to apply knowledge of mathematics, science and engineering for the solution of mechanical engineering problems.

PO2: Problem analysis: Graduates will be able to formulate and analyze complex mechanical engineering problems.

PO3: Design/development of solutions. Graduates will be able to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, and public health.

PO4: Conduct investigations of complex problems: Graduates will be able to design and conduct experiments, and to analyze and interpret data.

PO5: Modern tool usage: Graduates will be able to use the techniques, skills, and modern engineering tools necessary for mechanical engineering practice.

PO6: The engineer and society: Graduates will be able to include social, cultural, ethical issues with engineering solutions.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO9: Individual and team work: Graduates will be able to function effectively on multidisciplinary teams.

PO10: Communication: Graduates will be able to communicate effectively.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12: Life-long learning: Graduates will be able to adopt technological changes and promote life-long learning.

Mapping PO with PEO					
POs	**PEO1**	**PEO2**	**PEO3**	**PEO4**	**PEO5**
PO1	✓	✓			✓
PO2	✓	✓			✓
PO3	✓	✓			✓
PO4		✓			
PO5		✓	✓		✓
PO6			✓	✓	
PO7	✓		✓	✓	✓
PO8	✓		✓	✓	
PO9	✓			✓	✓
PO10		✓	✓	✓	✓
PO11	✓	✓		✓	✓
PO12	✓	✓	✓	✓	✓

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1: Apply the acquired Mechanical Engineering knowledge for the upliftment of profession, organization and society.

PSO 2: Implement the learned principles of Mechanical Engineering to analyze, evaluate complex mechanical problems and to create advanced mechanical systems or processes.

PSO 3: Work as an individual or as a team and shoulder the responsibility assigned for the betterment.

HS	**Humanities and Social Sciences including Management courses**
BS	**Basic Science courses**
ES	**Engineering Science Courses**
CA	**Continuous Assessment Marks**
FE	**Final Exam Marks**

ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

B. E. (Four Year) Degree Programme (FULL–TIME)

Choice Based Credit System (CBCS)

REGULATIONS 2022-2023

1. Condition for Admission

Candidates for admission to the first year of the four year B.E. Degree programmes shall be required to have passed the final examination of the plus 2 Higher Secondary Course with Mathematics, Physics and Chemistry as courses of study and candidates who have passed the Higher Secondary Examination through vocational stream under Engineering, conducted by the Board of Secondary Education, Government of Tamil Nadu or an examination of any other authority accepted by the Syndicate of this University as equivalent thereto. They shall satisfy the conditions regarding qualifying marks, age and physical fitness as may be prescribed by the Syndicate of the Annamalai University from time to time.

Candidates who have passed the Diploma programme in Engineering of the State Board of Technical Education, Tamil Nadu will be eligible for admission to the second year of the four year degree programme in B.E. under the lateral entry scheme provided they satisfy other conditions.

2. Branches of Study in B.E.

BRANCH I	**-**	**Chemical Engineering**
BRANCH II	**-**	**Civil Engineering**
BRANCH III	**-**	**Civil and Structural Engineering**
BRANCH IV	**-**	**Computer Science and Engineering**
BRANCH V	**-**	**Electrical and Electronics Engineering**
BRANCH VI	**-**	**Electronics and Communication Engineering**
BRANCH VII	**-**	**Electronics and Instrumentation Engineering**
BRANCH VIII	**-**	**Information Technology**
BRANCH IX	**-**	**Mechanical Engineering**
BRANCH X	**-**	**Mechanical Engineering (Manufacturing)**
BRANCH XI	**-**	**Computer Science and Engineering (Artificial Intelligence and Machine Learning)**
BRANCH XII	**-**	**Computer Science and Engineering (Data Science)**

3. Courses of Study and Scheme of Examinations

The courses of study with respective syllabi and the scheme of Examinations are given separately.

4. Choice Based Credit System (CBCS)

The curriculum includes six components namely Humanities / Social Sciences /Management, Basic Sciences, Engineering Sciences, Professional Core, Professional/Programme Electives and Open Electives in addition to Seminar & Industrial Training and Project. Each semester curriculum shall normally have a blend

of theory, practical and theory cum practical courses. The total credits for the entire degree Programme is 173 (132 for lateral entry students).

5. Eligibility for the Degree

A candidate shall be eligible for the degree of Bachelor of Engineering if the candidate has satisfactorily undergone the prescribed courses of study for a period of four academic years and has passed the prescribed examinations in all the four academic years. For the award of the degree, a student has to

Earn a minimum of 173 credits (132 for lateral entry students).

Serve in any one of the Co-curricular activities such as

- **National Cadet Corps (NCC)**
- **National Service Scheme (NSS)**
- **National Sports Organization (NSO) and**
- **Youth Red Cross (YRC)**

for at least one year. The students enrolled in any one of the co-curricular activities (NCC / NSS / NSO / YRC) will undergo training for about 80 hours and attend a camp of about seven days. The training shall include classes on hygiene and health awareness and also training in first-aid. While the training activities will normally be during weekends, the camp will normally be during vacation period.

(or)

Enrol as a student member of a recognized professional society such as

- **Student Chapters of Institution of Engineers (India)**
- **Student Chapters of other Professional bodies like ICI, ISA, IIChE, IEEE, SAE, ASHRAE, CSI and IWS**

5.1 B.E (Honours) Degree

A student shall be eligible to get Under Graduate degree with Honours, if he/she completes an additional 20 credits. Thus the total credits are 193. Out of 193 credits (152 credits for lateral entry students), 20 credits must be earned by studying additional course offered by the same or allied Departments (listed in Annexure) in the sixth, seventh and eighth semesters. These additional 20 credits could be acquired through the MOOC courses of SWAYAM portal also.

5.2 B.E Degree with Minor Engineering

A student shall be eligible to get Under Graduate degree with additional Minor Engineering, if he/she completes an additional 20 credits. Out of the 193 credits, 20 credits must be earned from the courses offered by any one of the Departments (listed in Annexure) in the Faculty of Engineering and Technology in sixth, seventh and eighth semesters. The additional 20 credits can also be acquired through the MOOC courses offered in SWAYAM portal.

6. Assignment of Credits for Courses

Each course is normally assigned one credit per hour of lecture/tutorial per week and half credit for one hour for laboratory or practical or drawing course per week.

7. Duration of the Programme

A student is normally expected to complete the B.E. programme in four years but in any case not more than seven years from the time of admission.

8. Registration for Courses

A newly admitted student will automatically be registered for all the courses prescribed for the first, second and third semesters without any option.

Every other student shall enrol for the courses intended to be credited in the succeeding semester in the current semester itself by completing the registration form indicating the list of courses. This registration will be done a week before the last working day of the current semester.

A student is required to earn 173 (132 for lateral entry students) credits in order to be eligible for obtaining the degree. However the student is entitled to enjoy an option to earn either more or less than the total number of credits prescribed in the curriculum of a particular semester on the following guidelines:

8.1 Slow Learners

The slow learners may be allowed to withdraw certain courses with the approval by the Head of the Department and those courses may be completed by them in the fifth year of study and still they are eligible to be awarded with I Class. A student can withdraw a maximum of 2 courses per semester from IV semester to VII semester and take up those courses in the fifth year of study. However, courses withdrawn during odd semesters (V and VII) must be registered in the odd semester of fifth year and courses withdrawn during even semesters (IV and VI) must be registered in the even semester of fifth year.

8.2 Advance Learners

The advance learners may be allowed to take up the open elective courses of eighth semester in sixth and seventh semesters one in each to enable them to pursue industrial training/project work in the entire eighth semester period provided they should register those courses in the fifth semester itself. Such students should meet the teachers offering those elective courses themselves for clarifications. No specific slots will be allotted in the time table for such courses.

9. Project Work

The student typically registers for project at the end of seventh semester and completes it at the end of the eighth semester along with the courses prescribed for study in the eighth semester. However a student who has registered and successfully completed the courses of eighth semester by acquiring additional credits in the earlier semesters can attempt to spend his/her period of study in an industry and complete his/her project work, submit the project report and appear for viva-voce examination at the end of eighth semester.

10. Mandatory Induction program

A 3-week long induction program for the UG students entering the institution, right at the start is proposed. Normal classes start only after the induction program is over. The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

- **Physical Activity**
- **Creative Arts**
- **Imparting Universal Human Values**
- **Literary Activities**
- **Conduct of crash courses on soft skills**
- **Lectures by Eminent People**
- **Visits to Local Area**
- **Familiarization to Dept./Branch & Innovative practices**

11. Electives

The elective courses fall under two basic categories: Professional/Programme Electives and Open Electives.

11.1 Professional Elective courses

The Professional Elective courses are offered in the concerned branch of specialization and a student can choose the Professional Elective courses with the approval of the Head of the Department concerned.

11.2 Open Elective courses

Apart from the various Professional elective courses, a student must study five open elective courses of which the student may opt to study either that offered by the Department concerned or from the open elective courses offered by any other Department in the Faculty of Engineering & Technology, with the approval of the Head of the concerned Department and the Head of the Department offering the course. In case the student opts to study an open elective offered by other department in the Faculty, it shall be handled by the faculty of that Department offering the chosen open elective.

A student may be required to choose Intellectual Property Rights (IPR) and Cyber Security as open electives in the eighth semester as part of the requirements of the study.

11.3 MOOC (SWAYAM) Courses

Further, the student can be permitted to earn not more than 40 % of his total credits (that is 64 credits) by studying the Massive Open Online Courses offered through the SWAYAM Portal of UGC with the approval of the Head of the Department concerned. These courses will be considered as equivalent to open elective courses in the eighth semester and the credit earned through MOOC courses may be transferred and considered for awarding Degree to the student concerned.

A student who earns 3 or more credits from a 12 week MOOC course through SWAYAM portal (Syndicate Resolution No.:3 dated 28.12.2017) shall be exempted from studying the Open elective course in the eighth semester and permitted to transfer the credits. Besides the student is permitted to claim for the conversion to the next higher grade in accordance with the Syndicate Resolution No.: 31 dated 09.09.2020

11.4 Value added courses

A student can study one or more value added courses being offered by the other Departments of Study either within the Faculty or any other Faculty in the University in any semester of the B.E degree programme except First Year, with the restriction

that only one Value added Course can be registered at a time.

11.5 Extra One Credit Courses

One credit courses shall be offered by a Department with the prior approval from the Dean, Faculty of Engineering and Technology.

11.5.1 Industry Expert

For one credit courses, a relevant potential topic may be selected by a committee consisting of the Head of the Department concerned and the Board of Studies member from the Department and a senior faculty member from the Department concerned. An expert from industry familiar with the topic chosen may be accordingly invited to handle classes for the students. The details of the syllabus, time table and the name of the industrial expert may be sent by the above committee to the Dean for approval. The credits earned through the extra one credit courses shall be over and above the total credit requirement prescribed in the curriculum for the award of the degree. Students can take a maximum of two extra one credit courses (one each in VI and VII semesters). They shall be allowed to take extra one credit courses offered in other Departments with the permission of Head of the Department offering the courses. A separate mark sheet shall be issued for extra one credit courses.

11.5.2 NSQF Courses

A student can be permitted to acquire additional credits not more than two by undergoing any two of the one credit courses conducted under the auspices of National Skills Qualification Framework (NSQF). NSQF is a nationally integrated education and competency based skill and quality assurance framework that will provide for multiple pathways, horizontal as well as vertical, including vocational education, vocational training, general education and technical education, thus linking one level of learning to another higher level. This will enable a student to acquire desired competency levels, transit to the job market and at an opportune time, return for acquiring additional skills to further upgrade their competencies.

11.6 Skill related /Naan Mudhalvan

A student is required to study Three open elective courses One each in the fifth, sixth and seventh semester of study as part of acquiring skills in the specified field.

12. Assessment

12.1Theory Courses

The break-up of Continuous Assessment for the theory courses relates to evaluating the performance under the five Course Outcomes uniformly with 5 Marks for each outcome spread over Two Mid-Semester tests and One Assignment, totalling to 25 Marks. Similarly the break-up mark for University End Semester exams involves evaluating the performance under the five Course Outcomes with 15 Marks for each Outcome, totalling to 75 Marks.

The break-up of continuous assessment and examination marks for theory courses is as follows:

First assessment (Mid-Semester Test-I Covering Units I &II)	**: 8 marks**
Second assessment (Mid-Semester Test-II Covering Units III, IV &V)	**: 12 marks**
Third Assessment (Assignment Covering Units I, II, III, IV &V)	**: 5 marks**
End Semester Examination	**: 75 marks**

The break-up of Continuous Assessment for the theory course titled Basic Engineering in the II semester that involves two disciplines requires evaluating the performance under the five Course Outcomes, with 3 for one discipline and two for the other, uniformly with 5 Marks for each outcome spread over Two Mid-Semester tests and One Assignment, totalling to 25 Marks. Similarly the break-up mark for University End Semester exams involves evaluating the performance under the five Course Outcomes with 15 Marks for each Outcome, totalling to 75 Marks.

12.2 Practical Courses

The break-up of Continuous Assessment for the practical courses involves evaluating the performance under the five Course Outcomes uniformly with 8 Marks for each outcome spread over Two tests and Record work, totalling to 40 Marks. Similarly the break-up mark for University End Semester exams relates to evaluating the performance under the five Course Outcomes with 12 Marks for each Outcome, totalling to 60 Marks

The break-up of continuous assessment and examination marks for Practical courses is as follows:

First Assessment (Test-I Relating to Cycle I)	**:**	**15 marks**
Second Assessment (Test-II Relating to Cycle II)	**:**	**15 marks**
Maintenance of Record book	**:**	**10 marks**
End Semester Examination		**: 60 marks**

12.3 Theory cum Practical Course

The break-up of Continuous Assessment for the theory cum practical courses necessitates to evaluating the performance as being followed for the theory and practical courses individually and requires the students to clear each component separately. The average of the marks secured by the student in the theory and practical courses and the appropriate grade relating to the average shall be assigned to the student.

12.4 Project Work

The continuous assessment marks for the project work will be 40 and to be assessed by a review committee consisting of the project guide and a minimum of two members nominated by the Head of the Department. One of the committee members will be nominated as the Chairman by the Head of the Department. The Head of the Department may be a member or the Chairman. At least two reviews should be conducted during the semester by the review committee. The student shall make presentation on the progress made before the committee. 60 marks are allotted for the project work and viva voce examination at the end of the semester.

12.5 Industrial Internship

After attending the internship during the semester vacation of II / III year for a period of 4 weeks duration in each year, the student has to submit a report and appear for the viva-voce exam along with the V/VII semester end semester examinations.

13. Substitute Assessment

A student, who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the final

examination, may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.

A student who wishes to have a substitute assessment for a missed assessment must apply to the Dean / Head of the Department within a week from the date of the missed assessment.

14. Student Counsellors (Mentors)

To help the students in planning their course of study and for general advice on the academic programme, the Dean / Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester and obtain the final approval of the Dean / Head of the Department.

15. Class Committee

For all the branches of study during the first two semesters, a common class committee will be constituted by the Dean of the faculty. From among the various teachers teaching the same common course to different classes during each semester of the first year, the Dean shall appoint one of them as course coordinator. The composition of the class committee during first and second semesters will be as follows:

- **Course coordinators of all courses.**
- **All the Heads of the Sections, among whom one may be nominated as Chairman by the Dean.**
- **The Dean may opt to be a member or the Chairman.**

For each of the higher semesters, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from third to eighth semester will be as follows:

- **Teachers of the individual courses.**
- **A seminar coordinator (for seventh semester only) shall be appointed by the Head of the Department**
- **A project coordinator (for eighth semester only) shall be appointed by the Head of the Department from among the project supervisors.**
- **One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.**
- **The Head of the Department may opt to be a member or the Chairman.**

The class committee shall meet three times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory/40 marks for seminar/ industrial training, practical

and project work will be finalized for every student and tabulated and submitted to the Head of the Department (to the Dean in the case of I & II Semester) for approval and transmission to the Controller of Examinations.

16. Attendance requirements

The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.

17. Temporary break of study

A student is permitted to go on break of study for a maximum period of one year either as two breaks of one semester each or a single break of one year.

If a student wishes to apply for break of study, the student shall apply to the Dean in advance, in any case, not later than the last date of the first assessment period. The application duly filled by the student shall be submitted through the Head of the Department. In the case of short term employment/ training/ internship, the application for break of study shall be approved and forwarded by the Head of the Department concerned to the Dean.

However, the student must complete the entire programme within the maximum period of seven years.

18. Procedure for withdrawing from the Examinations

A student can withdraw from all the examinations of the semester only once during the entire programme on valid grounds accepted by the University. Such withdrawal from the examinations of a semester will be permitted only if the candidate applies for withdrawal at least 24 hours before the commencement of the last examination. The letter grade 'W' will appear in the mark sheet for such candidates.

19. Passing and declaration of examination results

All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the Controller of Examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA), and prepare the mark sheets.

90 to 100 marks	**:**	**Grade 'S'**
80 to 89 marks	**:**	**Grade 'A'**
70 to 79 marks	**:**	**Grade 'B'**
60 to 69 marks	**:**	**Grade 'C'**
55 to 59 marks	**:**	**Grade 'D'**
50 to 54 marks	**:**	**Grade 'E'**
Less than 50 marks	**:**	**Grade 'RA'**
Withdrawn from the examination	**:**	**Grade 'W'**

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course, is declared to have successfully completed that course. Such a course cannot be repeated by the student.

A student who is detained for lack of attendance must re-register for and repeat the courses in the respective semester.

A student who obtains letter grade RA in the mark sheet must reappear for the examination of the courses except for Honours courses.

A student who obtains letter grade W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

S - 10; A - 9; B - 8; C - 7; D - 6; E - 5; RA - 0

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-evaluation of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department.

After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester.

GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

CGPA is similarly calculated considering all the courses taken from the time of admission.

20. Awarding Degree

After successful completion of the programme, the degree will be awarded with the following classification based on CGPA.

20.1 Honours Degree

To obtain Honours Degree a student must earn a minimum of 193 credits within four years (152 credits within three years for lateral entry students) from the time of admission, pass all the courses in the first attempt from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students) and obtain a CGPA of 8.25 or above.

A Student is required to complete 6 elective courses, 2 each in the V, VI and VII semesters with a stipulation that 2 of the 6 courses need to be of 4 credits each, while the remaining 4 has to be of 3 credits each, thus totaling to 20 credits.

However, if the student either does not clear the extra course(s) relating to become eligible for the Honours Degree or discontinues it in any of the semesters, then the student may revert to the category of the First Class with Distinction or First class, provided the student is eligible for that respective category. The student may claim for revised mark sheet, paying the stipulated fee in order that the unsuccessful appearance or discontinuity of the course(s) is not reflected in the new mark sheet.

20.2 First Class with Distinction

To obtain B.E Degree First Class with Distinction, a student must earn a minimum of 173 Credits within four years (132 credits within three years for lateral entry students) from the time of admission, by passing all the courses in the first attempt from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry

students) and obtain a CGPA of 8.25 or above.

20.3 First Class

To obtain B.E Degree First Class, a student must earn a minimum of 173 credits within *five* years (132 credits within *four* years for lateral entry students) from the time of admission and obtain a CGPA of 6.75 or above for all the courses from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

20.4 Second Class

For Second Class, the student must earn a minimum of 173 credits within seven years (132 credits within six years for lateral entry students) from the time of admission.

20.5 B.E Degree with Minor Engineering

For Minor Engineering, the student must earn a minimum of 193 credits within four years (152 credits within three years for lateral entry students) from the time of admission, pass all the courses. The rules for awarding the B.E degree in First Class with Distinction or in First Class or in Second Class will be applicable for this also.

A Student is required to complete 6 elective courses, 2 each in the V, VI and VII semesters with a stipulation that 2 of the 6 courses need to be of 4 credits each, while the remaining 4 has to be of 3 credits each, thus totaling to 20 credits.

21. Ranking of Candidates

The candidates who are eligible to get the B.E. degree with Honours will be ranked together on the basis of CGPA for all the courses of study from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

The candidates who are eligible to get the B.E. degree in First Class with Distinction will be ranked next after those with Honours on the basis of CGPA for all the courses of study from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

The Candidates passing with First Class will be ranked next after those with distinction on the basis of CGPA for all the courses of study from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

The ranking of candidates will be done separately for each branch of study.

22. Transitory Regulations

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.

Wherever there had been change of syllabi, examinations based on the existing syllabi will be conducted for three consecutive times after implementation of the new syllabi in order to enable the students to clear the arrears. Beyond that the students will have to take up their examinations in equivalent courses, as per the new syllabi, on the recommendations of the Head of the Department concerned.

ANNEXURE

S.No.	Branch of Study in B.E	Honours Elective Courses from Same and Allied Departments of	Minor Engineering Courses from Other Departments of
1.	Chemical Engineering	a. Chemical Engineering b. Pharmacy c. Electronics and Instrumentation Engineering	1. Civil Engineering 2. Mechanical Engineering 3. Electronics and Instrumentation Engg. 4. Information Technology 5. Civil and Structural Engg. 6. Electrical Engineering 7. Electronics and Communication Engg. 8. Mechanical (Manufacturing) Engg. 9. Computer Science and Engineering 10. Computer Science and Engineering. (Artificial Intelligence and Machine Learning) 11. Computer Science and Engineering (Data Science)
2.	Civil Engineering	1. Civil Engineering 2. Civil and Structural Engg.	1. Mechanical Engineering 2. Electrical Engineering 3. Chemical Engineering 4. Computer Science and Engineering 5. Computer Science and Engineering (Artificial Intelligence and Machine Learning) 6. Computer Science and Engineering (Data Science) 7. Mechanical (Manufacturing) Engg 8. Electronics and Instrumentation Engg 9. Information Technology 10. Electronics and Communication Engg.
3.	Civil and Structural Engineering		
4.	Computer Science and Engineering	1. Computer Science and Engg. 2. Information Technology 3. Electronics and Communication Engineering 4. Computer Science	1. Civil Engineering 2. Electronics and Instrumentation Engg. 3. Electronics and Communication Engg. 4. Mechanical Engineering 5. Mechanical (Manufacturing) Engg.
5.	Computer Science and Engineering (Artificial Intelligence and Machine Learning)		
6.	Computer Science		

	and Engineering (Data Science)	**and Engineering(Artificial Intelligence and Machine Learning)** **5. Computer Science and Engineering(Data Science)**	6. **Civil and Structural Engg.** 7. **Electrical Engineering** 8. **Chemical Engineering**
7.	**Electrical and Electronics Engineering**	**1. Electrical Engineering** **2. Electronics and Instrumentation Engineering** **3. Electronics and Communication Engineering**	**1. Civil Engineering** **2. Civil and Structural Engg.** **3. Mechanical Engineering** **4. Chemical Engineering** **5. Mechanical (Manufacturing) Engg.** **6. Computer Science and Engineering** **7. Computer Science and Engineering (Artificial Intelligence and Machine Learning)** **8. Computer Science and Engineering (Data Science)** **9. Information Technology**
8.	**Electronics and Communication Engg.**		
9.	**Electronics and Instrumentation Engg.**		
10.	**Information Technology**	**1. Computer Science and Engg.** **2. Information Technology** **3. Electronics and Communication Engineering** **4. Computer Science and Engineering.(Artificial Intelligence and Machine Learning)** **5. Computer Science and Engineering(Data Science)**	**1. Civil Engineering** **2. Electronics and Instrumentation Engg.** **3. Electronics and Communication Engg.** **4. Mechanical Engineering** **5. Mechanical (Manufacturing) Engg.** **6. Civil and Structural Engg.** **7. Electrical Engineering** **6. Chemical Engineering**
11.	**Mechanical Engineering**	**1. Mechanical Engineering** **2. Mechanical (Manufacturing) Engg.**	**1. Civil Engineering** **2. Civil and Structural Engg.** **3. Electrical Engineering** **4. Chemical Engineering** **5. Computer Science and Engineering** **6. Computer Science and Engineering (Artificial**

12.	**Mechanical (Manufacturing) Engg.**		**Intelligence and Machine Learning)** **7. Computer Science and Engineering (Data Science)** **8. Electronics and Instrumentation Engg.** **9. Information Technology** **10. Electronics and Communication Engg.**

ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

(DST-FIST-Level-1 Sponsored Department)

COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATION 2022-23)

FIRST SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
22ETBS101	BS-I	Mathematics-I	3	1	-	25	75	100	4
22ETBS102	BS-II	Physics	3	1	-	25	75	100	4
22ETBS103	BS-III	Chemistry	3	1	-	25	75	100	4
22ETES104	ES-I	Programming for Problem Solving	2	1	-	25	75	100	3
22ETHS105	HS-I	Heritage of Tamils	1	-	-	25	75	100	1
22ETHP106	HSP-I	Communication Skills and Language Laboratory	-	-	3	40	60	100	1.5
22ETSP107	ESP-I	Engineering Workshop Practices	-	-	3	40	60	100	1.5
22ETSP108	ESP-II	Electrical Wiring and Earthing Practice Laboratory	-	-	3	40	60	100	1.5
						Total Credits			20.5

SECOND SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
22ETHS201	HS-II	English	3	1	-	25	75	100	4
22ETBS202	BS-IV	Mathematics-II	3	1	-	25	75	100	4
22ETES203	ES-II	Basic Engineering*	4	-	-	25	75	100	4
22ETHS204	HS-III	Tamils and Technology	1	-	-	25	75	100	1
22ETBP205	BSP-I	Physics Laboratory	-	-	3	40	60	100	1.5
22ETBP206	BSP-II	Chemistry Laboratory	-	-	3	40	60	100	1.5
22ETSP207	ESP-III	Computer Programming Laboratory	-	-	3	40	60	100	1.5
22ETSP208	ESP-IV	Engineering Graphics	2	-	3	40	60	100	3
						Total Credits			20.5

*** Civil & Mechanical for Circuit Branches**
Mechanical & Electrical for Civil, Civil & Structural and Chemical
Civil & Electrical for Mechanical & Manufacturing

THIRD SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	22ETBS301	BS-V	Engineering Mathematics III	3	1		25	75	100	4
2	22ETES302	BS-VI	Environmental Studies	3			25	75	100	3
3	22CEES303	ES-II	Engineering Mechanics	3			25	75	100	3
4	22MEES304	ES-III	Introduction to Python Programming	2			25	75	100	2
5	22MEPC305	PC-I	Thermodynamics	3			25	75	100	3
6	22MEPC306	PC-II	Fluid Mechanics & Fluid Machines	3			25	75	100	3
7	22MESP307	ESP-IV	Electrical and Electronics Lab			3	40	60	100	1.5
8	22MECP308	PCP-I	Thermal Lab			3	40	60	100	1.5
9	22MECP309	ES-III	Python Lab			2	40	60	100	1
10	22MECP310	PCP-II	Machine Drawing	1		3	40	60	100	2.5
								Total Credits		24.5

FOURTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	22EEBS401	BS-VII	Probability random process and Numerical methods	2	1		25	75	100	3
2	22MEES402	ES-IV	Instrumentation & Control Engineering	2			25	75	100	2
3	22MEPC403	PC-III	Strength of Materials	3			25	75	100	3
4	22MEPC404	PC-IV	Thermal Engineering	3			25	75	100	3
5	22MEPC405	PC-V	Manufacturing Processes	2			25	75	100	2
6	22MEPC406	PC-VI	Design of Machine Elements	3			25	75	100	3
7	22ETHS407	HS-II	Universal Human Values	2	1		25	75	100	3
8	22MECP408	PCP-III	Strength of Materials Lab			3	40	60	100	1.5
9	22MECP409	PCP-IV	Fluid Mechanics lab			3	40	60	100	1.5
10	22MECP410	PCP V	Manufacturing Process Lab			3	40	60	100	1.5
							Total Credits			23.5
Students must undergo Internship for 4 weeks during the semester vacation of II year which will be assessed in the forthcoming V Semester.										

FIFTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	22MEPC501	PC-VII	Applied Thermodynamics	3			25	75	100	3
2	22MEPC502	PC-VIII	Engineering Materials and Metallurgy	2			25	75	100	2
3	22MEPC503	PC-IX	Theory of Machines	3			25	75	100	3
4	22MEPC504	PC-X	Manufacturing Technology	2			25	75	100	2
5	22MEPE505	PE-I	Professional elective I	3			25	75	100	3
6	22MEPE506	PE-II	Professional elective II	3			25	75	100	3
7	22MEOE507	OE-I	Open elective I	3			25	75	100	3
8	22MECP508	PCP-VI	Manufacturing Technology lab			3	40	60	100	1.5
9	22MECP509	PCP-VII	Applied thermal lab			3	40	60	100	1.5
10	22MECP510	PCP-VIII	Instrumentation & Controls lab			3	40	60	100	1.5
11	22ETIT511	IT-II	Industrial Training / Rural Internship/ Innovation/ Entrepreneurship	*Four weeks during the II year semester vacation*				100	100	4.0
				Total Credits						27.5

SIXTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	22MEPC601	PC-XI	Operations Research	2	-	-	25	75	100	2
2	22MEPC602	PC-XII	Heat Transfer	3	-	-	25	75	100	3
3	22MEPE603	PE-III	Professional elective III	3	-	-	25	75	100	3
4	22MEPE604	PE-IV	Professional elective IV	3	-	-	25	75	100	3
5	22MEPE605	PE-V	Professional elective V	3	-	-	25	75	100	3
6	22YYOE606	OE-II	Open elective II	3	-	-	25	75	100	3
7	22MECP607	PCP-IX	Machine theory lab	-	-	3	40	60	100	1.5
8	22MECP608	PCP-X	Computer Programming lab	-	-	3	40	60	100	1.5
				Total Credits						20.0
Students must undergo Internship for 4 weeks during semester vacation of III year which will be assessed in the forthcoming VII Semester.										

SEVENTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	22ETHS701	HS-IV	Engineering Ethics	2	-	-	25	75	100	2
2	22MEPC702	PC-XIII	Automotive Engineering	3	-	-	25	75	100	3
3	22MEPC703	PC-XIV	Power Plant Engineering	2			25	75	100	2
4	22MEPC704	PC-XV	Automation in Manufacturing	3			25	75	100	3
5	22MEPE705	PE-VI	Professional elective VI	3	-	-	25	75	100	3
6	22MEPE706	PE-VII	Professional elective VII	3	-	-	25	75	100	3
7	22YYOE707	OE-III	Open Elective III	3	-	-	25	75	100	3
8	22MECP708	PCP-XI	Heat transfer lab	-		3	40	60	100	1.5
9	22ETIT709	IT-III	Industrial Training / Rural Internship/ Innovation / Entrepreneurship	*Four weeks during the III year semester vacation*				100	100	4.0
				Total Credits						24.5

EIGHTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	22MEOE801	OE-IV	Open Elective IV	3	-	-	25	75	100	3
2	22MEOE802	OE-V	Open Elective V	3	-	-	25	75	100	3
3	22MEPV803	PV-I	Project Work & Viva voce	-	PR	S				
					10	2	40	60	100	6
				Total Credits						12

L	No. of Lecture Hours	PR	No. of Hours for Discussion on Project work
T	No. of Tutorial Hours	S	No. of Seminar Hours on Industrial Training / Project
P	No. of Practical Hours	FE	Final Examination Marks
CA	Continuous Assessment Marks		
Credits	Credit points allotted to that course	Total	Total Marks

PROFESSIONAL ELECTIVES

1. **22MEPE SCN Internal Combustion Engines**
2. **22MEPE SCN Mechatronic Systems**
3. **22MEPE SCN Microprocessors in Automation**
4. **22MEPE SCN Composite Materials**
5. **22MEPE SCN IoT and Smart Manufacturing**
6. **22MEPE SCN Refrigeration and Air Conditioning**
7. **22MEPE SCN Finite Element Analysis**
8. **22MEPE SCN Artificial Intelligence and Machine Learning**
9. **22MEPE SCN Gas Dynamics and Jet Propulsion**
10. **22MEPE SCN Process Planning and Cost Estimation**
11. **22MEPE SCN Industrial Management and Engineering**
12. **22MEPE SCN Design of Transmission Systems**
13. **22MEPE SCN Total Quality Management and Reliability Engineering**
14. **22MEPE SCN Energy Conservation and Management**
15. **22MEPE SCN Digital Twin Driven Smart Manufacturing**
16. **22MEOE SCN Solar energy utilization**
17. **22MEOE SCN Energy Management In Buildings**

OPEN ELECTIVES

1. **22MEOE SCN Automotive Safety**
2. **22MEOE SCN Electric and hybrid vehicles**
3. **22MEOE SCN Computational fluid dynamics**
4. **22MEOE SCN Fuels and combustion**
5. **22MEOE SCN Renewable energy technology**
6. **22MEOE SCN Industrial pollution prevention and control**
7. **22MEOE SCN Power plant instrumentation**
8. **22MEOE SCN Energy auditing**
9. **22MEOE SCN Waste heat recovery Systems and co generation**
10. **22MEOE SCN Maintenance and Safety Engineering**
11. **22MEOE SCN Engine Pollution and Control**
12. **22MEOE SCN Constitution of India**
13. **22MEOE SCN Entrepreneurship**
14. **22MEOE SCN Industry 4.0**
15. **22MEOE SCN Robotics**
16. **22MEOE SCN Electric Systems For E-Mobility (Mechanical)**
17. **22MEOE SCN Machine learning**
18. **22MEOE SCN An Introduction To Gender And Gender Equality**
19. **22MEOE SCN YOGA and Health**
20. **22MEOE SCN National Service Scheme (NSS)**
21. **22MEOE SCN National Cadet Corps (NCC)**

HONOURS ELECTIVES

1. **22MEHE SCN Computational Heat transfer**
2. **22MEHE SCN Steam Engineering**
3. **22MEHE SCN Advanced Engines and Emission Systems**
4. **22MEHE SCN Energy Auditing**
5. **22MEHE SCN Mechanical Vibration**
6. **22MEHE SCN Robotics**

MINOR ELECTIVES

1. **22MEMI SCN Basic Thermal Engineering**
2. **22MEMI SCN Instrumentation and Control**
3. **22MEMI SCN Elements of Heat transfer**
4. **22MEMI SCN Elements of Machine Design**
5. **22MEMI SCN Power Plant Technology**
6. **22MEMI SCN Automobile Technology**

FIRST SEMESTER

22ETBS101	MATHEMATICS – I	L	T	P	C
		3	1	0	4

Course Objectives:

- **To familiarize definite integrals and its application in finding area and volume.**
- **To Introduce the fundamentals of functions of several variables.**
- **To make the student to learn infinite series and its nature.**
- **To impart knowledge about Vector calculus.**
- **To provide the concept of eigen values and eigen vectors of a real matrix and its properties of great utility in many branches of engineering.**

Unit - I Integral Calculus

Evaluation of definite integrals and their properties-Applications of definite integrals to evaluate surface areas and volumes of revolutions. Improper integral-Beta and Gamma functions and their properties.

Unit – II Functions of several Variables

Rolle's theorem-Mean value theorem. Indeterminate forms-L'Hospital's rule, Functions of two variables: Taylor's and Maclaurin's series expansions-Maxima and minima for functions of two variables.

Unit - III Sequences and Series

Convergence of sequence and series- tests for convergence: Comparison test(only for series with positive terms)-D'Alembert's ratio test-Cauchy's root test-Integral test-Leibnitz's test(Alternating series).

Unit – IV Vector Calculus (Differentiation)

Gradient, divergence and curl- Directional derivative-unit normal vector-Irrotational and solenoidal vectors- Expansion formulae for operators involving

Unit - V Matrices

Rank of a matrix- Symmetric, skew- Symmetric and orthogonal matrices-Characteristic equation- Eigen values and Eigen vectors –Cayley-Hamilton Theorem-Diagonalization of symmetric matrices by Orthogonal transformation.

TEXT BOOKS:

1. **Veerarajan T., "Engineering Mathematics for First Year", Tata McGraw-Hill, New Delhi, 2008.**
2. **B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36th Edition, 2010**

REFERENCE BOOKS:

1. **G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th publishers, Reprint,2002.Edition, Pearson**
2. **Erwin kreyszig, "Advanced Engineering Mathematics", 9 Edition, John Wiley &Sons,2006.**

3. **Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New**

COURSE OUTCOMES:

At the end of this course, students will able to

1. **Solve improper integrals using Beta and Gamma functions.**
2. **Evaluate the extreme values for functions of two variables.**
3. **Analyze the convergence of infinite series.**
4. **Explore vector differentiation and Recognize solenoidal and irrotational fields.**
5. **Solve eigen values and eigen vectors of a real matrix and Orthogonal transformation of a matrix.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-		1	1	-	-
CO2	3	3	2	2	-	-	-	1		1	-	-
CO3	3	3	2	-	-	-	-	1	1		-	-
CO4	3	3	-	-	-	-	-		1	1	-	-
CO5	3	3	3	2	2	-	-	1	1	1	-	-

22ETBS102	PHYSICS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- **To understand the ray of light to undergo the phenomenon of interference diffraction and polarization.**
- **To understand the principle and various application of laser.**
- **To develop knowledge in crystal structure and its properties.**
- **To understand the energy quantization of subatomic particles like electron.**
- **Rationalize the law of conservation of energy in solar water heater and solar cells.**

UNIT - I WAVE OPTICS

Huygens' Principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer and Mach-Zehnder interferometer. Fraunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; diffraction gratings and their resolving power.

UNIT - II LASERS

Introduction – Principles of Laser – Stimulated emission, Properties of laser beams: mono- chromaticity, coherence, directionality and brightness Einstein's theory of, stimulated emission A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid- State lasers (ruby, Neodymium), dye lasers, laser speckles, applications of lasers in science, engineering and medicine.

UNIT - III CRYSTAL PHYSICS

Introduction to solid Materials – Crystal structure – Geometry of lattice unit

cell – Bravais' lattice – crystal systems, Crystal structures of Materials – (Cordination number, Atomic radius, packing factor and packing density) – Types of crystal Lattice (Simple Cubic, Body Centered Cubic, Face Centered Cubic and Hexagonal Closed Packed) Miller Indices and their calculations - Finding Miller indices of crystal planes.

UNIT - IV QUANTUM MECHANICS

Heisenberg uncertainity Principle –CDual nature of Matter and radiation – De Broglie's Wave length – Wave Velocity and group velocity. The wave Equation, Schrödinger's time dependent and independent wave equations - The Wave function and its physical significance - The particle in a box Problem (one dimensional box) - Energy quantization – Eigen values and Eigen functions.

UNIT - V ENERGY PHYSICS

Introduction to energy sources - Energy sources and their availability (Conventional and Non- conventional energy sources) solar energy – Methods of Harvesting solar energy – Solar heat collector, solar water heater and solar cells. Wind energy – Basic principle and components of wind energy Conversion system (WECS) – Application of wind energy. Biomass - Biogas Generation - Classification of Biogas plants –Properties and application of Biogas.

TEXT BOOKS :

1. **Arumugam.M. "Engineering Physics", Anuradha agencies, 2nd Edition, 1997.**
2. **John Twidell& Tony Weir, " Renewable Energy Resources" , Taylor & Francis, 2005.**
3. **Avadhanulu. M.N. and Kshirsagar P.G., "A Text Book of Engineering Physics", S. Chand & Company Ltd., 7th Enlarged Revised Ed., 2005.**
4. **Gaur R.K. and Gupta S.L., "Engineering Physics", Dhanpat Rai Publishers, New Delhi, 2003.**
5. **Rai.G.D. , "Solar Energy Utilization" Volume-1 & 2 by - Khanna Publishers, New Delhi.**
6. **Pajput. R. K. Non – Conventional energy sources and Utilization - S . Chand Publication – 2013.**

REFERENCE BOOKS :

1. **Rajendran.V , "Engineering Physics", Tata McGraw Hill publishers, 2009.**
2. **Rai G.D., "Non-conventional Energy sources", Khauna Publications, 1993.**
3. **Mani. P. "Engineering Physics", Dhanam Publication, Chennai, 2011.**
4. **Agarwal.M.P, "Solar Energy", S.Chand& Co., I Edn, New Delhi, 1983.**

COURSE OUTCOMES :

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

1. **Illustrate the construction of different types of interferometer.**
2. **Describe different types of laser and its application.**
3. **Analyze the importance of packing factor in different crystal system.**
4. **Evaluate the quantum mechanical concept of wave velocity and group velocity.**
5. **Compare the different energy resource and their availability.**

Mapping of Course Outcomes with Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	3	2	-	1	1		-	1
CO2	3	2	-	-	2	1	1	1		1	-	-
CO3	3	1	1	-	-	1	-		1	1	-	-
CO4	2	1	2	2	1	1	-	1	1		-	-
CO5	3	2	-	-	1	2	1	1		1	-	1

22ETBS103	CHEMISTRY	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- **To understand water treatment techniques and basic knowledge on surface chemistry.**
- **To provide knowledge on electrochemical cells and chemistry involved in corrosion.**
- **To learn various processes involved in fuel refining and mechanism involved in energy storage devices.**
- **To develop knowledge about synthesis of various types of polymers and nano materials.**
- **To get basic knowledge on refractories, lubricants and spectroscopical techniques.**

UNIT – I WATER CHEMISTRY AND SURFACE CHEMISTRY

Hardness of water – Softening of hard water by ion exchange method – Boiler feed water – boiler troubles – Internal treatment methods – Estimation of hardness by EDTA method – Desalination of brackish water – Reverse Osmosis. Disinfection of water – Break point chlorination – Adsorption – Types of Adsorption – Freundlich and Langmuir adsorption isotherms – Applications of adsorption.

UNIT – II ELECTROCHEMISTRY AND CORROSION

Electrode potential – Electrochemical cell – Measurement of EMF – Nernst equation for cell EMF – Concentration cells – Electrochemical series – Conductometry – Conductance, Cell constant – Types of conductometric titrations. Potentiometry – Principle of acid base titration. Corrosion – Dry and wet corrosion – Galvanic, concentration cell and pitting corrosion – Control of corrosion by Cathodic protection method.

UNIT – III FUELS AND STORAGE DEVICES

Fuels – Classification – Calorific values – HCV and LCV – Analysis of coal – Proximate and ultimate analysis – Refining of petroleum. Cracking – Fixed bed – Synthetic petrol – Fischer – Tropsch process – Flue gas analysis by Orsat apparatus. Batteries – Primary and secondary – Dry cell – Lead acid storage battery –Ni-Cd battery – Lithium battery – H2-O2 fuel cell.

UNIT – IV POLYMERS AND NANO MATERIALS

Polymers – Types of polymerization – Addition, condensation and copolymerisation – Mechanism of addition polymerization (Free radical). Plastics –

Thermoplastics and thermosetting plastics – Preparation, properties and uses of polyethylene, polyvinyl chloride, polystyrene, Nylon and bakelite. Nanochemistry – Introduction to nano materials. Synthesis – Precipitation, sol- Gel process, electrodeposition and chemical vapour deposition methods. Carbon nano tubes, fullerenes, nano wires and nano rods.

UNIT – V ENGINEERING MATERIALS AND SPECTROSCOPIC TECHNIQUES

Refractories – Classification, characteristics (Refractoriness, RUL, Thermal spalling, porosity) and uses, Lubricants – Classification, properties (cloud and pour point, flash and fire point, viscosity index) and applications. Principles of spectroscopy – Beer – Lambert's Law – UV – Visible and IR spectroscopy – Basic principles and instrumentation (block diagram) – Fluorescence and its applications in medicine.

TEXT BOOKS :

1. **Jain, P.C. and Monica Jain (2010) "Engineering Chemistry" DhanpatRai& Sons, New Delhi.**
2. **Dara, S.S. and Umare, S.S. (2014) "Text Book of Engineering Chemistry" S. Chand & Co. Ltd., New Delhi.**
3. **Gopalan, R., Venkappaya, D. and Nagarajan, S. (2008) "Engineering Chemistry" Tata McGraw Publications Ltd., New Delhi.**
4. **Puri, B.R., Sharma, L.R. and Pathania, M.S. (2013) "Principles of Physical Chemistry" Vishal Publication Company, New Delhi.**
5. **Sharma, Y.R. (2010) "Elementary Organic Spectroscopy, Principle and Chemical Applications" , S. Chand Publishers, New Delhi.**
6. **Asim K Das and Mahua Das (2017) "An Introduction to Nanomaterials and Nanoscience" CBS Publishers & Distributors Pvt. Ltd., New Delhi.**

COURSE OUTCOMES :

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

1. **Develop innovative methods in soft water production for industrial uses and about adsorption analysis.**
2. **Describe the concept of electrochemistry and its applications; corrosion and its controlling methods.**
3. **Relate the properties of fuels and applications of energy storage devices.**
4. **Synthesis various polymers and understand about nanomaterials.**
5. **Explain refractories, lubricants and demonstarte the concepts of certain spectroscopical techniques**

Mapping of Course Outcomes with Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	3	1	-	1	1	1	-	-
CO2	3	2	1	-	-	1	1			1	-	-
CO3	3	-	-	2	2	-	1	1			-	-
CO4	2	-	1	-	1	1	1	1		1	-	-
CO5	3	1	-	-	2	1	-		1	1	-	-

22ETES104	PROGRAMMING FOR PROBLEM SOLVING	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

- **To understand the fundamentals of C programming**
- **To provide students with understanding of code organization and functional hierarchical decomposition using complex data types.**
- **To understand how to break a large problem into smaller parts, writing each part as a module or function**
- **To effectively utilize structures and pointers in problem solving**
- **To enable students to take up Systems programming or Advanced C programming course.**

UNIT – I FUNDAMENTALS OF PROGRAMMING

Introduction to Programming, Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

UNIT - II EXPRESSIONS AND CONTROL STRUCTURES

Arithmetic Expressions and Precedence, Conditional Branching and Loops, Writing and evaluation of Conditionals and consequent Branching, Iteration and Loops.

UNIT – III ARRAYS

Arrays: Arrays (1-D, 2-D), Character arrays and Strings, Basic Algorithms: Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required).

UNIT – IV FUNCTIONS

Function: Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference, Recursion: Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

UNIT – V FILES AND STRUCTURES

Structure: Structures, Defining structures and Array of Structures, Pointers: Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation). File handling (only if time is available, otherwise should be done as part of the lab).

TEXT BOOKS :

1. **Byron Gottfried, "Schaum's Outline of Programming with C" ,McGraw-Hill.**
2. **E. Balaguruswamy, "Programming in ANSI C", TataMcGraw-Hill.**

REFERENCE BOOKS :

1. **Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Prentice Hall ofIndia.**

COURSE OUTCOMES :

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

1. **Formulate algorithms, draw flowcharts and write pseudocode for solving arithmetic and logical problems.**
2. **Develop C programs using branching and looping statements.**
3. **Implement searching and sorting algorithms and analyze the order of complexities.**
4. **Define and call simple functions by value and by reference and also to write recursive functions.**
5. **Utilize structures, pointers and files in C programming.**

Mapping of Course Outcomes with Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	-	-	-	-	-	1	1	1	-	-
CO2	2	2	3	2	-	-	-	1	1	1	-	-
CO3	2	2	3	2	-	-	-	1	1	1	-	-
CO4	1	1	-	-	-	-	-	1	1	1	-	-
CO5	2	1	1	-	-	-	-	1	1	1	-	-

22ETHS105	தமிழர் மரபு HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

அலகு I: <u>மொழி மற்றும் இலக்கியம்</u>: 3

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் –சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II: **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**: 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III: <u>நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்</u>: 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV: <u>தமிழர்களின் திணைக் கோட்பாடுகள்</u>: 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V: <u>இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு</u>: 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

1. **Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)**
2. **Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.**
3. **Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).**
4. **The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)**
5. **Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly**

Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

6. **Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)**

7. **Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)**

8. **Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.**

PAPER – 1

HERITAGE OF TAMILS

UNIT I

Language and Literature: Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II

Heritage - Rock art paintings to modern art - Sculpture: Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III

Folk and Martial arts - Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV

Thinai concept of Tamils – Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V

Contribution of Tamils to Indian National Movement and Indian Culture: Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. **Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)**
6. **Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.**
7. **Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).**
8. **The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)**
9. **Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)**
10. **Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay)(Publishedby: The Author)**
11. **Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)**
12. **Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.**

22ETP106	COMMUNICATION SKILLS AND LANGUAGE LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- **To facilitate computer assisted multimedia instruction enabling individualized and independent language learning.**
- **To sensitize the students to the nuances of English speech sounds, word accent, intonation and rhythm.**
- **To bring about a consistent accent and intelligibility in students pronunciation of English by providing an opportunity for practice in speaking.**
- **To improve the fluency of students in spoken English .**
- **To train students to use Language appropriately for public speaking, group discussion and interviews.**

LIST OF TOPICS

1. **Listening Comprehension**
2. **Pronunciation, Intonation, Stress and Rhythm**

3. **Common Everyday Situations: Conversations and Dialogues**
4. **Communication at Workplace**
5. **Interviews**
6. **Formal Presentations**

SUGGESTED SOFTWARE PACKAGE:

1. **Globarena Package for communicative English The Globarena Package consists of the following exercises**
2. **Reading comprehension**
3. **Listening comprehension**
4. **Vocabulary exercises**
5. **Phonetics**
6. **Role Play in dialogues**
7. **Auto Speak**

TEXT BOOKS :

1. **Daniel Jones Current," English Pronouncing Dictionary", Edition with CD.**
2. **R. K. Bansal and J. B. Harrison, "Spoken English ",Orient Longman 2006 Edn.**
3. **J. Sethi, Kamlesh Sadanand& D.V. Jindal, "A Practical course in English Pronunciation, (with two Audio cassettes)", Prentice-Hall of India Pvt. Ltd., New Delhi.**
4. **T.Balasubramanian," A text book of English Phonetics for Indian Students", (Macmillan).**
5. **"English Skills for Technical Students", WBSCTE with British Council, OL.**

COURSE OUTCOMES:

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

1. **Demonstarate their awareness of correct usage of English Grammar in writing and speaking.**
2. **Acquire speaking ability in English both in terms of fluency and comprehensibility.**
3. **Enhance competence in the four modes of literacy; Writing, Speaking, Reading and Listening.**
4. **Ensure improvement in accuracy and fluency in producing and understanding spoken and written English**
5. **Exposure of the grammatical forms of English and the use of these forms in specific communicative contexts.**

Mapping of Course Outcomes with Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	3	-	-	-	-	-	1	1	3	-	3
CO2	-	3	-	-	-	-	-	1	1	3	-	3
CO3	-	-	2	-	-	-	-	1	1	3	-	3
CO4	-	2	-	-	-	-	-	1	1	3	-	3
CO5	-	-	3	-	-	-	-	1	1	3	-	3

22ETSP107	ENGINEERING WORKSHOP PRACTICES	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- **To provide the students simple hands-on-experience in the basic aspects of production engineering in fitting, carpentry and sheet metal.**
- **To familiarize the students in the various hand forging operations**

Carpentry: Use of hand tools - exercises in planning and making joints namely, Lap joint, Lenthhening joint, half lap joint, dovetail joint, mortising and tenoning etc.

Fitting: Use of bench tools, vice, hammers, chisels, files, hacksaw, centre punch, twist drill, taps and dies - Simple exercises in making T, V joint and dovetail joints.

Sheet Metal Work: Use of hand tools - Simple exercises in making objects like cone, funnel, tray, cylinder.

Smithy: Demonstration of hand forging and drop forging.

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. **Use basic tools of fitting, carpentry and sheet metal fabrication.**
2. **Fabricate simple carpentry joints.**
3. **Develop skill to make simple fitting joints.**
4. **Create simple shapes of sheet material.**
5. **Distinguish hand forging and drop forging operation.**

Mapping of Course Outcomes with Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	2	-	-	1	1	1	-	2
CO2	3	-	2	-	-	-	-	1	1	1	-	1
CO3	3	-	2	-	-	-	-	1	1	1	-	-
CO4	3	-	1	-	-	-	-	1	1	1	-	1
CO5	3	-	2	-	-	-	-	1	1	1	-	2

22ETSP108	ELECTRICAL WIRING AND EARTHING PRACTICE LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES :

- **To create an awareness on the electrical safety in industrial and commercial environment.**
- **To enable the understanding on the principles of different types of electrical wiring.**
- **To offer exposure on the need for earthing and earthing practices.**
- **To provide practical knowledge on the various types of lighting circuits.**
- **To introduce methods for measuring the variables in electric circuits.**

a) Study of Basics of Safety Precautions
Study of Wiring Materials
a) Study of types of Wiring
Fan and Fluorescent Lamp Connections
Residential Wiring
Stair case Wiring
Industrial Wiring
Series and Parallel Lamp Circuits
Measurement of Earth Resistance
Measurement of Frequency and Phase of AC Circuits

COURSE OUTCOMES:

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

1. **Familiarize with the electrical safety measures.**
2. **Identify the different types of electrical wiring.**
3. **Demonstrate the necessity of Earthing.**
4. **Explain the different types of lighting circuits.**
5. **Review the methods for measuring electrical variables.**

Mapping of Course Outcomes with Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	1	-	-	-	1	1	1	-	2
CO2	3	-	-	2	-	-	-	1	1	1	-	2
CO3	3	-	-	2	-	-	-	1	1	1	-	2
CO4	3	-	-	2	-	-	-	1	1	1	-	2
CO5	3	-	-	2	-	-	-	1	1	1	-	2

SECOND SEMESTER

22ETHS201	ENGLISH	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- **To ensure the students with good vocabulary**
- **To make the students participate actively in writing activities**
- **To practice the unique qualities of professional writing style**
- **To develop the students the proficiency in communicative skills**
- **To ensure the students to face the demand of their profession**

UNIT- I VOCABULARY BUILDING

1. **The concept of Word Formation -**
2. **Root words from foreign languages and their use in English**
3. **Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Count and uncount nouns.**
4. **Synonyms, antonyms, and standard abbreviations.**
5. **Language development - Wh questions asking and answering yes or no questions.**

UNIT –II BASIC WRITING SKILLS

1. **Sentence Structures**
2. **Use of phrases and clauses in sentences**
3. **Importance of proper punctuation**
4. **Creating coherence and Techniques for writing precisely**
5. **Organizing principles of paragraphs in writing**

UNIT – III NATURE AND STYLE OF SENSIBLE WRITING

1. **Describing and Defining**
2. **Classifying and Providing examples or evidence**
3. **Writing introduction and conclusion**
4. **Comprehension**
5. **Precis Writing**

UNIT – IV WRITING PRACTICES & ORAL COMMUNICATION

1. **Listening to lectures and making notes**
2. **Mechanics of presentation, asking and giving instruction**
3. **Essay Writing – Writing analytical essays and issue based essays.**
4. **Dialogue writing and conversation**
5. **Letter writing – Formal and informal**

UNIT – V GROUP DISCUSSION AND JOB APPLICATION

1. **Characteristics and practices of group discussion**
2. **Job application**
3. **Resume preparation**
4. **Writing reports – minutes of a meeting, accident, survey**
5. **E-mail – etiquette**

TEXT /REFERENCE BOOKS:

1. **Michael Swan,"Practical English Usage", OUP, 1995.**
2. **F.T. Wood,,"Remedial English Grammar",Macmillan,2007.**
3. **William Zinsser,"On Writing Well", Harper Resource Book, 2001,**

4. **Liz Hamp - Lyons and Ben Heasly,"Study Writing", Cambridge University Press, 2006.**
5. **Sanjay Kumar and PushpLata, "Communication Skills" Oxford University Press, 2011.**
6. **"Exercises in Spoken English. Parts. I-III", CIEFL, Hyderabad,. Oxford University Press.**
7. **Raman, Meenakshi and Shama, Sangeetha – "Technical Communication Principles and Practice", Oxford University Press, New Delhi,2014.**

COURSE OUTCOMES :

At the end of this course, students will able to

1. **Apply comprehension, writing and speaking skills. Get an exposure of vocabulary and gain a good glossary.**
2. **Apply proper Grammar in speech and writing.**
3. **Demonstrate knowledge of remembering, understanding, applying, analyzing, evaluating & creating.**
4. **Determine how to articulate their ideas effectively to a variety of listeners.**
5. **Illustrate ability to speak and write effectively in English.**

Mapping of Course Outcomes with Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	2	-	2	-	-		1	1	3	-	3
CO2	-	2	-	2	-	-		1	1	3	-	3
CO3	-	-	3	-	-	-		1	1	3	-	3
CO4	-	-	2	3	-	-		1	1	3	-	3
CO5	-	-	3	2	-	-		1	1	3	-	3

22ETBS202	MATHEMATICS-II	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- **To familiarize multiple integrals and its application in finding area and volume.**
- **To make the student to learn line, surface and volume integrals.**
- **To solve Second order linear differential equations with constant coefficients.**
- **To acquaint the student with the techniques in the theory of analytic functions.**
- **To Introduce the fundamentals of complex integrations.**

UNIT-I MULTIVARIABLE CALCULUS (INTEGRATION)

Double integrals (Cartesian) - change of order of integration in double integrals - Change of variables (Cartesian to polar) - Applications: Area as a double integral. Triple integrals (Cartesian) - Applications: Volume as a triple integral.

UNIT – II VECTOR CALCULUS (INTEGRATION)

Line, Surface and Volume integrals - Gauss divergence theorem (without

proof) - Green's theorem in the plane (without proof) – Stokes theorem (without proof).Verification of the above theorems and evaluation of integrals using them.

UNIT – III ORDINARY DIFFERENTIAL EQUATIONS

First order ordinary differential equations (Linear and Bernoulli's differential equations, exact differential equations). Solution of Second order ordinary linear differential equations with constant co-efficient (method of variation of parameters only).Solution of Second order ordinary linear differential equations with variable co-efficient (Euler and Legendre's linear equations).

UNIT – IV COMPLEX VARIABLE (DIFFERENTIATION)

Analytic functions and their properties-Cauchy-Riemann equations-Harmonic functions – harmonic conjugate of elementary analytic functions–Construction of an analytic function. Mobius transformations.

UNIT – V COMPLEX VARIABLE (INTEGRATION)

Cauchy theorem (without proof) –Cauchy Integral formula (without proof) – Cauchy Integral formula for higher derivatives (without proof) – zeros and poles of an analytic functions – singularities. Residues - Cauchy Residue theorem (without proof) –Evaluation of definite integral using them. Taylor's series and Laurent's series.

TEXT BOOKS:

1. **B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36 Edition,2010.**
2. **Erwin kreyszig, "Advanced Engineering Mathematics", 9 Edition, John Wiley &Sons, 2006.**

REFERENCE BOOKS:

1. **G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9 Edition, Pearson, Reprint,2002.**
2. **W. E. Boyce and R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", 9thEdn., Wiley India, 2009.**
3. **S. L. Ross, "Differential Equations", 3rd Ed., Wiley India,1984.**
4. **J. W. Brown and R. V. Churchill, "Complex Variables and Applications", 7th Ed., Mc- Graw Hill, 2004.**
5. **N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.**

COURSE OUTCOMES:

At the end of this course, students will able to

1. **Solve double and triple integrals in finding area and volumes.**
2. **Apply line, surface and volume integrals in Gauss, Greens and Stoke'stheorems.**
3. **Solve Second order linear differential equations with constant coefficients.**
4. **Construct analytic function and analyze conformal mappings.**
5. **Evaluate the complex integrals and contour integration.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	-	-	1			-	-
CO2	3	3	2	-	-	-	-			1	-	-
CO3	3	3	3	3	3	-	-	1		1	-	-
CO4	3	3	2	-	-	-	-			1	-	-
CO5	3	3	3	2	-	-	-	1	1	1	-	-

22ETES203	BASIC ENGINEERING*	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- **To understand the basics of Electrical circuit laws and fundamentals of AC circuits**
- **To understand the working of DC Machines, transformers and AC machines**
- **To learn the basics of electronic devices and Communication Systems**
- **To inculcate a knowledge on essentials of Civil Engineering and to expose on the role of significance and contributions**
- **To satisfying societal needs and illustrate the concepts of various construction techniques**

UNIT-I BASIC CIRCUITS

Definition of current and voltage - Electrical circuit elements (R, L and C)- Ohm's Law- Kirchhoff's laws - solution for currents and voltages - AC circuits - RMS-Average values- Introduction to 3 phase systems - Advantages

UNIT-II ELECTRICAL MACHINES

Laws of Electromagnetism - Construction of DC Machines- DC Generator - EMF Equation - DC Motor- Principle of operation - Types– Characteristics

Single-phase Transformer: Construction and Working principle-EMF equation - Three-phase transformer-Working principle.

Three-phase induction motor – Construction and working principle- Single-phase induction motor- Alternators- Working principle

UNIT-III BASIC ELECTRONICS

P-N junction - VI Characteristics of PN junction diode, Zener diode - Rectifier circuits- Voltage Regulator using Zener diode - Elements of Communication Systems -Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

UNIT-IV

Introduction to Civil Engineering - Various disciplines of Civil Engineering - Introduction to various building materials Stone, Bricks, Steel, Cement, Concrete – its characteristics, types and uses. Surveying - Principles and objectives of surveying; Types, Classifications of surveying, measurement of areas and distances – chain – compass: Introduction to Leveling, Total station, Remote sensing.

UNIT-V

Building construction – foundations; Bearing capacity of soil, functions of foundations, Types - Shallow and Deep. Brick masonry – Header, Stretcher, Flemish and English Bond. Columns, Lintels, Roofs – functions, types, roofing materials. Bridges – necessity – selection of site – components of a bridge: Dams – types – selection site - forces acting on a dam – Roads – uses - classification of

roads – components of a road.

TEXTBOOKS :

1. **Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 2014.**
2. **A K Theraja&B L Theraja, A Textbook of Electrical Technology, Vol.2, S. ChandPublishing, 2014.**
3. **Ramesh babu. V, A text book of Basic Civil Engineering, Anuradha Agencies, Kumbakonam, 1995.**
4. **Palanichamy M.S., Basic Civil Engineering, Tata McGraw Hill Publishing Company ltd, 2000.**

REFERENCE BOOKS :

1. **Del Toro, "Electrical Engineering Fundamentals", Second edition, Pearson Education, New Delhi, 1989.**
2. **John Bird, "Electrical Circuit theory and technology", Routledge, 5th edition, 2013.**
3. **V.K. Mehta, Rohit Mehta, "Basic Electrical Engineering", S.Chand Publications, 2012.**
4. **Ramamrutham V, Basic Civil Engineering, DhanpatRai Publishing Co. (P) Ltd., 1999.**
5. **Natarajan K V, Basic Civil Engineering, Dhanalakshmi Publications, Chennai, 2005.**
6. **Satheesh Gopi, Basic Civil Engineering, Pearson Publications, 2010.**

COURSE OUTCOMES:

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

- **Apply the concepts related with electrical circuits and AC fundamentals.**
- **Explore the concepts of DC machines, Transformers and AC machines**
- **Explore the basic electronic devices and their applications. Gain insight on the various elements of Communication systems.**
- **Develop the skill to satisfy the social needs**
- **Describe the suitable method of construction technique**

Mapping of Course Outcomes with Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-			1	-	2
CO2	3	2	1	-	-	-	-	1		1	-	2
CO3	3	2	1	-	-	-	-	1			-	2
CO4	3	-	1	-	-	-	-	1	1	1	-	2
CO5	3	-	1	-	-	-	-			1	-	2

22ETHS204	தமிழரும் தொழில்நுட்பமும் TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

அலகு I: நெசவு மற்றும் பானைத் தொழில்நுட்பம்: 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II: வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு– சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ–சாரோசெனிக் கட்டிடக் கலை.

அலகு III: உற்பத்தித் தொழில் நுட்பம்: 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV: வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V: அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: 3

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

1. **Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)**
2. **Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.**
3. **Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).**
4. **The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)**
5. **Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)**

6. **Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)**
7. **Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)**
8. **Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.**

PAPER – 2
TAMILS AND TECHNOLOGY

1. **<u>Weaving and Ceramic Technology</u>: Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.**

2. **<u>Design and Construction Technology</u>: Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period**

   - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

3. **<u>Manufacturing Technology</u>: Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.**

4. **<u>Agriculture and Irrigation Technology:</u> Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.**

5. **<u>Scientific Tamil & Tamil Computing</u>: Development of Scientific Tamil - Tamil computing –Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.**

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
   கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
   கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
   பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
2. **Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)**
3. **Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.**
4. **Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).**
5. **The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)**
6. **Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Service Corporation, Tamil Nadu)**
7. **Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) Publishedby: The Author)**
8. **Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)**
9. **Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.**

22ETBP205	PHYSICS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- **To access the Rigidity modulus of wire.**
- **To assess the various properties of light.**
- **To asses the characterization of Metals.**
- **To analyses the thickness of microsized objects.**

LIST OF EXPERIMENTS:

1. **Air Wedge**
2. **Newtons's Rings**
3. **Simple Pendulum**
4. **Dispersive power of the Prism**
5. **Diffraction Grating**
6. **Acoustic diffraction Grating**
7. **Compound Pendulum**
8. **Kunt's tube experiment**
9. **Young's double slit experiment**
10. **Laser Grating**
11. **Torsional Pendulum**
12. **Young's Modulus – Non-uniform Bending**
13. **Young's Modulus – Uniform Bending.**

COURSE OUTCOMES:

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

1. **Illustrate the knowledge of torsional properties of metals wire.**
2. **Explain the dispersion of light through the prism.**
3. **Calculate the wavelength of monochromatic and polychromatic source of light.**
4. **Analyze diffraction patterns can be formed by light passing through a series of fine lines.**
5. **Estimate the size and shape of given unknown fine powder using laser gratings.**

Mapping of Course Outcomes with Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	3	2	1	1	1	1	-	-
CO2	3	3	-	-	3	1	1	1	1	1	-	-
CO3	3	2	2	-	3	1	1	1	1	1	-	-
CO4	3	2	2	-	3	1	1	1	1	1	-	-
CO5	3	2	2	-	3	1	1	1	1	1	-	-

22ETBP206	CHEMISTRY LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- **To list the water quality standards.**
- **To assess the composition of an alloy.**
- **To appreciate the practical significance of acidimetry, alkalimetry, permananganometry, conductometry and potentiometry.**
- **To analyse quantitatively the amount of a substance present in a given sample.**

LIST OF EXPERIMENTS:

1. **Determination of surface tension and viscosity**
2. **Thin layer chromatography**
3. **Ion exchange column for removal of hardness of water**
4. **Determination of chloride content of water**
5. **Determination of the rate constant of a reaction**
6. **Determination of cell constant and conductance of solutions**
7. **Potentiometry - determination of redox potentials and emfs**
8. **Saponification/acid value of an oil**
9. **Determination of the partition coefficient of a substance between two immiscible liquids**
10. **Adsorption of acetic acid by charcoal**
11. **Volumetric analysis**

COURSE OUTCOMES:

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

1. **Determine the physical properties like surface tension and viscosity.**
2. **Determine rate of reactions and soapnification of oil.**

3. **Calculate the quantity of adsorbate adsorbed by charcoal.**
4. **Determine the impurity from Pharmacheutical products and hardness of water.**
5. **Determine exact concentration of acid and bases present in the industrial wastes.**

Mapping of Course Outcomes with Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	1	-	-	1	1	1	1	-	-
CO2	2	1	-	-	-	1	-	1	1	1	-	-
CO3	3	2	-	1	-	-	2	1	1	1	-	-
CO4	3	-	1	-	-	-	-	1	1	1	-	-
CO5	2	2	-	-	-	-	-	1	1	1	-	-

22ETSP207	COMPUTER PROGRAMMING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- **To enable students to code, compile and test C programs.**
- **To enable students to design algorithms using appropriate programming constructs for problem solving.**
- **Identify tasks in which the numerical techniques learned are applicable and apply them to write programs.**
- **To enable students to segregate large problems into functions using modular programming concepts.**
- **To enable students to apply pointer and structures in programs effectively.**

[The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given]

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 & 9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Tutorial 12: File handling:
Lab 12: File operations

COURSE OUTCOMES :

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

1. **Analyze program requirements and develop programs using conditional and looping statements.**
2. **Write programs for handling arrays and strings.**
3. **Create C programs with user defined functions and recursive function calls.**
4. **Utilize pointers and structures for dynamic memory allocation in C programming.**
5. **Develop C programs for handling files.**

Mapping of Course Outcomes with Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	2	-	-	1	1	1	-	-
CO2	2	1	1	-	2	-	-	1	1	1	-	-
CO3	2	1	1	-	2	-	-	1	1	1	-	-
CO4	1	1	1	-	2	-	-	1	1	1	-	-
CO5	1	1	1	-	2	-	-	1	1	1	-	-

22ETSP208	ENGINEERING GRAPHICS	L	T	P	C
		2	0	3	3

TRADITIONAL ENGINEERING GRAPHICS:

PrinciplesofEngineeringGraphics;OrthographicProjection;DescriptiveGeometry; Drawing Principles; Isometric Projection; Surface Development; Reading a Drawing; Sectional Views; Dimensioning, True Length, Angle.

COMPUTER GRAPHICS:

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling; Introduction to Building Information Modeling (BIM)

(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

COURSE OBJECTIVES :

- **To develop the ability to produce simple engineering drawing and sketches based on current practice**
- **To develop the means for communication of ideas, thoughts and design of objects, related to engineering applications, to others though drawing**
- **To develop the skills to read manufacturing and construction drawings used in industry**
- **To develop a working knowledge of the layout of plant and equipment**
- **To develop skills in abstracting information from calculation sheets and schematic diagrams to produce working drawings for manufacturers, installers and fabricators**

UNIT- I INTRODUCTION TO ENGINEERING DRAWING,

Introduction to Engineering Drawing: Lettering, Dimensioning and use of drawing instruments. Conic sections: Eccentricity method of/for drawing ellipse, parabola and hyperbola- Tangent and Normal from a point on the curve.

UNIT- II ORTHOGRAPHIC PROJECTIONS,

Orthographic projections: Introduction – Projections of pointsProjections of Straight lines: Determination of true length and true angle of inclinations using half cone and trapezoidal methods – drawing the projections of straight lines using half cone method from true length and true angle of inclinations.

UNIT -III PROJECTIONS OF REGULAR SOLIDS,

Projections of solids in simple position: Projections of cube, Tetrahedron, prisms, Pyramids, cone and cylinder. Projections of solids: Auxiliary projections – projections of prisms, pyramids, cylinder and cone when the axis is inclined to only one plane.

UNIT- IV SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS, Sections of solids: Sections of prisms, pyramids, cylinder and cones – true shape of section. Developments of solids: Developments of lateral surfaces of solids using parallel and radial line methods.

UNIT -V ISOMETRIC PROJECTIONS

Isometric projections: Projections of simple solids.Conversion of pictorial view of simple objects into orthographic projections (only elevation and plan)

Overview of Computer Graphics Covering:

Introduction to CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars). The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.

Customization & CAD Drawing

Consistingofsetupofthedrawingpageandtheprinter,includingscalesettings, Settingupof units and drawing limits;

Orthographicconstraints,Snaptoobjectsmanuallyandautomatically; Producing drawings by using various coordinate input entry methods to draw straight lines and other basic geometric entities.

Annotations, layering & other functions

applying dimensions to objects and annotations to drawings; Setting up and use of Layers, Printing document stop a per using the print command; orthographic projection techniques ;Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation;

TEXT/REFERENCE BOOKS:

1. **BhattN.D.,Panchal V.M.& Ingle P.R.,(2014), Engineering Drawing, Charotar Publishing House.**
2. **Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.**
3. **Agrawal B. &Agrawal C. M. (2012), Engineering Graphics, TMH Publication.**
4. **Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.**
5. **(Corresponding set of) CAD Software Theory and User Manuals.**

COURSE OUTCOMES :

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

1. **Use drawing convention and Construct the conic curves.**
2. **Apply theory of projections to solve points and straight lines.**
3. **Illustrate the simple and auxiliary projections of solids.**
4. **Visualize the sections of solids and development of solids surfaces.**
5. **Create the pictorial projections of real world applications.**

Mapping of Course Outcomes with Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	2	-	-	1	1	1	-	2
CO2	3	3	3	2	2	-	-	1	1	1	-	2
CO3	2	-	2	-	-	-	-	1	1	1	-	-
CO4	3	2	2	2	-	-	-	1	1	1	-	-
CO5	-	-	-	-	-	-	-	1	1	1	-	3

THIRD SEMESTER

22ETBS301	ENGINEERING MATHEMATICS III	L	T	P	C
		3	1	0	4

Course Objectives

- **To understand the basic concepts of partial differential equations which is helpful in solving Real world problems.**
- **Introduce Fourier series which is very useful in the study of electrostatics, acoustics and computing.**
- **Introduce Boundary value problems which is helpful in investigation of the important features of electromagnetic theory.**
- **The study of Fourier transform is useful in solving problems in frequency response of a filter and signal analysis.**
- **Provide a study of Z-transform which can played important role in the development of communication engineering.**

Unit – I: Partial Differential Equations

Formation of partial differential equations by eliminating arbitrary constants and arbitrary functions - Solution of standard type of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second order with constant coefficients.

Unit – II: Fourier series

Dirichlet's conditions - General Fourier series - Odd and Even functions - Half range sine series - Half range cosine series - Complex form of Fourier series – Parseval's identity.

Unit – III: Boundary Value Problems

Solutions of one-dimensional wave equation – One dimensional heat equation (without derivation) – Fourier series solutions in Cartesian co-ordinates.

Unit – IV: Fourier Transform

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem - Parseval's identity

Unit – V: Z – Transform and Difference Equations

Z – transform – Elementary properties – Inverse Z – transform - Convolution theorem – Solution of difference equations using Z – transform.

Text Books

Kandasamy,P., Thilagavathy,K. and Gunavathy,K., Engineering Mathematics,6th ed., (Vol-I & II) S.Chand& Co Ltd. 2006, New Delhi.

Ventakataraman,M.K., 2003. Engineering Mathematics-The National Publishing Co., Chennai.

References Books

1. **Ramana B V., Higher Engineering Mathematics.,2007, Tata McGraw Hill Pub.**
2. **Veerarajan, T., Engineering Mathematics, 3rd edition, 2005, Tata McGraw Hill Pub.**
3. **Vairamanickam.k., Nirmala.p., Tamilselvan.S., Transforms and Partial Differential Equations., 2014,Scitech Publications(India) Pvt.Ltd**

4. **Singaravelu, A., Engineering Mathematics, Meenakshi Publications, Chennai,2004.**

Course Outcomes

At the end of this course, students will able to

1. **Demonstrate his/her understanding of the most common partial differential equations.**
2. **Relate the concepts of Fourier series.**
3. **Show ability to solve boundary value problems.**
4. **Able to interpret signals problems using Fourier transform**
5. **Summarize Z-transform that play important roles in many discreate engineering problems.**

Mapping with Programme Outcomes															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2				1	1	1			2		
CO2	3	3	3	2				1	1	1			2		
CO3	3	3	3	2				1	1	1			2		
CO4	3	3	3	2				1	1	1			2		
CO5	3	3	3	2				1	1	1			2		

22ETES302	ENVIRONMENTAL STUDIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To study the nature and the facts about environment.**
- **To find and implement scientific, technological, economic and political solutions to environmental problems.**
- **To Study the dynamic processes and understand the features of the earth interior and surface.**

Unit I Introduction - Multidisciplinary nature of environmental studies - Definition, scope and importance - Need for public awareness. Natural resources - Forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification- Role of an individual in conservation of natural resources.- Equitable use of resources for sustainable lifestyles.

Unit II Concept of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological - pyramids - Introduction, types, characteristic features, structure and function of the following ecosystem - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

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

Unit IV Definition - Cause, effects and control measures of Air pollution - Water pollution - Soil pollution - Marine pollution- Noise pollution - Thermal pollution - Nuclear hazards- Solid waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Disaster management: floods, earthquake, cyclone and landslides.

Sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, and watershed management - Resettlement and rehabilitation of people; its problems and concerns. - Environmental ethics: Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Wasteland reclamation - Consumerism and waste products - Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation.

Unit V Population growth, variation among nations - Population explosion – Family Welfare Programme - Environment and human health - Human Rights - Value Education - HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health -Case Studies.

Field Work

Visit to a local area to document environmental assets-river / forest / grassland / hill / mountain - Visit to a local polluted site-Urban/Rural/ Industrial/ Agricultural - Study of common plants, insects, birds - Study of simple ecosystems-pond, river, hill slopes, etc. (Field work Equal to 5 lecture hours)

TEXT BOOKS

1. **Agarwal, K.C. 2008 Environmental Biology, Nidi Publ. Ltd. Bikaner.**
2. **Bharucha Erach, 2002 The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad.**

REFERENCES

1. **Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc.**
2. **Clark R.S., Marine Pollution, Clanderson Press Oxford (TB), 2018**
3. **Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai.**
4. **De A.K., Environmental Chemistry, Wiley Eastern Ltd, 2018**

COURSE OUTCOMES

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

1. **Analyze the multidisciplinary nature of environmental awareness.**
2. **Evaluate the significance of ecosystem.**
3. **Demonstrate the importance of biodiversity and its threats**
4. **Compare the effects of air, land and water pollution.**
5. **Analyzethe impact of population growth and importance of Human rights**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3					2		1	1	1					1
CO2				3				1	1	1			3		
CO3					3		2	1	1	1		1	3		
CO4	3		2		2			1	1	1		1	3		1
CO5	3							1	1	1		1			1

22CEES303	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To introduce the fundamentals of forces and their effects with their governing laws.**
- **To understand the definitions of particle, body forces and their equilibrium conditions.**
- **To understand and predict the forces and its related motions**

UNIT-I Introduction to Engineering Mechanics: Force Systems-Basic concepts, System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems;

UNIT-II Basic Structural Analysis: Static Indeterminancy - How to determine if a member is in tension or compression -Simple Trusses - Zero force members - Method of Sections - Method of Joints; Equilibrium in three dimensions - Beams & types of beams - Frames & Machines - Centroid and Centre of Gravity covering; Centroid of simple figures from first principle - centroid of composite sections - Centre of Gravity and its implications; Area moment of inertia- Definition - Moment of inertia of plane sections from first principles - Theorems of moment of inertia - Moment of inertia of standard sections and composite sections - Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

UNIT-III Friction covering: Types of friction - Limiting friction - Laws of Friction - Static and Dynamic Friction; Motion of Bodies - wedge friction - screw jack & differential screw jack.

Virtual Work and Energy Method: Virtual displacements - principle of virtual work for particle and ideal system of rigid bodies - degrees of freedom - Active force diagram - systems with friction - mechanical efficiency; Conservative forces and potential energy (elastic and gravitational) - energy equation for equilibrium - Applications of energy method for equilibrium; Stability of equilibrium.

UNIT-IV Review of particle dynamics: Basic terms- General principles in dynamics - Rectilinear motion - Plane curvilinear motion (rectangular, path, and polar coordinates) - 3-D curvilinear motion - Relative and constrained motion - Newton's 2nd law (rectangular, path, and polar coordinates) - Work-kinetic energy – power - potential energy – Impulse and momentum (linear, angular) - Impact (Direct and oblique).

UNIT-V Introduction to Kinetics of Rigid Bodies: Types of motion - Instantaneous centre of rotation in plane motion and simple problems - D'Alembert's principle and its applications in plane motion and connected bodies - Work energy principle and its application in plane motion of connected bodies - Kinetics of rigid body rotation.

Mechanical Vibrations: Basic terminology - free and forced vibrations - resonance and its effects - Degree of freedom - Derivation for frequency and amplitude of free

vibrations without damping and single degree of freedom system - simple problems - types of pendulum - use of simple - compound and torsion pendulums.
Tutorials from the above modules covering, To find the various forces and angles including resultants in various parts of wall crane, roof truss, pipes, etc.; To verify the line of polygon on various forces; To find coefficient of friction between various materials on inclined plan; Free body diagrams various systems including block-pulley; To verify the principle of moment in the disc apparatus; Helical block; To draw a load efficiency curve for a screw jack

TEXT BOOKS

1. **Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall**
2. **F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill**

REFERENCES

1. **R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.**
2. **Andy Ruina and RudraPratap (2011), Introduction to Statics and Dynamics, Oxford University Press**
3. **Shanes and Rao (2006), Engineering Mechanics, Pearson Education,**
4. **Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education**
5. **Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics**
6. **Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications**
7. **Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.**
8. **Tayal A.K. (2010), Engineering Mechanics, Umesh Publications**

COURSE OUTCOMES

At the end of this course, students will able to

1. **Evaluate the forces in static mechanics.**
2. **Analyse the structure and stability of static mechanics.**
3. **Interpret the friction forces and forces by virtual and energy method in static mechanics.**
4. **Estimate the dynamic parameter of particles.**
5. **Evaluate the dynamic parameter of rigid bodies and mechanical vibration.**

Mapping of COs with															
POs													PSOs		
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		3					1	1	1	2		3	3	
CO2	3	3	3	2				1	1	1			3	3	
CO3	3	3	3					1	1	1			3	3	
CO4	3	3	3					1	1	1			3	3	
CO5	3	3	3					1	1	1			3	3	

22MEES304	INTRODUCTION TO PYTHON PROGRAMMING	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

- **To familiarize with data types, variable, Operators, conditionals and looping.**
- **To provide in-depth Knowledge and understanding about the Functions.**
- **To make the students to understand the fundamentals of Classes and Objects.**
- **To impart the knowledge about File handling and networking.**

- **To educate the student in Database Management and GUI Programming in Python.**

UNIT-I Introduction

Elementary Programming, Selections and Loops: History of Python – Getting Started with Python – Programming Style – Writing a Simple Program – Reading Input from the Console

Identifiers – Variables, Assignment Statements, and Expressions – Simultaneous Assignments – Named Constants – Numeric Data Types and Operators – Type Conversions and Rounding–Introduction – Boolean Types, Values, and Expressions – if Statements – Two-Way if-else Statements – Nested if and Multi-Way if-elif-else Statements – Logical Operators – Conditional Expressions – Operator Precedence and Associativity – Detecting the Location of an Object Case Study: Computing Body Mass Index – The while Loop – The for Loop – Nested Loops – Keywords break and continue – Case Studies: Displaying Prime Numbers and Random Walk.

UNIT - II Python Function

Mathematical Functions, Strings and User Defined Functions: Simple and Mathematical Python Built–in Functions – Strings and Characters – Introduction to Objects and Methods

Formatting Numbers and Strings – Drawing Various Shapes Drawing with Colors and Fonts – Defining a Function – Calling a Function – Functions with/without Return Values

Positional and Keyword Arguments – Passing Arguments by Reference Values – Modularizing Code – The Scope of Variables – Default Arguments – Returning Multiple Values –Function Abstraction and Stepwise Refinement – Case Study: Generating Random ASCII Characters.

UNIT - III Class and Object

Introduction to Object – Oriented Programming – Basic principles of Object – Oriented Programming in Python – Class definition, Inheritance, Composition, Operator Overloading and Object creation – Python special Unit – Python Object System – Object representation, Attribute binding, Memory Management, and Special properties of classes including properties, Slots and Private attributes.

UNIT - IV Files and Exception Handling

Files, Exception Handling and Network Programming: Introduction –Text Input and Output – File Dialogs – –Exception Handling – Raising Exceptions – Processing Exceptions Using Exception Objects – Defining Custom Exception Classes – Binary IO Using Pickling – Case Studies: Counting Each Letter in a File and Retrieving Data from the Web–Client Server Architecture–sockets – Creating and executing TCP and UDP Client Server Unit – Twisted Framework – FTP – Usenets – Newsgroup Emails – SMTP – POP3.

UNIT - V Database and GUI

Database and GUI Programming: DBM database – SQL database – GUI Programming using Tkinter: Introduction – Getting Started with Tkinter – Processing Events – The Widget Classes – Canvas – The Geometry Managers – Displaying Images – Menus – Popup Menus – Mouse, Key Events, and Bindings – List boxes – Animations – Scrollbars – Standard Dialog Boxes–Grids.

TEXT BOOKS:

1. **Mark Lutz, "Learning Python, Powerful OOPs", O'Reilly, 5th edition 2013.**
2. **Guttag, John, "Introduction to Computation and Programming Using Python", MIT Press, 2016.**

REFERENCES:

1. **Jennifer Campbell, Paul Gries, Jason montajo, Greg Wilson, "Practical Programming An Introduction To Computer Science Using Python" The**

Pragmatic Bookshelf , 2018.
2. Wesley J Chun "Core Python Applications Programming", Prentice Hall, 2015.
3. Jeeva Jose, "Taming Python by Programming", Khanna Publishing House,1st edition,2018.
4. J.Jose, "Introduction to Computing and Problem Solving with Python", Khanna Publications,1st edition,2019.
5. Reema Thareja, "Python Programming", Pearson,1st edition,2017.

COURSE OUTCOMES:

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

1. Build the basic concepts of Conditional and Looping Statements in python.
2. Apply the various functions in Python
3. Apply the concepts of Object Oriented programming including encapsulation, inheritance and polymorphism as used in Python.
4. Select the commonly used operations in file system and able to develop application program to communicate from one end system to another end.
5. Develop menu driven program using GUI interface and to gain knowledge about how to store and retrieve data.

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2		1			1	1	1		1	1		
CO2	2		2		1			1	1	1		1		2	
CO3	2		2		1			1	1	1		1	1	1	
CO4	2		2		1			1	1	1		1		2	
CO5	2		2		1			1	1	1		1		2	

22MEPC305	THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To learn about work and heat interactions, and balance of energy between system and its surroundings
- To learn about application of I law to various energy conversion devices
- To evaluate the changes in properties of substances in various processes
- To understand the difference between high grade and low grade energies and II law limitations on energy conversion

Unit-I Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.

Unit-II First Law for Flow Processes - Derivation of general energy equation for a

control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

Unit-III Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale. Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; ideal gas; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in Ts coordinates;

Unit-IV Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart

Unit-V Thermodynamic cycles - Basic Rankine cycle; Basic vapor compression cycle and comparison with Carnot cycle. Definition of Isentropic efficiency for compressors, turbines and nozzles-Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.

TEXT BOOKS

1. **Engineering Thermodynamics, P.K. Nag, 6th edition, Tata McGraw Hill, 2017**
2. **Thermodynamics –An Engineering Approach, Yunus A Cengel & Michael A Boles, 9th edition, McGraw Hill, 2019**

REFERENCES

1. **Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2009, 7th Edition, Fundamentals of a Thermodynamics, John Wiley and Sons.**
2. **Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India**
3. **Moran, M. J. and Shapiro, H. N., 2015, 8th edition, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.**
4. **Basic and Applied Thermodynamics, P.K. Nag, 2nd edition, Tata McGraw Hill, 2017**

COURSE OUTCOMES

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

1. **Apply energy balance to systems and control volumes, in situations involving heat and work interactions**
2. **Evaluate changes in thermodynamic properties of substances**
3. **Evaluate the performance of energy conversion devices**
4. **Interpret between high grade and low grade energies.**
5. **Compare various thermodynamic cycles**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		2					1	1	1			3	3	3
CO2	3	3	2					1	1	1			3	3	3
CO3	3	3	2					1	1	1			3	3	3
CO4	3	3	2					1	1	1			3	3	3
CO5	3	3	2					1	1	1			3	3	3

22MEPC306	FLUID MECHANICS & FLUID MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To learn the properties of fluids and concepts of control volume**
- **To study the application of conservation laws to flow through pipes**
- **To understand the importance of dimensional analysis**
- **To analyze the flow in water pumps and turbines.**

Unit-I Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation, energy and momentum equation, Incompressible flow, Bernoulli's equation and its applications.

Unit-II Hydraulic and energy gradient- Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli (theory only)- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram. Flow through pipes in series and parallel.

Unit-III Need for dimensional analysis–methods of dimension analysis–Similitude–types of similitude Dimensionless parameters–application of dimensionless parameters–Model analysis.

Unit-IV Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components atentry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump–working principle. Rotary Pumps-Classification

Unit-V Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles, work done by water on turbines – draft tube-Specific speed, Unit-quantities, performance curves for turbines – governing of turbines.

TEXT BOOKS

1. **Fluid Mechanics, Sadhu Singh, Khanna Publishing House, NewDelhi 2016**
2. **Hydraulics and Fluid Mechanics, Modi P.N., Seth S.M Standard Book House, NewDelhi 2019.**
3. **A text book of Fluid Mechanics and Hydraulic Machines, R.K. Rajput, S.Chand and Company, 6th edition, 2018**

REFERENCES

1. **Bansal R.K., A Text Book of Fluid Mechanics and Hydraulic Machinery,9th ed., Laxmi Publication, New Delhi, 2018.**
2. **Theory and Applications of Fluid mechanics, K. Subramanya, Tata Mc Graw Hill, 2006**

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. **Analyze the fluid properties and fluid characteristics**
2. **Classify fluid flow through channels, ducts, pipes with various losses**
3. **Solve problems on dimensionless parameters**
4. **Analyze the performance of pumps**
5. **Evaluate the performance of turbines.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3							1	1	1		1	3	2	
CO2	3	3	2	2				1	1	1			3	2	
CO3	3	3			3			1	1	1			3	2	
CO4	3			2	3			1	1	1		1	3	2	
CO5	3		2			1		1	1	1			3	2	

22MESP307	ELECTRICAL AND ELECTRONICS LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- **To impart hands on experience in verification of circuit laws and measurement of circuit parameters**
- **To familiarize the students with the functioning of different types of DC, AC machines, their mountings and accessories apart from transformer.**
- **To study the behavior of AC and DC machines under loading conditions**
- **To learn the speed control of DC machines.**
- **To learn the characteristics of electronic devices and their applications**

LIST OF EXPERIMENTS

Electrical Engineering

1. **Speed Control of DC Shunt Motor**
2. **Load Test on DC shunt Motor**
3. **Load Test on Single phase Transformer**
4. **Load Test on Three phase Transformer**
5. **Load Test on Single phase Induction Motor**
6. **Load Test on Three phase Induction Motor**
7. **Load Test on Three Phase Alternator**

Electronics Engineering

1. **Verification of Ohm's and Kirchhoff's Laws**
2. **Characteristics of PN diode and Zener diode**
3. **Half wave and full wave Rectifiers**
4. **Application of Zener diode as Shunt Regulator**
5. **Characteristics of Bipolar Junction Transistor**

COURSE OUTCOMES

Upon completion of this course, students will be able to

1 **Analyze the construction, working principles & operations of DC machines and transformers, Induction motors and Alternators.**

2 **Estimate the performance of electrical machines under different loading conditions**

3 **Analyze the characteristics of basic electronic devices.**

4 **Analyze the circuits by applying basic laws.**

5 **Apply electronic devices for simple applications.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3		3			1	1	1		1	3	3	
CO2	3	3	3		3			1	1	1			3	3	
CO3	3	3	3		3			1	1	1			3	3	
CO4	3	3	3		3			1	1	1		1	3	3	
CO5	3	3	3		3	1		1	1	1			3	3	

22MECP308	THERMAL LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- **To inculcate the knowledge about the working of I.C engines and different types of dynamometers.**

To study the valve timing and port timing of an IC engine

To study and determine the properties of fuel like kinematic viscocity, calorific value etc.

List of Experiments

1. **Study and valve timing on four stroke diesel engine.**
2. **Study and port-timing on two stroke petrol engine.**
3. **Dismantling and assembling of four stroke single cylinder diesel engine**
4. **Study of various parts of multi-cylinder diesel/petrol engine.**
5. **Study of Carburetor**
6. **Study of fuel injection pump**
7. **Study of cooling system**
8. **Study of lubrication system**
9. **Study of air compressor**
10. **Determination of calorific value of liquid fuel**
11. **Determination of flash and fire point of liquid fuel**
12. **Determination of cloud and pour point fuel**
13. **Determination of kinematic viscosity of fuel**

COURSE OUTCOMES

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

1. **Find the data of port/ valve timing on internal combustion engine.**
2. **Evaluate and construct port/ valve timing diagram.**
3. **Observe the data of fuel properties.**
4. **Analyse and infer the fuel properties.**
5. **Demonstrate the system of heat engines and fuel properties.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			3	3			1	1	1		1	3	2	3
CO2	3			3	3			1	1	1		1	3	2	3
CO3	3			3	3			1	1	1		1	3	2	3
CO4	3			3	3			1	1	1		1	3	2	3
CO5	3			3	3			1	1	1		1	3	2	3

22MECP309	PYTHON LAB	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

- **To learn python programming and key python modules.**
- **To understand the process involved in computing with file handlings.**
- **To develop the python program to do variety of programming tasks.**
- **To impart programming skills for various application using python.**

LIST OF EXPERIMENTS

Write a python program to run the following exercises:

1. **Fibonacci sequence of number without importing any modules and libraries.**
2. **Random number generation**
3. **To print the no. of odd and even numbers for the given list of numbers without using loops and iterables.**
4. **Determination of the day of the given dates**
5. **Checking the given numbers are prime numbers (or) not.**
6. **Solving the quadratic equation.**
7. **Remove, print, and count the vowels in the given paragraph.**
8. **Multiplication table using for and while loops.**
9. **Find and print the file extensions path.**
10. **Create the file extension.**
11. **To sort the sentence in alphabetical order using input function to get the sentence.**
12. **Sorting of numbers using bubble and insertion sorts.**

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. **Write, and Test the Python Programs**
2. **Implement Conditionals and Loops for Python Programs**
3. **Use functions and represent Compound data using Lists, Tuples and Dictionaries**
4. **Read and write data from & to files in Python**
5. **Solve simple python programs and understand object oriented programming concepts.**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	2	1			1	1	1		1	1		
CO2	1		2		1			1	1	1				2	
CO3	1	2	3		1			1	1	1				2	
CO4	2		3		1			1	1	1			1	1	
CO5	2				1			1	1	1		1	1		2

22MECP310	MACHINE DRAWING	L	T	P	C
		1	0	3	2.5

COURSE OBJECTIVES

Students have an ability to apply knowledge of modeling, science & engineering.

Student can modeled this drawing even in CAD/CAM software by applying the basic knowledge of machine drawing.

Students will able to demonstrate an ability to design and conduct experiments, analyze and interpret data, assembly and disassembly drawings knowledge will be provided.

Orthographic and Assembly Drawings

To draw orthographic views from the given isometric views of simple objects. Detailed assembly drawing and additional views from the given drawing.

(a) Shaft coupling - Protected type and Pin type flexible coupling

(b) Bearings and Supports - Bushed bearing, Foot step bearing and Plummer Block

(c) Eccentric

(d) Steam engine stuffing box

(e) Screw jack.

Free Hand Sketches

Fasteners: Different form of rivet heads – Single, double riveted lap and butt joints - Foundation bolts - Locking arrangements for nuts - lock nut, split pin, locking plate and spring washer - Stud Set screws – Different forms of machine screws - pan, countersunk, slotted and philip headed screws - Keys - sunk taper key, gib headed taper key, feather key, woodruff key, saddle key.

TEXT BOOKS

1. **Gopalakrishna, K.R., Machine Drawing, Subhas stores, Bangalore.**
2. **Bhatt, N.D., Machine Drawing, Charotar Publishing House.**

REFERENCES

1. **Parkinson, A.C. (Sinha), A First Year Engineering Drawing, Wheeler Publishers, New Delhi.**
2. **Parkinson, A.C., Intermediate Engineering Drawing.**
3. **Narayana, K.L., Kanniah, P. & Venkata Reddy, K., A Text Book on Production Drawing, Premier Publishing House, Hyderabad.**
4. **Narayana, K.L., Kanniah, P. & Venkata Reddy, K., Machine Drawing, New Age International (P) Limited, Publishers.**
5. **Lakshmi Narayanan, V. & Mathur, M.L., A Text Book of Machine Drawing, Jain Brothers Publishers.**

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. **Construct the sectional elevation of assembled view from detailed drawing.**
2. **Illustrate the sectional plan of assembled view from the detailed drawing.**
3. **Apply the constraints and details of assembled parts of body/ end elevation.**
4. **Design fasteners and foundation bolts by free hand sketch.**
5. **Create Forms of machines screws and keys by free hand sketch.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		3					1	1	1		2	2	2	
CO2	3		3					1	1	1		2	2	2	
CO3	3		3					1	1	1		2	2	2	
CO4	3		3					1	1	1		2	2	2	
CO5	3		3					1	1	1		2	2	2	

FOURTH SEMESTER

22EEBS401	PROBABILITY RANDOM PROCESS AND NUMERICAL METHODS	L	T	P	C
		2	1	0	3

Course Objectives

- **Introduce Probability theory which is helpful in investigating the important features of the random experiment.**
- **To understand the basic concepts of random processes which are widely used in Electrical fields.**
- **The aim of theory of sampling is to get as much information as possible of the population to the process of making scientific judgments in the face of uncertainty and variation.**
- **To develop the skills of the students in finding numerical solution of Interpolation, differentiation and integration problems.**
- **Provide the study of numerical solution of algebraic and transcendental equations, the numerical solution of ordinary and partial differential equations.**

Unit–I: Probability and Random Variables

Definition – Types of random variables - probability distribution function - probability density function – expectation and moments – moment generating functions –joint probability distribution -marginal probability distribution function – joint probability density function – marginal probability density function – conditional probability density function.

Unit–II: Random Processes

Classification of random processes – methods of description of a random process – special classes of random processes – Average values of random process - stationary –Autocorrelation function and its properties - cross correlation function and its properties.

Unit–III: Test of Significance

Hypothesis, testing – Large sampling tests – small sampling test based on t, F and chi-square distributions – interval estimates of mean, standard deviation and proportion.

Unit–IV: Interpolation, Numerical Differentiation and Integration

Interpolation: Gregory Newton forward and backward interpolation formula; Stirling's central difference formula; Lagrange's interpolation formula for unequal interval. Numerical differentiation: Using Newton's forward and backward interpolation formula. Numerical integration: Trapezoidal rule, Simpson's one-third

and three-eight rules.

Unit–V: Solution of Algebraic, Transcendental and Ordinary Differential Equations

Solution of algebraic and transcendental equations: Bolzano's bisection method, Regula-falsi method, Newton – Raphson method.

Solution of simultaneous algebraic equation: Gauss elimination method, Crout's method, Gauss – Seidel iteration method.

Solution of ordinary differential equations: Taylor series method, Runge–Kutta fourth order method, Milne's - Predictor corrector method.

Text Books

1. **Kandasamy, P., Thilagavathy, K., and Gunavathy, K., Probability and Random Processes, S.Chand& Co. Ltd. 2006, New Delhi.**
2. **Venkataraman, M.K., Numerical methods in Science and Engineering, National Publishing Co., Chennai - 2003.**

Reference Books

1. **Lipschutz, S., and Schiller, J., Schaums¨s Outlines – Introduction to Probability and Statistics, McGraw Hill, New Delhi, 1998.**
2. **Veerarajan, T., Probability theory and Random Process, Tata McGraw Hill Co., Ltd., New Delhi, 2005**
3. **Kandasamy, P., Thilagavathy, K. and Gunavathy, K., Numerical Methods, S.Chand& Co. Ltd., New Delhi, 2004.**

Course Outcomes

At the end of this course, students will demonstrate the ability to

1. **Build skills in handling situations involving random experiments.**
2. **Utilize the concept of random processes.**
3. **Demonstrate the basic concepts of theory of sampling to any collection of individuals of their attributes can be numerically specified.**
4. **Solve problems algebraic transcendental equations and numerical integration.**
5. **Show numerical solution of ordinary and partial differential equations.**

Mapping with Programme Outcomes														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2				1	1	1			2		
CO2	3	3	2	2				1	1	1			2		
CO3	3	3	2	2				1	1	1			2		
CO4	3	3	3	2				1	1	1			2		
CO5	3	3	3	2				1	1	1			2		

22MEPC402	INSTRUMENTATION AND CONTROL ENGINEERING	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

- **To provide a basic knowledge about measurement systems and their components**
- **To learn about various sensors used for measurement of mechanical quantities**
- **To learn about system stability and control**
- **To integrate the measurement systems with the process for process monitoring and control**

Unit–I Generalised measurement system - Basic standards of measurement - Errors - Classification. Measurements of displacement, force and torque. Dynamometers: Hydraulic, Absorption and Eddy current.

Unit–II Measurement of strain - Bonded and unbounded strain gauges - Requirements of materials. Mechanical - Electrical - Opto mechanical strain gauges. Measurement of temperature - electrical and non-electrical methods - Bimetallic and pressure thermometer, thermocouples - requirements - Resistance thermometers - Pyrometry - Calibration methods.

Unit–III Measurements of Pressure and flow - Measurements of high pressure and low pressure - Measurements of flow by obstruction meters - Velocity probes - Hot wire anemometer - Calibration of pressure gauges and flow meters - Time constant of pressure gauges.

Unit–IV Elementary ideas of automatic control - Open and closed systems, on-off, proportional, and floating modes, reset and rate actions. Basic combined modes for pneumatic, hydraulic and electrical systems.

Unit–V Transfer function - Stability - Routh's criterion - Analysis of second order systems – System response to step – step, pulse - ramp inputs. Introduction to computerized measurement and control systems (Description only)

TEXT BOOKS

1. **Hollman, J.P., Experimental Methods for Engineers, Tata McGraw Hill 2017.**
2. **Benjamin Kuo, Automotive Control Engineering, EEE Publications.**

REFERENCES

1. **D.S. Kumar, 'Mechanical Measurement & Control', Metropolitan Book Company 2015.**
2. **Beckwith, T.C & Buck, N.L., Mechanical Measurements, Addison Wesley 2013.**
3. **Nagarth and Gopal, Control Engineering, Wiley Eastern Ltd 2018.**
4. **Control System by Nagoor Kani, RBA Publications 2014.**
5. **Erenest O. Doebeling, 'Measurement Systems', McGraw Hill 2019.**
6. **Instrumentation and control systems by W. Bolton, 2nd edition, Newnes, 2000**
7. **Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, Mechanical Measurements 6th Edition, Pearson Education India, 2013**
8. **Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York, 2009.**

COURSE OUTCOMES

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

1. **List measurement parameters and analyze errors of measurements**
2. **Design and maintain measuring equipments for the measurement of temperature and strain**
3. **Select and apply suitable transducer for pressure and flow measurement.**
4. **Explore the working of automatic control system.**
5. **Build control system and analyze the stability.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2				2			1	1	1		1	3	3	
CO2	2		2		2			1	1	1			3	3	
CO3	2							1	1	1	1		3	3	
CO4	2	2	2					1	1	1		1	3	3	
CO5	2				2			1	1	1	1	1	3	3	

22MEPC403	STRENGTH OF MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- **To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads**
- **To calculate the elastic deformation occurring in various simple geometries for different types of loading**

Unit-I Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.

Unit-II Beams and types- transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

Unit-III Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.

Unit-IV Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

Unit-V Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.

TEXT BOOKS

1. **Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2015.**
2. **R. Subramanian, Strength of Materials, Oxford University Press, 2016.**

REFERENCES

1. **Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2017.**
2. **Strength of Materials, D.S. Bedi, Khanna Publishing, Delhi 2019**
3. **Strength of Materials, R.K. Rajput, Laxmi Publications 2018**
4. **Strength of Materials, R. Subramanian, Oxford Publications 2016**

COURSE OUTCOMES

After completing this course, the students should be able to

1. **Find various types loads applied on machine components of simple geometry**
2. **Build shear force and bending moment diagram for various types of beams**
3. **Identify moment of inertia of various bodies**

4. **Estimate the torsional load and stresses on shafts and springs for various engineering applications.**
5. **Analyze the effects of axial and hoop stresses**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	3				1	1	1			3	3	
CO2	3	3	2	3				1	1	1			3	3	
CO3	3	3	2	3				1	1	1			3	3	
CO4	3	3	2	3				1	1	1			3	3	
CO5	3	3	2	3				1	1	1			3	3	

22MEPC404	THERMAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To understand the working of steam generator/steam engine/steam condenser**
- **To understand the working of steam turbine and its classification**
- **To apply the thermodynamic concepts in internal combustion engines**
- **To get an insight on the working and performance of air compressors**
- **To understand the working of various auxiliary systems present in internal combustion engines.**

Unit–I Steam Generators-Steam generation-Boilers-types of boilers-Water tube and fire tube-Mountings and accessories-Steam engine-Types-Compounding of steam engines-Steam condensers-TS diagram-Steam cycles-Rankine cycle, modified Rankine cycle, Reheat, Regenerative and binary vapour cycle.

Unit–II Steam turbine Steam turbines: classification, compounding of turbines-pressure velocity variation, velocity diagrams, work done, efficiency, condition for maximum efficiency, Steam turbine performance-reheat factor, degree of reaction, cycles with reheating and regenerative heating, governing of turbines

Unit–III Internal Combustion Engines Classification-components and their function. Valve timing and port timing diagram- actual and theoretical p-v diagram of four stroke and two stroke engines. Simple and modern carburetor. Desirable properties and qualities of fuels. Air-fuel ratio calculation - lean and rich mixtures. MPFI, diesel pump and injector system, -CRDI. Ignition system-battery and magneto ignition system. Principle of combustion in SI and CI engine, knocking phenomena and control. Lubrication and cooling system

Unit–IV Internal Combustion Engine Performance and Systems Indicator diagram, mean effective pressure. Torque, Engine power- BHP, IHP. Engine efficiency mechanical efficiency, volumetric efficiency, thermal efficiency and relative efficiency, Specific fuel consumption. Testing of I C engines: Morse test, Heat balance test and Retardation test, concepts of supercharging and turbocharging.

Unit–V Reciprocating Air Compressor Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling-work of multistage air compressor

TEXT BOOKS

1. Ballaney, P.L., "Thermal Engineering", Khanna Publishers, New Delhi, 5th ed.2020.

2. Ganesan, V., "Internal Combustion Engines", 4th Edition, Tata McGraw Hill, 2020.

REFERENCE BOOKS

1. Mahesh M. Rathore, "Thermal Engineering", 1st Edition, Tata McGraw Hill, 2010.

2. Mathur & Sharma, A Text Book on Internal Combustion Engine. Dhanpat Rai Publications 2018.

3. Khurmi, R.S., Thermal Engineering, S.Chand & Co., 14th ed., New Delhi, 2005.

4. Holman, J.P., "Thermodynamics", McGraw Hill, 9th edition 2008.

5. Rajput, R.K., "Thermal Engineering", Laxmi Publications, 8th Edition, 2013.

COURSE OUTCOMES

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

1. **Analyze the performance of different boilers.**
2. **Evaluate the performance of steam turbines**
3. **Explain the working of all IC engine components**
4. **Estimate the performance of IC engines**
5. **Evaluate the performance of air compressors under different operating conditions**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		1	1				1	1	1		1	1	1	
CO2	3		1	1				1	1	1		1	1	1	
CO3	3	2	1	1				1	1	1		1	1	1	
CO4	3		1	1				1	1	1		1	1	1	
CO5	3	2	1	1				1	1	1		1	1	1	

22MEPC405	MANUFACTURING PROCESSES	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

- **To provide fundamental knowledge on the various conventional manufacturing processes such as casting, forming, machining and welding and application of these processes in manufacturing industries.**

Unit-I METAL CASTING PROCESSES:

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications– Melting furnaces – Principle of special casting processes- Shell, investment – Pressure die casting – Centrifugal Casting - CO casting - Stir casting – Squeeze casting, Continuous casting - Defects in casting.

Unit-II BULK METAL FORMING PROCESSES

Introduction to plastic deformation and yield criteria - Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – Characteristics of the processes – Typical forging operations; Rolling of metals – Types of Rolling – Flat

strip rolling – shape rolling operations – Defects in rolled parts; Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion

Unit-III SHEET METAL FORMING PROCESSES

Press Tool operations: Types of presses; Shearing operations: Blanking and Piercing; Deep Drawing: Draw die design; Spinning, Banding, Stretch Forming, Embossing and Coining; Sheet metal characteristics – Formability of sheet metal – Test methods – Sheet metal die design: Types of dies, Die construction, Punch design, Pilots, Stripper and stock guide, Die stops

Unit-IV METAL MACHINING PROCESSES:

Cutting tools: Single point and multi point cutting tools; Tool nomenclature and Tool signature; Tool materials; Mechanism of Chip formation, orthogonal and oblique cutting, Cutting forces, Heat generation and cutting tool temperature; Tool wear, Tool life and machinability; Cutting fluids; Machining processes: Principles and operation of Turning, Drilling, Boring. Shaping, Milling, Grinding machines

Unit-V METAL JOINING PROCESSES:

Fusion welding processes – Type of Gas welding – Flame characteristics – Filler and Flux materials – Principles and types of Resistance welding – Arc welding, Electrodes, Coating and specifications – Manual meta arc welding, Gas metal arc welding – Flux cored arc welding - Submerged arc welding – Electro slag welding – Gas Tungsten arc welding - Weld defects – Brazing and soldering – methods and process capabilities – Adhesive bonding, Types and application

TEXT BOOKS

1. **Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2018.**
2. **Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.**

REFERENCES

1. **Gowri.S, P. Hariharan, A.SureshBabu, Manufacturing Technology I, Pearson Education, 2008.**
2. **HajraChouldhary S.K. and Hajra Choudhury. A. K., Elements of Workshop Technology, Volume I and II, Media Promoters and Publishers Private Limited, Mumbai, 1997.**
3. **Paul Degarma E., Black J.T. and Ronald A. Kosher, Materials and Processes, in Manufacturing, Eight Edition, Prentice Hall of India, 2017.**
4. **Rao. P. N., Manufacturing Technology Foundry, Forming and Welding, 2ndEd.Tata McGraw Hill, 2003. 5. Sharma, P.C., A Textbook of Production Technology, S.Chand and Co. Ltd**

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. **Summarize the concept of mould making and casting processes**
2. **Analyze the deformation behavior of metals under various metal forming processes**
3. **Apply a appropriate forming technique to produce a component using sheets**
4. **Find the mechanism of metal removal by cutting tools**
5. **Select a suitable joining method to assemble/fabricate components**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3				3	2		1	1	1		2	3	2	
CO2	3				3	2		1	1	1		2	3	2	
CO3	3				3	2		1	1	1		2	3	2	
CO4	3				3	2		1	1	1		2	3	2	
CO5	3				3	2		1	1	1		2	3	2	

22MEPC406	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To familiarize the various steps involved in the Design Process.**
- **To understand the principles involved in evaluating the shape and dimensions of Component to satisfy functional and strength requirements.**
- **To learn to use standard practices and standard data To learn to use catalogues and standard machine components.**

Unit–I Introduction: Types of Design factors. Factor of safety, Theories of failure - Curved beam, Crane hook and C frames. Design for fatigue strength: S-N diagram - Endurance limit modifying factors - Stress concentration - Fluctuation stress – Soderberg & Good Man equations.

Unit–II Shafts - Material and design stresses - Calculation of equivalent bending moment and twisting moment - Design of shafts subjected to combined bending moment and twisting moment.

Unit–III Theory of columns: Design of push rod, piston rod and I.C. Engine connecting rods sections. Wire ropes - Stresses – selection-Design procedure. Leaf springs – construction-equalized stresses in leaves - material and design. Open and closed coiled helical springs-stress - Wahl's factor.

Unit–IV Power screws - Thread forms Design consideration and materials - wear and shear - design procedure. Coupling - Types - Design and selection of coupling - Flange coupling, and Bushed pin type, flexible coupling.

Unit–V Design of Joints: Riveted Joints: Introduction - Types of riveted joints - failures of a riveted joint - strength and efficiency - Design of boiler joints. Welded joints: Introduction - Strength of transverse and parallel fillet welded joints - Axially loaded unsymmetrical welded sections - Eccentrically loaded welded joints.

TEXT BOOKS

1. **A Textbook of Machine Design, RS Khurmi, S.Chand Publications 2005**
2. **Pandya and Sha, Machine Design, Charotar Pub. House, Anand, India 2015.**

REFERENCES

1. **Machine Design, Sadhu Singh, Khanna Publishing House, Delhi 2019**
2. **Machine Design Data Book, Sadhu Singh, Khanna Publishing House 2019**
3. **Design Data Book, Mahadevan, CBS Publishers & Distributors 2019**
4. **Introduction to Machine Design, V.B. Bhandhari, McGraw Hill 2017**
5. **Richard Budynnas and J.E. Shigley's, Mechanical Engineering Design, McGraw Hill Book Company, 8th ed., 2017.**
6. **Prabhu, T.J., Fundamentals of Machine Design, 4th ed. 2000, Scitech Pub.**

7. Sundararajamoorthy, T.V. & N. Shanmugam, Machine Design, Anuradha Agencies.2018.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. **Design machine members subjected to static and variable loads.**
2. **Design shafts for various applications**
3. **Design various machine components according to the requirement as per the prescribed standards**
4. **Design power screws and couplings**
5. **Analyze riveted and welded joints for different kinds of loads.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		1			1	1	1		1	3	3	
CO2	3	2	3		1			1	1	1		1	3	3	
CO3	3	2	3		1			1	1	1		1	3	3	
CO4	3	2	3		1			1	1	1		1	3	3	
CO5	3	2	3		1			1	1	1		1	3	3	

22ETHS407	UNIVERSAL HUMAN VALUES	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

- **Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.**
- **Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.**
- **Strengthening of self-reflection.**
- **Development of commitment and courage to act.**

UNIT-I Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

Purpose and motivation for the course, recapitulation from Universal Human Values-Self-Exploration–what is it? -Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration-Continuous Happiness and Prosperity- A look at basic Human Aspirations-Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority-UnderstandingHappinessandProsperitycorrectly-Acriticalappraisal of the current scenario-Method to fulfill the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

UNIT-II Understanding Harmony in the Human Being - Harmony in Myself!

Understanding human being as a co-existence of the sentient 'I' and the material' Body'--Understanding the needs of Self ('I') and 'Body' - happiness and physical facility- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)- Understanding the characteristics and activities of 'I' and harmony in 'I'- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs. dealing with

disease

UNIT-III Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship- Understanding the meaning of Trust; Difference between intention and competence- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values inrelationship-Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals-Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students 'lives

UNIT-IV Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

Understanding the harmony in the Nature-Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self- regulation in nature- Understanding Existence as Co-existence of mutually interacting units in all-pervasive space-Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT-V Implications of the above Holistic Understanding of Harmony on Professional Ethics

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people- friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems- Case studies of typical holistic technologies, management models and production systems-Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations- Sumup. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. to discuss the conduct as an engineer or scientist etc.

TEXTBOOK

1. **Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi,2010**

REFERENCEBOOKS

1 **Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2019.**
2 **The Story of Stuff (Book).**
3 **TheStoryofMyExperiments withTruth- byMohandas KaramchandGandhi**
4 **Small is Beautiful - E. FSchumacher.**
5 **Slow is Beautiful - CecileAndrews**

6 Economy of Permanence - JCKumarappa
7 Bharat Mein Angreji Raj -PanditSunderlal
8 Rediscovering India - byDharampal
9 Hind Swaraj or Indian Home Rule - by Mohandas K.Gandhi
10 India Wins Freedom - Maulana Abdul KalamAzad
11 Vivekananda - Romain Rolland(English)
13 Gandhi - Romain Rolland (English)

COURSE OUTCOMES:

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

1. **Analyze the essentials of human values and skills, self exploration, happiness and prosperity.**
2. **Evaluate coexistence of the "I" with the body.**
3. **Identify and evaluate the role of harmony in family, society and universal order.**
4. **Find the holistic perception of harmony at all levels of existence.**
5. **Develop appropriate technologies and management patterns to create harmony in professional and personal lives**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1								1	1	1		1			1
CO2							1	1	1	1					1
CO3						2	1	1	1	1					1
CO4						2	2	1	1	1		1			1
CO5						2	2	1	1	1		1			1

22MECP408	STRENGTH OF MATERIALS LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

To impart practical training on simple machines like screw jack, worm wheel, etc.
To understand the theoretical and practical aspects of elasticity and plasticity of the materials through a variety of experiments.
To determine the mechanical advantage and efficiency of some of the simple machines like screw jack, worm wheel, differential wheel and axle.
To study the behavior of the materials by conducting tension, compression and shear, hardness impact, deflection and ductility tests.

List of Experiments

1. **Simple machine-compound wheel and axle.**
2. **Screw Jack**
3. **Worm wheel**
4. **Handle Winch**
5. **Deflection Test on Steel Pipe**
6. **Tension Test Steel Rod**
7. **Izod Impact Test**
8. **Shear Test on steel rod**
9. **Brinell Hardness Test**
10. **Rockwell Hardness Test**
11. **Test on Helical Springs**

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. **Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses**
2. **Determine the fundamental concepts of stress, strain and elastic behavior of materials.**
3. **Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.**
4. **Demonstrate engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.**
5. **Develop as a team to gain practical knowledge, helpful for a lifelong learning.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2				1	1	1			3	3	
CO2	3	3	2	2				1	1	1			3	3	
CO3	3	3	2	2				1	1	1			3	3	
CO4	3		2					1	1	1		2	3	3	
CO5	3							1	1	1	1		3	3	

22MECP409	FLUID MECHANICS LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

To understand the properties of fluids and fluid statics, methods for determination of co-efficient of discharged are to be explained and computed practically.

To study of the characteristic features of pumps and turbines using experiments in envisaged.

To understand the significance and role of such utilities in their further course of study.

List of Experiments

1. **Determination of Co-efficient of discharge of Mouth Piece.**
2. **Determination of Co-efficient of discharge of Venturimeter.**
3. **Determination of Co-efficient of Head loss due to Sudden Change in Section.**
4. **Determination of Co-efficient of Head loss due to Friction in Pipe.**
5. **Determination of Co-efficient of discharge of Rectangular Notch.**
6. **Study of Performance characteristics of Elmo Pump (Centrifugal Pump).**
7. **Study of Performance characteristics of Sump Pump (Centrifugal Pump).**
8. **Study of Performance characteristics of Submersible Pump (Centrifugal Pump).**
9. **Study of Performance characteristics of Gould's Pump (Reciprocating Pump).**
10. **Study of Performance characteristics of Pelton Turbine (Constant Speed method).**
11. **Study of Performance characteristics of Francis Turbine (Constant Head method).**
12. **Determination of Metacentric Height of a floating vessel (Demo Only).**

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. **Determine the properties of fluids, pressure and their measurements.**
2. **Measure flow in pipes and determine frictional losses.**
3. **Find forces on immersed plane and curved plates applying continuity equation and energy equation in solving problems on flow through conduits.**
4. **Determine the characteristics of pumps**

5. **Determine the characteristics of turbines.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			3				1	1	1		2	3	2	
CO2	3			3				1	1	1		2	3	2	
CO3	3			3				1	1	1		2	3	2	
CO4	3			3				1	1	1		2	3	2	
CO5	3			3				1	1	1		2	3	2	

22MECP410	MANUFACTURING PROCESS LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- **To impart practical training to the students on various welding processes**
- **To develop procedural and manual skills in machining and also to provide training in making greensand moulds**

List of Experiments

Foundry shop

1. **Face Plate (Solid Pattern)**
2. **Hexagonal Nut (Self Core Pattern)**
3. **Ball Handle (Split Pattern)**
4. **Pipe Flange (Split Pattern)**
5. **Lathe Saddle (Loose Piece Pattern)**

Welding shop

1. **Butt Joint**
2. **Lap Joint**
3. **Corner Joint**
4. **Arc Welding Power Sources with Effect of Heat input on bed geometry**
5. **Temperature Measurement of Arc Welding Process**
6. **Non-destructive testing of Welding**

Machine shop

1. **Plain Turning**
2. **Step Turning**
3. **Taper Turning**
4. **Thread Cutting**

COURSE OUTCOMES

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

1. **Demonstrate metal working machine (Lathe) for making simple operations**
2. **Create green sand moulds of given patterns**
3. **Create different types of weld joints.**
4. **Experiment with the non destructive testing**
5. **Work as a team for a lifelong learning**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			3				1	1	1		1	3	2	
CO2	3			3				1	1	1		1	3	2	
CO3	3			3				1	1	1		1	3	2	
CO4	3			3				1	1	1		1	3	2	
CO5	3			3				1	1	1		1	3	2	

FIFTH SEMESTER

22MEPC501	APPLIED THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To learn about of I law for reacting systems and heating value of fuels**
- **To learn about gas and vapor cycles and their first law and second law efficiencies**
- **To understand about the properties of dry and wet air and the principles of psychrometry**
- **To learn about gas dynamics of air flow and steam through nozzles**

Unit-I Combustion thermodynamics: Introduction to solid, liquid and gaseous fuels–Calorific or Heating Values of Fuels- Theoretical and experimental determination of Heating Values- Analysis of Exhaust and Flue Gas- combustion reactions- combustion equations of fuels- complete combustion- combustion analysis- Excess air supplied -Internal Energy and Enthalpy of Reaction-Enthalpy of Formation - Adiabatic flame temperature-Chemical equilibrium-Actual Combustion Analysis.

Unit-II Gas power cycles: Air standard – Carnot, Otto, Diesel and Dual cycles- p-v and T-S diagrams, description, efficiencies and problems-Comparison of these Cycles - Gas Turbine Cycle-Brayton Cycle, effect of reheat, regeneration and Intercooling-Combined gas and vapor power cycles.

Unit-IIIPsychrometrics and Air –conditioning systems:Properties of dry and wet air, use of psychrometric chart, analyzingprocesses involving heating/cooling and humidification/dehumidification, dew point.Air-conditioning -types of air-conditioning - Summer, winter, window and central air-conditioning. Concepts of RSHF, GSHF and ESHF -cooling load calculation

Unit-IV compressible flow:Basics of compressible flow - Equations of Compressible Fluid Flow- Stagnation properties, Propagation of Disturbances in Fluid and Velocity of Sound - Mach Number - choked flow, subsonic and supersonic flows- shock waves - Flow of Compressible Fluid Through a Convergent Nozzle - Variables of Flow in Terms of Mach Number

Unit-V Refrigeration cycles:Refrigerantsand their properties. Vapour compression refrigeration: Working principle, simple problems in vapour compression refrigeration cycle with sub-cooling and superheating. Introduction to absorption system.

TEXT BOOKS

1. **Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2009, 7th Edition, Fundamentals ofThermodynamics, John Wiley and Sons.**
2. **R.K. Rajput, 2007, Third Edition, Engineering Thermodynamics, Laxmi Publications (P) Ltd.**

REFERENCES

1. **Ballaney. P, "Thermal Engineering", 25th Edition, Khanna Publishers, 2017.**

2. Moran, M. J. and Shapiro, H. N., 2010, Fundamentals of Engineering Thermodynamics, JohnWiley and Sons 6th edition.
3. Nag, P.K, 2017, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd 6th edition

COURSE OUTCOMES

After completing this course, the students will to

1. **Perceive and Analyze the various types of fuels combustion analysis**
2. **Classify and Distinguish the various power cycles used in automobiles**
3. **Explore the working principles of Air conditions**
4. **Illustrate the basics of compressible flow**
5. **Demonstrate the working principles of refrigeration cycles**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3				1			1	1	1		1	3	3	1
CO2	3		2					1	1	1			3	3	1
CO3	3	3						1	1	1		2	3	3	1
CO4	3	3						1	1	1	1		3	3	1
CO5	3	3				1		1	1	1			3	3	1

22MEPC502	ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

- **To impart fundamental knowledge on the structure, properties, heat treatment, testing and applications of metallic and non-metallic materials used in engineering applications.**

Unit-I Unit cell, Crystal systems, BCC, FCC & HCP structures, Crystallographic planes & direction, Miller indices, Crystal imperfections - point, line & area defects. Constitution of alloys, compounds & solid solutions, Gibbs phase rule, lever rule. Phase diagrams: eutectic, peritectic, eutectoid and peritectoid reactions - Metallography - metallurgical microscope - preparation of specimen, micro & macro examination. Grain size ASTM grain size number, grain size measurement methods.

Unit-II Iron-Iron Carbon Diagram, Isothermal transformation diagram, Time Temperature Transformation Diagram, Continuous cooling transformation diagrams, Heat Treatment Methods: full annealing, stress relief annealing, spheroidzing, normalizing, Hardenability and Jominy end quench test, Case hardening: carburising, nitriding, cyaniding, and carbon nitriding, flame hardening, induction hardening, vacuum hardening and cryogenic treatment- Precipitation and Age hardening

Unit-III Classification of steels - Plain carbon steels - effect of C, Mn, Si, P & S. Purpose of alloying, effect of important alloying elements. - Important low alloy steels, stainless steel, tool steels - types, compositions and applications; Cast iron - types, composition and applications. Non ferrous metals: Physical, Mechanical, Metallurgical properties of Aluminum alloys, Magnesium alloys, Copper alloys, Nickel alloys and Titanium alloys – Classification of these alloys and applications.

Unit-IV Polymers – types of polymers, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS,PAI, PPO, PPS, PEEK, PTFE, Thermo set polymers – Urea and Phenol formaldehydes; Engineering

Ceramics – Properties and applications of Al_2O_3, SiC, Si_3N_4, PSZ and SIALON; Introduction to Composite Materials: MMC, PMC, CMC and Hybrid Composites- Applications of Composite Materials

Unit-V Mechanical behaviour of materials: Tensile behaviour: engineering stress, engineering strain, true stress, true strain, Stress – strain curve, Yield point phenomenon, strain aging. Impact Toughness behaviour: Charpy and Izod impact testing, DBT curve. Hardness: Brinell hardness, Rockwell hardness, micro hardness testing; Fatigue behaviour: Stress cycles, S-N curves, fatigue crack initiation, fatigue crack propagation; Creep behaviour: creep curve, creep mechanisms, deformation mechanism maps

TEXT BOOKS

1. Sydney, H., Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill Book Co., 2008.
2. Higgins, R.A., "Engineering Metallurgy - Part I, Applied Physical Metallurgy", ELBS., 1993.
3. William D Callister, "Material Science and Engineering", Wiley India Pvt. Ltd, Revised Indian edition, 2007.

REFERENCES

1. Raghavan, V., "Introduction to Physical Metallurgy", Prentice Hall of India Pvt.Ltd, 2015.
2. George E. Dieter., "Mechanical Metallurgy", McGraw Hill Book Company, New York, 2017.
3. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 9th Indian Reprint 2016.

COURSE OUTCOMES

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

1. Explore the configuration of materials structure and characteristics;
2. Design heat treatment methods for specific applications;
3. Choose the appropriate metals and alloys for specific applications;
4. Select the appropriate materials for specific applications;
5. Evaluate the mechanical properties of materials by modern tools and equipments.

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3						1	1	1			1	1	
CO2	3	2		2				1	1	1				2	
CO3	3							1	1	1		2	1	1	1
CO4	3	2						1	1	1		2	1	2	1
CO5	3		2					1	1	1				1	

22MEPC503	THEORY OF MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The objectives of this course is to equip the students with the students with the required knowledge for

i. **making use of the basic concepts of mechanisms while learning their working principle.**
ii. **applying the concept of linkage synthesis and determining the velocity and acceleration of various points and links of a mechanism.**
iii. **designing and drawing the cam profiles of specified contours and applying the concept of friction while designing the machine elements.**
iv. **analyzing the motion of gear trains and the working principle of governors.**
v. **applying the basic concepts of balancing and vibrations during vibration analysis of mechanical systems.**

Unit-I 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 generators-Universal Joint-Rocker mechanisms

Unit-II 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- introduction to linkage synthesis- three position graphical synthesis for motion and path generation

Unit-III 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, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers Surface contacts- sliding and rolling friction- friction drives-bearings and lubrication- friction clutches- belt and rope drives- friction in brakes

Unit-IV 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. Governors – Watt, Porter, Hartnell and Proell

Unit-V Elementary insights of vibrations – Free , forced and damped (Theory Only)Balancing of rotating masses – single rotating mass by single mass in same and different planes (Simple problems only) Balancing of reciprocating masses – Primary and secondary forces – swaying couples and hammer blow (Theory Only)

TEXT BOOKS

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. Rattan, s.s, "Theory of Machines", McGraw-Hill Education Pvt Ltd., 2014.

REFERENCES

1. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill, 2017.
2. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt.Ltd, New Delhi, 1988.
3. Uicker, J.J., Pennock G.R and Shigley, J.E., —Theory of Machines and Mechanisms‖, Oxford University Press, 2017.
4.Rao.J.S. and Dukkipatti.R.V. "Mechanism and Machine Theory", New Age International Pvt. Ltd., 2006.
5. Wilson and sadler, Kinematics and Dynamics of Machinery, Pearson, 2008.

COURSE OUTCOMES

Upon completion of the course, the students can able to

1) **Apply the basic concepts and definitions related to mechanisms to classify them and apply the same on the working principle of some common mechanisms.**
2) **Determine the velocity and acceleration of various points and links present in mechanism and apply the concept of linkage synthesis in simple mechanisms.**
3) **Analyze & synthesize the motion of the follower and draw the cam profile and ii) apply the concept of friction on the working of mechanical machine elements and drives.**
4) **Explain the terminology & governing equations related to gears & governors and apply these for the analysis of motion of gear trains and governors.**
5) **Perceive the concept of balancing of rotating/reciprocating masses in a system and apply the basic mathematical concepts in the vibration analysis of mechanical systems.**

Mapping of COs with POs

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	I	II	III
CO1	3	1	-	-	-			1	1	1			3		
CO2	3	3	2	1	-			1	1	1			3	2	
CO3	3	2	2	2	1			1	1	1			3	3	
CO4	3	3	2	2	1			1	1	1			3	1	
CO5	3	2	1	-	-			1	1	1			3	1	

22MEPC504	MANUFACTURING TECHNOLOGY	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

- **To acquaint the students with recent developments in modern manufacturing technologies such as casting, forming, welding and machining processes.**
- **To impart knowledge to the students on processing of plastics, powder metallurgy and additive manufacturing concepts.**

Unit-I Advanced casting processes - plaster mold and ceramic mold casting – vacuum casting – Evaporative pattern casting, ceramic shell investment casting, slush casting, squeeze casting and semisolid metal forming Special forming processes - Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, Super plastic forming – Micro forming – Incremental forming

Unit-II Advanced welding processes: Basic principle, Process variables, Chief characteristics and applications of the following processes: Laser beam welding, Electron beam welding, Plasma arc welding, Rotary Friction Welding, Friction stir welding, Explosive welding, Ultrasonic welding Diffusion welding, Vacum Brazing and Hybrid welding.

Unit-III Non Traditional Machining processes: Basic principle, Process variables, Chief characteristics and applications of the following processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, Electrical Discharge Machining, Electro-chemical machining (ECM), Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining (EBM), Introduction to Micro machining.

Unit-IV Manufacturing processes for plastics: Extrusion, Injection, Blow and rotational moulding of plastics-Thermoforming-Compression moulding – Transfer moulding - Casting– Foam moulding - Processing of reinforced plastics and composites –Moulding – compression, vacuum bag – contact – resin transfer – transfer / injection. Hand Layup and Filament winding

Unit-V Powder metallurgy processes: Methods of Powder production – Blending of metal powders- Compaction of metal powders- Sintering – hot pressing – Isostatic pressing – hot and cold (HIP and CIP), Selective Laser Sintering; Additive Manufacturing: Introduction – Stereo lithography – Fused deposition moulding – selective laser machining – Laminated object manufacturing – solid base curing – Direct manufacturing and rapid tooling

TEXT BOOKS:

1. **Kalpakjian and Schmid, Manufacturing processes for engineering materials (6th Edition)-PearsonIndia, 2018.**
2. **Taha H. A., Operations Research, 10th Edition, Prentice Hall of India, 2019.**

REFERENCES

1. **Amstead, B.H., Ostwald Phylips and Bageman.R.L., "Manufacturing Processes" John Wileys Sons, 1987.**
2. **Muccic, E.A., "Plastic Processing Technology", Materials park, OHIO, ASM Int.,1994.**
3. **Jaeger, R.C., "Introduction to microelectronic Fabrication", Addision-Wesley, 1988**

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. **Explore the advances in casting and forming techniques**
3. **Select appropriate joining technique to fabricate components using newer materials**
4. **Prescribe the suitable non-traditional machining process to machine precision components**
5. **Demonstrate the processing of various plastic components**
6. **Produce components using powder metallurgy and additive manufacturing techniques**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3							1	1	1			1		
CO2	3	2						1	1	1		1		2	
CO3	3							1	1	1			1	1	
CO4	3	2						1	1	1				1	1
CO5	3							1	1	1			1	2	

22MECP508	MANUFACTURING TECHNOLOGY LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- **To provide hands on experience in handling precise metrology instruments and their calibration.**
- **To provide hands on experience in special machines**

List of Experiments

Machine Shop

1. **Keyway machining using a shaper**
2. **Angular machining using a shaper**
3. **Convex profile machining on a slotter**

Special Machine Shop

1. **Plain milling**
2. **Spur gear milling**

Metrology Lab

1. **Inspection of screw - thread**
   (A) Checking the straightness of straight edge
   (B) Measurement of radius (internal and external)
2. **Calibration of micrometer**

Metallurgy Lab

1. **Effect of section size on hardness**
2. **End quenching (or) Jominy hardenability test**

COURSE OUTCOMES

Upon the completion of this course, the students would be able to

1. **Explore the usage of precision instruments and the handling methods.**
2. **Apply the basic operation of various traditional and non-traditional manufacturing processes.**
3. **Justify the most appropriate manufacturing process and material for a given product.**
4. **Select/Suggest process for the production of gears.**
5. **Work as a team to gain knowledge for a lifelong learning.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2		2	2		1	1	1		1	3	2	1
CO2	3		2					1	1	1		1	3	2	1
CO3	3		2					1	1	1		1	3	2	1
CO4	3	3						1	1	1		1	3	2	1
CO5	3							1	1	1	2	1	3	2	1

22MECP509	APPLIED THERMAL LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To evaluate the performance and emission characteristics of an single cylinder diesel engine
- To conduct performance test on double stage reciprocating air compressor
- To conduct the heat balance test on single and double cylinder diesel engine.
- To understand the usage of different refrigeration tools.

List of Experiments

1. Load Test on Four Stroke Diesel Engine / petrol engine
2. Study and performance test on Air Compressor
3. Heat Balance Test on Four Stroke Diesel Engine
4. Speed test on multi cylinder Four Stroke Diesel Engine
5. Performance test on Refrigeration trainer
6. Trial on Ice Plant
7. Performance test on window air conditioner
8. Performance test on central A/C plant
9. Performance test on heat pump trainer

COURSE OUTCOMES

Upon completion of this practical class, the students will be able to:

1. Observe the data of internal combustion engine (load test, speed test and Heat balance test), air compressor and refrigeration systems.
2. Evaluate the parameter of internal combustion engine, air compressor and refrigeration systems.
3. Analyze the character of internal combustion engine, air compressor and refrigeration systems.
4. Infer and interpret the internal combustion engine, air compressor and refrigeration systems.
5. Demonstrate the applications of internal combustion engine, air compressor and refrigeration systems.

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			2	2			1	1	1		1	3	2	1
CO2	3			2	2			1	1	1		1	3	2	1
CO3	3			2	2			1	1	1		1	3	2	1
CO4	3			2	2			1	1	1		1	3	2	1
CO5	3			2	2			1	1	1		1	3	2	1

22MECP510	INSTRUMENTATION & CONTROLS LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

To learn the temperature measuring techniques

To make the students understand the working principle of various measuring devices.

To understand the concept of proportional control action, integral control action and derivative control

List of Experiments

1. **Determination of coefficient of discharge of Orificemeter**
2. **Determination of coefficient of discharge of Venturimeter**
3. **Determination of Reynolds number by Reynolds apparatus**
4. **Experiment on DC motor position control system**
5. **Experiments on DC Servo motor controller**
6. **Experiments on pressure process station by On/Off method**
7. **Experiments on temperature trainer by On/Off and PID method**
8. **Measurement of displacement using LVDT**
9. **Measurement of strain using strain gauge.**
10. **Measurement of temperature using resistance temperature detector**
11. **Temperature measurement by bimetallic thermometer**

COURSE OUTCOMES

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

1. **Observe the data of instrument/ control system variables in mechanical applications.**
2. **Evaluate the parameter of instrument/ control system of mechanical applications.**
3. **Analyze the character of instrument/ control system in mechanical applications.**
4. **Infer and interpret the instrument/ control system in mechanical applications.**
5. **Demonstrate the application of instrumentation and control system.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			3	2			1	1	1		1	2	2	
CO2	3			3	2			1	1	1		1	2	2	
CO3	3			3	2			1	1	1		1	2	2	
CO4	3			3	2			1	1	1		1	2	2	
CO5	3			3	2			1	1	1		1	2	2	

SIXTH SEMESTER

22MEPC601	OPERATIONS RESEARCH	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

- **To introduce students the use of quantitative methods and techniques for effective decision–making and to provide an understanding of the systematic approach to solve decision making problems.**
- **To introduce the operations research models and to apply them for modelling and solving Engineering problems in general and manufacturing situations in particular.**
- **To apply these techniques constructively to make effective business decisions and for real life problems.**

UNIT I

Linear programming – formulation, graphical method, Simplex method, Big M method - Applications – Problems.

UNIT II

Transportation problems – Balanced and unbalanced transportation problems – various methods of finding initial basic feasible solution – finding optimal solutions.

Assignment problems – various types of assignment problems - Hungarian algorithm - Traveling salesman problem.

UNIT III

Waiting line Problems: characteristics of queuing problems – terminologies - kendall and Lee notation - cost of waiting and cost of providing service - single channel - single stage type of problems with poisson arrivals and exponential service times.

Monte Carlo simulation: need for simulation – advantages and disadvantages – Application problems in maintenance, queue and inventory.

UNIT IV

Network models: Minimal spanning tree problem - shortest route problem - Maximum flow problems.

PERT and CPM: Difference between PERT and CPM - critical path method (CPM) - Determination of critical path – Project evaluation review technique (PERT) calculations - probability of meeting the time schedule - crashing of project network.

UNIT V

Decision Theory - Decision making under risk condition - expected value criteria - Decision trees. Decision making under uncertain conditions – Laplace criterion, Minimax criterion, maximin criterion, savage regret criterion, Hurwitz criterion.

TEXT BOOKS

1. **Prem Kumar Gupta and Hira D.S., "Operations Research", S. Chand & Co. Pvt. Ltd., 7th edition, 2014.**
2. **Vohra, N.D., "Quantitative Techniques in Management", Tata McGraw-Hill, 3rd edition, 2007.**

REFERENCE BOOKS

1. **Anderson, D.R., Sweeney, D.J., Williams, T.A, Martin, K, An Introduction to Management Science: Quantitative Approach to Decision Making, South Western, 13th Edition, 2012.**
2. **Barry Render, Ralph M. Stair Jr., "Quantitative analysis for Management", Pearson, 13th edition, 2018.**
3. **Sharma J.K., Operations Research: Theory and Applications, Trinity Press, 6th edition, 2016.**
4. **Srinivasan G., Operations Research: Principles and Applications, PHI, 3rd edition, 2017.**
5. **Taha, "Operations Research: An introduction", Tata McGraw-Hill, 10th edition, 2017.**

COURSE OUTCOMES:

1. **Mathematically formulate a given engineering and business problems as a linear programming problem, and apply Graphical, Simplex or Big-M methods to obtain the optimal solution.**
2. **Justify the determined feasible solution in transportation and assignment method and finding an optimal solution using MODI method and Hungarian method.**
3. **Categorize various Queuing models and find the optimal solution using queuing model and simulate different real life probabilistic situations and to solve them using Monte-Carlo simulation technique.**
4. **Determine the optimal project duration and cost using CPM and PERT technique, also construct complex project network and control the complex project.**
5. **Develop models that can be used to improve decision making under risk and uncertainty within an organization and Sharpen their ability to structure problems and to perform logical analyses.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3							1	1	1			1		
CO2	3	2	1		1			1	1	1			1		
CO3	3		1	1				1	1	1				2	
CO4	3	2	1					1	1	1				2	
CO5	3							1	1	1			1		2

22MEPC602	HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.**
- **Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.**
- **The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.**

Unit-I Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, Composite Medium, critical insulation thickness. Extended surfaces

Unit-II Lumped system approximation and Biot number, Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Unit-III Heat convection, basic equations, boundary layers- Forced convection, external and internal flows-Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection-Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Unit-IV Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method. Radiation Shields

Unit-V Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε-NTU methods. Boiling and Condensation heat transfer, Pool boiling curve. Introduction mass transfer, Similarity between heat and mass transfer.

TEXT BOOKS

1. **Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2017**
2. **J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 2017.**

REFERENCES

1. **F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, SixthEdition, 2018.**
2. **A. Bejan, Heat Transfer John Wiley, 2011**

COURSE OUTCOMES

After completing the course, the students will be able to

1. **Apply the physical mechanism to classify the modes of heat transfer and analyze one dimensional conduction heat transfer**
2. **Develop exact solutions for the two dimensional conduction problems**
3. **Solve problems in convection mode of heat transfer**
4. **Summarize the basics of radiation and solve problems on radiation heat transfer.**
5. **Perceive the basics of heat exchanger its design and correlation between heat and mass transfer.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2				1	1	1				2	
CO2	3	2	2	2				1	1	1				2	
CO3	3	2	2	2				1	1	1				2	
CO4	3					1		1	1	1	1		2		
CO5	3			2				1	1	1		1	2		

22MECP607	MACHINE THEORY LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- **To supplement the principles learnt in kinematics and Dynamics of Machinery.**
- **To make the students understand the working principle of various types of governors, balancing systems, Cam analyzer, Torsional vibration of single rotor system, whirling speed concept, action of forces in gyroscope.**

List of Experiments

1. **Experimental verification of natural frequency in undamped vibration of single rotor system.**
2. **Determine the characteristic curves of watt/ Hartnell governors.**
3. **Determination of mass moment of inertia of connecting rod and fly wheel.**
4. **Studies on cam analyser.**
5. **Study of gyroscopic couple.**
6. **Whirling of speed – determination of critical speed.**
7. **Study and experiments on static and dynamic balancing of rotating masses.**
8. **Slip and coefficient of friction in a belt drive**
9. **Epicycle gear train tutor**

COURSE OUTCOMES

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

1. **Observe the data of mechanical system in the rigid body dynamics.**
2. **Evaluate the parameter of mechanical system in the rigid body dynamics.**
3. **Analyze the rigid body dynamics of mechanical system.**
4. **Infer and interpret the rigid body dynamics of mechanical systems.**
5. **Demonstrate the rigid body dynamics.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		3					1	1	1		1	3	3	
CO2	3		3					1	1	1		1	3	3	
CO3	3		3					1	1	1		1	3	3	
CO4	3		3					1	1	1		1	3	3	
CO5	3		3					1	1	1		1	3	3	

22MECP608	COMPUTER PROGRAMMING LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- **To understand the strength of OOPS using c++**
- **To impart programming skills in C++ programming.**
- **To provide hands-on experience in developing basic mechanical models and assembly drawing using AUTO CAD.**
- **To introduce the basics of MAT LAB.**

List of Experiment

1. Preliminary 2D drawing exercise using AutoCAD.
2. Assembly drawing of machine components using AutoCAD
  a. Knuckle Joint
  b. Bushed bearing
3. Search, generate, manipulate data using MS office/ Open Office
4. Presentation and Visualization – 2D and 3D plots - Bar and Pie charts using MS office / open office.
5. C++, Programming,
  a. Otto cycle efficiency
  b. Compressor dimensions
6. Simple MATLAB Exercises
7. Demo on CATIA and modelling softwares

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. **Decide the commands and initial setting of drawing utilities.**
2. **Construct the drawing from the simple views/ detailed drawing / pictorial views.**
3. **Create the constraints and detailing of drawing.**
4. **Build algorithms to develop code using C++ / MATLAB and presentation (MS Office) of mechanical applications.**
5. **Execute and infer the mechanical applications (C++, MATLAB and MS Office).**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	2	1	2			1	1	1		1	3	2	
CO2	3	1	2	1	2			1	1	1		1	3	2	
CO3	3		2	1	2			1	1	1		1	3	2	
CO4	3	3	2	1	2			1	1	1		1	3	2	
CO5	3	3	2	1	2			1	1	1		1	3	2	

SEVENTH SEMESTER

22ETHS701	ENGINEERING ETHICS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

The objective is to Prepare the students to understand

- **The various dimensions in Engineering Ethics, markers for identifying the moral issues in Engineering Profession**
- **The experimental nature of the profession and the responsibilities associated in reality, taking into consideration the codes, safety and risk factors.**
- **The responsibilities towards the employer and the rights as an employee.**
- **Finally applying ethical and moral principles to take balanced decisions in all situations.**

Unit-I Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Ethical Theories – Classical and contemporary theories on Virtue Ethics, Utilitarian Ethics, Duty Ethics and Rights Ethics. Uses of Ethical Theories.

Unit-II Engineering as Experimentation – Engineers as responsible Experimenters –- Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – Research Ethics. The Challenger case study.

Unit-III Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal gas tragedy.

Unit-IV Internal responsibility to employers – Collegiality, Loyalty, Respect for Authority, Collective Bargaining – External responsibilities to employers – Confidentiality, Conflicts of Interest, Occupational Crime – Professional Rights – Employee Rights – Privacy, Equal opportunity and Discrimination – International Rights - Intellectual Property Rights (IPR).

Unit-V Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct

TEXT BOOKS

1. **Govindarajan M, Natarajan S and Senthilkumar, V S, "Professional Ethics And Human Values", PHI Learning, New Delhi, 2013.**
2. **Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York, 2017.**

REFERENCES

1. **Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Thompson Learning, 2012.**
2. **Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, 2008.**
3. **David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003).**

COURSE OUTCOMES

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

1. **Determine the moral values based on the moral autonomy and the various theories associated with the profession.**
2. **Examine the codes and standards in the experimental nature of the Engineering profession.**
3. **Determine the safety and risk with the benefits associated with the profession**
4. **Discover the various internal and external responsibilities towards the employer and the rights as an employee.**
5. **Interpret other related domain ethics and the various roles of the engineers as technology developers, managers, consulting Engineers and expert Witnesses.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1							3		1		1		1	
CO2	1			2				1				1	1		
CO3	1							1		1		1	2	2	
CO4	1							3	2	1		1			1
CO5	1						1	3		1	1	1			2

22MEPC702	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To understand the construction and working principle of various parts of an automobile**
- **To learn the present scenario of Indian Automotive industry.**

Unit-I Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines-components, function and materials, variable valve timing (VVT).Present Scenario of Indian Automotive industry.

Unit-II Engine auxiliary systems, electronic injection for SI and CI engines, Unit-injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

Unit-III Transmission systems, clutch types & construction, gear boxes- manual and automatic gear shift mechanisms, Over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.

Unit-IV Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems, antilock braking system (ABS),electronic brake force distribution (EBD) and traction control.

Unit-V Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, Electric and Hybrid vehicles, application of Fuel Cells in automobiles.

TEXT BOOKS

1. **Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 2020.**
2. **Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2017.**

REFERENCES

1. **Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.**
2. **Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.**

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. **Infer the fundamentals of automobile layouts and gain knowledge on components of IC engines.**
2. **Explain the working of fuel intake systems used in CI and SI engines. Gain facts about emission from IC engines and its treatment.**
3. **Outline the working of the components of transmission systems available in automobiles**
4. **Summarize requirement for steering geometry and working concepts of various steering and braking systems used in automobiles**
5. **Identify and Show the alternative energy sources for operating automobiles.**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3					1		1	1	1		1	1	2	
CO2	3					1	3	1	1	1		1		2	
CO3	3					1		1	1	1		1	1	2	
CO4	3					1		1	1	1		1		2	
CO5	3					1		1	1	1		1	1		1

22MEPC703	POWER PLANT ENGINEERING	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

- **To provide an overview of all power plants and the associated energy conversion issues**
- **To understand how power is achieved form renewable sources of energy and functions.**
- **To apply the concepts of economics in power plant andlearn environmental issues of power plant.**

Unit-I Coal based thermal power plants, basic Rankine cycle and its modifications, General layout of modern coal power plant, Power plant boilers including super critical boilers, FBC boilers, boiler mountings and accessories, Different systems of thermal power plants, fuel and ash handling, draught system, feed water treatment, Cooling towers and cogeneration systems, Siteselection of a steam power.

Unit-II Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Diesel power plant: General layout, Components ofDieselpower plant,

Performance of diesel powerplant,fuelsystem,lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant.

Unit-III Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants, Site selection of nuclear power plants

Unit-IV Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems

Unit-VEconomic and environmental issues of power plant:Terminology used in power plant: Peak load, Base load, Load factor, Load curve, demand factor- Various factor affecting the operation of power plant power tariffs, load distribution parameters, load curve, capital and operating cost of different, cost of power, tariff methods, pollution control technologies including waste disposal options for coal and nuclear plants.

TEXT BOOKS

1. **Nag P.K., Power Plant Engineering, 4th ed., Tata McGraw Hill, 2017.**
2. **El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.**
3. **Arora and Domkundwar, A course in power Plant Engineering, Dhanpat Rai and CO, 2005**

REFERENCES

1. **R.K.Rajput, A textbook of Power plant Engineering, Laxmi Publications (P) Ltd.,**
2. **Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.**
3. **G.R. Nagpal, S.C.sharma, Power Plant Engineering, Khanna Publishers.**

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. **Assess the various process of coal based power plant**
2. **Assess the elements and their functions and operation of gas turbine power plants diesel power plant.**
3. **Appraise the fundamentals of nuclear reactors and Nuclear power plant.**
4. **Classify various non-conventional power plants/hydroelectric power plant**
5. **Estimate economic parameters of power plant.**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		2	2	2		1	1	1	1		1	1	1	
CO2	3	3	2		1		1	1	1	1		1	1	1	
CO3	3	2	2	1			1	1	1	1		1	1	1	
CO4	3	2	2	1			1	1	1	1		1	1	1	
CO5	3		2	1			1	1	1	1	2	1	1	1	

22MEPC704	AUTOMATION IN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. **To throw light on the implementation of CIM and Automation in Manufacturing Industries.**
2. **To get the knowledge of various automation elements of manufacturing.**
3. **To understand the basics of CAPP and FMS.**
4. **To offer an insight into Cellular Manufacturing.**
5. **To educate students by the robotics and different material handling system required in manufacturing shop floor.**
6. **To educate students by covering different Integrated production management system.**

UNIT I

Automation : Automation in production systems – automated manufacturing systems, computeriz ed manufacturing support systems, reasons for automating, merits and demerits, automation principles and strategies, manufacturing industries and products, manufacturing operations – processing and assembly operations, other factory operations Industrial Robotics : Introduction, robot anatomy, joints and links,common robot and configurations, joint drive systems, robot control systems, end effectors, sensors in robotics, applications of robots –material handling, processing, assembly and inspection

UNIT II

Numerical Control: Introduction, basic components of an NC system, classifications of NC systems, nomenclature of NC machine axes, interpolation methods, features of CNC, the machine control unit for CNC, CNC software. direct numerical control, distributed numerical control, applications of NC, advantages and disadvantages of NC, adaptive control machining.PLC, Micro-controllers, CNC-Adaptive Control Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case

studies.

UNIT III

NC Part Programming: NC coding systems, manual part programming, simple examples on drilling, milling and turning operations computer assisted part programming, part programming with APT language, simple examples in drilling and milling operations.

UNIT IV

Group Technology & Cellular Manufacturing: Introduction, part families, parts classification and coding, features of parts classification of coding system, OPITZ , MICLASS, Product Flow Analysis, composite part concept, machine cell design, applications Computer Aided Process Planning :Introduction, retrieval CAPP system, generative CAPP systems, benefits of CAPP.Flexible Manufacturing Systems:Introduction, types of FMS, components, FMS layout configurations, computer control system, humanresources,applicationsandbenefits. Introduction to Computer Integrated Manufacturing.

UNIT III

Modeling and Simulation:Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods. Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

COURSE OUTCOMES:

After successful completion of the course, the students are able to

1. **Apply the concepts of automation and robotics in manufacturing processes.**
2. **Interpret the working of NC, CNC and adaptive control machining system.**
3. **Classify with manual and APT programming.**
4. **Design cellular manufacturing.**
5. **Apply modeling and simulation concept in industrial applications.**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3				3	1		1	1	1		1	3	2	1
CO2	3	2						1	1	1		1		2	1
CO3	3				3			1	1	1		1	3		

CO4	3					1		1	1	1		1	3	2	1
CO5	3				3	1		1	1	1		1	3	2	1

TEXT BOOK(s):

1. **Automation,ProductionsystemsandComputerIntegratedManufacturingbyM.P.Groover,PearsonEducation/PHI.**
2. **SeropeKalpakjianandStevenR.Schmid,Manufacturing — EngineeringandTechnology,7thedition,Pearson**
3. **YoramKoren,Computercontrolofmanufacturingsystem,1stedition**

REFERENCE BOOK(s):

1. **CAD/CAMbyM.P.GrooverandE.W.Zimmers,PearsonEducation/PHI.**
2. **CAD/CAMbyP.N.Rao,TMH**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3				3	1		2				1	3	2	1
CO2	3	2										1		2	1
CO3	3				3							1	3		
CO4	3					1						1	3	2	1
CO5	3				3	1						1	3	2	1

22MECP708	HEAT TRANSFER LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

To make the students understand the modes of heat transfer and to conduct the trails on various experiments to analyze the heat transfer parameters.

To understand the behavior of a system at different operating conditions

The students will learn the basics of solar energy, how to determine solar intensity, and how to estimate daily and annual solar energy potential at each location

To evaluate the performance of steam boiler, turbine and condenser.

List of Experiments

1. **Experiment on (parallel flow and counter flow) heat exchanger**
2. **Determination of Stefan-Boltzmann constant**
3. **Determination of critical heat flux**
4. **Experiment on composite wall apparatus.**
5. **Natural convection from vertical cylinder**
6. **Performance test on Solar air heater**
7. **Performance test on water heater**
8. **Performance test on Solar Still**
9. **Study and performance test on steam boilers**
10. **Study and performance test on Steam turbines**
11. **Study and performance test on Reader vertical steam engine.**
12. **Study and performance test on steam condenser.**

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Observe the data of heat transfer applications, solar applications(air heater, water heater and still) and steam systems (boilers, engines, turbines and condenser).

2. Evaluate the parameter of heat transfer applications, solar applications and steam systems.

3. Analyze the character of heat transfer applications, solar applications and steam systems.

4. Infer and interpret the heat transfer applications, solar applications and steam systems.

5. Demonstrate the heat transfer applications, solar applications and steam systems.

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			2				1	1	1		1	2	2	
CO2	3			2				1	1	1		1		2	
CO3	3			2				1	1	1		1		2	
CO4	3			2				1	1	1		1	1	2	
CO5	3			2				1	1	1		1	1	1	1

EIGHTH SEMESTER

22MEPV803	PROJECT WORK & VIVA VOCE	L	PR	S	C
		-	10	2	6

COURSE OBJECTIVES

- **To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.**
- **To train the students in preparing project reports and to face reviews and viva voce examination.**

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. **Decide a topic through literature review/ survey of industries.**
2. **Develop links across different areas of knowledge, ideas and information so as to apply these skills to the project task.**
3. **Improve the advancement of technology / innovative method through collaborative skills.**
4. **Compile and present the project work task.**
5. **Demonstrate the communicate skills to present the ideas clearly and coherently about the project task.**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3	3			1	1	1	1		1		2	
CO2	3	3	3	3			1	1	1	1		1	1	2	
CO3	3	3	3	3			1	1	1	1		1		2	3
CO4	3	3	3	3			1	1	1	1		1		1	3
CO5	3	3	3	3			1	1	1	1		1	1	1	

PROFESSIONAL ELECTIVE COURSES

21MEPESCN	INTERNAL COMBUSTION ENGINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To familiarize with the terminology and air fuel cycles associated with IC engines and its applications.**
- To understand combustion, and various parameters of I.C Engines .
- To learn about different fuel injection system used in I.C Engines.
- **To learn about engine auxiliaries systems used in IC engines and performance of the engine**
- **To learn about the recent trends I.C engines**

UNIT-I Engine Terminology and fuel air cycle

Basic components – terminology of IC engines, working – four stroke/two stroke - petrol/diesel engine, classification of IC engines, Engine cycle- first law analysis, Otto, diesel and duel cycles - comparison.

UNIT-II SI and CI Engine Combustion

SI engine combustion - combustion phenomenon – normal and abnormal combustion - pre ignition and detonation – effects and factors affecting knocking – factor influencing combustion chamber design – types of combustion chambers – CI engine combustion - combustion phenomenon – delay period – diesel knock – criteria for combustion chamber design – types of combustion chambers – cold start of CI engine

UNIT-III Fuel Supply Systems

Fuel supply system in SI engine – air fuel mixture formation – carburetors– types of carburetors – design and operating principles – electronically controlled carburetors – gasoline injection systems – single point fuel injection – multi point fuel injection(MPFI) – gasoline direct injection(GDI) – fuel supply system in CI engine – fuel metering requirements – mechanical injection – common rail injection – fuel supply computations in SI and CI engine

UNIT-IV Auxiliaries and Testing and Emission formation of IC Engine

Ignition system of SI engine , battery ignition system – magneto ignition system – electronic ignition system. lubrication system – types of lubrication - wet sump, dry sump and mist lubrication . engine cooling – necessity of engine cooling – types of cooling – air cooling – liquid cooling . testing of IC engine – performance parameters – performance of SI and CI engine – emission formation in SI and CI engine - strategies for emission control – in-cylinder and after burn control

UNIT-V Recent Trends in I.C. Engines

Air assisted combustion ,Homogeneous charge compression ignition engines- variable geometry turbochargers- common Rail Direct injection systems - GDI Engines -Hybrid Electric Vehicles -NOx Adsorbers - on board Diagnostics

TEXT BOOKS

1. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 2017
2. Ganesan V, "Internal Combustion Engines", Tata Mcgraw Hill Education Private Limited; 4th edition (1 April 2012)

REFERENCES

1. Stockel M W, Stockel T S and Johnson C, "Auto Fundamentals", The Goodheart, Wilcox Co.Inc., Illinois, 2019.
2. Bosch "Automotive Handbook", Fifth Edition, SEA Society of Automotive Engineers,400 Common wealth Drive, Warrendale, USA, 2018
3. Rajput R.K. "Internal Combustion Engines" Lakshmi Publications (P) Ltd., New Delhi, Second Edition reprint 2016.
4. Obert E. F, "Internal Combustion Engines and Air Pollution", Harper and Row Publication Inc.NY, 1973.
5. Heisler H, "Advanced Engine Technology", Edward Arnold, 1995.

6.Scott Pot, "I.C.Engine: Fundamental, Thermodynamics of internal combustion Engines, Independently published on 2018
7 Charless Fayette tayler, "Internal combustion Engines in theory and practice - MIT Press - -1960
8.Shyam.K. Agrawal , "Internal combustion engines - New age publishers,Jan.2006.
9.Robert leroy streeter, "Internal combustion engines, Theory and Design : Franklin classics.2018

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. **Analysis the different air fuel cycles used in I.C.Engine**
2. **Analysis the combustion phenomenon in S.I and C.I Engines.**
3. **Classify and compare the different fuel injection system**
4. **Categorize the engine Auxiliaries and compare the engine emission**
5. **List the recent trends in I.C.Engine**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3				1		1	1	1	1		1	2	2	
CO2	3				1		1	1	1	1		1	2	2	
CO3	3				1		1	1	1	1		1	2	2	1
CO4	3				1		1	1	1	1		1	2	2	1
CO5	3				3		1	1	1	1		1	2	3	1

22MEPESCN	MECHATRONIC SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To construct various system models and to determine their stability.**
- **To understand the functions and applications of sensors and transducers.**
- **To learn the structure of microprocessor and their applications in mechanical devices.**
- **To provide competence on PLC and its programming.**
- **To render exposure in the design and development of mechatronic systems.**

UNIT-I Introduction to Mechatronics - Open and Closed Loop System. Mathematical System Models and Transfer Function – Mechanical – Electrical - Thermal - Fluid Systems.

UNIT-II Construction and Reduction Techniques - Block Diagram - Signal Flow Graph. Stability Analysis – Routh Criterion - Frequency Response – Polar Plot - Bode Plot - Nichols Plot.

UNIT-III Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers - LVDT - Capacitance Sensors - Strain Gauges - Eddy Current Sensor - Hall Effect Sensor -Temperature Sensors - Light Sensors – Micro sensors. Signal Conditioning – Operational Amplifiers - Protection – Filtering - ADC and DAC.

UNIT-IV Actuation Systems – Construction - Working Principle - Characteristics - Stepper Motor and Servo Motor - Hydraulic and Pneumatic Systems - Micro actuators. Smart materials - Shape Memory Alloy - Piezoelectric - Magnetostrictive Actuators. Introduction - Pin Configuration - Architecture of 8085 Microprocessor - Addressing Modes - Instruction Set, Timing Diagram of 8085.

UNIT-V Introduction - Architecture of PLC - Input / Output Processing - Programming with Timers, Counters and Internal Relays. Stages of Mechatronics Design Process - Comparison of Traditional and Mechatronics Design Concepts with Examples - Case Studies of Mechatronics Systems - Pick and Place Robot - Engine Management System – Automatic Car Park Barrier.

TEXT BOOKS

1. **Bolton - Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, Addison Wesley Longman Ltd., 2019.**
2. **Nagoor Kani.A – Control Systems, RBA Publications, Chennai, 2017.**

REFERENCES BOOKS

1. **Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2015.**
2. **Anthony Esposito, "Fluid Power with Applications", Pearson Education Inc.,2013**
3. **Majumdar S.R., "Pneumatic Systems – Principles and maintenance", Tata McGraw- Hill, 2017.**
4. **Devdas Shetty, Richard A. Kolk, "Mechatronics System Design", Thomson Learning Publishing Company, Vikas Publishing House, 2012.**

COURSE OUTCOMES

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

1. **Develop transfer functions for various systems**
2. **Analyze the stability of various systems**
3. **Identify suitable sensors and signal conditioning systems.**
4. **Explain various actuators and architecture & timing diagram of microprocessor.**
5. **Design appropriate mechatronic system for real time application. Implement PLC as a controller in a mechatronic system.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	3	2				1	1	1		1	2	2	
CO2	1	3	3	3	1	1		1	1	1		1	2	2	
CO3	3		1		1			1	1	1		1	1	1	
CO4	3		1		1			1	1	1		1	1	1	
CO5	3	2	3		2			1	1	1		1		2	

22MEPESCN	MICROPROCESSORS IN AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To introduce the basic concepts of Digital circuits, Microprocessor system and digital controller**
- **To learn the programming of Micro Processor.**

Unit-I Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers.

Unit-II Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals.

Unit-III Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing.

Unit-IV Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085;Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt requests and their handling, Programmable interrupt controller; Interfacing peripherals: Programmable peripheral interface (8255).
Unit-V Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication(8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features, Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z-Transform, Digital Filters, Implementation of Digital Algorithm.

TEXT BOOKS

1. **Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited 1982**
2. **Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, TataMcGraw-Hill Publishing Company Ltd 1983.**

REFERENCES

1. **Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers 2013**
2. **Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2012).**
3. **Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall**

COURSE OUTCOMES

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

1. **Perform numerical conversions**
2. **Explore the block and timing diagram of 8085 microprocessor**
3. **Explore the working cycles and interfaces of 8085 microprocessor**
4. **Write assembly language programs for automation.**
5. **Apply the use of microprocessors in automation with given problems.**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1						1	1	1		1		2	
CO2	3		2		1			1	1	1		1	1	1	
CO3	3		2		1			1	1	1		1	1	1	
CO4	3	1	2	2				1	1	1		1	2	2	

CO5	3	1	2			1		1	1	1		1	1	2	

22MEPESCN	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To impart an in-depth knowledge on composite materials, types, production processing and properties.**

UNIT-I:

Introduction to Composites – Definition – Classification – Advantages – Disadvantages. Elastic behavior of Fiber reinforce composites under longitudinal and transverse loading – Elastic modules of particulate composites. Fiber reinforcement - Properties of synthetic fibers: Glass fiber – Carbon fiber – organic fiber – Ceramic fiber. Properties of natural fibers: Blast fiber – Leaf fiber – Seed fiber – Surface treatment of natural fibers. Particulate materials – Nano reinforcement: Nano fiber – nano tubes – nano clay – nano particles.

UNIT-II:

Matrix materials: Functions - Polymer matrix – properties of thermoset polymers – thermo plastics – Elastomers. Metallic matrix materials: Aluminium alloy – titanium alloy – magnesium alloy. Ceramic matrix materials: crystalline oxide - Alumina – Zirconia – Silicon carbide – Silicon Nitride – Boron Carbide – Aluminium Nitride. Glasses and Glass–ceramics.

UNIT-III:

Polymer Matrix Composite (PMC): Processing of PMC – Hand lay-up process – Spray-up process – Resin transfer moulding – Filament winding process – Putrusion – Compression moulding. Structure and Mechanical properties of PMCS – Applications.

UNIT-IV:

Metal Matrix Composites (MMC): Selection of reinforcement – Processing of MMCs: Liquid State processing – Solid state processing – Gaseous State processing – Deposition techniques - Properties of MMCs. – Applications. Carbon-Carbon composites: High pressure processing – properties – applications.

UNIT-V:

Ceramic Matrix Composites (CMC): Processing of CMCs: - Cold pressing and sintering – Hot pressing – Sol-Gel technique – Reaction bonding – Mechanical properties of CMCs. – Applications. Nano composites: Polymer nano composites – Properties of clay –Properties and applications of Polymer Nano composites – Clay-polymer – Graphite-polymer – Nano fiber reinforced composites. Properties and applications of metal matrix nano composites and ceramic nano composites.

TEXT BOOKS

1. **Composite Materials - Science and Engineering, Krishan K. Chawla, Springer, Third Edition, 2013**
2. **Composite materials and processing, M. Balasubramanian, CRC Press, 2014.**

REFERENCE BOOKS

1. **Modern Composite Materials, Broutman.L.J and Krock.R.H, Addison Wesley, 1967.**

2. An Introduction to Metal Matrix Composites, Clyne.T.W. And Wihers.P.T., Cambridge University Press, 1993.
3. Fundamentals of Composite Manufacturing, B. Strong, SME, 1989
4. Composite materials, Engineering and Science, Mathews .F.L. and Rawings .R.D., Chapman.
5. Composite materials, Chawla K.K., Springer¬Verlag, 1987.
6. Engineering Materials, Kenneth G.Budinski, Prentice Pvt. Ltd., 41th Indian Reprint, 2002

COURSE OUTCOMES:

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

1. Analyze mechanical strength of the composite material
2. Develop polymer matrix composites.
3. Explain the processing routes of polymer matrix composites and indicate the mechanical properties.
4. Explain the processing routes of metal matrix composites and indicate the mechanical properties.
5. Describe the mechanical properties and applications of ceramic matrix composites and nano composites.

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1		2					1	1	1		1		2	
CO2	1	2						1	1	1		1	1	2	
CO3	1				1			1	1	1		1	1	2	
CO4	1		2					1	1	1		1	1	2	
CO5	1		2			1		1	1	1		1	1	2	

22MEPESCN	IOT AND SMART MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide an overview of how computers can be utilized in mechanical component design
- To learn the principles of CAD/CAM.

Unit-I Internet of Things (IoT): Overview - Design Principles for Connected Devices; Internet Principles -Prototyping: Costs versus ease of prototyping, prototyping and Production, open source versus Closed Source - Prototyping Embedded devices – Electronics - Embedded Computing Basics, Arduino/Raspberry Pi/ BeagleBone Black/ etc., Electric Imp andother notable platforms- Prototyping of Physical Design - Prototyping online Components – Introduction to Application Programming Interface (API)

Unit-II Real Time Reactions, Other Protocols. Techniques for Writing Embedded Code – Memory Management, Performance and Battery Life, Libraries and debugging. Automatic Storage Management in a Cloud World – Introduction to Cloud, Relational Databases in the Cloud, Automatic Storage Management in the Cloud. Smart Connected System Design Case Study

Unit-III Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

Unit-IV Introduction to Smart Manufacturing: Definition – conventional/legacy manufacturing–Smart Manufacturing Processes- Three Dimensions: (1) Demand Driven and Integrated Supply Chains;(2) Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations);and (3) Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization and reduction of Greenhouse Gasses (GHG))

Unit-V Smart Design/Fabrication - Digital Tools, Product Representation and Exchange Technologies and Standards, Agile / Additive Manufacturing Systems & Standards - Mass Customization, Smart Machine Tools
Smart Applications: Online Predictive Modeling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes; Smart Energy Management of manufacturing processes and facilities

TEXT BOOKS

1. **A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition,Wiley, 2013.**
2. **N. Vengurlekar and P. Bagal, Database Cloud Storage: The Essential Guide toOracle Automatic Storage Management, 1st edition, McGraw-Hill Education, 2013.**

REFERENCES

1. **M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1stedition, Morgan Kaufmann, 2010.**

COURSE OUTCOMES
Upon completion of this course, the students will be able to

1. **Apply the basic principles of IoT**
2. **Identify real time reactions and protocols**
3. **Recognize the different application areas of IOT.**
4. **Explore the basics of smart manufacturing**
5. **Recognize the applications of smart manufacturing in day to day life.**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2				2			1	1	1		1	1	1	
CO2	2	2			2			1	1	1		1	1	1	
CO3	2							1	1	1		1	1	1	
CO4	2							1	1	1		1	1	1	
CO5	2	2						1	1	1		1	1	1	

22MEPESCN	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To familiarize with the terminology associated with refrigeration systems and air conditioning**
- **To understand basic refrigeration processes**
- **To understand the basics of psychrometry and practice of applied psychrometrics**

- **To acquire the skills required to model, analyze and design different refrigeration as well as air conditioning processes and components**

Unit–I Introduction – Unit-of refrigeration – Refrigeration systems – Refrigeration cycles and concepts – Coefficient of Performance – Reversed Carnot cycle – Refrigeration System - Heat pump – Air Refrigeration – types – problems – Air craft Refrigeration system (Description only).

Unit–II Introduction to Steam Jet Refrigeration, vapour absorption refrigeration and solar refrigeration – (Description only) – performance Analysis of vapour compression cycle – Ideal and actual conditions – Problems – Representation of cycle on p-h and T-s diagram – Properties of refrigerants and their choice for different applications – Eco friendly refrigerant.

Unit–III Refrigeration equipment – (Description only) – Compressors – Reciprocating, centrifugal and screw – open, hermetic and semi-hermetic Units – condensers – air and water cooled condensers, evaporative condensers – Evaporators – Double tube, shell and tube, dry and flooded types – Expansion devices – Protection devices – High and Low pressure cut out Thermostat – solenoid valve.

Unit–IV Psychrometry of Air conditioning Processes – sensible heating and cooling, latent heat process, total heat process, sensible heat factor – bypass factor – cooling and Dehumidifying coil, heat coils, air washer, adiabatic dehumidifiers, water and steam injection – Adiabatic mixing – Problems on Psychrometric processes.

Unit–V Air-conditioning system – classification – Unitary, packaged and central type summer and winter air conditioning systems – (Description only) – merits and demerits – Comfort indices – Air purification – Air-conditioning – Heat gain and load calculations – RSHF, GSHF and ERSHF – energy efficiency in building – Need for reheating.

TEXT BOOKS

1. **Arora, C.P., "Refrigeration and Air Conditioning", McGraw Hill, 3rd ed, New Delhi, 2017.**
2. **R.S. Khurmi & J.K. Guptha, Refrigeration and Air-Conditioning, S.Chand & company, 3rd ed, New Delhi, 2005.**

REFERENCES

1. **Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 2014.**
2. **Arora, S.C. & Domkundwar, S., Refrigeration and Air-conditioning, Dhanpat Rai & Sons, NewDelhi, 2016.**
3. **Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 2014.**
4. **Ballaney, P.L., Refrigeration and Air-conditioning, Khanna Publisher, New Delhi, 2003.**

COURSE OUTCOMES

Upon completion of this course the student will able to

1. **Infer the principles and operation of Air refrigeration cycle and Air craft refrigeration systems.**
2. **The student relate the various types Refrigeration system and performance analyse of VCR system with different types of refrigerant and its properties.**
3. **The student would infer and interpret the various Refrigeration and Air Conditioning system components.**

4. **Analyse the various process involved in the psychrometry of mixture of water vapour and air.**
5. **The student will gain skill in design of cooling load estimation for Air Conditioning system and the various air conditioning systems employed in industries**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		3					1	1	1		1	3	3	
CO2	3		3					1	1	1		1	3	3	
CO3	3		3					1	1	1		1	3	3	
CO4	3		3					1	1	1		1	3	3	
CO5	3		3					1	1	1		1	3	3	

22MEPESCN	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To illustrate the principle of mathematical modeling of engineering problems**
- **To introduce the basics and application of Finite Element Method**

Unit-I Historical Background, Basics of FEA,FEM applications. General field problems in engineering, Modeling — discrete and continuous models, difficulties involved in solution- relevance and place of FEM. Boundary and initial value problems

Unit-II Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept ofFinite Element Method. Simultaneous Linear equation – Gauss elimination, Choleskeys factorization and Gauss seidel iterative methods.

Unit-III One dimensional second order equation, discretization, linear and higher order elements, derivationof shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution ofproblems from solid mechanics and heat transfer, longitudinal vibration and mode shapes, fourthorder beam equation, transverse deflections and natural frequencies.

Unit-IV Two dimensional equations, variational formulation, finite element formulation, triangular elementsshapefunctions, elemental matrices and RHS vectors; application to thermal problems, torsion ofnon-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.

Unit-V Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software.

TEXT BOOKS

1. **Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2020.**
2. **Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.**

REFERENCES

1. **Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann, 2004.**

2. **Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 4th ed., Prentice Hall, 2015.**

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. **Explore the basics of FEM formulation**
2. **Solve simple structural and thermal problems**
3. **Formulate problems on natural vibrations**
4. **Generate solutions for solving two dimensional equations**
5. **Determine solutions for plane stress and dynamic problems**

POs → / COs ↓	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			2	3			1	1	1				2	2
CO2	3			2	3			1	1	1			2	2	
CO3	3			2	3			1	1	1				2	
CO4	3			2	3			1	1	1				2	
CO5	3			2	3			1	1	1				2	

22MEPESCN	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To introduce the fundamentals of artificial intelligence, knowledge representation and reasoning**
- **To familiarize the basic problem solving methods and its applications**
- **To introduce basic concepts of machine learning, Bayesian Decision Theory and Normal Distribution.**

UNIT-I INTRODUCTION Artificial Intelligence: Definition – Problems, Problem spaces and search: Defining the problem as a state space search – Production Systems – Problem characteristics. Heuristic Search Techniques: Generate and test - Hill climbing – A* Algorithm – Problem reduction – Constraint Satisfaction Problem

UNIT-II KNOWLEDGE REPRESENTATION AND REASONING Predicate logic: Representing simple facts in logic. Symbolic reasoning under uncertainty - Statistical Reasoning: Probability and Bayes' theorem – Bayesian networks.

UNIT-III PLANNING AND FUZZY LOGIC Goal stack planning - non linear planning - hierarchical planning - representation for planning - partial order planning algorithm. Fuzzy Logic Systems: Crisp sets – Fuzzy sets – Fuzzy logic control: Fuzzy room cooler.

UNIT-IV CLASSIFICATION ALGORITHMS Types of learning – Bayesian decision theory – univariate and multivariate normal densities – Support Vector Machines – Linear and logistic regression – Decision trees – Perceptron and Back propagation neural networks.

UNIT – V COMPONENT ANALYSIS AND CLUSTERING ALGORITHMS Principal Component Analysis – Linear discriminant analysis – k-means clustering – Expectation maximization algorithms – Gaussian mixture models. 1D CNN for time series prediction.

TEXT BOOKS:

1. **Elaine Rich, Kevin Knight, Shivashankar B. Nair, Artificial Intelligence, Tata McGraw Hill**

2. R. O. Duda, E. Hart, and D.G. Stork, Pattern classification, Second edition, John Wiley & Sons, Singapore

REFERENCES:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach, Prentice Hall
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press

COURSE OUTCOMES:

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

1. Build intelligent agents for solving real time problems in the environment
2. Apply the suitable knowledge representation method for solving problems using symbolic reasoning and uncertainty
3. Design problem solving approaches using search algorithms including uninformed search, informed search and heuristic search
4. Explore the basic concepts of Bayesian theory and normal densities
5. Implement different classification algorithms used in machine learning

POs → / COs ↓	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3		1	2		1	1	1	1		1	1	2	
CO2	3	3	2	1	2		1	1	1	1		1		2	
CO3	3	3		1	2		1	1	1	1		1	1	2	
CO4	3	3	2	1	2		1	1	1	1		1		2	
CO5	3	3	2	1	2		1	1	1	1		1	1	1	

22MEPESCN	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the features of compressible isentropic flows and irreversibilities like shocks.
- To provide a basic knowledge of jet and rocket propulsion technologies.

Unit-I Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow, Isentropic flow through variable area ducts, nozzle s and diffusers, subsonic and supersonic flow I variable area ducts, choked flow, Area-Mach number relations for isentropic flow

Unit-II Non-isentropic flow in constant area ducts, Rayleigh and Fanno flows.

Unit-III Normal shock relations, oblique shock relations, isentropic and shock tables

Unit-IV Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

Unit-V Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights.

TEXT BOOKS

1. **Ahmed F. El-Sayed, Aircraft Propulsion and Gas Turbine Engines, CRC Press, 2017.**
2. **H.S. Mukunda, "Understanding Aerospace Chemical Propulsion", Interline Publishing, 2020.**

REFERENCES

1. **Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley, 2009.**
2. **Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley, 1975.**
3. **Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986.**

COURSE OUTCOMES

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

1. Apply the compressible flow concepts and the use of gas tables.

2. Evaluate the compressible flow behavior in constant area ducts with friction and heat transfer.

3. Analyze the development of shock waves and its effects

4. Analyze the different types of jet engines and their performance parameters

5. Classify types of rocket engines, propellants and their performance parameters. Apply gas dynamics principles to jet and space propulsion systems

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2					1	1	1	1		1	3	2	
CO2	1	2					1	1	1	1		1	3	2	
CO3	1	2			1	1	1	1	1	1		1	3	2	
CO4	1	2	2			1	1	1	1	1		1	3	2	
CO5	1	2	2				1	1	1	1		1	3	2	

22MEPESCN	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To introduce process planning concepts to make cost estimation for various products**
- **To learn the basics of cost estimation.**

Unit-I Introduction of Process Planning- methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection

Unit-II Process planning activities- process parameter calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies

Unit-III Introduction to cost estimation- importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates, estimating procedure, estimation of labor cost, material cost, allocation of overhead charges, calculation of depreciation cost

Unit-IV Machining time estimation- importance of machine time calculation, machining time for different lathe operations, drilling and boring time calculations, Machining time calculation for Milling, Shaping, Planning and Grinding

Unit-V Production costs- different production processes for different jobs, estimation of forging cost, estimation of welding cost, estimation of foundry cost, estimation of machining cost

TEXT BOOKS

1. **Peter Scalon, Process Planning, Design/ Manufacture Interface, Elsevier Sci.&Tech. 2002.**
2. **Ostwaal P.F. and Munez J., Manufacturing Processes and Systems, 9th ed., John Wiley 1998.**

REFERENCES

1. **Chitale A.V. and Gupta R.C., Product Design and Manufacturing, 6th ed., Prentice Hall 2014.**

COURSE OUTCOMES

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

1. **Explore the basics of process planning**
2. **Estimate the economics of process planning**
3. **Explore the economics of cost estimation**
4. **Calculate machining time**
5. **Calculate production cost**

POs → / ↓COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2					1	1	1	1			1	1
CO2	2		2					1	1	1	1		1	1	
CO3	2		2					1	1	1	1		1	1	
CO4	2		2					1	1	1	1		1	1	
CO5	2		2					1	1	1	1		1	1	

22MEPESCN	INDUSTRIAL MANAGEMENT AND ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To introduce students various Industrial Engineering and Management concepts.**
- **To provide an understanding of the systematic approaches of various management functions.**
- **To enhance the management skills through the application of appropriate techniques.**

UNIT I

Engineering Economics - nature and scope of managerial economics – basic economic tools in managerial economics - decision and efficiency analysis. Consumer behaviour - law of demand and supply - elasticity - determinants - uses. Pricing under different market conditions: Monopoly - monopolistic competition - oligopoly, pricing policies - Porter's five forces - model of competition. Financial markets: Primary and secondary markets - money market instruments - capital. market instruments. National income - concepts. Trade and development: Free trade versus protection - balance of payments - globalisation - W.T.O.

UNIT II

Organizational Components to be Managed - Individual Behaviour: Governing factors -Determinants of personality . Motivation – Importance – Theories: Maslow's Theory of Need Hierarchy - Theory X and Theory Y - techniques of motivation. Job satisfaction – Governing factors –Effects.Group Dynamics - Development of Inter- personal Relationship.GroupBehaviour -Group cohesiveness.Conflict - Functional and Dysfunctional Conflict - Conflict resolution model.Stress– Sources – Management of Stress. Leadership – Types – Theories:Hersey and Blanchard's situational leadership model - Path-Goal theory

UNIT III

Principles of Management - Functions of management - Scientific management: Contributions of Taylor, Gilberth, Gantt- Forms of business organisation - line, functional, line and staff organisations - Industrial ownership: single, partnership, joint stock company, co- operative organisations, state and central government owned. Costing:
Objectives - Elements of costs - estimation of selling price – simple problems, Allocation of overheads.

UNIT IV

Break-even analysis - concept and applications - Depreciation - straight line and declining balance method.
Plant Location: Influencing factors. Location models– Breakeven analysis – Qualitative factor rating Method.
Plan Layout: Layout Objectivess– Types of Layout – Load distance analysis – Muthur grid technique. Concept of Line balance – Largest candidate rule.

UNIT V

Method Study: Objectives and procedure for methods analysis, Recording techniques, Operations Process Chart, Flow Process Chart, Man-Machine chart , Multiple Activity Chart, and Two Handed process chart, String Diagram, Therbligs, Micro motion and macro-motion study: Principles of motion economy.
Work Measurement: Objectives, Work measurement techniques – time study, work sampling -Determination of time standards- Observed time, basic time, normal time, rating factors, allowances, and standard time.

TEXT BOOKS

1. **Kumar. B.,"Industrial Engineering",Khanna Publications, 1995.**
2. **M. Govindarajan and S.Natarajan, Principles of Management, Prentice Hall of India Pvt. Ltd. New Delhi, 2007.**
3. **Jain, S.K., "Applied Economics for Managers and Engineers",Vikas Publishers, 1997.**

REFERENCES

1. **Herald Koontz and Heinz Weihrich, "Essentials of Management", McGraw Hill Publishing Company, Singapore International Edition, 1980.**
2. **"Mechanical Estimating and Costing", TTTI Madras, Tata McGraw Hill,2003.**
3. **Mehta P.L., "Managerial Economics", Sultan Chand & Sons, 1995.**
4. **Vaish M.C., "Money, Banking, Trade and Public Finance", New Age International (P) Ltd., 1996.**
5. **Ties, AF, Stoner and R. Edward Freeman, "Management", Prentice Hall of India Pvt. Ltd. New Delhi, 1992.**
6. **Chandran, S., "Organizational Behaviors",Vikas Publishing House Pvt. Ltd, 1994.**

7. Jain. S.K., Applied Economics for Managers and Engineers, Vikas Publishers,
1997.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. **Recognize the factors such as demand and production for pricing criteria**
2. **Employ the effective interpersonal, team building and leadership skills**
3. **Improve the organizational performance through the effective management of human resources**
4. **Apply the various Industrial Engineering Techniques in industries**
5. **Apply the concepts of Method Study and Time study**

POs → / ↓ COs	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3							3	1	1	3	1	3	2	
CO2	3							3	1	1	3	1	3	2	
CO3	3							3	1	1	3	1	3	2	
CO4	3							3	1	1	3	1	3	2	
CO5	3							3	1	1	3	1	3	2	

22MEPESCN	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To gain knowledge on the principles and procedures for the design of power Transmission components.

To understand the standard procedure available for Design of transmission systems

To learn to use standard data and catalogues

Unit–I Bearings: - Hydrodynamic Journals Bearings - Design procedure - Minimum film thickness - Selection of Antifriction bearings - Life of bearings - Equivalent load, Cubic mean load - load rating - Design Procedure..

Unit–II Belt Drives of flat belts, V-Belts using manufacturer's table - Matched set of V-Belts, Chain drives for Power transmission design procedure.

Unit–III Gear drives: Toothed gear - types of failure - Design analysis - Gear Materials - Design of spur and Helical gears based on surface strength and bending strength - Forces acting on toothed gears.

Unit–IV Bevel and worm gears: Bevel gears classification - terminology - forces on bevel gear tooth - Design procedure - working gears - Design of worm gears - Terminology - centre distance - losses - design procedure.

Unit–V Gear Box: Standard Step ratio - Speed diagram - Kinematics layout - Design of six speed, twelve speed, eighteen speed gear box - calculation of actual speed.

TEXT BOOKS

1. **R.S. Khurmi, "Machine Design", S. Chand company Ltd., 25th ed. 2020.**
2. **T.J. Prabhu, "Design of Transmission Elements", 4th ed. 2000.**

REFERENCES

1. **Richard Bundya and Shigley, "Mechanical Engineering Design", McGraw Hill Book Company 2017.**
2. **T.V. Sundarajamoorthy, N.Shanmugham, "Machine Design", Khanna Publishers 2018.**

COURSE OUTCOMES

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

1. **Design and select hydrodynamic and antifriction bearings**
2. **Design flat, V belts and chain drives for power transmission**
3. **Design Toothed, spur and helical gears for power transmission**
4. **Design bevel and worm gears.**
5. **Design multi speed gear box for machine tool and automotive applications**

POs → / COs ↓	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3	2				1	1	1		1	3	2	
CO2	3	3	3	2				1	1	1		1	3	2	
CO3	3	3	3	2				1	1	1		1	3	2	
CO4	3	3	3	2				1	1	1		1	3	2	
CO5	3	3	3	2				1	1	1		1	3	2	

22MEPESCN	TOTAL QUALITY MANAGEMENT AND RELIABILITY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- **To provide an understanding and impart the knowledge and on the application of conventional and modern tools and techniques of TQM which are used in manufacturing and service industries.**
- **To understand the various principles, practices of TQM to achieve quality and for continuous process improvement.**
- **To understand the concepts and importance of reliability.**

UNIT I

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality. Basic concepts of TQM – Principles of TQM - TQM Framework - TQM implementation - Barriers to TQM - difference between traditional and TQM organization. Contributions of Quality Gurus – Philosophies – Deming - Deming's chain reaction - 14 points – seven deadly diseases of management – Crosby - four absolutes - 14 steps - Juran - quality trilogy.

UNIT II

Customer focus- introduction - customer satisfaction - customer perception of quality - Customer complaints - service quality - translating needs to requirements - Kano model - Customer retention. Supplier partnership – customer / supplier relations – partnering – sourcing - Supplier selection - relationship development - Supplier Rating. Continuous process improvement – improvement strategies - PDCA cycle - 5s – Kaizen - Poka-yoke.

UNIT III

The seven traditional tools of quality – New management tools. Six-sigma – Concepts – methodology – DMAIC - implementation – Various formulae to measure

different metrics related to Six Sigma defects - applications to manufacturing, service sector including IT.- Bench marking – Types – reasons - Bench marking process - pitfalls and criticisms.

UNIT IV

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function - Goal post view of Quality vs. Taguchi's loss function approach. Performance measures - Introduction - Balance score card - Quality costs - Quality awards - Malcolm Baldrige national quality award. Quality System - ISO 9000 standards – ISO 9001:2015 – principles - requirements – Documentation – implementation – auditing – Advantages and disadvantages. QS 9000 – ISO 14000 – Concepts - requirements - Benefits.

UNIT V

Reliability: Introduction – Definition – factors affecting reliability – methods to improve reliability – failure data analysis - Failure Rate – hazard rate - Mean Time Between Failures (MTBF)-Mean Time To Failure (MTTF) – Types of failures - Bathtub curve- – Evaluation of reliability – Series, Parallel and series parallel systems - stand-by redundancy -Down time, Repair time, Availability. Failure Mode Effect Criticality Analysis (FMECA): Introduction – Types – FMECA worksheet - procedure - risk priority number (RPN).

TEXT BOOKS:

1. **Besterfield Dale H., Carol Besterfield-Michna., Glen H Besterfield., and Mary Besterfield- Scare., "Total Quality Management", PHI, 3rd edition, 2007.**
2. **Gupta A.K., "Reliability Engineering and Terotechnology", Macmillan India Limited, 1996.**
3. **Poornima M. Charantimath., "Total Quality Management", Pearson, 3rd edition, 2017.**

REFERENCE BOOKS:

1. **James R Evans and William M Lindsay, "Managing for Quality and Performance Excellence", Cengage Learning, 10th edition, 2016.**
2. **Jayakumar V., and Raju R., "Total Quality Management", Lakshmi Publications, 2018.**
3. **Janakiraman B and Gopal R.K., Total Quality Management: Text and Cases, PHI, 2006.**
4. **Srinath L.S., Reliability Engineering, Affiliated East West Press, 2005.**
5. **Sunil Luthra., Dixit Garg., AshishAgarwal and Sachin K Mangla., "Total Quality Management (TQM): Principles, Methods and Applications, CRC Press, 2021.**

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. **Recognize the core features of the Total quality management in terms of various dimensions of quality in manufacturing and service processes and develop an understanding on quality management philosophies and frameworks.**
2. **Develop an understanding of customer perception of quality and to understand the methods of developing relationship with supplier.**
3. **Develop the ability to apply the tools of quality control and quality management for continuous process improvement and to understand proven methodologies to enhance management processes, such as six sigma and benchmarking.**

4. **Measure the cost of poor quality and process effectiveness and efficiency to track performance quality and to identify areas for improvement.**
5. **Recognize the basic concepts of reliability and to identify and analyze the failures of the components and subcomponents of mechanical and electronic items, and also should be able to explain the purpose of redundancy in a system.**

POs → / COs ↓	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2				1			1	1	1	1			1	
CO2	2				1			1	1	1	1			2	
CO3	2				1			1	1	1	1		1	1	
CO4	2				1			1	1	1	1			1	1
CO5	2				1			1	1	1	1			1	1

22MEPESCN	ENERGY CONSERVATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To understand the energy data from industries and carry out energy audit for energy savings**
- **To understand the world energy scenario.**

Unit-I Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.

Unit-II Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

Unit-III Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.

Unit-IV Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets.

Unit-V Energy Economics- discount period, payback period, internal rate of return, net present value; LifeCycle costing- ESCO concept.

TEXT BOOKS

1. **Witte L.C., Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere Publ., Washington, 1988.**
2. **Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.**

REFERENCES

1. **Murphy W.R. and McKay G., Energy Management, Butterworths, London, 1987.**
2. **Yogi Goswami, D. and Frank Kreith, Energy Conversion, Second Edition, Science, 2017.**

COURSE OUTCOMES

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

1. **Compare the various international and national energy models for Energy auditing**
2. **Implement and classify various energy consumption and efficiency**
3. **Identify the various thermal system consumption and conservation**
4. **Relate the energy conservation in various mechanical equipments.**
5. **Value the money by various economic methods.**

POs → / COs ↓	Mapping of COs with POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		2			2	3	1	1	1	1	1	3	2	1
CO2	3		2			2	3	1	1	1	1	1	3	2	1
CO3	3		2			2	3	1	1	1	1	1	3	2	2
CO4	3		2			2	3	1	1	1	1	1	3	2	2
CO5	3		2			2	3	1	1	1	1	1	3	2	3

22MEPESCN	DIGITAL TWIN DRIVEN SMART MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To introduce digital twin concepts and their applications in industry.**
- **To familiarize with trends in discrete Industry**
- **To be acquainted with digital twin in process industry.**
- **To impart knowledge in Industry 4.0**
- **To elaborate the advantages of digital twin.**

UNIT I INTRODUCTION

Digital twin - Definition, types of Industry & its key requirements, Importance, Application of Digital Twin in process, product, service industries, History of Digital Twin, DTT role in industry innovation, Technologies/tools enabling Digital Twin

UNIT II DIGITAL TWIN IN A DISCRETE INDUSTRY

Basics of Discrete Industry, Trends in the discrete industry, control system requirements in a discrete industry, Digital Twin of a Product, Digital Thread in Discrete Industry, Data collection & analysis for product & production improvements, Automation simulation, Digital Enterprise

UNIT III DIGITAL TWIN IN A PROCESS INDUSTRY

Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection & analysis for process improvements, process safety, Automation simulation, Digital Enterprise

UNIT V INDUSTRY 4.0

Industrial Revolutions, Industry 4.0 – Definition, principles, Application of Industry 4.0 in process & discrete industries, Benefits of Industry 4.0, challenges in Industry 4.0, Smart manufacturing, Internet of Things, Industrial Gateways, Basics of Communication requirements.

UNIT VADVANTAGES OF DIGITAL TWIN

Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.

COURSE OUTCOMES:

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

- **CO1: Acquire knowledge on digital twin and its importance.**
- **CO2: Support digital twin in discrete Industry.**
- **CO3: Value digital twin in process industry.**
- **CO4: Operate Industry 4.0 and Smart Manufacturing in Industry.**
- **CO5: Discover the advantages of digital twin.**

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

TEXT BOOKS:

1. **Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation",Springer Series in Advanced Manufacturing., Switzerland, 2017**
2. **Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing",Elsevier Science., United States, 2019**

REFERENCES:

1. **Alasdair Gilchrist , "Industry 4.0: The Industrial Internet of Things", Apress., United States ,2015.**
2. **Christoph Jan Bartodziej, "The Concept Industry 4.0 An Empirical Analysis of Technologies andApplications in Production Logistics", Springer Gambler., Germany, 2017.**
3. **Ibrahim Garbie, "Sustainability in Manufacturing Enterprises, Concepts, analyses andassessments for Industry 4.0", Springer., Switzerland, 2016.**
4. **Ronald R. Yager and Jordán Pascual Espada, "New Advances in the Internet of Things",Springer., Switzerland, 2018**
5. **Ulrich Sendler, "The Internet of Things, Industries 4.0 Unleashed", Springer., Germany, 2016.**

22MEOESCN	SOLAR ENERGY UTILIZATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To learn the operation of solar thermal energy systems**
- **Study of solar thermal power plants**
- **To study the components of solar photovoltaic power plants**
- **Utilization of solar energy in buildings**

Unit-I Solar Radiation Sun and earth geometry, solar radiation-beam and diffuse radiations, measurement of solar radiation – pyranometer, pyrheliometer, sunshine recorder. Solar collectors and applications.

Unit-II Solar Thermal Systems Flat plate and evacuated tube collectors, domestic hot water and process heat systems, solar cooker, solar dryer, solar desalination and solar pond.

Unit-III Solar Power Plant Principles of solar parabolic concentrators-trough and dish types, compound parabolic concentrators, fresnel lens collectors, central receiver plant, direct steam generation systems, solar furnaces.

Unit-IV Solar Photovoltaics Solar photovoltaic theory, mono and polycrystalline silicon technologies, PV modules and integrated systems, implementation and maintenance.

Unit-V Solar-Conscious Buildings Orientation and design of buildings, passive solar heat- thermal capacity, insulation, solar cooling-refrigeration and air-conditioning, space heating, sensible and latent heat energy storages in buildings.

TEXT BOOKS

1. **Sukhatme.K, Suhas P. Sukhatme, "Solar energy: Principles of thermal collection and storage", Tata McGraw Hill publishing Co. Ltd, 8th edition, 2017.**
2. **Soteris A. Kalogiru, "Solar Energy Engineering: Processes and systems", 1st edition, Academic press, 2013.**

REFERENCES

1. **Martin A. Green, "Third generation Photovoltaics: Advanced energy conversion", 1st edition, 2005.**
2. **Garg.H.P, Prakash.J, "Solar energy fundamentals and applications", Tata McGraw Hill publishing Co. Ltd, 2017.**
3. **Yogi Goswami.D, Frank Kreith, Jan F.Kreider, "Principle of solar engineering", 3rd edition, Taylor and Francis, 2nd edition, 2015.**
4. **Tiwari.G.N, "Solar energy: Fundamentals, Design, Modeling and Applications", CRC Press Inc., 2012.**

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. **Explore the various components and measuring devices**
2. **Analyze the operation of solar thermal energy systems**
3. **Explore the various components of solar power plants**
4. **Analyze the advantages of photovoltaics in solar power plant**
5. **Evaluate the methods to effectively utilize solar energy in buildings**

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

22MEOESCN	ENERGY MANAGEMENT IN BUILDINGS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To effectively manage energy in buildings**
- **To learn the basics of natural ventilation and air conditioning**
- **To determine the various building loads**

Unit-I Introduction Conventional versus Energy Efficient buildings – Historical perspective - Water – Energy – IAQ requirement analysis – Future building design aspects – Criticality of resources and needs of modern living

Unit-II Landscape and Building Envelopes Energy efficient Landscape design - Micro-climates – various methods – Shading, water bodies- Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, Insulation, Design methods and tools.

Unit-III Heating, Ventilation and Air-Conditioning Natural Ventilation, Passive cooling and heating - Application of wind, water and earth for cooling, evaporative cooling, radiant cooling – Hybrid Methods – Energy Conservation measures, Thermal Storage.

Unit-IV Heat Transmission in Buildings Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; Solar temperature; Decrement factor; Phase lag. Design of daylighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.

UNIT-V Passive Cooling & Renewable Energy in Buildings Passive cooling concepts: Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth airtunnel. Introduction of renewable sources in buildings, Solar water heating, small wind turbines, stand-alone PV systems, Hybrid system – Economics.

TEXT BOOKS

1. **Krieder, J and Rabi, A., Heating and Cooling of buildings : Design for Efficiency, Mc Graw Hill, 1994.**
2. **Steve Doty, Wayne Turner C, Energy Management Handbook 7th Edition, The Fairmont Press, 2009.**

REFERENCES

1. **Guide book for National Certification Examination for Energy Managers and Energy Auditors**

COURSE OUTCOMES

Upon completion of the course, students will be able to

1.Compare conventional vis-à-vis energy efficient buildings and versatile with energy conservation building codes.
2. Design an energy efficient landscape system.
3. Examine different solutions for HVAC in buildings
4. Analyze the heat transmission in buildings.
5. Adopt integration of renewable energy in buildings.

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

OPEN ELECTIVE COURSES

22MEOESCN	AUTOMOTIVE SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
The course should enable the students to:

- **Recognize the essential requirements and principles of automotive safety**
- **Understand the many types of car safety equipment and how they work**
- **Be familiar with how different convenience systems work.**
- **Acquire a basic knowledge of an automobile's active safety features.**
- **Learn about the navigation and vehicle integration systems.**

Unit-I Introduction Automotive safety: Introduction, Types. Active safety: driving safety, conditional safety, perceptibility safety, operating safety. Passive safety: exterior safety, interior safety.

Unit-II Passive Safety Concepts Design of body for safety, deceleration of vehicle, passenger. Concept of crumble zone, Safety Cage. Optimum crash pulse, deceleration on impact with stationary and movable obstacles. Deformation behavior of vehicle body. Deformation behavior of Lightweight materials.

Unit-III Passive Safety Equipments and Convenience System Seat belt, Seat belt tightener system and importance, collapsible steering column. Air bags and its activation. Designing aspects of automotive bumpers and materials for bumpers. Steering and mirror adjustment, central locking system, Tire pressure control system, rain sensor system, automated wiper system.

Unit-IV Active Safety Antilock braking system, Stability Control. Adaptive cruise control, Lane Keep Assist System, Collision warning, avoidance system, Blind Spot Detection system, ADAS (Advanced Driver Assistance System)

Unit-V Vehicle Integration and Navigation System Looking out sensors and Looking in sensors, Intelligent vision system, Vehicle Integration system. Global Positioning System. Vehicle Navigation System. Road Network.

TEXT BOOKS

1. **LjuboVlacic, Michel Parent, Fumio Harashima –"Intelligent Vehicle Technologies Theory and Applications" -Butterworth-Heinemann, 2001**
2. **J. Marek, H.-P. Trah, Y. Suzuki, I. Yokomori -"Sensors for Automotive Applications "-WILEYVCH Verlag GmbH & Co. 2003**

REFERENCES

1. **Robert Bosch GmbH -"Safety, Comfort and Convenience Systems"-Wiley; 3rd edition, 2007**

2. **Bosch, "Automotive Hand Book", 6th edition, SAE, 2018.**
3. **J.Powloski -"Vehicle Body Engineering" -Business books limited, London -1969.**
4. **Ronald.K.Jurgen -"Automotive Electronics Handbook" -Second edition- McGraw -Hill Inc., - 1999.**

COURSE OUTCOMES

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

1. **Create a safer public environment by knowing the importance of automotive safety systems.**
2. **Distinguish different passive automotive safety systems and discuss about them.**
3. **Summarize the working concepts of passive safety devices and convenience systems of an automobile.**
4. **Develop knowledge about active automotive safety systems.**
5. **Create awareness on vehicle integration and navigation systems of modern automobiles and learn about its parts.**

22MEOESCN	ELECTRIC AND HYBRID VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To understand the basic concept of Hybrid, Electric Vehicles, energy Storage devices and controls.**
- **To learn the various energy storage devices**

Unit-I Introduction to Need for Alternative System History of electric and hybrid vehicles. Need of electric and hybrid vehicles – comparative study of diesel, petrol, electric and hybrid vehicles. Limitations of electric vehicles. Specification of different electric and hybrid vehicles.

Unit-II Energy Storage Devices and Fuel Cells Electromechanical batteries- types of batteries –lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency and ultra-capacitors.
Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell- Connecting cell in series- water management in the PEM fuel cell- Thermal Management of the PEM fuel cell
Unit-III Electric Vehicles Electric vehicle layout, performance of electric vehicles – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations, specifications, system components, electronic control system, safety and challenges in electric vehicles.
Unit-IV Hybrid Vehicles Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, hybrid electric drive train design, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles.

Unit-V Propulsion Motors and Controllers Types of electric motors – working principle of AC and DC motors. Characteristic of shunt, series and compound type of DC motors- permanent magnet and separately exited DC motors. AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers.

TEXT BOOKS

1. **James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2012**
2. **Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003**

REFERENCES

1. **Ron HodKinson, " light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005**
2. **Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press,2019**

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. **Explore the necessity of alternative systems for vehicles.**
2. **Analyze the basics and working of energy storage devices.**
3. **Explore the operation of electric vehicles.**
4. **Explore the concepts of hybrid vehicles.**
5. **Analyze the basics electric motors and controllers.**

22MEOESCN	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To impart knowledge about various computational methods for fluid flow and heat transfer problems so as to enable the students to write computer programs for solving elementary fluid dynamics/heat transfer problems.**
- **Students will be exposed to governing equations required for CFD and their mathematical behavior.**
- **Students will be exposed to modeling of Fluid flow and heat transfer problem.**

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One and Two dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Simple problems on elliptic and parabolic equations with Finite Difference and Finite Volume methods.

UNIT III FINITE VOLUME METHOD FOR CONVECTION AND DIFFUSION

Steady one-dimensional convection and diffusion – Central and upwind differencing schemes - Properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, and QUICK Schemes.

UNIT IV FINITE VOLUME METHOD FOR FLOW FIELD ANALYSIS

Finite volume method -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms-Simple problems.

UNIT V INTRODUCTION TO TURBULENCE MODELS AND MESH GENERATION

Turbulence models, mixing length model, Two equation (k-ε) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

COURSE OUTCOME

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

1. Formulate governing equations for physical problems.

2. Solve diffusion problems using FDM amd FVM

3. Linearize and solve convection and diffusion problems using FVM
4. Analyze flow field problems using FVM
5. Infer the turbulence phenomnon and mesh generation.

TEXT BOOKS:

1. **Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd.Second Edition, 2007.**
2. **Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.**

REFERENCES:

1. **Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.**
2. **Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.**
3. **Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005**
4. **Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.**
5. **Pradip Niyogi, Chakrabarty, S.K., Laha, M.K. "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.**
6. **Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005.**

POs	Mapping of COs with POs												PSOs		
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1									3		
CO2	3	3	3	2									3		
CO3	3	3	3	2									3		
CO4	3	3	3	2									3		
CO5	3	3	2	1									3		

22MEOESCN	FUELS AND COMBUSTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To impart the knowledge about the different types of fuels.**
- **To study the principles of combustion, flame properties and fuel handling devices.**
- **To study the petroleum refining process and combustion systems.**

Unit-I Fuels-solid, liquid and gaseous fuels-characteristics. Coal- coking and caking coals- Composition and characteristics- Estimation of calorific value-Proximate analysis, Ultimate analysis. Flue gas analyser- Orsat apparatus, Carburisation, gasification and liquefaction of coal. Hydrogenation of coal, Handling and storage.

Unit-II Petroleum – origin of petroleum-classification, composition and properties – specific gravity – viscosity – flash point – fire point – cloud point –pour point, freezing point, smoke point, carbon residue, diesel index, sulphur content, moisture content,

octane and cetane number. Petroleum refining and other conversion processes. Liquefaction of solid fuels. Storage and handling of liquid fuels.

Unit-III Gaseous fuels- composition and properties-Gas calorimeter-fuel types-methane-wood gas- water gas- LPG-LNG-CNG -blast furnace gas-Gobar gas-Syn gas-producer gas- Gasifiers-Biogas-digesters –reactions. Comparative study of solid, liquid and gaseous fuels.

Unit-IV Principle of combustion - stoichiometry, heat of reaction and formation. Combustion process- submerged combustion, slow combustion, pulsating and explosive combustion. Chemical kinetics-NOx and soot kinetics. Fuel and flue gas composition, Excess air calculation.

Unit-V Flames-flame propagation-flame temperature-theoretical, adiabatic temperature -ignition limits- limits of in flammability. Types of burners-oil burners-types-gas burners- atmospheric and air aspiration burners-Coal burning equipments – pulverized, fluidized bed and cyclone firing.

TEXT BOOKS

1. Om Prakash Gupta, Elements of Fuels, Furnaces and Refractories, Khanna publishers, 1999.

2. Sharma S.P. and Chander, Fuels and Combustion, Tata McGraw Hill Publishing Company, 1987.

REFERENCES

1. **Samir Sarkar, Fuels and Combustion, 2nd edition, Orient Longman, 1990.**
2. **Roger A. Strehlow, Combustion Fundamentals, McGraw Hill Publishing Company.**
3. **Kenneth K. Kuo, Principles of Combustion, Wiley sons.**
4. **Borman Gary, L. and Kenneth W. Ragland, Combustion Engineering, McGraw Hill Publishing Company, 1998.**
5. **Smith, M.L. and Shinson, K.W., Fuels and Combustion, McGraw Hill Publishing Company.**

COURSE OUTCOMES

At the end of the course student can able to

1. **Determine the different characteristics of fuels**
2. **Determine the properties of liquid fuels**
3. **Analyze the properties of gaseous fuels**
4. **Solve problems related to different forms of combustion**
5. **Analyze coal burning methods and equipments**

22MEOESCN	RENEWABLE ENERGY TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To emphasis the current energy status and role of renewable energy sources.**
- **To familiarize various aspects of Solar energy and utilization**
- **To familiarize various aspects of Biomass energy and utilization**

- **To familiarize other renewable energy sources**

Unit-I –Introduction World energy status, Current energy scenario in India, Environmental aspects of energy utilization, Environment - Economy - Energy and Sustainable Development, Energy planning. Reserves of Energy resources, Renewable energy resources - potentials -achievements – applications. Technical and social implications, issues in grid integration of power from renewable energy sources.

Unit-II - Solar Energy Basic concepts, Solar radiation – Measurement, Solar thermal systems – Flat plate and concentrating collectors, Solar passive space - Solar heating and cooling techniques – Solar desalination – Solar Pond - Solar cooker - Solar dryers- Solar furnaces - Solar pumping, Solar green house- Solar thermal electric power plant – Solar photo voltaic conversion – Solar cells – PV applications, Hybrid systems.

Unit-III - Wind Energy Introduction-Availability- Wind power plants, Power from the wind, Wind energy conversion systems, site characteristics, Wind turbines types – Horizontal and vertical axis-design principles of wind turbine – Blade element theory, Magnus effect- Performance. Wind energy Applications – Hybrid systems, Wind energy storage, Safety and environmental aspects.

Unit-IV - Biomass Energy Biomass – usable forms- composition- fuel properties – applications, Biomass resources, Biomass conversion technologies - direction combustion - pyrolysis – gasification -anaerobic digestion, Bioethanol and Biodiesel Production - Economics - Recent developments. Energy farming, Biogas technology - Family biogas plants, Community and institutional biogas plants – design consideration – applications.

Unit-V - Other Renewable Energy Sources Tidal energy – Wave energy – Open and closed OTEC Cycles – Small hydro – Geothermal energy – Social and environmental aspects. Fuel cell technology - types, principle of operation – applications. Hydrogen energy production - Storage – transportation – utilization.

TEXT BOOKS

1. **Godfrey Boyle, "Renewable Energy", Power for a Sustainable Future, Oxford University Press, U.K, 2012.**
2. **Tiwari.G.N, "Solar Energy – Fundamentals Design", Modelling and applications, Narosa PublishingHouse,NewDelhi,2012**

REFERENCES

1. **Freris.L.L, "Wind Energy Conversion systems", Prentice Hall, UK, 1990.**
2. **Veziroglu.T.N, "Alternative Energy Sources", Vol 5 and 6, McGraw-Hill, 1978**
3. **Johnson Gary.L, "Wind Energy Systems", Prentice Hall, New York, 1985.**
4. **G.D. Rai, "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 1999.**
5. **S.P. Sukhatme, "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2017**
6. **Kothari P, K C Singal and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Pvt. Ltd.,New Delhi, 2011**

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. **Describe the current energy scenario of India and World**
2. **Gauge the solar energy and apply suitable technologies for harnessing them.**
3. **Quantify wind energy and deploy appropriate devices for energy generation**
4. **Recover energy from biomass adopting proper concepts.**

5. **Employ appropriate engineering principles for tapping energy from ocean and geothermal resources.**

22MEOESCN	INDUSTRIAL POLLUTION PREVENTION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- **To learn various pollution norms**
- **To learn the various methods to curtail industrial pollution**
- **To learn the principles of water treatment**

Unit-I Sustainability Industrial activity and environment, industrialization and sustainable development indicators of sustainability-sustainability strategies. Barriers to sustainability, Pollution prevention in achieving sustainability

Unit-II Environmental Regulations Prevention vs control of industrial pollution, Environment policies and Regulations to encourage pollution prevention, Environment friendly chemical processes, Regulations for clean environment and implications for industries

Unit-III Pollution Definition of pollutant, types of pollution; Air, Water, Land, noise-adverse effects of pollutants eco system and human health - need for effluent treatment and toxicity, control. Water standards for portable, agricultural and left-off streams- air standards for cities, industrial areas, resorts.

Unit-IV Air Pollution Control Methods Particulate emission control- gravitational settling chambers- cyclone separators, fabric filters, electrostatic precipitators, wet scrubbers, absorbers. Control of sulphur di oxide, oxides of nitrogen, carbon monoxide and hydrocarbons. Noise pollution measurements and its control.

Unit-V Principles of Water Treatment Primary, secondary and tertiary treatments - advanced waste water treatments; recovery of metals from process effluents

TEXT BOOKS

1. **Bishop.P, "Pollution Prevention: Fundamentals and Practice", McGraw Hill International Edn., McGraw Hill Book Co., Singapore, 2000**
2. **Freeman.H.M, "Industrial Pollution Prevention Hand Book", McGraw Hill,1995**

REFERENCES

1. **James. G. Mann and Liu.Y.A, "Industrial Water Reuse and Waste Water Minimization", McGraw Hill, 1999**
2. **Pandey.G.N and Carney.G.C, "Environmental Engineering", Tata McGraw Hill, New Delhi,2017**

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. **Explore the significance of sustainable development and its barriers.**
2. **Explore the regulations for pollution mitigation**
3. **Explore the various land, water and air pollutants**
4. **Explore the methods of mitigating air pollution**
5. **Explore the basic principles of water treatment**

22MEOESCN	POWER PLANT INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To enable the student to gain a fair knowledge on various power plants & their related instruments.**
- **To get detailed knowledge on thermal power plant.**
- **To learn the measurements of various parameter in power plant and their control.**

Unit-I Overview of Power Generation Brief survey methods of power generation hydro, thermal, nuclear, solar and wind power-Importance of instrumentation in power plants –Layout of Thermal power plant – Complete layout of Boiler and Turbine – Process and instrumentation diagram of thermal power plant – distributed digital control system in power plants.

Unit-II Measurements in Power Plants Use of transducers in electrical measurements-current, voltage, power, power factor - function of synchroscope – measurement of non-electrical parameters – flow of feed water, fuel, air and steam - measurement of steam pressure and temperature – Drum level measurement.

Unit-III Analysers in Power Plants Flue gas analysis – oxygen analyzer – CO analyzer – analysis of impurities in feed water and steam – conductivity and dissolved oxygen analyzers – Gas chromatography – PH meter – pollution monitoring instruments, smoke density measurements, dust monitor, radiation detector.

Unit-IV Control Loops in Boiler Combustion control – air/fuel ratio control- furnace draft control – drum level control – steam temperature control and attemperation – super heater control - Deaerator control - interlocks in boiler operation. UNIT-V - TURBINE

Unit-V Turbine Monitoring and Control Speed measurement, vibration and eccentricity measurement, shell temperature monitoring and control – lubricating oil temperature control – cooling system, protection and interlocks in turbines.

TEXT BOOKS

1. **Sam G.Dukelow, "The control of Boilers", instrument society of America, 1991.**
2. **Krishnaswamy.K and M.Ponni Bala, "Power Plant Instrumentation", Eastern Economy Edition, 2011.**

REFERENCES

1. **Jain.R.K, "Mechanical and industrial Measurements", Khanna Publishers, New Delhi, 1995.**

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. **Explore the basics of power plant and its instrumentation.**
2. **Analyze the electrical and non electrical measurements in power plant.**
3. **Investigate the various analyzers used in power plant**
4. **Explore the various controls used in boilers**
5. **Analyze the methodology of controlling turbines in power plant**

22MEOESCN	ENERGY AUDITING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To familiarize various forms of energy**
- **To understand energy management concepts**
- **To learn the methods of energy audit and usage of instruments**
- **To analyze and report the outcome of energy audit**

Unit-I Fundamentals of Energy Basics of energy and its various forms: Conventional and non -conventional sources. Different fuels and its energy contents. Renewable energy - solar energy, wind energy, bio energy, hydro energy, geothermal energy, wave energy, tidal energy and OTEC.

Unit-II Energy Management Energy management- various approaches, cost effectiveness, bench marking, optimization of energy requirement and maximization of system efficiencies. Fuels and energy substitution.

Unit-III Energy Audit Energy audit – need, preliminary audit, detailed audit, methodology and approach. Instruments for audit, monitoring energy and energy savings.

Unit-IV Assessment and Reporting Evaluation of saving opportunities – determining the savings in INR, non- economic factors, conservation opportunities, estimating cost of implementation.

Unit-V Energy Audit Reporting the plant energy study report, importance, effective organization, report writing and presentation.

TEXT BOOKS

1. **Energy Management Audit & Conservation by Barun Kumar De Publisher: Vrinda Publications 2014**
2. **Abbi Y P, Shashank Jain., Handbook on Energy Audit and Environment Management, TERIPress, 2006..**

REFERENCES

1. **Energy Management: W.R.Murphy, G.Mckay (Butterworths) 1981.**
2. **Energy Management Principles: C.B.Smith (Pergamon Press) 2015**
3. **Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific) 2013**

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. **Explore the fundamentals of energy and its forms**
2. **Apply various energy management concepts**
3. **Quantify the methods of energy audit and usage of instruments**
4. **Estimate the energy saving and economics related to energy**
5. **Analyze , prepare energy audit report and define its outcome.**

22MEOESCN	WASTE HEAT RECOVERY SYSTEMS AND CO GENERATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **It deals with the difference cogeneration schemes and techno economics of co generation.**
- **It introduces difference ways heat recovery systems and thermodynamics aspects of waste heat recovery.**

Unit-I Co-Generation Introduction-principles of thermodynamics, combined cycles, topping, bottoming, organic rankine cycles, advantages of cogeneration technology.

Unit-II Application and Techno Economics of Cogeneration Cogeneration application in various industries like cement, sugar mill, paper mill etc. Sizing of waste heat boilers-performance calculations, part load characteristics, selection of co-generational technologies-financial considerations- operating and investments-costs of co-generation.

Unit-III Waste Heat Recovery Introduction-principles of thermodynamics and second law- sources of waste heat recovery-diesel engines and power plant.

Unit-IV Waste Heat Recovery Systems Recuperators, regenerators, economizers plate heat exchangers. Waste heat boilers-classification, location, service conditions and design considerations. Unfired combined cycle, supplementary fired combined cycle, fired combined cycle.

Unit-V Applications and Techno Economics Applications in industries-fluidized bed heat exchangers, heat pipe exchangers-heat pumps and thermic fluid heaters. Selection of waste heat recovery technologies-financial considerations, operations and investment costs of waste heat recovery.

TEXT BOOKS

1. **Charles H Butler, "Co-generation", Mc Graw Hill, New York,1984.**
2. **Horlock J H, "Co-generation-Heat and Power, Thermodynamics and Economics", Oxford, UK, 1987.**

REFERENCES

1. **Bent Sorensen, Renewable Energy Conversion, Transmission, and Storage Technology &Engineering, Academic Press, 2007.**
2. **Charles R. Russell, Elements of Energy Conversion, Permagon Press, 1967..**

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. **Explore the significance of co-generation**
2. **Estimate the economics of co-generation systems**
3. **Explore the thermodynamics in waste recovery**
4. **Compare the various systems used for waste heat recovery**
5. **Estimate the economics of waste heat recovery systems**

22MEOESCN	MAINTANANCE AND SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **Applying the principles of maintenance engineering.**
- **Analyzing the equipment replacement, inspection and overhaul decisions.**
- **Evaluating machines condition and spare parts inventory.**
- **Explaining the fundamental concept and principles of industrial safety.**
- **Analyzing human and product safety and adapt the safety audit.**

Unit–I Definition and objectives of maintenance – Scope of responsibilities – Maintenance principles – Types of maintenance – Maintenance planning and control – Maintenance policies – Maintenance planning – Maintenance organisation – Maintenance strategy.

Unit-II Preventive maintenance – Replacement decisions – Simple problems – Inspection decisions – Overhaul decisions – Opportunistic decisions – Shutdown programme – Systems approach to maintenance management – Impact of terotechnology on maintenance management – Planning and scheduling – Maintenance planning procedure – Planning follow up – Maintenance management and control using computer – Applications – Office automation – Accounting and financial management – Inventory control – Personal record keeping – Job planning – Training – Maintenance performance indices – Maintenance management audit.

Unit-III Condition based maintenance – Levels of monitoring – Condition monitoring methods – On load and off load monitoring techniques – Some other methods of monitoring equipment condition – Applications - Management of spare parts – Inventory control – Classification of inventories –Advantages.

Unit-IV Safety Engineering - Accident Prevention - Various steps to accomplish accident prevention - Safety measures and safety precaution in workshops – Personal protective equipments – Safety education and training – Accident reporting, investigation and statistics.

Unit-V Safety and human factors in maintainability – Safety and maintainability design –Electrical, mechanical and other hazards – Tools for safety analysis – Safety and human behaviour – Product safety –Safety audit.

TEXT BOOKS

1. **Gupta. A. K., Reliability, maintenance and safety engineering, University Science Press, Chennai, 2015.**
2. **Srivastava. S.K., Maintenance engineering and management, S. Chand & company Ltd., New Delhi, 1998.**
3. **Venkataraman, Maintenance engineering and management, Prentic-Hall of India Pvt., Ltd., New Delhi, 2007.**
4. **L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.**
5. **Charles D Reese, Occupational Health & Safety Management, CRC Press 2018.**

REFERENCES

1. **R. C. Mishra Maintenance Engineering & Management, PHI 2nd Edition 2012**
2. **B.S Dhillon, Engineering Maintenance a modern approach, C.R.C Publishers 2nd edition 2002**
3. **Alakesh Manna, A Text Book of Reliability and Maintenance Engineering, IK International Publishing House 2011**
4. **NVS Raju, Plant Maintenance and Reliability Engineering, 1st edition Cengage Learning, 2011.**
5. **Rolland P. Blake - Industrial Safety, Prentice Hall of India Pvt. Ltd.**

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. **Explain the fundamental principles of maintenance engineering.**
2. **Evaluate the period of equipment replacement, inspection and overhaul.**
3. **Estimate the machine condition and spare parts inventory.**
4. **Explain the fundamental concept and principles of industrial safety.**
5. **Estimate the industrial hazards and plan the safety in industries.**

22MEOESCN	ENGINE POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To create awareness on air pollution due to I.C. engines and its effects on human health.**
- **To study the different emission formation mechanism of engines.**
- **To study the methods of reducing or eliminating the harmful gases from engine.**
- **To study the different norms and legislations to put a check over the air pollution.**

Unit–I Atmospheric pollution from internal combustion engines– Global warming – Green house effect- Sources of automotive pollution – effects of pollutions on health and environment – fuels – types of hydrocarbons-properties of fuels and testing, fuel additives.

Unit–II Pollution formation mechanism- SI and CI engine– oxides of nitrogen, Zeldovich mechanism, carbon monoxide, hydrocarbon formation and different types of smoke, smog, particulate emission, soot formation.

Unit–III Evaporative emission control – PCV – crank case emission – Air fuel mixture – hot, cold and internal EGR - air injection – thermal reactor –water injection- in cylinder control of pollution – catalytic converters – selective catalyst reduction(SCR) – DeNOx catalyst- application of micro processor in emission control.

Unit–IV Emission measurements-Non dispersive infrared gas analyser, gas chromatography, Chemiluminescent analyser and flame ionisation detector – smoke measurement – Particulate measurement – high volume sampler – micro dilution tunnel –noise measurement and control.

Unit–V Fuel modification-GDI, HCCI and CRDI-driving cycles for emission measurement – chassis dynamometer – constant volume sampling (CVS) system – National and international emission norms, driving cycles.

TEXT BOOKS

1. **John B. Heywood, Internal combustion engines, McGraw Hill 2017.**
2. **Crouse William, Automotive emission control, Gregg Division, McGraw Hill, 1971.**

REFERENCES

1. **George, Springer and Donald J. Patterson, Engine emissions, pollutant formation and Measurement, Plenum press, 2012.**
2. **Obert, E.F., Internal Combustion engines and air pollution, Intext Educational Publishers, 1980.**
3. **Pundir, B.P., Engine Emissions, Narosa Publishing House, 2007.**

COURSE OUTCOMES

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

1. **Explore the sources and effects of automobile pollution**
2. **Analyze the various engine pollutions.**
3. **Compare the various mechanisms of emission control in engines.**
4. **Analyze the various emission measuring equipments in engines.**
5. **Explore the emission standards and fuel modification in engines.**

22MEOE SCN	CONSTITUTION OF INDIA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- **Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.**
- **To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.**
- **To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.**

Unit–I History of Making of the Indian Constitution History-Drafting Committee, (Composition & Working)
Philosophy of the Indian Constitution Preamble Salient Features

Unit–II Contours of Constitutional Rights & Duties Fundamental Rights-Right to Equality-Right to Freedom-Right against Exploitation-Right to Freedom of Religion-Cultural and Educational Rights-Right to Constitutional Remedies-Directive Principles of State Policy-Fundamental Duties.

Unit–III Organs of Governance Parliament-Composition-Qualifications and Disqualifications-Powers and Functions-Executive-President-Governor-Council of Ministers-Judiciary, Appointment and Transfer of Judges, Qualifications-Powers and Functions

Unit–IV Local Administration District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Unit–V Election Commission Election Commission: Role and Functioning-Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning.Institute and Bodies for the welfare of SC/ST/OBC and women.

References

1. **The Constitution of India, 1950 (Bare Act), Government Publication.**
2. **Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.**
3. **M. P. Jain, Indian Constitution Law, 8th Edn., Lexis Nexis, 2017.**
4. **D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2019**

COURSE OUTCOMES

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

1. **Learn the history of making Indian constitution**
2. **Learn the constitutional rights and duties of citizen**
3. **Understand the various organs of Indian Constitution**
4. **Understand the significance of local administration**
5. **Learn the role and functions of election commission.**

22MEOE SCN	ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- **To develop and strengthen entrepreneurial quality and motivation in students.**
- **To impart basic entrepreneurial skills and understandings to run a business efficiently and effectively.**

Unit I ENTREPRENEURAL COMPETENCE Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.

Unit II ENTREPRENEURAL ENVIRONMENT Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services - Central and State Government Industrial Policies and Regulations - International Business.

Unit III BUSINESS PLAN PREPARATION Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

Unit IV LAUNCHING OF SMALL BUSINESS Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

Unit V MANAGEMENT OF SMALL BUSINESS Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Modules- Effective Management of small Business.

Textbooks

1. **Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2018.**
2. **S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001.**

References

1. **Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra, 2nd Edition ,2005**
2. **Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 2019.**
3. **Arya Kumar. Entrepreneurship. Pearson. 2012**
4. **Donald F Kuratko, T.V Rao. Entrepreneurship: A South Asian perspective. Cengage Learning. 2012**

COURSE OUTCOMES:

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

1 **Identify the real time entrepreneur and to impart the knowledge of entrepreneur.**
2 **Impart the knowledge of training activities and the policies of the government.**
3 **Identify the product both economical and viable ways to stabilize in the market.**
4 **Explore the financial activities and finding the partner for the development of product.**
5 **Maintain relation between successes of the product against financial activities of the company.**

22MEOEXXX	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- **To train and equip individuals with the basic technologies behind Digital Transformation.**
- **To Analyze and utilize the building blocks of Industry 4.0.**
- **To Utilize and create the key technologies involved in Industry 4.0, change management, and implementation strategies.**

UNIT - I:

Introduction to Industry 4.0, Digital Transformation & Smart Manufacturing, and Building Blocks of Industry 4.0

Theory component:

Overview of Industry 4.0 and Evolution in Various Industries - Opportunities for Digital Transformation - Traditional Vs Smart Manufacturing - Key Concepts and Drivers for Digital transformation - Industrial Revolutions (1.0 to 4.0) - Additive Manufacturing - Augmented Reality/Virtual Reality - Autonomous Robots - Big Data and Analytics - The Cloud - Horizontal and Vertical System Integration - The Industrial Internet of Things (IIoT) - Digital Twin - Cybersecurity

Practical component:

Identify various wastes enterprise level in manufacturing organizations and make the list of it and analyze the source of it and list its root causes.

UNIT-II:

Opportunities in Industry 4.0, Transformation & Change Management and Key Uses of Smart Manufacturing

Theory component:

Risk of Data security - IT Infrastructure - Legacy machines - Operational Excellence - Competitive Edge - Increased Work Safety - Flexible Production - Customer Satisfaction - Transforming Customer Experience, Operational Processes, and Business models - Change Management and its Theories - Vision and Strategies - Role of Leadership in Digital Transformation - Adoption Issues and Implementation Challenges - AR for Maintenance and Training - Predictive Maintenance - Virtual Training - Cobots in Manufacturing - Real-Time Dashboards and Alerts

Practical component:

Propose a solution to eliminate each waste with industry 4.0 technologies learned and do process mapping.

UNIT-III:

Implementing Industry 4.0 for Smart Manufacturing, Introduction to Smart Factories, Its Use Cases and Examples

Theory component:

Typical Industrial Set-up - Implementing Industry 4.0 - Industry Wise Pain Points and Challenges - Key Performance Indicators in Industries - Connected Manufacturing Solutions: Use Cases and Examples - Connected Supply Chain: Use Cases and Examples - Manufacturing Analytics: Concepts, Examples and Use Cases

Practical component:

1. Creation of Key Performance Indicator (KPI) Dashboard for an Automotive

Manufacturing company.

2. **Understand the key KPIs and their calculations.**
3. **Perform Vertical Integration.**
4. **Perform conditional monitoring of process and quality parameters.**
5. **Create a working KPI dashboard based on production data.**
6. **Create a manufacturing dashboard using Industrial IoT tools.**

UNIT - IV

Impact of Industry 4.0 on Environment & Sustainability and Overview of Digital Twins

Theory component:

Environmental Management in Industry 4.0 - Technologies for Environmental Management - Challenges in Implementing Industry 4.0 for Environment and Sustainability - Introduction to Digital Twins and Their Functions - Role of Digital Twins in Smart Manufacturing - Digital Twins Built on IoT Platform - Implementation of Digital Twins - Applications of Digital Twins in Automotive Industry - Future Trends

Practical component:

Hands-on project demo using IOT platform that mimics the real world scenario.

UNIT-V:

Smart Machines and Digital Industry Transformation

Theory component: Introduction to Smart Machines - Evolution of Smart Machines - Building Blocks of Smart Machines - Sensors and Signal Processing - Controllers in Smart Machines - Smart Machines and Future Technology - Product Life Cycle Management - Material Requirement Planning - Manufacturing Process Management - Manufacturing Execution System - Enterprise Resource Planning

Practical component:

1. **ROI case study**
2. **Prepare an ROI report based on the Cost of Technology**

COURSE OUTCOMES:

On completion of the course, a group of students (4 Nos) will be able to

1. **Identify the location of their institute and calculate the energy consumption and utilization of the identified place.**
2. **Design a dashboard for real-time monitoring of electricity consumption and utilization of the identified place using node MCU.**
3. **Connect appropriate sensors with all resources to be monitored and communicate the real-time data to the central server.**
4. **Calculate the wastage due to poor utilization of the resources and prepare the wastage report for the identified place.**
5. **Prepare a plan and schedule for preventing wastages based on the real-time data monitored.**
6. **Prepare an ROI report for the energy saved.**

22MEOEXXX	ROBOTICS SIMULATION FOR MANUFACTURING	L	T	P	C
		3	0	0	3

COURSEDESCRIPTION:

Robotics is being used in many aspects of manufacturing to help increase productivity and efficiency while lowering production costs. Large number of Robots are deployed in manufacturing industry to collaborate with workers to perform repetitive, monotonous, or intricate tasks under the worker's guidance and control. In this course, students will get exposed to RoboAnalyzer® a 3D model-based software that can be used to teach and learn Robotics concepts. Virtual Robot Module, a part of RoboAnalyzer, has been developed as an application which has joint and Cartesian motion. It has also been made as a COM server, using which one can integrate VRM with MATLAB, MS Excel and other applications that have a COM interface. It also has been integrated with Robotics Tool box for MATLAB.

COURSEOBJECTIVE:

Students to get a acquaintance with current industry demands, intensive competency needs and scope of the automated Machining in the current industry scenario. Analysis of work hold in procedures through simulation software. Programming and setting parameters for desired solutions. Current industry demands, competency needs, job roles and scope of the automated Machining in the current industry and Execute programming solution using lab exercises integrated in to the platform as part of the tutorials.

Unit	Assessment elements/Coverage	Aligned to Course Outcome
ntroduction to Robotics	- Quiz on Introduction to Robotics - Quiz on Anatomy of Robot - Quiz on Robot Configuration - Quiz on DOF, Cartesian movement & Drive Systems and End Effectors - Quiz on Sensors in Robotics - Quiz on Industrial Applications of Robots - Quiz on Robotic Safety	

Spatial Representation of Object	**- Quiz on Relative Position and Orientation of an Object with respect to a reference** **- Quiz on Homogeneous representation of Position and orientation of an Object** **- Assignment- Relationship between visual and homogeneous representation of an object using HTM module in Robo analyzer** **- Assignment on Translation** **- Transformation, rotation transformations and DH Parameter.** **- LAB-Virtual models of Industrial robots**	**LO1. Model a2 DOF Planar robotic arm and trace given curved profile through specific intermediate points using cubic polynomial profile.**
Robot Kinematics using Robo Analyzer	**- Quiz on Introduction to robot kinematics** **- Quiz on Forward Kinematics** **- Quiz on Inverse Kinematics** **- Quiz on Motion planning of Robots** **- Quiz on Joint and Cartesian motion** **- LAB-Assignment on forward and inverse kinematics** **- LAB-Understanding coordinate frames and transformations** **- LAB-Inverse and forward Dynamics of robots** **- LAB-Creating robot joint trajectories** **- LAB-Assignment on Motion planning in Cartesian space** **- LAB-Case Study: Works pace analysis of a 6axis Robot**	**LO2. Do mathematical Modeling of the same (as inLO1) robotic arm with different arm length and trace the given profile in theLO1 using Robo Analyzer.**

Course Outcomes:

On completion of the course, the students will be able to-
LO1. Modela2DOF planar robotic arm and trace given curved profile through specific intermediant points using cubic polynomial profile.
LO2. Do mathematical modeling of the same (as in LO1) robotic arm with different arm length and trace the given profile in theLO1usingRoboAnalyzer.

Prerequisites:

- **Engineering Mathematics,**
- **Kinematics and Mechanics**

Student Assessment Plan:

The whole Assessment framework is built around our proprietary 'Measure& Reward' framework. Each part of the Assessment is Objective oriented and measurable. Additionally, itenablesstagedscoringonfinalsimulationattributes,suchthatstudentisrewardedfor

Stage wise progression as well overall attainment.

Internals +Theory assessment– 40 Marks

- **Unit Testes –LMS Based(Online, MCQ)**
- **Every Sub-units/Unit will have a Quiz / overall Graded Quiz other than Lab exercise and Capstone Projects**
- **All Assessments are online based and self-graded**
- **Average of Unit wise Assessments**

FinalPracticalAssessment–60 Marks

- **Experiment parameters and Questions are provided for Students**
- **Students have to Study the experiment and simulate it in the software and submit the Environment/Simulation Robot programming file through LMS**
- **Based on the simulation and the Result of the simulation assessment will be Qualified**

Student Assessment Plan for term 1:

Students will be given various profiles similar to the profile given below and ask to program in RoboAnalyzer for tracing the given profile. Students will be asked to restrict the arm lengthto0.7mand0.4m.Studentswillbeconsideredasqualifiedforterm1forexactly tracing the given profile

Student Assessment Plan for term 2:

Students will be given a different arm length of both the arms with variation upto20% from their term1 assessment and ask to do a mathematical modeling for the new arm length and do the simulation for tracing the profile given in theterm1.

NOS alignment

Aligned with NSDC–SSCNOS Standards.

Sr.#	QP No.	NSQF	Qualification Title	NO S No.	Detai ls
1	ASC/Q83 04	Level6	Automotive Robotics And Automation Simulation Engineer	ASC/N83 15	Simulation and integration of robot and automation system

22MEOEXXX	ELECTRIC SYSTEMS FOR E-MOBILITY (MECHANICAL)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

Students to get exposed to Electric vehicle & mobility dynamics & Battery Management Systems. Understand and build strong foundation on advanced concepts of switched-mode converter circuits. Learn about motors and its control units & Implement the motor and accompanying rotary sensor into a motor control circuit in both hardware and software. Demonstrate equivalent circuit cell model simulation.

UNIT I INTRODUCTION TO ELECTRIC VEHICLES & AUTOMATION

THEORY COMPONENT:

Future of Mobility – Electrification : The Basic Technologies (Part 1) Electric Vehicles, batteries, EVs Made - up of- Electrification : The Basic Technologies (Part 2) –Charging & Charging Infrastructure - EV & the power systems, Industry Perspective on Applications of Electrification - Electrification Impacts –Vehicle Automation – The Basic Technologies - Automation – The Impacts.

UNIT II CONVERTER CIRCUITS

THEORY COMPONENT:

Single-, Two, and Four-Quadrant Switches - Basic issues of Power Semiconductors- Introduction to DCM and Mode Boundary - Converter Topologies.

PRACTICAL/ASSIGNMENT COMPONENT:

1. **Understand why a diode works in some cases, while a transistor is needed in others**
2. **Understand when single-quadrant, two-quadrant, or four-quadrant switch realizations are needed**
3. **Complete Assignment to Understand the tradeoff between voltage breakdown, switching time, and forward voltage drop in a power semiconductor device**
4. **Complete Assignment to Model switching loss using equivalent circuits**
5. **Complete Assignment to Design gate drivers**
6. **Work on LT spice File: Synchronous Boost Converter, with associated driver, dead time generator, and PWM models**
7. **Work on assignment origin of discontinuous conduction modes**
8. **Will be able to Analyze a converter to find the CCM-DCM mode boundary**
9. **Will be able to Analyze a converter circuit to find its conversion ratio in DCM**
10. **Switching Loss Modeling and DCM Analysis**
11. **Conversion ration analysis of the Cuk Converter in DCM**
12. **Get exposed to solved study problems on DCM analysis**

13. **Understand the origins of basic converter topologies**
14. **Student will be able to Analyze converter circuits containing transformers**
15. **Apply transformer analysis techniques to the forward converter**
16. **Apply transformer analysis techniques to the flyback converter**

UNIT III MOTOR AND MOTOR CONTROL
THEORY COMPONENT:

AC motor Designs - AC motor Control - DC motors – DC motor control and stepper motors.

UNIT IV INTRODUCTION TO BATTERY MANAGEMENT SYSTEM
THEORY COMPONENT:

Battery Boot Camp - How lithium-ion cells works - BMS sensing and high-voltage control - BMS design requirements 2-5 - How are cells made? How can they fail?

UNIT V : EQUIVALENT CIRCUIT CELL MODEL SIMULATION
THEORY COMPONENT:

Defining an equivalent-circuit model of a Li-ion cell - Identifying parameters of static model - Identifying parameters of dynamic model- Simulating battery packs in different configurations - Co-simulating battery and electric-vehicle load

COURSE OUTCOMES:
Students will be able to,

1. **Get exposed to the concepts & need of Electric vehicles , Mobility & Automation**
2. **How to implement the power semiconductor devices in a switching converter**
3. **Understand the origins of the discontinuous conduction mode and be able to solve**
4. **converters operating in DCM**
5. **Demonstrate the basic dc-dc converter and dc-ac inverter circuits**

22MEOEXXX	MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- **The objective of this course is to provide a view of data science, machine learning, basic implementation using Python and how machine learning is applied in various domains in the industry.**

UNIT I - INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Why AI? - What is AI? - AI in Practice - AI in Business - AI Platforms.

UNIT II - INTRODUCTION TO DATA SCIENCE

Data Science: The Data Revolution - Components of Data Science - Data Science in Action – Conclusion.

UNIT III - PYTHON FOR DATA SCIENCE

Why Python Libraries – NumPy - Introduction to NumPy - Operations on NumPy – Pandas – Introduction to Pandas – Introduction to Pandas Object – Working with datasets – Pandas Plots - Matplotlib – Introduction to Matplotlib – Types of Plots – Scikit-learn – Machine Learning using sklearn. [Practical hands-on exercises using NumPy, Pandas, Matplotlib]

UNIT IV - DATA VISUALIZATION USING PYTHON

Data visualization using Python: Data Visualization: Developing insights from data using Basic Plots using Matplotlib (Box, Scatter, Line, Bar, Pie, Histogram), Statistical analysis using Heatmap, Kernel Density plot using Seaborn, Network Graphs, Choropleth Map Using Ploty, Word Cloud. [Practical hands-on exercises for creating charts]

UNIT V - EXPLORE MACHINE LEARNING USING PYTHON

Introduction to Machine Learning - Regression – Classification – Clustering – Introduction to Artificial Neural Network. [Hands-on Exercises for Practicing Machine Learning Models Using Capstone Project]

COURSE OUTCOMES:

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

1. **Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.**
2. **Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.**
3. **Assess and select appropriate data analysis models for solving real-world problem.**
4. **Demonstrate the importance of data visualization, design, and use of visual components.**

REFERENCES

1. **https://infyspringboard.onwingspan.com/web/en/app/toc/lex_884033713 0015322000_shared/overview (Introduction to AI)**
2. **https://infyspringboard.onwingspan.com/web/en/app/toc/lex_126663064 02263577000_shared/overview (Introduction to Data Science)**
3. **https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01333 063698060902494_shared/overview (Python for Data Science)**
4. **https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01260 51913436938241455_shared/overview (Data visualization using Python)**
5. **https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01260 0400790749184237_shared/overview (Explore Machine Learning Using Python)**

22MEOEXXX	AN INTRODUCTION TO GENDER AND GENDER EQUALITY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

- **To familiarize students with the concepts of sex and gender through literary and media texts.**
- **To help students ask critical questions regarding gender roles in society.**
- **To provide students with the material to discuss gender issues such as gender based discrimination, violence and development.**
- **To help students think critically about gender based problems and solutions.**

UNIT-I

Conceptualizing Gender: Sex and Gender, Types of Gender. Concepts in relation with Gender- Gender needs, Gender Roles, Gender Stereotyping, Gender Discrimination, Gender Identity.

UNIT-II

Gender in India: Gender Status and gender disparity in Education, Labour force participation and economy, Political participation, Health. Gender and Media- Role of Media in constructing ideologies, Gender sensitivity, Gender equality, Gender and development

UNIT-III

Gender Issues and Gender based Violence: Human Rights violations, Major gender-based violence: Sexual abuse, Domestic Violence, Female infanticide, dowry death, workplace harassment.

UNIT-IV

International and National response to gender discrimination: International Convention on Elimination of all forms of Discrimination against Women (CEDAW), National Human Rights Commission, National and State Women's Commission

UNIT-V

State Initiatives to promote Gender Equality. Law Enforcing Agencies: All Women's Police Stations, Vigilance Cell, Legal Aid– Cells, Women's cell, Family Courts, Childline, Jagrata Samithi, Equal opportunity cell, Service Providers and Helplines for Women and Children.

REFERENCES:

1. **Mukherjee, Mukul (1992), Human Rights and gender issues, New Delhi: Institute of Social Sciences.**
2. **Bhasin Kamala (2000): Understanding gender, kali for women, N. Delhi.**
3. **Gupta K R (2009), Gender: Problems and policies, New Delhi: Atlantic Publishers.**
4. **Manoranjan pal (2009), Gender and Discrimination: Health, Nutritional status and role of women in India, London : Oxford University Press**

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. **Define and Evaluate gender as a social construct.**
2. **Analyze current social events in the light of gender perspectives.**
3. **Discuss, analyze and argue about issues related to gender and their impact on society, culture and development.**
4. **Articulate connections between global, regional, and local issues human rights, with an awareness of the importance of context.**
5. **Explain key concepts related to curb gender inequality**

22MEOEXXX	YOGA AND HEALTH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- **Develop healthy mind in a healthy body thus improving social health also improve efficiency**
- **Invent Do's and Don't's in life through Yam**
- **Categorize Do's and Don't's in life through Niyam**
- **Develop a healthy mind and body through Yog Asans**
- **Invent breathing techniques through Pranayam**

UNIT-I:

Yoga – Meaning and Relevance. Tradition and origin of yoga. The body, mind and role interlink with yoga. Concepts of yoga. Types of yoga – Hatha Yoga, Bhakti Yoga, Raja yoga, Karma yoga, Jnana yoga, Kundalini yoga, Mantra Yoga, Tantra Yoga and integral Yoga (Sri Aurobindo) .

UNIT-II

Components of fitness – Flexibility, Strength, speed, ability, co-ordinative abilities and Endurance. Fitness development – cycling, Aerobic activities, Jogging, calisthenics, Rhythmic exercise and circuit Training. Components of wellness – Factors (Psychological, Physiological and Anatomical), Progression, warming up and Limbering down, Special Physical Fitness Exercise and Principles of Physical fitness development.

UNIT-III

Bandhas and yogic purification: Bandhas: Jallandhar bandha, uddiyana Bandha, moola bandha and Mahabandha. Yogi purification: Bamana Dhouti, Barisara Dhouti, sahaj Agnisara Dhouti, Nouli, Neti kriya, Nasa-polar shahaj Bastrikria, Water bath, Tub-bath, Hip-bath, sun bath, spinal bath, Air bath, Hot foot bath, The sitz bath, Tratak and message.

UNIT-IV

Yogic Diet Food and meditation Food types : Sattvic (Cheese, Butter, curd, Ghee, sweet fruits, Honey, apples, bananas, Grapes, Papaya, Pomegranates, Mangoes, pears, Pineapple, Guavas, Figs etc. Rajasic (Eggs, Meat, Salt, Chillies, Chutney, Asafoetida, Pickles, Tea, Coffee etc.) and Tamasic (Beaf, Pork, wine, onion, Garlic, Rotten, state things). Balanced diet, carbohydrate, proteins, Fats and vitamins (Fat and water soluble).

UNIT- V

Yoga therapy Curative power for life – threatening diseases and disorders (Arthritis, Arteriosclerosis, Chronic fatigue, diabetes, Asthma and obesity). Yoga control the respiratory problem, high blood pressure, Body pain and weight reduction. Yogic practices reduce anxiety, create self awareness and provide personal social values.

REFERENCES:

1. **George Feuerstein : The Yoga Tradition (Its history, literature, Philosophy and practice) Sri Ananda : the complete Book of Yoga Harmony of Body and Mind (Orient Paper Backs : Vision Book Pvt. Ltd., 1982)**
2. **Swamy Satyananda Saraswathi : Asana, Pranayama, Mudra, Bandha (India : Yoga Publications Trust, Munger, Bihar)**
3. **Swami Sivandana Practice of Yoga (The Divine Life Society, Shivananda Nagar P.O. U.P. Himalayas, India)**
4. **Swami Sivananda Practice of Karma Yoga (The Divine Life Society, Shivananda Nagar P.O. U.P. Himalayas, India)**
5. **B.K.S. Iyenkar : Light on the Yoga Sutras of Patanjali (Haper Collinks Publications India Pvt. Ltd., New Delhi)**

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. **Demonstrate the ability to create and present various yoga sequences.**
2. **Demonstrate an understanding of health problems associated with inadequate fitness levels**
3. **Demonstrate the ability to perform yoga movements in various combination and forms.**
4. **Demonstrate and understanding of sound nutritional practices as related to health and physical performance.**
5. **Identify and apply injury prevention principles related to yoga activities**

22MEOEXXX	NATIONAL SERVICE SCHEME	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- **Understand the community in which they work and their relation**
- **Identify the needs and problems of the community and involve them in problem-solving**
- **Develop capacity to meet emergencies and natural disasters**
- **Practice national integration and social harmony and**
- **Utilize their knowledge in finding practical solutions to individual and community problems**

UNIT-I: National Service Scheme

History and its Objectives - Organizational structure of N.S.S. at National, State, University and College Levels - Advisory committee and their - functions with special reference to college principal - Programme officer, N.S.S. group leader and N.S.S. volunteers in the implementation.

UNIT-II: National Integration

Need of National integration - Various obstacles in the way of National Integration; such as caste, religion, language and provisional problems etc.

UNIT-III: Special Programme

Legal awareness - Health awareness - First-aid - Career guidance - Leadership training - cum - Cultural Programme - Globalization and its Economic Social Political and Cultural impacts.

UNIT IV: Special Camping Programme

Nature and its objectives - Selection of camp site and physical arrangement - Organization of N.S.S. camp through various committees and discipline in the camp. d) Activities to be undertaken during the N.S.S. camp - Use of the mass media in the N.S.S. activities.

UNIT V: N.S.S. Regular Activities

Traffic regulation - Working with Police Commissioner's Office - Working with Corporation of Chennai - Working with Health Department - Blind assistance - Garments collection - Non-formal education - 'Environmental Education, Awareness and Training (EEAT)' - Blood donation.

REFERENCES:

1. **National Service Scheme Manual, Government of India, 2006.**

2. **Training Programme on National Programme scheme, TISS.**
3. **Orientation Courses for N.S.S. Programme officers, TISS.**
4. **Case material as Training Aid for field workers, Gurmeet Hans.**
5. **Social service opportunities in Hospitals, KapilK.Krishan,TISS.**

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. **Develop social and civic responsibility**
2. **Acquire competence for group living and sharing responsibilities**
3. **Acquire leadership qualities and democratic attitude;**
4. **Develop capacity to meet emergencies and natural disasters; and**
5. **Practice national integration**

22MEOEXXX	NATIONAL CADET CORPS	L	T	P	C
		3	0	0	3

Course Objective

This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, learning military subjects including weapon training.

Unit – I (Lecture)

NCC Organisation and National Integration

NCC Organisation – History of NCC- NCC Organization - NCC Training- Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honours and Awards – Incentives for NCC cadets by central and state govt. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Factors affecting national integration.

Unit – II (Lecture)

Personality Development and Leadership

Introduction - Factors influencing / shaping Personality - Self-Awareness – Know yourself/ Insight - Communication Skills - Leadership Traits – Types – Attitude - Time Management - Effects of Leadership - Stress Management Skills - Interview Skills - Conflict Motives - Resolution - Importance of Group / Team Work - Influencing Skills - Body Language - Sociability: Social Skills

Unit – III (Lecture)

Social Awareness and Community Development

Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY-JGSY-NSAP-PMGSY-Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility

Unit – IV (Lecture)

Specialized Subject (Army Wing)

Basic structure of Armed Forces- Military History – War heroes- battles of Indo-Pak war- Param Vir Chakra- Career in the Defence forces- Service tests and interviews-Fieldcraft and Battlecraft-Basics of Map reading.

Unit – V (Practical)

Basic Physical Training and Weapon Training

Basic physical Training – various exercises for fitness (with Demonstration) - Food – Hygiene and Cleanliness. Drill- Words of commands- position and commands- sizing and forming- saluting- marching (WITH DEMONSTRATION)

Main Parts of a Rifle- Characteristics of .22 rifle- Characteristics of 7.62mm SLR- Characteristics of 5.56mm INSAS rifle - stripping and assembling – position and holding- safety precautions – range procedure- firing simulation.

TEXT BOOK:

1. "National Cadet Corps- A Concise handbook of NCC Cadets", Ramesh Publishing House, New Delhi, 2014.

REFERENCES:

1. "Cadets Handbook – Common Subjects SD/SW", published by DG NCC, New Delhi.

2. "Cadets Handbook- Specialized Subjects SD/SW", published by DG NCC, New Delhi.

3. "NCC OTA Precise", published by DG NCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to

1. **Display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion**
2. **Acquaint and provide knowledge on personality development, self awareness, communication skills with leadership traits to work as a team and sociability values**
3. **Understanding about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils**
4. **Acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles.**
5. **Demonstrate health exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders and basic knowledge of weapons and their use and handling.**

HONOURS ELECTIVE COURSES

22MEHE SCN	COMPUTATIONAL HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To impart fundamental mathematical concepts related to computational heat transfer.**
- **To impart fundamental mathematical concepts about fluid flow and heat transfer.**
- **To train students in the usage of computational codes and develop new ones.**

Unit-I Mathematical Description of Physical Phenomena Governing Differential Equation - Energy Equation - Momentum Equation - Nature of Co-ordinates - Discretization Methods Finite Difference Methods in Partial Differential Equations Parabolic Equations - Explicit, Implicit and Crank Nicholson Methods. Finite Differences in Cartesian and Polar Co-ordinates. Local Truncation Error - Consistency Convergence - Stability - ADI Methods. Elliptic Equations - Laplace's Equation. Laplace's Equation in a Square - Non-rectangular Regions - Mixed Boundary Condition - Jacobi - Gauss- Siedel and SOR Methods. Necessary and Sufficient Conditions for Iterative Methods Finite Difference

Unit-II Applications in Heat Conduction and Convection Control Volume Approach - Steady and Unsteady One Dimensional Conduction - Two and Three Dimensional Situations - Solution Methodology.

Unit-III Convection and Diffusion Upwind Scheme - Exponential Scheme. Hybrid Scheme - Power Law Scheme : Calculation of the Flow Field - Simpler Algorithm.

Unit-IV Finite Element Method Concept General Applicability of the Method using one dimensional heat transfer equation - Approximate Analytical Solution - Raleigh's Method. Galerikin Method, Solution Methods. Finite Element Method Packages - General Procedure - Discretisation of the domain - Interpolation Polynomials -

Unit-V Formulation of Element Characteristic Matrices and Vectors - Direct, Variational and Weighted - Residual Approach - Higher Order Isoparametric Element Formulations Conduction and Diffusion Equations - Heat Transfer Packages - Heat 2, HEATAX, RADIAT, ANSYS.

TEXT BOOKS

1. **Subash V.Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 1980**
2. **Jaluria and Torrance, Computational Heat Transfer - Faluria and Torrance, Hemisphere Publishing Corporation, 1986.**

REFERENCES

1. **Mitchell A.R and Grifths D.F., Finite Difference Method in Partial Differential Equations, John Wiley & Sons, 1980.**
2. **Rao S.S., The Finite Element Methode in Engineering, Pergamon Press – 2005.**
3. **Zienkiewicz O.C. and Taylor R.L., The Finite Element Method IV Edition - Vol. I & II, McGraw Hill International Edition, 2013**

22MEHE SCN	STEAM ENGINEERING	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- **To impart the basics of steam engineering**
- **To impart knowledge on various boiler codes**
- **To study the methods to analyze the boiler performance**

Unit-I Introduction-Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart Boilers ,Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blowdown; IBR, Boiler standards

Unit-II Piping & Insulation-Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.

Unit-III Steam Systems Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems.

Unit-IV Boiler Performance Assessment-Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

Unit-V Energy Conservation and Waste Minimization- Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization - Instrumentation & Control Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments, its selection

TEXT BOOKS:

1. **T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication 2002**
2. **Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons 2016.**

REFERENCES:

1. **Yunus A. Cengel and Boles, "Engineering Thermodynamics ",Tata McGraw-Hill Publishing Co. Ltd 2019**
2. **P. Chatopadhyay; Boiler Operation Engineering: Questions and Answers; Tata McGrawHill Education Pvt Ltd, N Delhi**

22MEHESCN	ADVANCED ENGINES AND EMISSION SYSTEMS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- **To explore recent trends, combustion modes and add on devices of automotive engines persisting in transportation system**
- **To reveal formation of pollution strategies of emission and control in in-cylinder combustion and after burn conditions.**
- **To understand measurement of exhaust emission using chassis dynamometer and trends in vehicle emission standards.**

Unit-I Advanced Engines Advanced combustion modes – Gasoline Direct Injection (GDI) engine – stratified and homogeneous charge mode - ignition technology – plasma ignition – Common Rail Diesel Injection (CRDI) system – high pressure injection - Homogeneous Charge Compression Ignition (HCCI) engine - hybrid electric vehicles –

fuel cells – add on devices - variable valve timing (VVT) – VTEC - downsizing and turbo charging

Unit-II SI and CI Engine Combustion Features of SI engine combustion processes - combustion process characterization – pre ignition and knocking- Thermodynamic analysis of burned and unburned mixture states - Combustion variations - factors affecting combustion - effect on performance and emissions -
Features of CI engine combustion process - combustion process characterization - Ignition delay and factors affecting delay - air motion - Mixing controlled combustion and heat release rates - effect of engine design variables - Thermodynamic analysis of CI engine combustion
Unit-III Pollutant Formation Pollutant formation in SI Engine - Unburned HC formation - HC oxidation in the cylinder and exhaust - exodus of HC contribution of different sources - Flame quenching in SI engines kinetics of NO and NO_2 formation – CO and CO_2 – Pollutant formation in CI Engines Formation of HC in CI engines – effect of nozzle design and other variable - NO and NO_2 formation in premixed and diffusion combustion periods. Formation of CO and kinetic effects - effect of engine variables - Composition of particulates - soot formation - soot structure - stoichiometric considerations, nucleation, growth and oxidation

Unit-IV Emission Control Systems Strategies for emission control - emissions control inside the engine - EGR, crankcase and evaporative emission control - Exhaust gas after treatment - thermal and catalytic reactors - elements of reactors, catalysts and substrates – oxidation and reduction – Three way catalytic reactors - closed loop feedback control - catalyst deactivation mechanism - cold start HC control - Lean de-NOx catalysts - NOx traps and SCR- Diesel particulate filters (DPF) - DPF regeneration

Unit-V Measurement of Emissions Measurement of emissions - instrumentation for CO, HC, NOx, PM and smoke emissions - chassis dynamometer – isokinetic sampling - constant volume sampling (CVS) system – development of driving cycles – driving cycle tests procedures – European, US and Japan driving cycles - trends in vehicle emission standards - emission limits - national and international emission norms

TEXT BOOKS

1. **J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Editions, 2017.**
2. **B. P. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, Narosa Publishing House, New Delhi, 2007.**

REFERENCES

1. **Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Ed. Eran Sher, Academic Press, 1998.**
2. **V Ganesan, Internal Combustion Engines (Fourth Edition)Tata McGraw-Hill Education Pvt. Ltd, 2017**

22MEHESCN	ENERGY AUDITING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **Familiarizing with management, especially with management in energy sector engineering.**
- **Fundamentals of product strategy management. Studying methods of energy accounting and energy auditing in energy sector, industry and final consumption.**
- **Finding opportunities to increase the rational use of energy.**

Unit-I Introduction: Energy Scenario - Principles and Imperatives of Energy Conservation – Energy Consumption Pattern - Resource Availability - Role of Energy Managers in Industries

Unit-II Thermal Energy Auditing: Energy Audit - Purpose, Methodology with respect to Process Industries -Power Plants, Boilers etc. - Characteristic Method Employed in Certain Energy Intensive Industries - Various Energy Conservation Measures in Steam System - Losses in Boiler, Methodology of Upgrading Boiler Performance. Energy Conservation in Pumps, Fans & Compressors, Air conditioning and refrigeration systems, Steam Traps - Types, Function, Necessity

Unit-III Role of Instrumentation in Energy Conservation: Total Energy Systems - Concept of Total Energy -Advantages & Limitations - Total Energy System & Application - Various Possible Schemes Employing Steam Turbines Movers Used in Total Energy Systems - Potential & Economics of Total Energy Systems

Unit-IV Electrical Energy Auditing: Potential Areas for Electrical Energy Conservation in Various Industries - Energy Management Opportunities in Electrical Heating, Lighting System, Cable Selection - Energy Efficient Motors - Factors Involved in Determination of Motor Efficiency- Adjustable AC Drives, Application & its use Variable Speed Drives Belt Drives

Unit-V Energy Management: Importance of Energy Management, Energy Economics - Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing (5)

TEXT BOOKS

1. **CB Smith, Energy Management Principles, Pergamon Press, New York, 2014**

REFERENCES

1. **Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997**
2. **Witte, Larry C, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington, 1988**
3. **Diamant, RME, Total Energy, Pergamon, Oxford, 1970**

22MEHESCN	MECHANICAL VIBRATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **This course introduces to the students the different types of vibrations,**
- **To learn the causes ofvibrations and means of damping it out.**

Unit-I Single Degree Freedom Damped, Free Vibrations systems – effects of viscous damping – Logarithmic decrement – Coulomb damping.

Unit-II Forced Vibration - constant harmonic excitation – effect of rotating and reciprocating unbalance – Vibration isolation and transmissibility – vibration measuring instruments.

Unit-III Two degree of Freedom Systems Principal modes of Vibration -spring mass system. -Double pendulum two rotor system – Vibration of geared systems –combined rectilinear and angular modes-undamped dynamic vibration absorber.

Unit-IV Multi degree freedom systems – influence numbers and Maxwell's reciprocal theorem– Matrix method - stiffness matrix, dynamic matrix– Natural frequencies and

principal modes by matrix iteration.

Unit-V Numerical methods for finding natural frequency – Far coupled systems – Rayleigh's approach–Dunkerley's method – Introduction to Finite element method – Standard Eigen value problem –Non standard Eigen value problems – Finite element formulation.

TEXT BOOKS

1. **Grover G.K. Mechanical Vibrations, Nemchand & Bros., Roorkee, 1993.**
2. **V. Ramamurthi, Mechanical Vibration Practice With Basic Theory- Narosa Publishinghouse, 2000**

REFERENCES

1. **TSE S. Morse Ivan & Hinkle T., Mechanical Vibrations, PHI**
2. **William T. Thomson & Marie Dillon Dahleh, Theory of Vibration with Applications, Fifth Edition, 1998**
3. **Rao S.S. Mechanical Vibrations, sixth Edition, Addison Wesley Publishing Company, NewYork, 2018.**

22MEHESCN	ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To impart knowledge in Robot Kinematics and Programming**
- **To learn Robot safety issues and economics.**

UNIT-I Fundamentals of Robot Robot - Definition - Robot Anatomy - Co ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

UNIT-II Robot Drive Systems and End Effectors Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, 90 Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT-III Sensors and Machine Vision Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications Inspection, Identification, Visual Serving and Navigation.

UNIT-IV Robot Kinematics and Robot Programming Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion

Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT-V Implementation and Robot Economics RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

TEXT BOOKS

1. **Klafter R.D., Chmielewski T.A and Negin M., "Robotic Engineering - An Integrated Approach", Prentice Hall, 2003.**
2. **Groover M.P., "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2001.**

REFERENCES

1. **Craig J.J., "Introduction to Robotics Mechanics and Control", Pearson Education, 2008.**
2. **Deb S.R., "Robotics Technology and Flexible Automation" Tata McGraw Hill Book Co., 2017.**
3. **Koren Y., "Robotics for Engineers", Mc Graw Hill Book Co., 1992.**
4. **Fu.K.S.,Gonzalz R.C. and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book Co., 2017.**
5. **Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill, 1995. 6. Rajput R.K., "Robotics and Industrial Automation", S.Chand and Company, 2008.**
6. **Surender Kumar, "Industrial Robots and Computer Integrated Manufacturing", Oxford and IBH Publishing Co. Pvt. Ltd., 1991.**

MINOR ELECTIVES COURSES

22MEMISCN	BASIC THERMAL ENGINEERING	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

To make the student understand the basic concepts and applications of the following Basics and fundamental laws of Thermodynamics.

- **Properties of steam**
- **Internal combustion engines.**
- **Heat transfer, refrigeration and air conditioning.**
- **Metrology and mechanical measurements.**

Unit–I Thermodynamics Basic concepts of thermodynamics - System properties, state and equilibrium - Process and cycle - Work - Heat and other forms of energy - Zeroth law and application - First law - Statements - Applications to closed and open systems - General energy equation and application - Second law - Statements - Reversibility, Carnot cycle and theorems - Clausius inequality - Concept of entropy - Availability and irreversibility.

Unit–II Properties of Steam Properties of steam - Use of steam tables - Mollier chart - Rankine cycle - Representation on P-V and T-S diagrams - Reheat cycles - calculation of efficiencies. Steam turbines - Impulse and reaction type - Governing of steam turbines - Types - Condensers.

Unit–III Internal Combustion Engines Internal combustion engine - Principle of operation - Two stroke and four stroke cycle engines - Petrol and diesel engines - Conventional and electronic fuel injection systems - Cooling and lubrication methods - Testing of 1C engines - Simple problems - Air standard cycles - Otto, Diesel and dual cycle - Efficiencies - Simple problems.

Unit–IV Refrigeration - Units of refrigeration - Refrigerants and their properties - Types of refrigeration system - Air, vapour compression and vapour absorption systems - simple problems in Air and Vapour compression only – Psychometric and Psychometric processes. Air conditioning - Summer and winter air conditioning.

Unit–V Metrology and Mechanical Measurements Measurement and precision engineering: Linear and angular measurement - Measurement of flatness, stiffness and hardness. Comparators, side bands, slip gauges, angular gauges and auto collimeter. Measurement of pressure Mcleod vaccum gauge and electrical resistance pressure gauges - Dynamic characteristics of pressure measuring systems. Measurement of temperature Bimetallic thermometers - Linear quartz thermometer and pyrometers. Measurement of strain: Electrical resistance strain gauge, constant current strain gauge and strain gauge bridge circuit.)

TEXT BOOKS

1. **Nag P.K, Engineering Thermodynamics, sixth Edition, Tata Mc Graw Hill Publishing Company Limited, New Delhi, 2017.**
2. **Ballaney P.L , Thermal Engineering, Khanna Publishers, Delhi, 1991**

REFERENCES

1. **Mathur M.L and Sharma R.P, Internal Combustion Engines, Dhanpat Rai & Sons, New Delhi, 2010.**
2. **Arora C.P, Refrigeration and Airconditioning, Tata Mc Graw Hill Publishing Company Limited, New Delhi, 2017.**
3. **Thomas G. Beckwith and Lewis Buck.N, Mechanical Measurements, Narosa Publishing Company. New Delhi, 2020.**

22MEMISCN	INSTRUMENTATION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To provide a basic knowledge about measurement systems and their components**
- **To learn about various sensors used for measurement of mechanical quantities**
- **To learn about system stability and control**
- **To integrate the measurement systems with the process for process monitoring and control**

Unit–I Generalised measurement system - Basic standards of measurement - Errors - Classification. Measurements of displacement, force and torque. Dynamometers: Hydraulic, Absorption and Eddy current.

Unit–II Measurement of strain - Bonded and unbounded strain gauges - Requirements of materials. Mechanical - Electrical - Opto mechanical strain gauges. Measurement of temperature - electrical and non-electrical methods - Bimetallic and pressure thermometer, thermocouples - requirements - Resistance thermometers - Pyrometry - Calibration methods.

Unit–III Measurements of Pressure and flow - Measurements of high pressure and low pressure - Measurements of flow by obstruction meters - Velocity probes - Hot wire anemometer - Calibration of pressure gauges and flow meters - Time constant of pressure gauges.

Unit–IV Elementary ideas of automatic control - Open and closed systems, on-off, proportional, and floating modes, reset and rate actions. Basic combined modes for pneumatic, hydraulic and electrical systems.

Unit–V Transfer function - Stability - Routh's criterion - Analysis of second order systems – System response to step – step, pulse - ramp inputs. Introduction to computerized measurement and control systems (Description only)

TEXT BOOKS

1. **Hollman, J.P., Experimental Methods for Engineers, Tata McGraw Hill 2017.**
2. **Benjamin Kuo, Automotive Control Engineering, EEE Publications.**

REFERENCES

1. **D.S. Kumar, 'Mechanical Measurement & Control', Metropolitan Book Company 2015.**
2. **Beckwith, T.C & Buck, N.L., Mechanical Measurements, Addison Wesley 2013.**
3. **Nagarth and Gopal, Control Engineering, Wiley Eastern Ltd 2018.**
4. **Control System by Nagoor Kani, RBA Publications 2014.**
5. **Erenest O. Doebeling, 'Measurement Systems', McGraw Hill 2019.**
6. **Instrumentation and control systems by W. Bolton, 2nd edition, Newnes 2000,**
7. **Thomas G. Beckwith, Roy D. Marangoni, John H. LienhardV , Mechanical Measurements (6th Edition) 6th Edition, Pearson Education India, 2013**
8. **Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York, 2019.**

22MEMISCN	ELEMENTS OF HEAT TRANSFER	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- **The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.**
- **Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.**
- **The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.**

Unit-I Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, Composite Medium, critical insulation thickness. Extended surfaces

Unit-II Lumped system approximation and Biot number, Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Unit-III Heat convection, basic equations, boundary layers- Forced convection, external and internal flows-Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection-Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Unit-IV Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity

method. Radiation Shields

Unit-V Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε-NTU methods. Boiling and Condensation heat transfer, Pool boiling curve. Introduction mass transfer, Similarity between heat and mass transfer.

TEXT BOOKS

1. **Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2017**
2. **J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 2017.**

REFERENCES

1. **F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2018.**
2. **MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002**
3. **A.Bejan, Heat Transfer John Wiley, 1993**

22MEMISCN	ELEMENTS OF MACHINE DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- **To familiarize the various steps involved in the Design Process.**
- **To understand the principles involved in evaluating the shape and dimensionsof a component to satisfy functional and strength requirements.**
- **To learn to use standard practices and standard data.**
- **To learn to use catalogues and standard machine components.**

Unit–I Introduction: Types of Design factors. Factor of safety, Theories of failure - Curved beam, crane hook and C frames. Design for fatigue strength: S-N diagram - Endurance limit modifying factors - Stress concentration - Fluctuation stress – Soderberg & Good Man equations.

Unit–II Thin cylinders – Stresses in thin cylindrical shell due to internal pressure – circumferential and longitudinal stresses and deformation in thin cylinders Design of mechanical elements: Shafts – Design for static load – bending and torsion – 79 Equivalent twisting moment. Coupling - Types - Design and selection of coupling - Flange coupling, Bushed pin type, flexible coupling design and selection.

Unit–III Theory of columns: Design of push rod, piston rod and I.C. Engine connecting rods sections. Wire ropes - Stresses - selection Design procedure–leaf springs - construction equalized stresses in leaves - material and design. Open and closed coiled helical springs stress - Wahl's factor.

Unit–IV Power screws - Thread forms Design consideration and materials - wear and shear - design procedure. Threaded fasteners – Bolted joints – simple and eccentrically loaded bolted joints.

Unit-V Design of Joints: Riveted Joints: Introduction - Types of riveted joints - failures of a riveted joint - strength and efficiency - Design of boiler joints. Welded joints: Introduction - Strength of transverse and parallel fillet welded joints - Axially loaded unsymmetrical welded sections - Eccentrically loaded welded joints.

TEXT BOOKS

1. **Khurmi, R.S., "Machine Design", S. Chand and Company Ltd., New Delhi, 14th edition, 2017.**
2. **Pandya, and Sha., "Machine Design", Charotar Publisher, house, Anand, India 2015**

REFERENCES

1. **Richard Budynnas, J.E. Shigley's, "Mechanical Engineering Design", McGraw Hill Book Company, 10th ed., 2017.**
2. **Prabhu, T.J., "Fundamentals of Machine Design", Scitect Publisher 4th edition, 2000.**
3. **Sundararajamoorthy, T.V., and N. Shanmugam, "Machine Design", Anuradha Agencies, 2018.**

22MEMISCN	POWER PLANT TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To provide an overview of power plants and the associated energy conversion issues

Unit-I Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

Unit-II Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Unit-III Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

Unit-IV Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems

Unit-V Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

TEXT BOOKS

1. **Nag P.K., Power Plant Engineering, 4th ed., Tata McGraw Hill, 2017.**
2. **El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.**

REFERENCES

1. **Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.**

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

1. Describe the working of coal based power plants

2. Employ appropriate engineering principles for tapping energy from gas turbine, combined cycles power plant

3. Apply suitable nuclear power reactor for power generation.

4. Recognize different forms of energy resources and apply them for suitable applications in energy sectors.

5. Interpret the economics in different power plants.

22MEMISCN	AUTOMOBILE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- **To impart the knowledge about the engine chassis, transmission, steering, suspension systems, rear axles and final drive of Automobiles.**
- **To Study the concept of electrical system, sensors and fuel injection system in automobiles**

UNIT-I Engine chassis frame – layout of chassis and its main components – functions of the chassis frame – types – laden – monocoque – various loads acting on the chassis frame. The Clutch - Function- Single plate, multi plate clutches - Torque converters.

UNIT-II Gear Boxes - Function – Sliding mesh - Constant mesh and synchromesh gear boxes - Selector Mechanism – Working of Automatic gear boxes - over drive - Front wheel drive - Propeller shaft and universal joints - Constant velocity Universal joints.

UNIT-III Front axle and steering geometry - Principle of power steering - steering mechanism – Re-circulating ball mechanism - cam & double pin steering gear boxes - Camber angle, Caster angle, King pin inclination - Types of frames and suspension systems. Independent suspension - Rear suspension - Pneumatic suspension.

UNIT-IV Rear axle - final drive - Single and double reduction axle, torque and thrust members - arrangements. Differential - function of differential - differential lock - rear axle-housing construction - Rear axle arrangements. Brakes - Mechanical, disc, hydraulic and pneumatic brakes - servo brakes – antilock braking systems.

UNIT-V Electrical system of the automobile - Battery – Ignition system - Gasoline injection- throttle body injection and multi point fuel injection systems- controls -– CRDI system for diesel engine. Engine sensors - types– oxygen sensors, crank angle position sensors – fuel metering, vehicle speed sensors - detonation sensor – altitude sensor, flow sensor, throttle position sensors, relays. GPS navigation system.

TEXT BOOKS

1. **William H. Crouse and Donald L. Anglin, "Automotive Mechanics", Tata McGraw Hill, 2017, Tenth Edition.**
2. **Gupta R.B., Automobile Engineering, Sathya Prakasam New Market, New Rohta road, New Delhi 2016.**

REFERENCE BOOKS

1. **Crouse William, Automotive Emission control, Gregg Division McGraw-Hill 1983.**
2. **Bosch "Automotive Handbook", Robert Bosch GmbH, Germany, 2018, Sixth Edition.**
3. **John.B. Heywood, Internal Combustion Engines, McGraw-Hill 2017.**
4. **Newton & Steeds, Motor Vehicles 1989.**