ANNAMALAI UNIVERSITY

Faculty of Engineering and Technology

HAND BOOK OF

MECHANICAL ENGINEERING

2021

ANNAMALAI UNIVERSITY
FACULTY OF ENGINEERING AND TECHNOLOGY
B.E. (Four Year) Degree Programme (FULL–TIME)
Choice Based Credit System (CBCS)
REGULATIONS 2021-2022

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 (listed in Annexure-I) 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 Electives and Open Electives in addition to Seminar & Industrial Training and Project. Each semester curriculum shall normally have a blend of theory and practical courses.

The total credits for the entire degree Programme is **166 (127** 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

5.1 Earn a minimum of 166 credits (127 for lateral entry students).

5.2 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

5.3 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 186. Out of 186 credits (147credits for lateral entry students), 20 credits must be earned by studying additional course offered by the same or allied Departments (listed in Annexure-II) in sixth, seventh and eighth semesters. These additional 20 credits could be acquired through the MOOC courses of SWAYAM portal also.

5.4 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 186 credits, 20 credits must be earned from the courses offered by any one of the Departments (listed in Annexure-II) in the Faculty of Engineering and Technology in sixth, seventh and eighth semesters. These additional 20 credits could be acquired through the MOOC courses offered in SWAYAM portal also.

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 166 (127 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. Mandatory Internship (Industrial Training)

To promote industrial internship at the graduate level in technical institutes and also to enhance the employability skills of the students passing out from Technical Institutions, the internship for the students at different stages of the programme, is included in the curriculum. **The student has to undergo the internship during the semester vacation in the II year and III year of the programme in accordance with the details outlined below**. **Further the student has to submit a report on completion of the internship during the subsequent Odd semester that is in the V and VII semesters respectively**. **During the vacation in the II and III year of the programme,**

The student may choose any of the following **Internship / Innovation / Entrepreneurship** related activities for a total of **4 weeks** duration in each year

(i) Work on innovation or entrepreneurial activities resulting in start-up.

(ii) Undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/Medium enterprises.

(iii) Undergo internship with National Employment Enhancement Mission (NEEM) Facilitator.

10. 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.

11. 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

12. Electives

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

12.1 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.

12.2 Open Elective courses

Apart from the various Professional elective courses, a student must study **four** open elective courses **three/two** of which offered by the Department concerned and **one/two** open elective course offered by any other Department in the Faculty of Engineering & Technology during either sixth or seventh or eighth semester of study, with the approval of the Head of the Department and the Head of the Department offering the course.

12.3 MOOC (SWAYAM) Courses

Further, the student can be permitted to earn not more than 20 % of his total credits (that is 32 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 the

professional elective and/or open elective courses. Thus the credit earned through MOOC courses can be transferred and considered for awarding Degree to the student concerned.

12.4 Value added courses

A student can study one or more value added courses being offered by the Departments of Study in the same/other Faculties of our University preferably in the sixth or seventh semester of the B.E degree programme.

12.5 One Credit Courses

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

12.5.1 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 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 one credit courses (one each in VI and VII semesters). They shall be allowed to take 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 one credit courses.

12.5.2 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). NSQFis 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.

13. Assessment

13.1 Theory Courses

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

First assessment (Mid-Semester Test-I)	:	10 marks
Second assessment (Mid-Semester Test-II)	:	10 marks
Third Assessment	:	5 marks
End Semester Examination	:	75 marks

13.2 Practical Courses

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

First assessment (Test-I)	:	15 marks

Second assessment (Test-II)	:	15 marks
Maintenance of record book	:	10 marks
End Semester Examination	:	60 marks

13.3 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.

13.4 Industrial Internship

After attending the internship during the semester vacation of III / IV year, the student has to present a report at the start of the subsequent odd semester (V / VII semester) to the committee which will assess and award marks out of 100. The committee is constituted with an Internship Coordinator and a minimum of two members nominated by the Head of the Department for each class.

14. 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.

15. 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.

16. 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 ofI & II Semester) for approval and transmission to the Controller of Examinations.

17. 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.

18. 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.

19. 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.

20. 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-valuation 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.

21. Awarding Degree

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

21.1 Honours Degree

To obtain **Honours Degree** a student must earn a minimum of **186 credits** within four years (147credits 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.

21.2First Class with Distinction

To obtain B.E Degree First Class with Distinction, a student must earn a minimum of 166 Credits within four years (127 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.

21.3 First Class

To obtain B.E Degree First Class, a student must earn a minimum of 166 credits within *five* years (127 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).

21.4 Second Class

For Second Class, the student must earn a minimum of 166 credits within **seven** years (127 credits within **six** years for lateral entry students) from the time of admission.

21.5 B.E Degree with Minor Engineering

For Minor Engineering, the student must earn a minimum of 186 credits within four years (147 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.

22. 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.

23. 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.

Diploma Programmes Eligible for the B.E (Lateral Entry) Programmes offered in FEAT

(from2021-2022)

Sl.No.	Branches of Study	Eligible Diploma Programme (FT / PT / SW)	
1.	**Chemical Engineering**	i.	Petrochemical Engineering
		ii.	Chemical Engineering
		iii.	Environmental Engineering and Pollution Control
		iv.	Leather Technology (Footwear)
		v.	Leather Technology
		vi.	Plastic Technology
		vii.	Polymer Technology
		viii.	Sugar Technology
		ix.	Textile Technology
		x.	Chemical Technology
		xi.	Ceramic Technology
		xii.	Petro Chemical Technology
		xiii.	Pulp & Paper Technology
		xiv.	Petroleum Engineering
2.	**Civil Engineering**	i.	Civil Engineering
		ii.	Civil Engineering (Architecture)
		iii.	Environmental Engineering and Pollution Control (Full Time)
3.	**Civil and Structural Engineering.**	iv.	Architectural Assistantship
		v.	Civil Engineering (Rural Tech.)
		vi.	Civil and Rural Engineering
		vii.	Agricultural Engineering
4.	**Computer Science and Engineering**	i.	Electronics and Communication Engineering
		ii.	Computer Technology
		iii.	Computer Science and Engineering
		iv.	Information Technology
		v.	Computer Engineering
		vi.	Computer Networking
		vii.	Electronics(Robotics)
		viii.	Mechatronics Engineering
5.	**Electrical and Electronics Engineering**	i.	Electrical and Electronics Engineering
		ii.	Electronics and Communication Engg.
		iii.	Electronics and Instrumentation Engg.
		iv.	Electronics Engineering(Instrumentation)
		v.	Instrument Technology
		vi.	Instrumentation and Control Engineering
		vii.	Electrical Engineering (Instruments and Control)
		viii.	Electrical Engineering

Sl.No.	Branches of Study	Eligible Diploma Programme (FT / PT / SW)	
1.	**Chemical Engineering**	i.	Petrochemical Engineering
		ii.	Chemical Engineering
		iii.	Environmental Engineering and Pollution Control
		iv.	Leather Technology (Footwear)
		v.	Leather Technology
		vi.	Plastic Technology
		vii.	Polymer Technology
		viii.	Sugar Technology
		ix.	Textile Technology
		x.	Chemical Technology
		xi.	Ceramic Technology
		xii.	Petro Chemical Technology
		xiii.	Pulp & Paper Technology
		xiv.	Petroleum Engineering
		ix.	Instrumentation Technology
		x.	Electronics (Robotics)
		xi.	Mechatronics Engineering

Sl.No.	Branches of Study	Eligible Diploma Programme (FT / PT / SW)	
6.	**Electronics and Communication Engineering**	i.	Electronics and Communication Engineering
		ii.	Computer Technology
		iii.	Computer Science and Engineering
		iv.	Information Technology
		v.	Computer Engineering
		vi.	Computer Networking
		vii.	Electronics(Robotics)
		viii.	Mechatronics Engineering
		ix.	Electrical and Electronics Engineering
		x.	Electronics and Instrumentation Engg.
7.	**Electronics and Instrumentation Engineering**	i.	Electrical and Electronics Engineering
		ii.	Electronics and Communication Engg.
		iii.	Electronics and Instrumentation Engg.
		iv.	Electronics Engineering(Instrumentation)
		v.	Instrument Technology
		vi.	Instrumentation and Control Engineering
		vii.	Electrical Engineering (Instruments and Control)
		viii.	Electrical Engineering
		ix.	Instrumentation Technology
		x.	Electronics (Robotics)
		xi.	Mechatronics Engineering
8.	**Information Technology**	i.	Electronics and Communication

			Engineering
		ii.	Computer Technology
		iii.	Computer Science and Engineering
		iv.	Information Technology
		v.	Computer Engineering
		vi.	Computer Networking
		vii.	Electronics(Robotics)
		viii.	Mechatronics Engineering
9.	**Mechanical Engineering**	i.	Mechanical Engineering
		ii.	Mechanical and Rural Engineering
		iii.	Mechanical Design and Drafting
		iv.	Production Engineering
		v.	Production Technology
		vi.	Automobile Engineering
		vii.	Automobile Technology
		viii.	Metallurgy
10.	**Mechanical Engineering (Manufacturing Engineering)**	i.	Mechatronics Engineering
		ii.	Machine Tool Maintenance and Repairs
		iii.	Tool and Die making
		iv.	Tool Engineering
		v.	Tool Design
		vi.	Foundry Technology
		vii.	Refrigeration and Air Conditioning
		viii.	Agricultural Engineering
		ix.	Agricultural Technology
		x.	Marine Engineering
		xi.	Mechanical Engineering(Production)
		xii.	Mechanical Engineering(Tool &Die)
		xiii.	Mechanical Engineering (Foundry)
		xiv.	Mechanical Engineering(R & A.C.)
		xv.	Electronics(Robotics)
		xvi.	Mining Engineering
		xvii.	Agricultural Engineering and Farm Machinery
		xviii.	Equipment Technology
11	**Computer Science and Engineering (Artificial Intelligence and Machine Learning)**	i.	Electronics and Communication Engineering
		ii.	Computer Technology
		iii.	Computer Science and Engineering
		iv.	Information Technology
		v.	Computer Engineering
		vi.	Computer Networking
		vii.	Electronics(Robotics)
		viii.	Mechatronics Engineering

12	**Computer Science and Engineering (Data Science)**	i. Electronics and Communication Engineering ii. Computer Technology iii. Computer Science and Engineering iv. Information Technology v. Computer Engineering vi. Computer Networking vii. Electronics(Robotics) viii. Mechatronics Engineering

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	1. Chemical Engineering 2. Pharmacy 3. 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.	1. Civil Engineering

No.	Branch		
5.	Computer Science and Engineering (Artificial Intelligence and Machine Learning)	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)	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 8. Chemical Engineering
6.	Computer Science and Engineering (Data Science)		
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 Intelligence and Machine

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

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

PROGRAM EDUCATIONAL OBJECTIVES

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

PROGRAMME OUTCOMES

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

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)
Curriculum for First Year B.E (2021-22 onwards)

DEPARTMENT OF MECHANICAL ENGINEERING
COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATION -2021)

SEMESTER I									
Course Code	Category	Course	L	T	P/D	CA	FE	Total	Credits
ETBS101	BS-I	Mathematics-I	3	1	-	25	75	100	4
ETBS102	BS-II	Physics	3	1	-	25	75	100	4
ETBS103	BS-III	Chemistry	3	1	-	25	75	100	4
ETES104	ES-I	Programming for Problem Solving	2	1	-	25	75	100	3
ETSP105	ESP-I	Computer Programming Laboratory	-	-	4	40	60	100	2
ETSP106	ESP-I	Engineering Workshop/Manufacturing Practices	1	-	3	40	60	100	2.5
ETSP107	ESP-II	Electrical Wiring and Earthing Practice Laboratory	-	-	2	40	60	10	1
							Total Credits		20.5

SEMESTER II									
Course Code	Category	Course	L	T	P/D	CA	FE	Total	Credits
ETHS201	HS-I	English	3	1	-	25	75	100	4
ETBS202	BS-IV	Mathematics-II	3	1	-	25	75	100	4
ETES203	ES-II	Basic Electrical and Electronics Engineering	3	-	-	25	75	100	3
ETHP204	HSP-I	Communication Skills and Language Laboratory	-	-	2	40	60	100	1
ETBP205	BSP-I	Physics Laboratory	-	-	3	40	60	100	1.5
ETBP206	BSP-II	Chemistry Laboratory	-	-	3	40	60	100	1.5
ETSP207	ESP-IV	Engineering Graphics and Drafting	2	-	3	40	60	100	3.5
							Total Credits		18.5

THIRD SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	21ETBS301	**BS-V**	Engineering Mathematics III	3	1		25	75	100	4
2	21ETES302	**BS-VI**	Environmental Studies	3			25	75	100	3
3	21CEES303	**ES-II**	Engineering Mechanics	3			25	75	100	3
4	21MEES304	**ES-III**	Introduction to Python Programming	2			25	75	100	2
5	21MEPC305	**PC-I**	Thermodynamics	3			25	75	100	3
6	21MEPC306	**PC-II**	Fluid Mechanics & Fluid Machines	3			25	75	100	3
7	21MESP307	**ESP-IV**	Electrical and Electronics Lab			3	40	60	100	1.5
8	21MECP308	**PCP-I**	Thermal Lab			3	40	60	100	1.5
9	21MECP309	**PCP-II**	Machine Drawing	1		3	40	60	100	2.5
									Total Credits	**23.5**

FOURTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	21EEBS401	**BS-VII**	Probability random process and Numerical methods	2	1		25	75	100	3
2	21MEES402	**ES-IV**	Instrumentation & Control Engineering	2			25	75	100	2
3	21MEPC403	**PC-III**	Strength of Materials	3			25	75	100	3
4	21MEPC404	**PC-IV**	Applied Thermodynamics	3			25	75	100	3
5	21MEPC405	**PC-V**	Manufacturing Processes	3			25	75	100	3
6	21MEPC406	**PC-VI**	Design of Machine Elements	3			25	75	100	3
7	21ETHS407	**HS-II**	Universal Human Values	2	1		25	75	100	3
8	21MECP408	**PCP-III**	Strength of Materials Lab			3	40	60	100	1.5
9	21MECP409	**PCP-IV**	Fluid Mechanics lab			3	40	60	100	1.5
10	21MECP410	**PCP V**	Manufacturing Process Lab			3	40	60	100	1.5
									Total Credits	**24.5**
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	21MEPC501	**PC-VII**	Thermal Engineering	3			25	75	100	3
2	21MEPC502	**PC-VIII**	Engineering Materials and Metallurgy	3			25	75	100	3
3	21MEPC503	**PC-IX**	Theory of Machines	3			25	75	100	3
4	21MEPC504	**PC-X**	Manufacturing Technology	3			25	75	100	3
5	21MEPE505	**PE-I**	Professional elective I	3			25	75	100	3
6	21MEPE506	**PE-II**	Professional elective II	3			25	75	100	3
7	21MECP507	**PCP-VI**	Manufacturing Technology lab			3	40	60	100	1.5
8	21MECP508	**PCP-VII**	Machine theory lab			3	40	60	100	1.5
9	21MECP509	**PCP-VIII**	Instrumentation & Controls lab			3	40	60	100	1.5
10	21ETIT510	**IT-II**	Industrial Training / Rural Internship/ Innovation/ Entrepreneurship	*Four weeks during the II year semester vacation*			100	100		4.0
							Total Credits			**26.5**

SIXTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	21MEPC601	**PC-XI**	Automation in Manufacturing	3	-	-	25	75	100	3
2	21MEPC602	**PC-XII**	Heat Transfer	3	-	-	25	75	100	3
3	21MEPE603	**PE-III**	Professional elective III	3	-	-	25	75	100	3
4	21MEPE604	**PE-IV**	Professional elective IV	3	-	-	25	75	100	3
5	21MEPE605	**PE-V**	Professional elective V	3		-	25	75	100	3
6	21YYOE606	**OE-I**	Open elective I	3	-	-	25	75	100	3
7	21MECP607	**PCP-IX**	Applied thermal lab	-	-	3	40	60	100	1.5
8	21MECP608	**PCP-X**	Heat transfer lab	-	-	3	40	60	100	1.5
							Total Credits			**21.0**
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	21ETHS701	**HS-IV**	Engineering Ethics	2	-	-	25	75	100	2
2	21MEPC702	**PC-XIII**	Power Plant Engineering	3	-	-	25	75	100	3
3	21MEPE703	**PE-VI**	Professional elective VI	3	-	-	25	75	100	3
4	21MEPE704	**PE-VII**	Professional elective VII	3	-	-	25	75	100	3
5	21YYOE705	**OE-II**	Open Elective II Allied branch	3	-	-	25	75	100	3
6	21MECP706	**PCP-XI**	Automation lab	-		3	40	60	100	1.5
7	21ETIT707	**IT-III**	Industrial Training / Rural Internship/ Innovation / Entrepreneurship	*Four weeks during the III year semester vacation*				100	100	4.0
				Total Credits						**19.5**

EIGHTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	21MEOE801	**OE-III**	Open Elective III (From the same Department)	3	-	-	25	75	100	3
2	21MEOE802	**OE-IV**	Open Elective IV (From the same Department)	3	-	-	25	75	100	3
3	21MEPV803	**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. 21MEPE SCN   Internal Combustion Engines
2. 21MEPE SCN   Mechatronic Systems
3. 21MEPE SCN   Microprocessors in Automation
4. 21MEPE SCN   Composite Materials
5. 21MEPE SCN   IOT and Smart Manufacturing
6. 21MEPE SCN   Refrigeration and Air Conditioning
7. 21MEPE SCN   Finite Element Analysis
8. 21MEPE SCN   Artificial Intelligence and Machine Learning
9. 21MEPE SCN   Gas Dynamics and Jet Propulsion
10. 21MEPE SCN   Process Planning and Cost Estimation
11. 21MEPE SCN   Principles of Management
12. 21MEPE SCN   Automobile Engineering
13. 21MEPE SCN   Design of Transmission Systems
14. 21MEPE SCN   Total Quality Management
15. 21MEPE SCN   Energy Conservation and Management

OPEN ELECTIVES

1. 21MEOE SCN Automotive Engineering
2. 21MEOE SCN Automotive Safety
3. 21MEOE SCN Electric and hybrid vehicles
4. 21MEOE SCN Computational fluid dynamics
5. 21MEOE SCN Fuels and combustion
6. 21MEOE SCN Energy Management In Buildings
7. 21MEOE SCN Renewable energy technology
8. 21MEOE SCN Industrial pollution prevention and control
9. 21MEOE SCN Power plant instrumentation
10. 21MEOE SCN Introduction to hydraulics and pneumatics
11. 21MEOE SCN Basic thermodynamics and heat transfer
12. 21MEOE SCN Energy auditing
13. 21MEOE SCN Energy conservation
14. 21MEOE SCN Solar energy utilization
15. 21MEOE SCN Waste heat recovery Systems and co generation
16. 21MEOE SCN Maintenance and Safety Engineering
17. 21MEOE SCN Engine Pollution and Control
18. 21MEOE SCN Constitution of India
19. 21MEOE SCN Entrepreneurship

HONOURS ELECTIVES

1. 21MEHE SCN Computational Heat transfer
2. 21MEHE SCN Steam Engineering
3. 21MEHE SCN Advanced Engines and Emission Systems
4. 21MEHE SCN Energy Auditing
5. 21MEHE SCN Mechanical Vibration
6. 21MEHE SCN Robotics

MINOR ELECTIVES

1. 21MEMI SCN Basic Thermal Engineering
2. 21MEMI SCN Instrumentation and Control
3. 21MEMI SCN Elements of Heat transfer
4. 21MEMI SCN Elements of Machine Design
5. 21MEMI SCN Power Plant Technology
6. 21MEMI SCN Automobile Technology

Course code	ETBS101			
Category	Basic Science Course			
Course title	**Mathematics - I**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	3	**1**	**0**	**4**

Unit 1: Calculus (6 lectures)

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 2: Calculus (6 lectures)

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 3: Sequences and series (10 lectures)

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 4: Vector Calculus (Differentiation) (8 lectures)

Gradient, divergence and curl- directional derivative-unit normal vector-irrotational and solenoidal vectors-expansion formulae for operators involving ∇.

Unit 5: Matrices (10 lectures)

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.

Suggested Text/Reference Books :

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson, Reprint,2002.

2. Erwin kreyszig, Advanced Engineering Mathematics, 9thEdition, John Wiley &Sons,2006.

3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,

2008.

4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi,11th Reprint, 2010.

5. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole,2005.

6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint,2008.

7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36thEdition, 2010.

Course Outcomes :

The objective of this course is to familiarize the prospective engineers with techniques in calculus,multivariate analysisandlinearalgebra.Itaimstoequipthestudentswithstandard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

The students will learn:

1. To apply differential and integral calculus to improper integrals.Apartfromsomeotherapplicationstheywillhaveabasicunderstandingof Beta and Gamma functions.

2. The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.

3. The tool of sequences and series for learning advanced Engineering Mathematics.

4. To deal with vector calculus that are essential in most branches of engineering.

5. The essential tool of matrices and linear algebra in a comprehensive manner.

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

Course code	**ETBS102**			
Category	Basic Science Course			
Course title	**PHYSICS**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	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   (9 Lectures)

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   (8 Lectures)

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, CO_2), solid- state lasers (ruby, Neodymium), dye lasers, laser speckles, applications of lasers in science, engineering and medicine.

Unit - III Crystal Physics   (7 Lectures)

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   (8 Lectures)

Heisenberg uncertainity Principle –Dual 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 (8 Lectures)

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", DhanpatRai 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 :
1. Gain knowledge on the construction of different types of interferometer
2. Description on 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. Compared the different energy resource and their availability

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

Course Code	ETBS103			
Category	Basic Science Course			
Course title	Chemistry			
Scheme and Credits	L	T	P	Credits
	3	1	0	4

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 – H_2-O_2 fuel cell.

Unit – IV : Polymers and Nano Materials

Polymers – Types of polymerization – Addition, condensation and copolymerisation – Mechanismof 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, porocity) 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.

Suggested Tex 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.

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 Adsorption analysis.
2. Describe the concept of electrochemistry and its applications; corrosion and its controlling Methods.
3. Demonstrate the properties of fuels and applications of energy storage devices.
4. Evaluate the synthetic method of various polymers and the applications of Nanochemistry.
5. Describe the principles of UV,IR techniques and properties of Refractories and Lubricants.

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

Course code	**ETES104**
Category	Engineering Science Course
Course title	**Programming for Problem Solving**

Scheme and Credits	**L**	**T**	**P**	**Credits**	
	2	1	0	**3**	

Unit 1: (8 lectures)

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 memorylocations,

Syntax and Logical Errors in compilation, object and executable code.

Unit 2: (14 lectures)

Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops.

Unit 3: (12 lectures)

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 4: (10 lectures)

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 5: (6 lectures)

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).

Suggested Text Books :
1. Byron Gottfried, Schaum's Outline of Programming with C,McGraw-Hill
2. E. Balaguruswamy, Programming in ANSI C, TataMcGraw-Hill

Suggested 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	-	-	-	-	-	-	-	-	-	-
CO2	2	2	3	2	-	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-	-
CO4	1	1		-	-	-	-	-	-	-	-	-
CO5	2	1	1	-	-	-	-	-	-	-	-	-

Course code	ETSP105			
Category	Engineering Science Course			
Course title	**Computer Programming Laboratory**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	0	**0**	**4**	**2**

[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

Laboratory 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	-	-	-	-	-	-	-
CO2	2	1	1	-	2	-	-	-	-	-	-	-
CO3	2	1	1	-	2	-	-	-	-	-	-	-
CO4	1	1	1	-	2	-	-	-	-	-	-	-
CO5	1	1	1	-	2	-	-	-	-	-	-	-

Course code	ETSP106			
Category	Engineering Science Courses			
Course title	**Engineering Workshop / Manufacturing Practices**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	1	**0**	**3**	**2.5**

(i) Lectures & Videos: (10 ours)

1. Manufacturing Methods- casting, forming, machining, joining, advancedmanufacturing
2. methods (3 lectures)
3. CNC machining, Additive manufacturing (1lecture)
4. Fitting operations & power tools (1lecture)
5. Electrical & Electronics (1 lecture)

6. Carpentry (1lecture)
7. Plastic molding, glass cutting (1lecture)
8. Metal casting (1lecture)
9. Welding (arc welding & gas welding), brazing (1lecture)

Suggested Text/Reference Books:
1. HajraChoudhury S.K., Hajra Choudhury A.K. and NirjharRoy S.K., "Elements of WorkshopTechnology",Vol.I2008andVol.II2010,Mediapromotersandpublishers private limited,Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering andTechnology",4thedition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I"Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture",

   4thedition, Prentice Hall India,1998.
5. RaoP.N.,"ManufacturingTechnology",Vol.IandVol.II,TataMcGrawHi llHouse,2017.

Course Outcomes :

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

(ii) Workshop Practice: (60 hours)
1. Machine shop (10 hours)
2. Fitting shop (8hours)
3. Carpentry (6hours)
4. Electrical & Electronics(8hours)
5. Welding shop (8 hours (Arc welding 4 hrs + gas welding 4hrs)
6. Casting (8hours)
7. Smithy (6 hours)
8. Plastic moulding& Glass Cutting (6hours)
9. Examinationscouldinvolvetheactualfabricationofsimplecomponents,ut ilizingoneormore of the techniques coveredabove.

Laboratory Outcomes :

Upon completion of this course, the students will be able to
1. Summarize the various conventional and latest manufacturing processes
2. Gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

3. Acquire the ability to fabricate models of their own.
4. Develop skill to make simple fitting joints.
5. Get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturingprocesses.

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

Course code	**ETSP107**			
Category	Engineering Science Courses			
Course title	**Electrical Wiring and Earthing Practice Laboratory**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	-	**-**	**2**	**1**

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.

1. a) Study of Basics of Safety Precautions
   b) Study of Wiring Materials
2. a) Study of types of Wiring
   b) Fan and Fluorescent Lamp Connections
3. Residential Wiring
4. Stair case Wiring
5. Industrial Wiring
6. Series and Parallel Lamp Circuits
7. Measurement of Earth Resistance
8. Measurement of Frequency and Phase of AC Circuits

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

- Familiarize with the electrical safety measures.
- Identify the different types of electrical wiring.
- Know the necessity of Earthing.
- Gain knowledge on the different types of lighting circuits.
- Understand 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	-	-	-	-	-	-	-	2
CO2	3	-	-	2	-	-	-	-	2	-	-	2
CO3	3	-	-	2	-	-	-	-	2	-	-	2
CO4	3	-	-	2	-	-	-	-	2	-	-	2
CO5	3	-	-	2	-	-	-	-	2	-	-	2

SECOND SEMESTER

Course code	ETHS201
Category	Humanities and Social Sciences including Management courses
Course title	English

Scheme and Credits	L	T	P	Credits	
	3	1	0	4	

Module 1: Vocabulary Building

1.1 The concept of Word Formation

1.2 Root words from foreign languages and their use in English

1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Count and uncount nouns.

1.4 Synonyms, antonyms, and standard abbreviations.

1.5 Language development - Wh questions asking and answering yes or no questions.

Module 2:. Basic Writing Skills

2.1 Sentence Structures

2.2 Use of phrases and clauses in sentences

2.3 Importance of proper punctuation

2.4 Creating coherence and Techniques for writing precisely

2.5 Organizing principles of paragraphs in writing

Module 3: Nature and Style of sensible Writing

3.1 Describing and Defining

3.2 Classifying and Providing examples or evidence

3.3 Writing introduction and conclusion

3.4 Comprehension

3.5 Precis Writing

Module 4: Writing Practices & Oral Communication

    4.1 Listening to lectures and making notes

    4.2 Mechanics of presentation, asking and giving instruction

    4.3 Essay Writing – Writing analytical essays and issue based essays.

    4.4 Dialogue writing and conversation

    4.5 Letter writing – Formal and informal

Module 5: Group Discussion and Job Application

    5.1 Characteristics and practices of group discussion

    5.2 Job application

    5.3 Resume preparation

    5.4 Writing reports – minutes of a meeting, accident, survey

    5.5 E-mail – etiquette

Suggested Readings:

1. Practical English Usage. Michael Swan. OUP. 1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007.
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5. Communication Skills. Sanjay Kumar and PushpLata. 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 :

The student will acquire basic proficiency in English including reading and listening

1. Comprehension, writing and speaking skills.Get an exposure of vocabulary and gain a good glossary.
2. Get knowledge regarding use of Grammar in speech and writing.
3. Acquire a knowledge of remembering, understanding, applying, analyzing, evaluating & Creating.
4. Determine how to articulate their ideas effectively to a variety of listeners.
5. Acquire 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	-	-		-		3	-	3
CO2	-	2	-	2	-	-		-		3	-	3
CO3	-	-	3	-	-	-		-		3	-	3
CO4	-	-	2	3	-	-		-		3	-	3
CO5	-	-	3	2	-	-		-		3	-	3

Course code	ETBS202			
Category	Basic Science Course			
Course title	**Engineering Mathematics - II**			
Scheme and	**L**	**T**	**P**	**Credits**
Credits	**3**	**1**	**0**	**4**

Module 1: Multivariable Calculus (Integration)   (8 lectures)

Double integrals (Cartesian) - change of order of integration in double integrals - Changeofvariables(Cartesiantopolar) - Applications: Area as a double integral.Triple integrals (Cartesian) - Applications: Volume as a triple integral.

Module 2:Vector Calculus (Integration)   (8 lectures)

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.

Module 3: Ordinary differential equations   (8 lectures)

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).

Module 4: Complex Variable (Differentiation)   (8 lectures)

Analytic functions and their properties-Cauchy-Riemann equations-harmonic functions - harmonicconjugate ofelementaryanalyticfunctions– Construction of an

analytic function. Mobius transformations.

Module 5: Complex Variable (Integration) **(8 lectures)**

Cauchy theorem(withoutproof) -CauchyIntegralformula(without proof) - CauchyIntegralformula for higher derivatives (without proof) – zeros and poles of an analytic functions – singularities.Residues - Cauchy Residuetheorem (without proof) - Evaluationofdefiniteintegral using them.Taylor'sseries and Laurent's series.

Suggested Text/Reference Books :

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson, Reprint,2002.

2. Erwin kreyszig, Advanced Engineering Mathematics, 9thEdition, John Wiley &Sons, 2006.

3. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary
Value   Problems, 9th Edn., Wiley India, 2009.

4. S. L. Ross, Differential Equations, 3rd Ed., Wiley India,1984.

5. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.

6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint,

7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36thEdition,2010.

Course Outcomes :

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.
The students will learn:

- The mathematical tools needed in evaluating multiple integrals and their usage.
- The effective mathematical tools for the solutions of differential equations that model physical processes.
- The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.
- To deal with Complex Variable for Differentiation that are essential in most branches of engineering.
- To deal with Complex Variable for Integration that are essential in most branches of engineering..

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO 1	3	3	3	2	-	-	-	-	-	-	-	-
CO 2	3	3	2	-	-	-	-	-	-	-	-	-
CO 3	3	3	3	3	3	-	-	-	-	-	-	-
CO 4	3	3	2	-	-	-	-	-	-	-	-	-
CO 5	3	3	3	2	-	-	-	-	-	-	-	-

Course Code	**ETES203**			
Category	Engineering Science Course			
Course Title	**Basic Electrical and Electronics Engineering**			
Scheme and Credits	L	T	P	Credits
	3	**0**	**0**	**3**

Course Objectives
- To understand the basic laws and AC systems.
- To learn the need for earthing and protection.
- To understand the working of transformers and DC Machines.
- To know the operation and principles of AC machines.
- To learn the basic electronic and power electronic devices and their applications.

Unit-I Basic Circuits
Definition of current and voltage - Electrical circuit elements (R, L and C)- Ohm's Law- Kirchhoff's laws - mesh current and node voltage methods.
AC circuits - RMS-Average values-sinusoidal steady state response of simple RLC circuits. Introduction to 3 phase systems - Advantages.

Unit-II DC Machines and Transformers
Laws of Electromagnetism–Construction of DC Machines– DC Generator- EMF Equation – Losses – Characteristics - DC Motor- Principle of operation–Types– Characteristics - Speed control of D.C shunt and series motors.
Single-phase Transformer: Construction and Working principle, EMF equation, Losses, regulation and efficiency- Three-phase transformer: Construction and Connections

Unit-III Induction Motors and Alternators
Construction, Working principle of Three-phase induction motor - Single-phase induction motor - Types and Applications. Alternators - types -construction- working principle - EMF equation.

Unit-IV Basic Electronics

P-N junction - VI Characteristics of PN junction diode, Zener diode - Rectifier circuits- Voltage Regulator using Zener diode - Working principle and characteristics - BJT, SCR, JFET and IGBT.

Unit-V Fundamentals of Communication Engineering

Introduction – Elements of Communication Systems– Principles of Amplitude and Frequency Modulations. Digital Communication - Communication Systems: Radio, Antenna, TV, Fax, ISDN, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

TEXT BOOKS :
1. V.K. Mehta, Rohit Mehta, "Basic Electrical Engineering", S.Chand Publications, 2012.
2. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 2014.
3. C. L. Wadhwa, "Basic Electrical Engineering", New Age International Publications, Fourth Edition, 2007
4. Bimbhra, P.S., "Power Electronics", Khanna Publishers, 2014.

REFERENCE BOOKS :
1. Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
2. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017
3. Muhammad H.Rashid, "Spice for Circuits and electronics", 4th ed., Cengage India,2019.
4. Del Toro, "Electrical Engineering Fundamentals", Second edition, Pearson Education, New Delhi, 1989.
5. John Bird, "Electrical Circuit theory and technology", Routledge, 5th edition, 2013.

COURSE OUTCOMES:
At the end of the course, the students will be able to
- Understand the concepts related with electrical circuits and AC fundamentals.
- Acquire knowledge on the concepts of DC machines and Transformers.
- Familiarize with the operating principle of AC machines.
- Enhance the knowledge about the basic electronic devices and their applications.
- Gain insight on the various elements of Communication systems.

Mapping of Course Outcomes with Programme Outcomes

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

Course code	ETHP204			
Category	Humanities and Social Sciences including Management courses			
Course title	**Communication Skills and Language Laboratory**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	0	**0**	**2**	**1**

List of Topics
1. Listening Comprehension
2. Pronunciation, Intonation, Stress andRhythm
3. Common Everyday Situations: Conversations andDialogues
4. Communication atWorkplace
5. Interviews
6. FormalPresentations

Suggested Software package: Globarena Package for communicativeEnglish

The Globarena Package consists of the followingexercises

1. Readingcomprehension
2. Listening comprehension
3. Vocabularyexercises
4. Phonetics
5. Role Play in dialogues
6. AutoSpeak

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

Course Outcomes:
1. Student will heighten 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 student to improve their 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	-	-	-	-	-	-	-	3	-	3
CO2	-	3	-	-	-	-	-	-	-	3	-	3
CO3	-	-	2	-	-	-	-	-	-	3	-	3
CO4	-	2	-	-	-	-	-	-	-	3	-	3
CO5	-	-	3	-	-	-	-	-	-	3	-	3

Course code	ETSP205			
Category	Basic Science Course			
Course title	**Physics Laboratory**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	0	**0**	**3**	**1.5**

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:
1. Acquired the knowledge of torsional properties of metals wire.
2. Generalized 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	-	-	-	-	-
CO2	3	3	-	-	3	1	1	-	-	-	-	-
CO3	3	2	2	-	3	1	1	-	-	1	-	-
CO4	3	2	2	-	3	1	1	-	-	1	-	-
CO5	3	2	2	-	3	1	1	-	-	1	-	-

Course code	ETBP206			
Category	Basic Science Course			
Course title	**Chemistry Laboratory**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	0	**0**	**3**	**1.5**

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 andviscosity
2. Thin layerchromatography
3. Ion exchange column for removal of hardness ofwater
4. Determination of chloride content ofwater

5. Determination of the rate constant of areaction

6. Determination of cell constant and conductance ofsolutions

7. Potentiometry - determination of redox potentials andemfs

8. Saponification/acid value of anoil

9. Determination of the partition coefficient of a substance between two immiscible liquids

10. Adsorption of acetic acid bycharcoal

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	-	-	-	-	-
CO2	2	1	-	-	-	1	-	-	-	-	-	-
CO3	3	2	-	1	-	-	2	-	-	-	-	-
CO4	3	-	1	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-

Course code	ETSP207	
Category	Engineering Science Courses	
Course title	**Engineering Graphics and Drafting**	
Scheme and Credits	**L**	**T**	**P**	**Credits**
	2	**0**	**3**	**3.5**

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 Modelling; Solid Modelling; Introduction to Building Information Modelling (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 1: 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 2: 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 3: 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 4: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 5: 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.

Customisation& 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,   Printingdocumentstopaperusing theprintcommand;orthographicprojectiontechniques;Drawingsectionalviewsofcompos ite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation;

Suggested Text/Reference Books:
1. BhattN.D.,PanchalV.M.&IngleP.R.,(2014),EngineeringDrawing,CharotarPu blishing 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 UserManuals.

Course Outcomes :
At the end of the course a student will be able to
1. Utilize drawing instruments effectively and able to present engineering drawings and sketches.
2. Describe the concept of orthographic, isometric projections of points, lines and regular solids.
3. Visualize the images and drawings in engineering perspective.
4. Practice sectioning of bodies like machines and equipments.
5. Develop their technical communication skills and promote life-long learning.

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

THIRD SEMESTER

21ETBS301	ENGINEERING MATHEMATICS III	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES
- To learn partial differential equations, Fourier series, Boundary value problems.
- To learn the transforms such as Sine, Cosine, Fourier transform and Z-transforms.
- To gain knowledge of the method to find the Solution of difference equations.

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

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

TEXT BOOKS

1. Kandasamy P , Tilagavathy K and Gunavathy K, "Engineering Mathematics" ,9th edition., (Vol I & II) S.Chand& Co Ltd. 2017, New Delhi.
2. Ventakataraman M K, "Engineering Mathematics", The National Publishing Co., Chennai, 2003.

REFERENCES

1. Veerarajan T, "Engineering Mathematics", 3 rd edition, Tata McGraw Hill Pub., 2017.
2. Singaravelu A, "Engineering Mathematics", Meenakshi Publications, Chennai, 2019.
3. Nayaranan S, Manicavchagom   Pillay T K and Ramanaiah G "Advanced Mathematics for Engineeirng students", Vol.2 & 3, Ananda Book Depot., 2019
4. Bali.N.P. and Manish Goyal, "A Textbook of Engineeirng Mathematics", 7th Edition, Laxmi Publications Pvt. Ltd., 2016

COURSE OUTCOMES

At the end of the course the students will be able to
1. Acquire knowledge on Partial differential equations.
2. Solve problems using Fourier series.
3. Determine solutions for one dimensional and Fourier transform.
4. Do simple problems in transforms and convolution theorem.
5. Solve boundary value and Z-transform problems.

(3-High 2-Medium 1-Low)

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
CO2	3	3	3		2			2		1	2		3		
CO3	3	3		3	2			2	2				3		
CO4	3	3				2	2	2					3		1
CO5	3	3	2	2				2				1			1

21ETES302	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. Understand the multidisciplinary nature of environmental awareness.
2. Learn the basic importance of ecosystem.
3. Demonstrate the importance of biodiversity and its threats
4. Understand the effects of land and water pollution.
5. Understand the 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					3									1
CO2				3									3		
CO3					3		3					2	3		
CO4	3		2		2							2	3		1
CO5	3								2			2			1

21CEES303	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, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; 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; Static Indeterminancy

UNIT II Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; 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- 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-momentum (linear, angular); Impact (Direct and oblique).

UNIT V Introduction to Kinetics of Rigid Bodies covering, Basic terms, general principles in dynamics; 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 covering, 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 (2019), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill

REFERENCES

1. R. C. Hibbler (2017), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
2. Andy Ruina and Rudra Pratap (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.(2015), A Text Book of Engineering Mechanics, Laxmi Publications
7. Khurmi R.S. (2018), Engineering Mechanics, S. Chand & Co.
8. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

COURSE OUTCOMES

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

1. Understand the concepts of co-ordinate systems.
2. Perform basic structural analysis in various bodies.
3. Learn the various laws of friction and solve problems by work and energy methods
4. Solve problems for the conditions in motion.
5. Learn the basics of kinematics and mechanical vibration.

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		3								2		3	3	
CO2	3	3	3	2									3	3	
CO3	3	3	3										3	3	
CO4	3	3	3										3	3	
CO5	3	3	3										3	3	

21MEES304	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. Explore the basic concepts of Conditional and Looping Statements in python.
2. Learn the various functions in Python
3. Apply the concepts of Object Oriented programming including encapsulation, inheritance and polymorphism as used in Python.
4. Simulate 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	Mapping of COs with POs												PSOs		
↓COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2									1	1		
CO2	2		2									1		2	
CO3	2		2									1	1	1	
CO4	2		2									1		2	
CO5	2		2									1		2	

21MEPC305	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; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; 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, Compressibility charts- 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 and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart

Unit-V Thermodynamic cycles - Basic Rankine cycle; Basic Brayton 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. Differentiate between high grade and low grade energies.
5. Learn 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										3	3	3
CO2	3	3	2										3	3	3
CO3	3	3	2										3	3	3
CO4	3	3	2										3	3	3
CO5	3	3	2										3	3	3

21MEPC306	FLUID MECHANICS & FLUID MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
- To learn about the application of mass and momentum conservation laws for fluid flows
- To understand the importance of dimensional analysis
- To obtain the velocity and pressure variations in various types of simple flows
- 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 and momentum equation, Incompressible flow, Bernoulli's equation and its applications.

Unit-II Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.

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.

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 – 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.

REFERENCES
1. Bansal R.K., A Text Book of Fluid Mechanics and Hydraulic Machinery,9th ed., Laxmi Publication, New Delhi, 2018.

COURSE OUTCOMES
Upon completion of this course, students will be able to
1. Learn the basics of fluid mechanics
2. Analyze simple flow situations mathematically
3. Understand the significance of dimensionless parameters
4. Gain knowledge about the functions of fluid machines
5. Able to evaluate the performance of pumps and 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						2					2	3	2	
CO2	3	3	2	2									3	2	
CO3	3	3			3								3	2	
CO4	3			2	3							2	3	2	
CO5	3		2						2		2	2	3	2	

21MESP307	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 Understand the construction, working principles & operations of DC machines and transformers, Induction motors and Alternators.
2 Understand 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 Employ 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				3			2	3	3	
CO2	3	3	3		3				3				3	3	
CO3	3	3	3		3				3				3	3	
CO4	3	3	3		3				3			2	3	3	
CO5	3	3	3		3	2			3				3	3	

21MECP308	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. Understand the various types of engines
2. Learn the working principles of dynamometers.
3. Know the dismantling and assembling procedure of a four stroke CI engines.
4. Determine kinematic viscosity and the influence of temperature on viscosity.
5. Determine the properties of fuels

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			2	3	2	3
CO2	3			3	3				2			2	3	2	3
CO3	3			3	3				2			2	3	2	3
CO4	3			3	3				2			2	3	2	3
CO5	3			3	3				2			2	3	2	3

21MECP309	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.

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.

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.

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. Improve their imagination skills
2. Improve their drawing skills
3. Understand and apply the knowledge of machine drawing as a system of communication in which ideas are expressed clearly and all information fully conveyed.
4. Understand the design of a system, component or process to meet desired needs within realistic constraints such as manufacturability, economic, environmental, safety & sustainability etc.., to represent a part drawing and assembly drawings.
5. Recognize the need and an ability to engage in self education and life-long 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	2	
CO2	3		3						2			2	2	2	
CO3	3		3						2			2	2	2	
CO4	3		3						2			2	2	2	
CO5	3		3						2			2	2	2	

21EEBS401	PROBABILITY RANDOM PROCESS AND NUMERICAL METHODS	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES

   Be exposed to probability, random processes, and statistical methods designed to contribute to the process of making scientific judgments in the face of uncertainty and variation.

   To develop the skills of the students in numerical mathematics - using method of finite difference interpolation, finding numerical solution of algebraic and transcendental equations, and finding 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 - stationarity – 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 rule.

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.2010
   2. Veerarajan, T., Probability Theory and Random Process, Tata McGraw Hill Co., Ltd. New Delhi 2018.

REFERENCES

1. Venkataraman, M.K., Numerical Method in Science and Engineering, National Publishing Co., Chennai - 2003.
2. Lipschutz, S. and Schiller. J., Schaums' Outlines – Introduction to Probability and Statistics, McGraw Hill, New Delhi, 2017.
3. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., Numerical Methods, S. Chand & Co. Ltd., New Delhi. 2006.

COURSE OUTCOMES

Upon completing this course, students should be able to:
1. Acquire skills in handling situations involving random variables
2. Able to solve problems on random processes
3. Solve problems using the test of significance.
4. Solve problems on interpolation
5. Solve problems on algebraic, transcendental and differential equations

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	3	2	3									3	3	
CO2	3	3	2	3									3	3	
CO3	3	3	2	3									3	3	
CO4	3	3	2	3									3	3	
CO5	3	3	2	3									3	3	

21MEPC402	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. Learn basic measurement systems
2. Design and maintain measuring equipments for the measurement of temperature and strain
3. Understand the operating principle of pressure and flow measuring devices.
4. Learn the basics of automatic control system.
5. Understand the significance of transfer functions.

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	3	3	
CO2	2		2		2								3	3	
CO3	2									2	2		3	3	
CO4	2	2	2									1	3	3	
CO5	2				2						2	1	3	3	

21MEPC403	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. Recognize various types loads applied on machine components of simple geometry
2. Draw shear force and bending moment diagram for various types of beams
3. Identify moment of inertia of various bodies
4. Learn the basics of torsional stresses in shafts and springs
5. Understand 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									3	3	
CO2	3	3	2	3									3	3	
CO3	3	3	2	3									3	3	
CO4	3	3	2	3									3	3	
CO5	3	3	2	3									3	3	

21MEPC404	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 Introduction to solid, liquid and gaseous fuels–Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy.

Unit-II Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Super critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling.

Unit-III Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point. Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.

Unit-IV Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, super saturation compressible flow in diffusers, efficiency of nozzle and diffuser.

Unit-V Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors. Analysis of steam turbines, velocity and pressure compounding of steam turbines.

TEXT BOOKS
1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2009, 7th Edition, Fundamentals ofThermodynamics, John Wiley and Sons.

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. Learn various types of fuels
2. Understand various power cycles used in automobiles
3. Learn the working principles of refrigeration and heat pumps
4. Learn the basics of compressible flow
5. Analyze energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors

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	3	3	1
CO2	3		2										3	3	1
CO3	3	3										2	3	3	1
CO4	3	3									1		3	3	1
CO5	3	3				1							3	3	1

21MEPC405	MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

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. Understand the concept of mould making and casting processes
2. Analyze the deformation behavior of metals under various metal forming processes
3. Select a appropriate forming technique to produce a component using sheets
4. Understand the mechanism of metal removal by cutting tools
5. Choose 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			2			2	3	2	
CO2	3				3	2			2			2	3	2	
CO3	3				3	2			2			2	3	2	
CO4	3				3	2			2			2	3	2	
CO5	3				3	2			2			2	3	2	

21MEPC406	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, Bushed pin type, flexible coupling design and selection.

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. Learn the basics elements in elemental design
2. Design shafts
3. Design various machine components according to the requirement as per the prescribed standards
4. Understand the design procedure for power screws and couplings
5. Understand the significance of designing joints

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	3	
CO2	3		3									2	3	3	
CO3	3		3									2	3	3	
CO4	3		3									2	3	3	
CO5	3		3									2	3	3	

21ETHS407	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. Gain more aware of themselves, and their surroundings (family, society, nature).

2. Be responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

3. Attain better critical ability.

4. Understand their commitment towards what human values, human relationship and human society.

5. Apply the concepts to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by

a) faculty-student or mentor-mentee programs throughout their time with the institution

b) Higher level courses on human values in every aspect of living. E.g. as a professional

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
CO2		3	3												1
CO3				2											1
CO4						3			2						1
CO5									2	2		2			1

21MECP408	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. Learn 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. Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.
5. Work as a team to gain practical knowledge, helpful for a lifelong learning.

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	3	2	2					2				3	3	
CO2	3	3	2	2					2				3	3	
CO3	3	3	2	2					2				3	3	
CO4	3		2					2	2			2	3	3	
CO5	3								2		2		3	3	

21MECP409	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. Compute 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					2			2	3	2	
CO2	3			3					2			2	3	2	
CO3	3			3					2			2	3	2	
CO4	3			3					2			2	3	2	
CO5	3			3					2			2	3	2	

21MECP410	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. Handle metal working machine (Lathe) for making simple operations
2. Prepare green sand moulds of given patterns
3. Prepare different types of weld joints.
4. Understand 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					2			1	3	2	
CO2	3			3					2			1	3	2	
CO3	3			3					2			1	3	2	
CO4	3			3					2			1	3	2	
CO5	3			3					2			1	3	2	

FIFTH SEMESTER

21MEPC501	THERMAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To apply the thermodynamic concepts into various thermal application like internal combustion engines, Steam engines and Compressors.
- 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.
- To learn the basic operation of refrigeration

Unit–I Steam cycle and turbine Steam generation- T-S diagram, Mollier chart, Steam cycles- Rankine cycle, Modified Rankine cycle, Improvement in steam cycles-Reheat, Regenerative and Binary vapor cycle 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–II 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–III 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–IV 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

Unit–V Refrigeration and Air conditioning Refrigerants, Vapour compression refrigeration: Working principle, simple problems in vapour compression refrigeration cycle with sub-cooling and superheating. Introduction to absorption system. Air-conditioning -types of air-conditioning - Summer, winter, window and central air-conditioning. Concepts of RSHF, GSHF and ESHF -cooling load calculation

TEXT BOOKS

1. Ballaney, P.L., "Thermal Engineering", Khanna Publishers, New Delhi, 24 th ed.2003.

2. Ganesan, V., "Internal Combustion Engines", 4th Edition, Tata McGraw Hill, 2012.

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. Learn the basics of steam engines.
2. Learn the basic elements of internal combustion engines
3. Explore the functioning and performance of IC engines and its sub systems
4. Recognize the functioning of reciprocating compressors
5. Recognize the concept of refrigeration and air conditioning

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	
CO2	3		1	1								1	1	1	
CO3	3	2	1	1								1	1	1	
CO4	3		1	1								1	1	1	
CO5	3	2	1	1								1	1	1	

21MEPC502	ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
		3	0	0	3

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. Understand 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	
CO2	3	2		2										2	
CO3	3											2	1	1	1
CO4	3	2										2	1	2	1
CO5	3		2											1	

21MEPC503	THEORY OF MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the kinematics and rigid- body dynamics of kinematically driven machine components
- To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link
- To be able to design some linkage mechanisms and cam systems to generate specified output motion

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. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017.

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.

COURSE OUTCOMES
Upon completion of the course, students can ale to
1. Design various types of linkage mechanisms
2. Perform displacement, velocity and acceleration analysis for simple mechanisms
3. Learn the significance of cam and followers
4. Learn the basics of gears and governors
5. Understand the need for vibration and balancing

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	3	2	
CO2	3	2	3										3	2	
CO3	3			2								2	3	2	
CO4	3				2							2	3	2	
CO5	3			2						3		2	3	2	

21MEPC504	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

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. Understand the advances in casting and forming techniques
2. Select appropriate joining technique to fabricate components using newer materials
3. Prescribe the suitable non-traditional machining process to machine precision components
4. Demonstrate the processing of various plastic components
5. 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		
CO2	3	2										1		2	
CO3	3												1	1	
CO4	3	2						2						1	1
CO5	3							2					1	2	

21MECP507	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. Understand the usage of precision instruments and the handling methods.
2. Learn 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.

POs⃗	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	2		2	2			2			1	3	2	1
CO2	3		2						2			1	3	2	1
CO3	3		2						2			1	3	2	1
CO4	3	3							2			1	3	2	1
CO5	3								2	2	2	1	3	2	1

21MECP508	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.

COURSE OUTCOMES

Upon the completion of the course, the students will be able to:
1. Determine the mass moment of inertia of connecting rod and flywheel either experimentally of theoretically or both.
2. Understand the working principle of governors.
3. Calculate the stiffness of springs.
4. Analyze the different types of motion in cams.
5. Ability to analyze particle 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						2			1	3	3	
CO2	3		3						2			1	3	3	
CO3	3		3						2			1	3	3	
CO4	3		3						2			1	3	3	
CO5	3		3						2			1	3	3	

21MECP509	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. Classify various temperature measuring devices
2. Determine the coefficient of discharge of various flow measuring devices.
3. Understand the concept of proportional control action, integral control action and derivative control action in a control system.
4. Learn the procedure for measuring strain using strain gauge.
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			1	2	2	
CO2	3			3	2				2			1	2	2	
CO3	3			3	2				2			1	2	2	
CO4	3			3	2				2			1	2	2	
CO5	3			3	2				2			1	2	2	

SIXTH SEMESTER

21MEPC601	AUTOMATION IN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
- To understand the importance of automation in the of field machine tool based manufacturing
- To get the knowledge of various elements of manufacturing automation – CAD/CAM,
  sensors, pneumatics, hydraulics and CNC
- To understand the basics of product design and the role of manufacturing automation

Unit-I Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools.

Unit-II Flexible automation: Computer control of Machine Tools and Machining Centers, NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing.

Unit-III Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods;

Unit-IV Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC-Adaptive Control Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

Unit-V Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

TEXT BOOKS
1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, Prentice Hall 2016
2. Serope Kalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition, Pearson 2018

REFERENCES
1. Yoram Koren, Computer control of manufacturing system, 1st edition 2017
2. Ibrahim Zeid, CAD/CAM: Theory & Practice, 2nd edition 2009.

COURSE OUTCOMES
Upon completion of this course, the students will be able to
1. Understand the importance of automation in manufacturing industry
2. Gain in depth knowledge on flexible automation
3. Learn the basics of CAD
4. Learn the current trends employed in industries
5. Understand the importance of modeling and simulation

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				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

21MEPC602	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. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", JohnWiley & Sons, 7th Edition, 2014
3. A. Bejan, Heat Transfer John Wiley, 2011

COURSE OUTCOMES
After completing the course, the students will be able to
1. Learn the basics of heat transfer modes and conduction mode of heat transfer.
2. Obtain exact solutions for the two dimensional conduction problems
3. Solve problems in convection mode of heat transfer
4. Learn the basics of radiation
5. Learn the basics of heat exchanger 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										2	
CO2	3	2	2	2										2	
CO3	3	2	2	2										2	
CO4	3				1						1		2		
CO5	3			2								1	2		

21MECP607	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. Learn about the different heat losses in the engine viz., cooling water, exhaust gas and un-accountable losses.
2. To learn about the performance parameter of Diesel and Petrol engine.
3. To learn about the air compressor performance parameters.
4. Understand the basic analysis of any refrigeration system
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			2	2				2			1	3	2	1
CO2	3			2	2				2			1	3	2	1
CO3	3			2	2				2			1	3	2	1
CO4	3			2	2				2			1	3	2	1
CO5	3			2	2				2			1	3	2	1

21MECP608	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. Calculate the temperature distribution and heat conduction in the metal rod.
2. Evaluate the radiation heat transfer between surfaces.
3. Analyze the performance of heat exchanger.
4. Understand the working of solar thermal plants.
5. Experimentally determine the performance of a steam boiler, turbine and condenser.

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					1			1	2	2	
CO2	3			2					1			1		2	
CO3	3			2					1			1		2	
CO4	3			2					1			1	1	2	
CO5	3			2					1			1	1	1	1

SEVENTH SEMESTER

21ETHS701	ENGINEERING ETHICS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

- To understand the moral and ethical dimensions in engineering.
- To take balanced decisions.

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 – Uses of Ethical Theories.

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

Unit-IV Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

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. Learn the basic theories in engineering ethics.
2. Learn the importance of codes in engineering practice.
3. Acquire knowledge on the safety and risk aspects in engineering.
4. Understand the various rights of engineers
5. Understand the various roles of engineers and their code of conduct.

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							3		1		1	1		
CO3	1							3		1		1	2	2	
CO4	1							3		1		1			1
CO5	1							3		1		1			2

21MEPC702	POWER PLANT ENGINEERING	**L**	**T**	**P**	**C**
		3	0	0	3

COURSE OBJECTIVES
- To provide an overview of power plants and the associated energy conversion issues
- To learn the basic components of power plants

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.

COURSE OUTCOMES
Upon completion of the course, the students will be able to
1. Understand the principles of operation of coal based power plant
2. Learn the working of gas power plants
3. Basics of nuclear reactors
4. Understand various non conventional power plants
5. Gain knowledge on power plant economics.

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	
CO2	3	2										1	1	1	
CO3	3	2										1	1	1	
CO4	3	2										1	1	1	
CO5	3	2										1	1	1	

21MECP706	AUTOMATION 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

Search, generate, manipulate data using MS office/ Open Office

Presentation and Visualization – graphs, charts, 2D, 3D

Preliminary Auto CAD 2 D drawing exercise

Auto CAD machine drawing

    Knuckle Joint

    Bushed bearing

    C++, Programming,

    Otto cycle efficiency

    Compressor dimensions

    Simple MATLAB Exercises

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Attempt the basics in MS office
2. Write and compile programmes in C++
3. Develop assembly drawings with different views using auto cad
4. Exchange file formats between AutoCAD & other analysis packages
5. Solve simple mathematical models using MATLAB.

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	2							1	3	2	
CO2	3		2	1	2							1	3	2	
CO3	3		2	1	2							1	3	2	
CO4	3		2	1	2							1	3	2	
CO5	3		2	1	2							1	3	2	

21MEST707	SEMINAR/INDUSTRIAL TRAINING	L	TR	S	C
		-	1	2	2

COURSE OBJECTIVES

- To expose students to the 'real' working environment and get acquainted with the organization structure, business operations and administrative functions.
- To have hands-on experience in the students' related field so that they can relate and reinforce what has been taught at the university.
- To promote cooperation and to develop synergetic collaboration between industry and the university in promoting a knowledgeable society.
- To set the stage for future recruitment by potential employers.

The student has to present a seminar on the chosen topic. However, the student can select a topic duly approved by the Seminar Coordinator and the Head of the Department concerned. The student who has presented the seminar has to submit a

report and appear for viva-voce examination at the end of the semester conducted by faculty members nominated by head of the department.

For Industrial training, the student has to undergo training in a reputed industry for 15 days and has to submit a report on completion of the training. The report will be evaluated by a team of faculty members nominated by the head of the department.

COURSE OUTCOME
Upon completion of the Training, students will have the
1. Ability to work in a team
2. Ability to take initiatives.
3. Ability to effectively communicate solution to problems (oral, visual, written).
4. Ability to manage a project within a given time frame.
5. Ability to apply prior acquired knowledge in problem solving.

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		3
CO2	2					1	1		1	1		1	1		3
CO3	2					1	1		1	1		1	1	1	
CO4	2					1	1		1	1		1	1	2	2
CO5	2					1	1		1	1		1	1	2	

EIGHTH SEMESTER

21MEPV803	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. Take up any challenging practical problems and find solution by formulating proper methodology.
2. Develop links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
3. Acquire collaborative skills through working in a team to achieve common goals.
4. Learn on their own, reflect on their learning and take appropriate actions to improve it.
5. Acquire the skills to communicate effectively and to present ideas clearly and coherently to specific audience in both the written and oral forms.

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	3	3	3			1		1			1		2	
CO2	3	3	3	3			1		1			1	1	2	
CO3	3	3	3	3			1		1			1		2	3
CO4	3	3	3	3			1		1			1		1	3
CO5	3	3	3	3			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 associated with IC engines and its applications.
- To understand the fuel air cycle and thermodynamic properties used in IC engines
- To understand combustion, and various parameters and variables affecting it in various types of IC engines.
- To learn about engine auxiliaries systems used in IC engines and performance of the engine

UNIT-I Introduction
Basic components – terminology of IC engines, working – four stroke/two stroke - petrol/diesel engine, classification of IC engines, Engine cycle- first law analysis, engine design – operating – performance parameters, IC engine applications.

UNIT-II Ideal, Fuel – Air and Actual Cycles
Review of ideal cycles – fuel-air cycles – factors and assumptions - variable specific heats – effect on internal energy, enthalpy, entropy, expansion and heat transfer – effect on air standard efficiencies - effect of variation of specific heats – effect of common engine variables – actual cycles – factors affecting losses of actual cycle – comparison of ideal, fuel-air and actual cycles

UNIT-III 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-IV Fuel Supply Systems
Fuel supply system in SI engine – air fuel mixture formation – carburettors – mixture requirement at operating conditions – types of carburettors – design and operating principles – electronically controlled carburettors – 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-V Auxiliaries and Testing of IC Engine
Ignition system of SI engine – requirements - battery ignition system – magneto ignition system – electronic ignition system – lubrication system – engine friction – 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

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 Johanson 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.

COURSE OUTCOMES
Upon completing this course, students should be able to:
1. Learn the working of advanced engines
2. Understand the various working cycles
3. Understand the combustion phenomenon
4. Study the fuel supply system in a engine
5. Learn the engine auxiliaries and performance of the 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	2	
CO2	3				1		1					1	1	2	
CO3	3				1		1					1		2	
CO4	3				1		1					1		2	
CO5	3				1		1					1		3	

21MEPESCN	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.

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. Test the stability of various systems
3. Learn the various sensors, transducers and operational amplifiers
4. Learn the functions of actuatorsand microprocessors
5. Learn the working of PLCs and design 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	3	2	2	1								1	2	2	
CO2	3	2			2	1						1	2	2	
CO3	3				2	1						1	1	1	
CO4	3				2							1	1	1	
CO5	3		2	1							1	1		2	

21MEPESCN	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. Able to perform numerical conversions
2. Learn the basic elements of 8085 microprocessor
3. Understand the working cycles and interfaces of 8085 microprocessor
4. Write assembly language programs
5. Provide good idea of the use of microprocessors in automation.

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		2	
CO2	3		2		1							1	1	1	
CO3	3		2		1							1	1	1	
CO4	3	1	2	2								1	2	2	
CO5	3	1	2			1						1	1	2	

21MEPESCN	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
- To understand the mechanical behaviour of composite materials
- To get an overview of the methods of manufacturing composite materials

Unit-I Definition and applications of composite materials, Fibers-glass, carbon, ceramic and aramid fibers; Matrices-polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices.

Unit-II Lamina-assumptions, macroscopic viewpoint, generalized Hookes law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix,

transformed stiffness.

Unit-III Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, crossply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies

Unit-IV Metal Matrix Composites: Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC. Limitations of MMC, Metal Matrix, Reinforcements particles- fibres. Effect of reinforcement - Volume fraction - Rule of mixtures, Processing of MMC - Powder metallurgy process - diffusion bonding - stir casting, squeeze casting

Unit-V Ceramics Matrix Composites: Engineering ceramic materials - properties - advantages limitations - Monolithic ceramics - Need for CMC Ceramic matrix - Various types of Ceramic Matrix composites - oxide ceramics - non oxide ceramics aluminium oxide - silicon nitride - reinforcements particles - fibres - whiskers. Sintering - Hot pressing Cold isostatic pressing (piping) - Hot isostatic pressing. (HIPing).

TEXT BOOKS
1. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 2016.
2. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 2009.

COURSE OUTCOMES
Upon completion of this course, the students will be able to
1. Know the basics of composites
2. Learn the rules for attaining a good composite
3. Understand the various methods of composites manufacture
4. Learn the powder metallurgy technique
5. Learn the properties of ceramic 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		2	
CO2	1	2										1	1	2	
CO3	1				1							1	1	2	
CO4	1		2									1	1	2	
CO5	1		2			1						1	1	2	

21MEPESCN	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 The Internet of Things: An overview; Design Principles for Connected Devices; Internet Principles. Thinking about 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 and other notable platforms Prototyping of Physical Design. Prototyping online Components – Getting Started with an API, Writing a New 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: What is "smart manufacturing" really and how does it differ from conventional/legacy manufacturing-Smart Manufacturing Processes- Three Dimensions: (1) Demand Driven and Integrated Supply Chains;(2) Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations);(3) Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization and reduction of GHG)
Unit- V Smart Design/Fabrication Smart Design/Fabrication - Digital Tools, Product Representation and Exchange Technologies and Standards, Agile (Additive) Manufacturing Systems and Standards. Mass Customization, Smart Machine Tools.

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. Understand the basic principles of IoT
2. Identify real time reactions and protocols
3. Recognize the different application areas of IOT.
4. Learn 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	
CO2	2	2			2							1	1	1	
CO3	2											1	1	1	
CO4	2											1	1	1	
CO5	2	2							1			1	1	1	

21MEPESCN	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 airconditioning 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, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 3rd Edition, 2017.
3. Arora, S.C. & Domkundwar, S., Refrigeration and Air-conditioning, Dhanpat Rai & Sons, NewDelhi, 2016.
4. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 2014.
5. 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. Understand the working cycles of refrigeration systems.
2. Solve problems on various refrigeration cycles.
3. Understand the components of refrigeration systems
4. Understand the psychrometry of mixture of water vapour and air.
5. Learn 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	3	3	
CO2	3		3									1	3	3	
CO3	3		3									1	3	3	
CO4	3		3									1	3	3	
CO5	3		3									1	3	3	

21MEPESCN	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. Understand 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									2	2
CO2	3			2	3								2	2	
CO3	3			2	3									2	
CO4	3			2	3									2	
CO5	3			2	3									2	

21MEPESCN	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. Understand 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	2	
CO2	3	3	2	1	2		1			1		1		2	
CO3	3	3		1	2		1			1		1	1	2	
CO4	3	3	2	1	2		1			1		1		2	
CO5	3	3	2	1	2		1			1		1	1	1	

21MEPESCN	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. Understand the basics of gas dynamics
2. Learn the basics of non-isentropic flow
3. Understand the need for shocks
4. Learn the operating principle of jet operation
5. 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	3			2									3	2	
CO2	3	3	3	2									3	2	
CO3	3					2						2	3	2	
CO4	3					2						2	3	2	
CO5	3		3	1								2	3	2	

21MEPESCN	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. Understand the basics of process planning
2. Detain economics of process planning
3. Learn 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
CO2	2		2					1			1		1	1	
CO3	2		2					1			1		1	1	
CO4	2		2					1			1		1	1	
CO5	2		2					1			1		1	1	

21MEPESCN	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:
- To understand the principles of management and their application to the functioning of an organization
- To learn the purpose of planning and Organizing

Unit-I Definition of management, science or art, manager vs entrepreneur; Types of managers- managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole

proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management.

Unit-II Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes.

Unit-III Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

Unit-IV Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

Unit-V Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

TEXT BOOKS
1. Robins S.P. and Couiter M., Management, Prentice Hall India, 14th ed., 2019.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2018.

REFERENCES
1. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 2017.

COURSE OUTCOMES
Upon completion of this course, the students will e able to
1. Understand the evolution of management, types of business organizations, types of managers and their skills required
2. Learn the nature and purpose of planning in an organization
3. Understand the need for organizing
4. Learn the importance of directing, motivation and leadership
5. Understand the importance of controlling in an organization

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	3	2	
CO2	3							3			3	1	3	2	
CO3	3							3			3	1	3	2	
CO4	3							3			3	1	3	2	
CO5	3							3			3	1	3	2	

21MEPESCN	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. Gain the basics of automobile
2. Learn the fuel injection systems used in CI and SI engines
3. Understand the transmission systems available in automobiles
4. Learn steering geometry and various braking systems used in automobiles
5. Gain knowledge on 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	2	
CO2	3					1						1		2	
CO3	3					1						1	1	2	
CO4	3					1						1		2	
CO5	3					1						1	1		1

21MEPESCN	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., 14th ed. 2005.
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. Know the procedures for selecting and designing bearings
2. Understand the concepts of belt drives, know the selection of belts and design them
3. Perform design analysis on spur and helical gears
4. Understand the design procedure of bevel and worm gears.
5. Design gear boxes upto 3 stages.

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	2	
CO2	3	3	3										3	2	
CO3	3	3	3										3	2	
CO4	3	3	3										3	2	
CO5	3	3	3										3	2	

21MEPESCN	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
- To facilitate the understanding of total quality management principles and processes
- To understand the various tools and techniques of TQM.

Unit-I Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.

Unit-II TQM principles; leadership, strategic quality planning; Quality councils-employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

Unit-III The seven traditional tools of quality; New management tools; Six sigma-concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.

Unit-IV TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM-concepts, improvement needs, performance measures.

Unit-V Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation; Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

TEXT BOOKS
1. Besterfield D.H. et al., Total quality Management, 5th ed., Pearson Education Asia, 2018.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indianedition, Cengage Learning, 2012.

REFERENCES
1. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
2. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

COURSE OUTCOMES
Upon completion of this course, the students will be able to
1. Learn the basics of TQM
2. Understand the principles of TQM
3. Gain knowledge on traditional tools of quality
4. Learn the tools and techniques of TQM
5. Know quality standards

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	
CO2	2				1						1			2	
CO3	2				1						1		1	1	
CO4	2				1						1			1	1
CO5	2				1						1			1	1

21MEPESCN	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. Understand the world power scenario and the gain insights into Energy auditing
2. Know the various energy efficient devices
3. Know the energy conservation measures in a thermal system
4. Know the significance of energy conservation in major equipments.
5. Learn the energy economics

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	3	2	1
CO2	3		2			2	3					1	3	2	1
CO3	3		2			2	3					1	3	2	2
CO4	3		2			2	3					1	3	2	2
CO5	3		2			2	3					1	3	2	3

OPEN ELECTIVE COURSES

21MEOESCN	AUTOMOTIVE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
To impart knowledge to students in about an overall understanding of Automobile Engineering and to understand
- Classification and layouts of different vehicles
- Different types of Engines in use
- Different types of clutch, gear box and transmission used
- Different types of brakes, drivelines and wheels and tyres

Unit-I Vehicle Classification and Layouts Study various vehicle layouts as front engine & front wheel drive, front engine & rear wheel drive, rear engine & rear wheel drive. Classification based on controls positioning. Types of Chassis frames & construction of Chassis frame and vehicular Body

Unit-II Engine Types (Based on Fuel Used) Gasoline, Diesel, LPG, CNG, Bio-Diesel (Basic study)

Unit-III Clutch, Transmission and Brakes Functions and type of clutches, single plate, multiple plates, centrifugal. Vehicle motion, resistances during motion, accelerated and constant velocity motions, tractive force, gradeabilty, power required and engine characteristics, gear ratio requirement. Manual Gear Boxes - Sliding mesh, constant mesh, synchromesh, epicyclical gear boxes, gear ratios, Automatic transmission. Service Brakes - Function, Internal expanding brakes, shoes and lining material, properties, hydraulic braking system, brake oil, bleeding of brakes, pneumatic braking system and vacuum brakes. Auxiliary Brakes - Exhaust brakes, parking brake.

Unit-IV Steering, Front Axle and Suspension Steering requirements, steering gears box types, steering system and linkages, steering geometry, wheel alignment, toe-in, toe-out, caster, camber, power steering. Purpose of front and rear suspension, types of suspension system, coil spring, leaf spring, torsion bars, shock absorbers, air suspensions, independent suspension and McPherson strut .

Unit-V Drive Line, Rear Axles and Wheels and Tyres Propellers shaft, final drive types, Bevel, hypoid, Drive axles & differential, fully or semi-floating and three quarter floating, dead axle. Types of wheel, rims, tread patterns of tyre, tubeless tyres, specifications of tyres.

TEXT BOOKS
1. Dr. Kirpal Singh, "Automobile Engineering (Volume – 1&2)", 13th Edition, Standard Publishers Distributors, 2020.

2. Rajput.R.K, "A Text Book of Automobile Engineering", Laxmi Publications (P) Ltd, 2017.

REFERENCES
1. Kamaraju Ramakrishna, "Automobile Engineering", Printice Hall of India, 2012
2. Donald L Anglin, Automotive Mechanics, 2017,William H Crouse.

COURSE OUTCOMES
Upon completion of this course, students will be able to
1. Gain the basics of automobile layout, drives and chassis
2. Classify different types of engines
3. Learn the clutch, transmission and brake systems
4. Learn steering, front axle and suspensionsystems used in automobiles
5. Gain knowledge in the drives, axles and tyres.

21MEOESCN	AUTOMOTIVE SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
The course should enable the students to:
- Know about the basics about the vehicle
- Understand the safety aspects in the vehicle.
- Know and understand the various safety aspects.
- To get the knowledge in sensors provided in the vehicle to avoid the crash and to detect the defects in the vehicle.

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, Driver alertness detection 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. Ljubo Vlacic, 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

The students should be able to:
1. Importance of safety in an automobile.
2. Know about the passive safety concepts in automobile.
3. Know the various active safety components
4. Learn the working of the various safety devices in dynamic condition.
5. Know about the impact of sensors in enhancing the automobile safety.

21MEOESCN	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 have deep knowledge on
1. Need for alternative systems
2. Basics and working of energy storage devices
3. Operation of electric vehicles
4. Concepts of hybrid vehicles
5. Electric motors and controllers

21MEOESCN	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 Introduction — Various applications of CFD, Governing equations-continuity, momentum, energy equations, Boundary conditions

Unit-II Fundamentals of Discretisation Basics of FDM, FVM, FEM. Revision of Numerical Methods. Discretisation of Computational Domain

Unit-III One Dimensional Unsteady State Problems Explicit Vs Implicit and Semi-implicit Methods. Numerical Oscillations, Derivation of Stability Criterion. Guiding Principles of FVM.

Unit-IV Introduction to Convection Upwind Differencing, False Diffusion, Significance of Peclet number.

Unit-V Algorithms in CFD Simple, Flow chart for Simple, Predictor- Corrector Methods, MAC Algorithm, TERM PROJECT.

TEXT BOOK
1. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill,1998.
2. Versteeg.H.K and Malalasekera.W, " An Introduction to Computational Fluid Dynamics, the Finite Volume Method", Addison Wesley Longmen Limited, 2008

REFERENCES
1. Patankar.S.V, "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2017.

COURSE OUTCOMES
At the end of the course student can able to
1. Gain deep knowledge on the governing equations used in CFD
2. Understand the fundamentals of discretisation
3. Able to solve one dimensional unsteady state simple problems
4. Gain knowledge on convection

5. Understand various algorithms used

21MEOESCN	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. Understand the different characteristics of fuels
2. Gain knowledge on the significance of liquid fuels
3. Understand the significance of gaseous fuels
4. Know the principle of combustion
5. Understand the different types of coal burning methods and equipments

21MEOESCN	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. Understand the significance of energy management in buildings
2. Select proper landscape and building envelope design for a effective energy management
3. Understand the basics of HVAC system
4. Gain knowledge on the heat transmission in buildings
5. Learn the concepts of passive cooling and understand the potential of renewable energy sources in buildings

21MEOESCN	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. Emphasis the current energy status and know the renewable energy potential.
2. Understand the various aspects of Solar energy and its utilization
3. Realize the significance of wind energy
4. Understand the bio energy conversion techniques
5. Learn the potential of OTEC, tidal, hydrogen and fuel cell as energy resources

21MEOESCN	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. Know the significance of sustainable development and its barriers.
2. Know the regulations for pollution mitigation
3. Know the various land, water and air pollutants
4. Know the methods of mitigating air pollution
5. Know the basic principles of water treatment

21MEOESCN	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. Gain detailed knowledge on power plant and its instrumentation.
2. Learn the electrical and non electrical measurements in power plant.
3. Understand the use of various analyzers in power plant
4. Know the various controls used in boilers
5. Learn the methodology of controlling turbines

21MEOESCN	INTRODUCTION TO HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
- To study the basics of fluid power systems
- To learn the various hydraulic and pneumatic systems
- To study the applications of hydraulic and pneumatic systems

Unit-I Basics of Fluid Power Systems Fluid power- Introduction – types, Advantages, Applications. Properties ofhydraulic fluids – General types of fluids – Fluid power symbols. Basics ofHydraulics- Sources of Hydraulic Power: Pumping theory – Pump classification Gear pump, Vane Pump, piston pump, construction and working of pumps –pump performance – Variable displacement pumps. seals and fittings.

Unit-II Hydraulic Valves and Actuators Construction of Control Components : Directional control valve- pressure controlvalve- electrical control solenoid valves, Relays. Fluid Power Actuators: Linear actuators- single, double, tandem and telescopic cylinders – Rotary actuators.

Unit-III Pneumatic Systems and Components Pneumatic Components: Properties of air – Compressors – Filter, Regulator, Lubricator Unit– Air control valves, Quick exhaust valves, pneumatic actuators. Fluidics –Introduction to fluidic devices, simple circuits.

Unit-IV Design of Hydraulic and Pneumatic Circuits Fluid Power Circuit Design- Speed control, synchronizing, Sequential circuit design for simple applications using cascade method. Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Accumulators: Types, application circuits, sizing of accumulators, Intensifier circuit.

Unit-V Application, Maintenance and Trouble Shooting Hydraulic / pneumatic circuits: applied to machine tools, presses, material handling systems, automotive systems, packaging industries, manufacturing automation. Maintenance in fluid power systems – preventive and breakdown. Maintenance procedures. Trouble shooting of fluid power systems – fault finding process, equipments / tools used, causes and remedies. Safety aspects involved.

TEXT BOOKS
1. Anthony Esposito, "Fluid Power with applications", Prentice Hall International, 2013.
2. Majumdar.S.R, "Oil Hydraulic Systems: Principles and Maintenance", TataMcGraw Hill, 2017.

REFERENCES

1. John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw HillInternational Edition, 1980.
2. Andrew Parr, "Hydraulics and Pneumatics: A technician's and engineer's guide", Elsevier Ltd, 2011.
3. Thomson, "Introduction to Fluid power", Prentcie Hall, 2004.
4. Majumdar.S.R, "Pneumatic systems – principles and maintenance", Tata McGraw-Hill, New Delhi, 2017.

COURSE OUTCOMES
Upon completion of the course, students will be able to
1. Understand the basics of fluid power systems
2. Learn the working of hydraulic valves and actuators
3. Gain knowledge on the operation of pneumatic systems
4. Design hydraulic and pneumatic circuits
5. Determine the applications, maintenance and trouble shooting of hydraulic/pneumatic devices

21MEOESCN	BASIC THERMODYNAMICS AND HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
- To study the basics of thermodynamics
- To learn the various gas power cycles
- To study the basics of heat transfer and refrigeration

Unit-I Basic Concepts of Thermodynamics System - Ideal gas laws - Perfect gas, thermodynamic equilibrium, property, state, process, path and cycle, zeroth law of thermodynamics - Point and path functions - Quasi static process, reversible and irreversible processes. First law of thermodynamics, energy, work, heat, PMM1, applications of First law to closed and open systems. Pressure - Volume diagrams, steady flow process, application of steady flow energy equation.

Unit-II Second Law of Thermodynamics Limitations of first law, statements of second law of Thermodynamics, PMM II, Clausius inequality, heat engine, heat pump, refrigerator, Carnot cycle, Carnot theorem, entropy, temperature - Entropy diagram, entropy changes for a closed system. Third law of thermodynamics.

UNIT-III Gas Power Cycles Otto, Diesel, dual cycles: Efficiency, mean effective pressure, comparison. Introduction to Brayton cycle - Reheat and regeneration.

Unit-IV Refrigeration and Air-Conditioning Vapour compression refrigeration: Working principle, simple problems in vapour compression refrigeration cycle with sub-cooling and superheating. Introduction absorption system. Air-conditioning - Factors affecting air-to vapour conditioning, types of air-conditioning - Summer, winter, window and central air-conditioning.

Unit-V Heat Transfer Modes of heat transfer, steady state heat conduction - Plane wall, composite wall, hollow and composite cylinders. Overall heat transfer coefficient. Convection, empirical relations. Laws of radiations - Concept of block body Radiant heat transfer between two surfaces.

TEXT BOOKS
1. Rajput.R.K, "*Thermal Engineering*", Lakshmi Publications, 2018.
2. Yunus A.Cengel, "*Introduction to Thermodynamics & Heat Transfer*",McGraw Hill Higher- Education, 2009.

REFERENCES

1. Kothandaraman.C.P, Domkundwar.S, Anand Domkundwar, *"A Course inThermal Engineering"*, Dhanpat Rai & Co. (P) Ltd., 2016.
2. Nag.P.K, *"Engineering Thermodynamics"*, Tata McGraw Hill, New Delhi, 2017.
3. Sarkar.B.K, *"Thermal Engineering"*, 3rd Edition, Tata McGraw Hill, New Delhi,2017

COURSE OUTCOMES

Upon completion of the course, students will be able to
1. Know the basic concepts of thermodynamics
2. Understand the various laws of thermodynamics and their applications
3. Learn the various gas power cycles
4. Understand the basics of refrigeration and air conditioning engineering
5. Understand the various modes of heat transfer

21MEOESCN	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. Gain knowledge on the fundamentals of energy
2. Understand various energy management concepts
3. Learn the methods of energy audit and usage of instruments
4. Asses the energy saving opportunities
5. Analyze and report the outcome of energy audit

21MEOESCN	ENERGY CONSERVATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To encourage the students to learn
- Energy conservation principles.
- Energy conservation in steam systems.
- Energy conservation in fluid flow machinery.
- Electrical energy conservation measures.

Unit-I Energy Conservation Principles Energy scenario, principles of energy conservation, resource availability, energy savings, current energy consumption in India, roles and responsibilities of energy managers in industries.

Unit-II Energy Conservation in Steam Systems Power plant components, conservation measures in steam systems, losses in boiler, methodology of upgrading boiler performance - blow down control, excess air control, pressure reducing stations, condensate recovery, condensate pumping, thermo compressors, recovery of flash steam, air removal and venting, steam traps, cooling towers.

Unit-III Energy Conservation in Fluid Machinery Centrifugal pumps, energy consumption and energy saving potentials, design consideration, minimizing over design. Fans and blowers - specification, safety margin, choice of fans, controls and design considerations. Air compressor and compressed air systems, selection of compressed air layout, energy conservation aspects to be considered at design stage.

Unit-IV Electrical Energy Conservation Potential areas for electrical energy conservation in various industries, conservation methods, energy management opportunities in electrical heating, lighting system, cable selection, energy efficient motors, factors involved in determination of motor efficiency, adjustable AC drives, variable speed drives, energy efficiency in electrical system.

Unit-V Energy Management Organizational background desired for energy management persuasion, motivation, publicity role, tariff analysis, industrial energy management systems, energy monitoring, auditing and targeting, economics of various energy conservation schemes – energy policy and energy labeling.

TEXT BOOKS
1. Reay.D.A, "Industrial energy conservation", Pergamon Press, 1st edition, 2003.
2. White.L.C, "Industrial Energy Management and Utilization", Hemisphere Publishers, 2002.

REFERENCES
1. Smith.C.B, "Energy Management Principles", Pergamon Press, 2015.
2. Trivedi.P.R and Jolka.K.R, "Energy Management", Common Wealth Publication, 2002.

COURSE OUTCOMES

Upon completion of the course, students will be able to
1. Learn the energy conservation principles

2. Know the modes of energy conservation in steam systems
3. Identify methods for energy conservation in a fluid system
4. Understand the electrical conservation measures.
5. Learn the concepts of energy management

21MEOESCN	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. Understand the basic components and measuring devices
2. Know the operation of solar thermal energy systems

3. Understand the components of solar power plants
4. Emphasize the advantages of photovoltaics
5. Learn the methods to effectively utilize solar energy in buildings

21MEOESCN	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. Learn the significance of co-generation
2. Understand the economics of co generation
3. Learn the thermodynamics of waste recovery
4. Learn the various systems used for waste heat recovery
5. Familiar with the economics of waste heat recovery

21MEOESCN	MAINTANANCE AND SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To develop your ability in formulating suitable maintenance strategies to achieve reliable a manufacturing system and achieve continuous system availability for production.
- To equip you with essential system diagnosis techniques so that you can identify and take appropriate actions on error symptoms and causes of failures.
- Apply safe working practices and understand the principles of preventive and first-line maintenance.
- Understand the principles of power transmission systems; remove and refit bearings, keyed shafts, belts & chains; install & align shafts; tension drive train components and to empower you with the skills to manage manufacturing system and man safely.

Unit–I Need for Maintenance - Types of maintenance - Maintenance organisation charts for large, medium and small size plants - Basic functions of maintenances. Preventive maintenance - Need for preventive maintenance - Starting of preventive maintenance programme - Equipment record - Check list - Inspection - What to inspect - Frequency of inspection aids to good preventive maintenance.

Unit–II Maintenance of Ball, Roller and Tapered Bearing - Maintenance of Belt, Chain, Gears, Pulleys, Shafting and Fasteners.

Unit–III Maintenance of cranes - Hooks and slings - Industrial trucks - Maintenance of Power Plant Equipments - Centrifugal pumps, fans & blowers. Maintenance of Mining Equipments-Bucket Wheel excavator.

Unit–IV Devices for safeguarding machines - points to be considered in designing the guards - Enclosures, covers and barricades - Safeguarding of fast and loose pulleys, chain and rope drives, revolving machines, pressure plates and self acting machines - Remote tripping and starting devices.

Unit–V Safety Engineering - Accident Prevention - Various steps to accomplish accident prevention - Safety measures and safety precaution in workshops - Protection of eyes - Protection against dangerous fumes - Protection against fire - Wage incentive to satisfy workman compensation.

TEXT BOOKS
   1. Charles D Reese, Occupational Health & Safety Management, CRC Press 2018.

REFERENCES
   1. R. C. Mishra Maintenance Engineering & Management, PHI 2nd Edition 2012
   2. Elsayed A. Elsayed, Reliability Engineering, Wiley, 3rd Edition 2021.
   3. B.S Dhillon, Engineering Maintenance a modern approach, C.R.C Publishers 2nd edition 2002
   4. Alakesh Manna, A Text Book of Reliability and Maintenance Engineering, IK International Publishing House 2011
   5. NVS Raju, Plant Maintenance and Reliability Engineering, 1st edition Cengage Learning, 2011.

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

1. Understand the need for maintenance and its procedure in industries
2. Understand the maintenance procedure for bearing and transmission systems.
3. Learn the maintenance technique for power plant and mining equipments
4. Know the various safe guarding machines.
5. Emphasize the significance of safety in industries.

1MEOESCN	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. Learn the sources of sources and effects of automobile pollution

2. Understand the various engine pollution.
3. Learn the various mechanisms of emission control.
4. Know the various emission measuring equipments.
5. Acquire the knowledge of emission standards and fuel modification in engines.

21MEOE 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.

21MEOE 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   Understand 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.

HONOURS ELECTIVE COURSES

21MEHE 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

21MEHE 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

21MEHESCN	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

21MEHESCN	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

21MEHESCN	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.

21MEHESCN	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

21MEMISCN	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.

21MEMISCN	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.

21MEMISCN	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

21MEMISCN	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.

21MEMISCN	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.

21MEMISCN	AUTOMOBILE TECHNOLOGY	L	T	P	C
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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.