KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

REGULATIONS, CURRICULUM & SYLLABI - 2020

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted during 2020 - 2021 and onwards)

BACHELOR OF ENGINEERING DEGREE IN MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

KONGU
Assuring the Best

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(Autonomous)

REGULATIONS 2020

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

BACHELOR OF ENGINEERING (BE) / BACHELOR OF TECHNOLOGY (BTech) DEGREE PROGRAMMES

These regulations are applicable to all candidates admitted into BE/BTech Degree programmes from the academic year 2020 – 2021 onwards.

1. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless otherwise specified:

i. "University" means ANNA UNIVERSITY, Chennai.

ii. "College" means KONGU ENGINEERING COLLEGE.

iii. "Programme" means Bachelor of Engineering (BE) / Bachelor of Technology (BTech) Degree programme

iv. "Branch" means specialization or discipline of BE/BTech Degree programme, like Civil Engineering, Information Technology, etc.

v. "Course" means a Theory / Theory cum Practical / Practical course that is normally studied in a semester like Mathematics, Physics etc.

vi. "Credit" means a numerical value allocated to each course to describe the candidate's workload required per week.

vii. "Grade" means the letter grade assigned to each course based on the marks range specified.

viii. "Grade point" means a numerical value (0 to 10) allocated based on the grade assigned to each course.

ix. "Principal" means Chairman, Academic Council of the College.

x. "Controller of Examinations" means authorized person who is responsible for all examination related activities of the College.

xi. "Head of the Department" means Head of the Department concerned of the College.

2. PROGRAMMES AND BRANCHES OF STUDY

The following programmes and branches of study approved by Anna University, Chennai and All India Council for Technical Education, New Delhi are offered by the College.

Programme	Branch
BE	Civil Engineering
	Mechanical Engineering
	Electronics and Communication Engineering
	Computer Science and Engineering
	Electrical and Electronics Engineering
	Electronics and Instrumentation Engineering
	Mechatronics Engineering
	Automobile Engineering
	Computer Science and Design
BTech	Chemical Engineering
	Information Technology
	Food Technology
	Artificial Intelligence and Data Science
	Artificial Intelligence and Machine Learning

3. ADMISSION REQUIREMENTS

3.1 First Semester Admission

The candidates seeking admission to the first semester of the eight semester BE / BTech Degree Programme:

Should have passed the Higher Secondary Examination (10 + 2) in the academic stream with Mathematics, Physics and Chemistry as three of the four subjects of study under Part-III subjects of the study conducted by the Government of Tamil Nadu or any examination of any other University or authority accepted by the Anna University, Chennai as equivalent thereto.

(OR)

Should have passed the Higher Secondary Examination of Vocational stream (Vocational groups in Engineering / Technology) as prescribed by the Government of Tamil Nadu.

They should also satisfy other eligibility conditions as prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

3.2 Lateral Entry Admission

The candidates who hold a Diploma in Engineering / Technology awarded by the State Board of Technical Education, Tamilnadu or its equivalent are eligible to apply for Lateral entry admission to the third semester of BE / BTech in relevant branches of study.

(OR)

The candidates who hold a BSc degree (10+2+3 stream) with mathematics as one of the subjects at the BSc level from a recognised University are eligible to apply for Lateral entry admission to the third semester of BE / BTech. Such candidates shall undergo two additional Engineering course(s) in the third and fourth semesters as prescribed by the College.

They should satisfy other eligibility conditions prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

4. STRUCTURE OF PROGRAMMES

4.1 Categorisation of Courses

The BE / BTech programme shall have a curriculum with syllabi comprising of theory, theory cum practical, practical courses in each semester, professional skills training, project work, internship, etc. that have been approved by the respective Board of Studies and Academic Council of the College. All the programmes have well defined Programme Outcomes (PO), Programme Specific Outcomes (PSO) and Programme Educational Objectives (PEOs) as per Outcome Based Education (OBE). The content of each course is designed based on the Course Outcomes (CO). The courses shall be categorized as follows:

i. Humanities and Social Sciences (HS) including Management Courses

ii. Basic Science (BS) Courses

iii. Engineering Science (ES) Courses

iv. Professional Core (PC) Courses

v. Professional Elective (PE) Courses

vi. Open Elective (OE) Courses

vii. Employability Enhancement Courses (EC) like Project work, Professional Skills, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship in Industry or elsewhere

viii. Audit Courses (AC)

ix. Mandatory Courses (MC) like Student Induction Program and Environmental Science.

x. Honours Degree Courses (HC)

4.2 Credit Assignment and Honours Degree

4.2.1. Credit Assignment

Each course is assigned certain number of credits as follows:

Contact period per week	Credits
1 Lecture / Tutorial Period	1
2 Practical Periods	1
2 Project Work Periods	1
40 Training / Internship Periods	1

The minimum number of credits to complete the BE/BTech programme is 169.

4.2.2. Honours Degree

If a candidate earns 18 to 20 additional credits in an emerging area, then he/she can be awarded with Honours degree mentioning that emerging area as his/her specialization. The respective board of studies shall recommend the specializations for honours degree and appropriate additional courses to be studied by the candidate which shall get approval from Academic Council of the institution. A candidate shall have not less than 8.0 CGPA and no history of arrears during the entire programme to opt for the honours degree.

Various specializations for various branches recommended by the respective boards of studies are given below:

S. No.	Specializations for Honours degree in emerging areas	To be offered as Honours, Only for the following branches mentioned against the specialization
1.	Construction Technology	Civil Engineering
2.	Robotics	Mechanical Engineering
3.	Electric Vehicles	Mechanical Engineering
4.	Artificial Intelligence and Machine Learning	Mechatronics Engineering
5.	Electric Vehicles	Automobile Engineering
6.	Artificial Intelligence and Machine Learning	Electronics and Communication Engineering
7.	Electric Vehicles	Electrical and Electronics Engineering
8.	Control Systems and Sensors Technology	Electronics and Instrumentation Engineering
9.	Cyber Security	Computer Science and Engineering
10.	Data Science	Computer Science and Engineering
11.	Cyber Security	Information Technology
12.	Data Science	Information Technology
13.	Waste Technology	Chemical Engineering
14.	Food Processing and	Food Technology

	Management	

The courses specified under Honours degree in the emerging area may include theory, theory cum practical, practical, project work, etc. under the particular specialization. A candidate can choose and study these specified courses from fourth semester onwards and he/she shall successfully complete the courses within the stipulated time vide clause 5. Total number of credits earned in each semester may vary from candidate to candidate based on the courses chosen. The registration, assessment & evaluation pattern and classification of grades of these courses shall be the same as that of the courses in the regular curriculum of the programme of the candidate vide clause 6, clause 7 and clause 15 respectively. A candidate can earn Honours degree in only one specialization during the entire duration of the programme.

4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like project work, internship, professional skills training, comprehensive test & viva, internship and entrepreneurships/start ups during the programme to gain/exhibit the knowledge/skills.

4.3.1 Professional Skills Training/ Entrepreneurships/Start Ups

A candidate may be offered with appropriate training courses imparting programming skills, communication skills, problem solving skills, aptitude skills etc. It is offered in two phases as phase I in fifth semester and phase II in sixth semester including vacation periods and each phase can carry two credits.

(or)

A candidate may be allowed to go for training at research organizations or industries for a required number of hours in sixth semester vacation period. Such candidate can earn two credits for this training course in place of Professional Skills Training course II in sixth semester. He/She shall attend Professional Skills Training Phase I in fifth semester and can earn two credits.

(or)

A candidate may be allowed to set up a start up and working part-time for the start ups by applying his/her innovations and can become a student entrepreneur during BE/BTech programme. Candidates can set up their start up from fifth semester onwards either inside or outside of the college. Such student entrepreneurs may earn a maximum of 2 credits per semester for two semesters each in place of either Professional Skills Training I or Professional Skills Training II. The area in which the candidate wants to initiate a start up may be interdisciplinary or multidisciplinary. The progress of the startup shall be evaluated by a panel of members constituted by the Principal through periodic reviews.

4.3.2 Comprehensive Test & Viva

The overall knowledge of the candidate in various courses he/she studied shall be evaluated by (i) conducting comprehensive tests with multiple choice questions generally with pattern similar to GATE and/or (ii) viva-voce examination conducted by a panel of experts assigned by the Head of the department. The members can examine the knowledge of the candidate by asking questions from various domains and the marks will be assigned based on their answers. This course shall carry two credits.

4.3.3 Internships

The curriculum enables a candidate to go for full time projects through internship during a part of seventh semester and/or entire final semester and can earn credits

vide clause 7.6 and clause 7.11.

A candidate is permitted to go for full time projects through internship in seventh semester with the following condition: The candidate shall complete a part of the seventh semester courses with a total credit of about 50% of the total credits of seventh semester including Project Work I Phase II in the first two months from the commencement of the seventh semester under fast track mode. The balance credits required to complete the seventh semester shall be earned by the candidate through either approved Value Added Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

A candidate is permitted to go for full time projects through internship during eighth semester. Such candidate shall earn the minimum number of credits required to complete eighth semester other than project through either approved Value Added Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

Assessment procedure is to be followed as specified in the guidelines approved by the Academic Council.

4.4 Value Added Courses / Online Courses / Self Study Courses

The candidates may optionally undergo Value Added Courses / Online Courses / Self Study Courses as elective courses.

4.4.1 **Value Added Courses:** Value Added courses each with One / Two credits shall be offered by the college with the prior approval from respective Board of Studies. A candidate can earn a maximum of six credits through value added courses during the entire duration of the programme.

4.4.2 **Online Courses:** Candidates may be permitted to earn credits for online courses, offered by NPTEL / SWAYAM / a University / Other Agencies, approved by respective Board of Studies.

4.4.3 **Self Study Courses:** The Department may offer an elective course as a self study course. The syllabus of the course shall be approved by the respective Board of Studies. However, mode of assessment for a self study course will be the same as that used for other courses. The candidates shall study such courses on their own under the guidance of member of the faculty following due approval procedure. Self study course is limited to one per semester.

4.4.4 The elective courses in the final year may be exempted if a candidate earns the required credits vide clause 4.4.1, 4.4.2 and 4.4.3 by registering the required number of courses in advance.

4.4.5 A candidate can earn a maximum of 30 credits through all value added courses, online courses and self study courses.

4.5 Flexibility to Add or Drop Courses

4.5.1 A candidate has to earn the total number of credits specified in the curriculum of the respective programme of study in order to be eligible to obtain the degree. However, if the candidate wishes, then the candidate is permitted to earn more than the total number of credits prescribed in the curriculum of the candidate's

programme.

4.5.2 From the first to eighth semesters the candidates have the option of registering for additional elective/Honours courses or dropping of already registered additional elective/Honours courses within two weeks from the start of the semester. Add / Drop is only an option given to the candidates. Total number of credits of such courses during the entire programme of study cannot exceed eight.

4.6 Maximum number of credits the candidate can enroll in a particular semester cannot exceed 30 credits.

4.7 The blend of different courses shall be so designed that the candidate at the end of the programme would have been trained not only in his / her relevant professional field but also would have developed to become a socially conscious human being.

4.8 The medium of instruction, examinations and project report shall be English.

5. DURATION OF THE PROGRAMME

5.1 A candidate is normally expected to complete the BE / BTech Degree programme in 8 consecutive semesters/4 Years (6 semesters/3 Years for lateral entry candidate), but in any case not more than 14 semesters/7 Years (12 semesters/6 Years for lateral entry candidate).

5.2 Each semester shall consist of a minimum of 90 working days including continuous assessment test period. The Head of the Department shall ensure that every teacher imparts instruction as per the number of periods specified in the syllabus for the course being taught.

5.3 The total duration for completion of the programme reckoned from the commencement of the first semester to which the candidate was admitted shall not exceed the maximum duration specified in clause 5.1 irrespective of the period of break of study (vide clause 11) or prevention (vide clause 9) in order that the candidate may be eligible for the award of the degree (vide clause 16). Extension beyond the prescribed period shall not be permitted.

6. COURSE REGISTRATION FOR THE EXAMINATION

6.1 Registration for the end semester examination is mandatory for courses in the current semester as well as for the arrear courses failing which the candidate will not be permitted to move on to the higher semester. This will not be applicable for the courses which do not have an end semester examination.

6.2 The candidates who need to reappear for the courses which have only continuous assessment shall enroll for the same in the subsequent semester, when offered next, and repeat the course. In this case, the candidate shall attend the classes, satisfy the attendance requirements (vide clause 8), earn continuous assessment marks. This will be considered as an attempt for the purpose of classification.

6.3 If a candidate is prevented from writing end semester examination of a course due to lack of attendance, the candidate has to attend the classes, when offered next, and fulfill the attendance requirements as per clause 8 and earn continuous assessment marks. If the course, in which the candidate has a lack of attendance, is an elective, the candidate may register for the same or any other elective course in the subsequent semesters and that will be considered as an attempt for the purpose of classification.

6.4 A candidate shall register for the chosen courses as well as arrear courses (if any vide clause 6.2 and 6.3) from the list of courses specified under Honours degree.

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Project Work, Professional Skills Training / Industrial Training, Internship and Entrepreneurships/ Start ups. Performance in each course of study shall be evaluated based on (i) Continuous Assessments (CA) throughout the semester and (ii) End Semester Examination (ESE) at the end of the semester except for the courses which are evaluated based on continuous assessment only. Each course shall be evaluated for a maximum of 100 marks as shown below:

<table>
<tr><th>Sl. No.</th><th>Category of Course</th><th>Continuous Assessment Marks</th><th>End Semester Examination Marks</th></tr>
<tr><td>1.</td><td>Theory / Practical</td><td>50</td><td>50</td></tr>
<tr><td>2.</td><td>Theory cum Practical</td><td colspan="2">The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components.</td></tr>
<tr><td>3.</td><td>Professional Skills Training / / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work 1 / Industrial Training / Mandatory Course</td><td>100</td><td>---</td></tr>
<tr><td>4.</td><td>Project Work 2 Phase I / Project Work 2 Phase II / Internships</td><td>50</td><td>50</td></tr>
<tr><td>5.</td><td>Value Added Course</td><td rowspan="2">The distribution of marks shall be decided based on the credit weightage</td><td rowspan="2">---</td></tr>
<tr><td>6.</td><td>All other Courses</td></tr>
</table>

7.2 Examiners for setting end semester examination question papers for theory courses, theory cum practical courses and practical courses and evaluating end semester examination answer scripts, project works, internships and entrepreneurships/start ups shall be appointed by the Controller of Examinations after obtaining approval from the Principal.

7.3 Theory Courses

For all theory courses out of 100 marks, the continuous assessment shall be 50 marks and the end semester examination shall be for 50 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 50. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. Three tests shall be conducted for 50 marks each and reduced to 30 marks each. The total of the continuous assessment marks and the end semester examination marks shall be rounded off to the nearest integer.

7.3.1 The assessment pattern for awarding continuous assessment marks shall be as follows:

Sl. No.	Type	Max. Marks	Remarks
1.	Test - I	30	Average of best two
	Test - II	30	
	Test - III	30	
2.	Tutorial	15	Should be of Open Book/Objective Type. Average of best 4 (or more, depending on the nature of the course, as may be approved by Principal)
3.	Assignment / Paper Presentation in Conference / Seminar / Comprehension / Activity based learning / Class notes	05	To be assessed by the Course Teacher based on any one type.
	Total	50	Rounded off to the one decimal place

However, the assessment pattern for awarding the continuous assessment marks may be changed based on the nature of the course and is to be approved by the Principal.

7.3.2 A reassessment test or tutorial covering the respective test or tutorial portions may be conducted for those candidates who were absent with valid reasons (Sports or any other reason approved by the Principal).

7.3.3 The end semester examination for theory courses shall be for a duration of three hours and shall be conducted between November and January during odd semesters and between April and June during even semesters every year.

7.4 Theory cum Practical Courses

For courses involving theory and practical components, the evaluation pattern as per the clause 7.1 shall be followed. Depending on the nature of the course, the end semester examination shall be conducted for theory and the practical components. The apportionment of continuous assessment and end semester examination marks shall be decided based on the credit weightage assigned to theory and practical components approved by Principal.

7.5 Practical Courses

For all practical courses out of 100 marks, the continuous assessment shall be for 50 marks and the end semester examination shall be for 50 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidate's records shall be maintained.

7.5.1 The assessment pattern for awarding continuous assessment marks for each course shall be decided by the course coordinator based on rubrics of that particular course, and shall be based on rubrics for each experiment.

7.6 Project Work II Phase I / Project Work II Phase II

7.6.1 Project work shall be assigned to a single candidate or to a group of candidates not exceeding 4 candidates in a group. The project work is mandatory for all the candidates.

7.6.2 The Head of the Department shall constitute review committee for project work. There shall be two assessments by the review committee during the semester. The candidate shall make presentation on the progress made by him/her before the committee.

7.6.3 The continuous assessment and end semester examination marks for Project Work II (both Phase I and Phase II) and the Viva-Voce Examination shall be distributed as below:

Continuous Assessment (Max. 50 Marks)						End Semester Examination (Max. 50 Marks)			
Zeroth Review		Review I (Max.. 20 Marks)		Review II (Max. 30 Marks)		Report Evaluation (Max. 20 Marks)	Viva - Voce (Max. 30 Marks)		
Rv. Com	Guide	Review Committee (excluding guide)	Guide	Review Committee (excluding guide)	Guide	Ext. Exr.	Guide	Exr.1	Exr.2
0	0	10	10	15	15	20	10	10	10

7.6.4 The Project Report prepared according to approved guidelines and duly signed by the Supervisor shall be submitted to Head of the Department. The candidate(s) must submit the project report within the specified date as per the academic schedule of the semester. If the project report is not submitted within the specified date then the candidate is deemed to have failed in the Project Work and redo it in the subsequent semester.

7.6.5 If a candidate fails to secure 50% of the continuous assessment marks in the project work, he / she shall not be permitted to submit the report for that particular semester and shall have to redo it in the subsequent semester and satisfy attendance requirements.

7.6.6 The project work shall be evaluated based on the project report submitted by the candidate in the respective semester and viva-voce examination by a committee consisting of two examiners and guide of the project work.

7.6.7 If a candidate fails to secure 50 % of the end semester examination marks in the project work, he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted as per clause 7.6.6.

7.6.8 A copy of the approved project report after the successful completion of viva-voce examination shall be kept in the department library.

7.7 Project Work I Phase I / Industrial Training

The evaluation method shall be same as that of the Project Work II as per clause 7.6 excluding 7.6.3, 7.6.5, 7.6.6 and 7.6.7. The marks distribution is given below:

Continuous Assessment (Max. 100 Marks)								
Zeroth Review		Review I (Max.. 20 Marks)		Review II (Max.. 30 Marks)		Review III (Max. 50 Marks)		
						Report Evaluation (Max. 20 Marks)	Viva - Voce (Max. 30 Marks)	
Review Committee	Guide	Review Committee (excluding guide)	Guide	Review Committee (excluding guide)	Guide	Review Committee	Guide	Review Committee
0	0	10	10	15	15	20	10	20

If a candidate fails to secure 50 % of the continuous assessment marks in this course, he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted.

7.8 Professional Skills Training

Phase I training shall be conducted for minimum of 80 hours in 4th semester vacation and during 5th semester. Phase II training shall be conducted for minimum of 80 hours in 5th semester vacation and during 6th semester. The evaluation procedure shall be approved by the Principal.

7.9 Comprehensive Test/Viva

A candidate can earn 2 credits by successfully completing this course. The evaluation procedures shall be approved by the Principal.

7.10 Entrepreneurships/ Start ups

A start up/business model may be started by a candidate individually or by a group of maximum of three candidates during the programme vide clause 4.3.1. The head of the department concerned shall assign a faculty member as a mentor for each start up.

A review committee shall be formed by the Principal for reviewing the progress of the Start ups / Business models, innovativeness, etc. The review committee can recommend the appropriate grades for academic performance for the candidate(s) involved in the start ups. This course shall carry a maximum of two credits in fifth semester and two credits in sixth semester respectively and shall be evaluated through continuous assessments for a maximum of 100 marks vide clause 7.1. A report about the start ups is to be submitted to the review committee for evaluation for each start up and the marks will be given to Controller of Examinations after getting approval from Principal.

7.11 Projects through Internships

Each candidate shall submit a brief report about the internship undergone and a certificate issued from the organization concerned at the time of Viva-voce examination to the review committee. The evaluation method shall be same as that of the Project Work II as per clause 7.6.

7.12 Value Added Course

Minimum of two assessments shall be conducted during the value added course duration by the offering department concerned.

7.13 Online Course

The Board of Studies will provide methodology for the evaluation of the online courses. The Board can decide whether to evaluate the online courses through continuous assessment and end semester examination or through end semester examination only. In case of credits earned through online mode from NPTEL / SWAYAM / a University / Other Agencies approved by Chairman, Academic Council, the credits may be transferred and grades shall be assigned accordingly.

7.14 Self Study Course

The member of faculty approved by the Head of the Department shall be responsible for periodic monitoring and evaluation of the course. The course shall be evaluated through continuous assessment and end semester examination. The evaluation methodology shall be the same as that of a theory course.

7.15 Audit Course

A candidate may be permitted to register for specific course not listed in his/her programme curriculum and without undergoing the rigors of getting a 'good' grade, as an Audit course, subject to the following conditions.

The candidate can register only one Audit course in a semester starting from second semester subject to a maximum of two courses during the entire programme of study. Such courses shall be indicated as 'Audit' during the time of registration itself. Only courses currently offered for credit to the candidates of other branches can be audited.

A course appearing in the curriculum of a candidate cannot be considered as an audit

course. However, if a candidate has already met the Professional Elective and Open Elective credit requirements as stipulated in the curriculum, then, a Professional Elective or an Open Elective course listed in the curriculum and not taken by the candidate for credit can be considered as an audit course.

Candidates registering for an audit course shall meet all the assessment and examination requirements (vide clause 7.3) applicable for a credit candidate of that course. Only if the candidate obtains a performance grade, the course will be listed in the semester Grade Sheet and in the Consolidated Grade Sheet along with the grade SF (Satisfactory). Performance grade will not be shown for the audit course.

Since an audit course has no grade points assigned, it will not be counted for the purpose of GPA and CGPA calculations.

7.16 Mandatory Course

A candidate shall attend and complete the induction training program of duration three weeks at the beginning of the first semester. It is mandatory for all candidates who have joined in various branches of all BE/BTech programmes. The induction training program includes the courses recommended by AICTE. Apart from this induction program, a candidate shall undergo the courses listed by AICTE as mandatory courses during their programme. No credits shall be given for such courses and shall be evaluated through continuous assessment tests only vide clause 7.1 for a maximum of 100 marks each. Since these courses have no grade points assigned, these courses will not be counted for the purpose of GPA and CGPA calculations.

7.17 Yoga and Values for Holistic Development (YVHD) and Universal Human Values (UHV)

Courses such as YVHD and UHV shall be offered to all candidates of all BE/BTech programmes. These courses shall carry a maximum of 100 marks each and shall be evaluated through continuous assessment tests only vide clause 7.1. The candidate(s) can earn 2 credits for UHV and 1 credit for YVHD by successfully completing these courses. Two continuous assessment tests will be conducted and the average marks will be taken for the calculation of grades.

8. REQUIREMENTS FOR COMPLETION OF A SEMESTER

8.1 A candidate who has fulfilled the following conditions shall be deemed to have satisfied the requirements for completion of a semester and permitted to appear for the examinations of that semester.

8.1.1 Ideally, every candidate is expected to attend all classes and secure 100 % attendance. However, a candidate shall secure not less than 80 % (after rounding off to the nearest integer) of the overall attendance taking into account the total number of working days in a semester.

8.1.2 A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to medical reasons (hospitalization / accident / specific illness) but has secured not less than 70 % in the current semester may be permitted to appear for the current semester examinations with the approval of the Principal on payment of a condonation fee as may be fixed by the authorities from time to time. The medical certificate needs to be submitted along with the leave application. A candidate can avail this provision only twice during the entire duration of the degree programme.

A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to his/her entrepreneurships/ start ups activities, but has secured not less than 60 % in the current semester can be permitted to appear for the current semester examinations with the recommendation of review committee and approval from the Principal.

8.1.3 In addition to clause 8.1.1 or 8.1.2, a candidate shall secure not less than 60 % attendance in each course.

8.1.4 A candidate shall be deemed to have completed the requirements of study of any semester only if he/she has satisfied the attendance requirements (vide clause 8.1.1 to 8.1.3) and has registered for examination by paying the prescribed fee.

8.1.5 Candidate's progress is satisfactory.

8.1.6 Candidate's conduct is satisfactory and he/she was not involved in any indisciplined activities in the current semester.

8.2. The candidates who do not complete the semester as per clauses from 8.1.1 to 8.1.6 except 8.1.3 shall not be permitted to appear for the examinations at the end of the semester and not be permitted to go to the next semester. They have to repeat the incomplete semester in next academic year.

8.3 The candidates who satisfy the clause 8.1.1 or 8.1.2 but do not complete the course as per clause 8.1.3 shall not be permitted to appear for the end semester examination of that course alone. They have to repeat the incomplete course in the subsequent semester when it is offered next.

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

9.1 A candidate shall normally be permitted to appear for end semester examination of the current semester if he/she has satisfied the semester completion requirements as per clause 8, and has registered for examination in all courses of that semester. Registration is mandatory for current semester examinations as well as for arrear examinations failing which the candidate shall not be permitted to move on to the higher semester.

9.2 When a candidate is deputed for a National / International Sports event during End Semester examination period, supplementary examination shall be conducted for such a candidate on return after participating in the event within a reasonable period of time. Such appearance shall be considered as first appearance.

9.3 A candidate who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of letter grades / marks.

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

10.1 A candidate may, for valid reasons, be granted permission to withdraw from appearing for the examination in any regular course or all regular courses registered in a particular semester. Application for withdrawal is permitted only once during the entire duration of the degree programme.

10.2 The withdrawal application shall be valid only if the candidate is otherwise eligible to write the examination (vide clause 9) and has applied to the Principal for permission prior to the last examination of that semester after duly recommended by the Head of the Department.

10.3 The withdrawal shall not be considered as an appearance for deciding the eligibility of a candidate for First Class with Distinction/First Class.

10.4 If a candidate withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examinations. A final semester candidate who has withdrawn shall be permitted to appear for supplementary examination to be conducted within reasonable time as per clause 14.

10.5 The final semester candidate who has withdrawn from appearing for project viva-voce for genuine reasons shall be permitted to appear for supplementary viva-voce examination within reasonable time with proper application to Controller of Examinations and on payment of prescribed fee.

11. PROVISION FOR BREAK OF STUDY

11.1 A candidate is normally permitted to avail the authorised break of study under valid reasons (such as accident or hospitalization due to prolonged ill health or any other valid reasons) and to rejoin the programme in a later semester. He/She shall apply in advance to the Principal, through the Head of the Department, stating the reasons therefore, in any case, not later than the last date for registering for that semester examination. A candidate is permitted to avail the authorised break of study only once during the entire period of study for a maximum period of one year. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for the break of study.

11.2 The candidates permitted to rejoin the programme after break of study / prevention due to lack of attendance shall be governed by the rules and regulations in force at the time of rejoining.

11.3 The candidates rejoining in new Regulations shall apply to the Principal in the prescribed format through Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.

11.4 The total period of completion of the programme reckoned from the commencement of the semester to which the candidate was admitted shall not exceed the maximum period specified in clause 5 irrespective of the period of break of study in order to qualify for the award of the degree.

11.5 If any candidate is prevented for want of required attendance, the period of prevention shall not be considered as authorized break of study.

11.6 If a candidate has not reported to the college for a period of two consecutive semesters without any intimation, the name of the candidate shall be deleted permanently from the college enrollment. Such candidates are not entitled to seek readmission under any circumstances.

12. PASSING REQUIREMENTS

12.1 A candidate who secures not less than 50 % of total marks (continuous assessment and end semester examination put together) prescribed for the course with a minimum of 45 % of the marks prescribed for the end semester examination in all category of courses vide clause 7.1 except for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course in the examination.

12.2 A candidate who secures not less than 50 % in continuous assessment marks prescribed for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course. If a candidate secures less than 50% in the continuous assessment marks, he / she shall have to re-enroll for the same in the subsequent semester and satisfy the attendance requirements.

12.3 For a candidate who does not satisfy the clause 12.1, the continuous assessment marks secured by the candidate in the first attempt shall be retained and considered valid for subsequent attempts. However, from the fourth attempt onwards the marks scored in the end semester examinations alone shall be considered, in which case the candidate shall secure minimum 50 % marks in the end semester examinations to satisfy the passing requirements, but the grade awarded shall be only the lowest passing grade irrespective of the marks secured.

13. REVALUATION OF ANSWER SCRIPTS

A candidate shall apply for a photocopy of his / her semester examination answer script within a reasonable time from the declaration of results, on payment of a prescribed fee by submitting the proper application to the Controller of Examinations. The answer script shall be pursued and justified jointly by a faculty member who has handled the course and the course coordinator and recommended for revaluation. Based on the recommendation, the candidate can register for revaluation through proper application to the Controller of Examinations. The Controller of Examinations will arrange for revaluation and the results will be intimated to the candidate concerned. Revaluation is permitted only for Theory courses and Theory cum Practical courses where end semester examination is involved.

14. SUPPLEMENTARY EXAMINATION

If a candidate fails to clear all courses in the final semester after the announcement of final end semester examination results, he/she shall be allowed to take up supplementary examinations to be conducted within a reasonable time for the courses of final semester alone, so that he/she gets a chance to complete the programme.

The candidates who have failed in the courses Professional Skill Training I/II and

Comprehensive Test/Viva shall be permitted to take up supplementary examinations.

15. AWARD OF LETTER GRADES

Range of % of Total Marks	Letter Grade	Grade Point
91 to 100	O (Outstanding)	10
81 to 90	A+ (Excellent)	9
71 to 80	A (Very Good)	8
61 to 70	B+ (Good)	7
50 to 60	B (Average)	6
Less than 50	RA (Reappear)	0
Satisfactory	SF	0
Withdrawal	W	-
Absent	AB	-
Shortage of Attendance in a course	SA	-

The Grade Point Average (GPA) is calculated using the formula:

$$\text{GPA} = \frac{\sum[(\text{course credits})\times(\text{grade points})] \text{ for all courses in the specific semester}}{\sum(\text{course credits}) \text{for all courses in the specific semester}}$$

The Cumulative Grade Point Average (CGPA) is calculated from first semester (third semester for lateral entry candidates) to final semester using the formula

$$\text{CGPA} = \frac{\sum[(\text{course credits})\times(\text{grade points})] \text{ for all courses in all the semesters so far}}{\sum(\text{course credits}) \text{for all courses in all the semesters so far}}$$

The GPA and CGPA are computed only for the candidates with a pass in all the courses.

The GPA and CGPA indicate the academic performance of a candidate at the end of a semester and at the end of successive semesters respectively.

A grade sheet for each semester shall be issued containing Grade obtained in each course, GPA and CGPA.

A duplicate copy, if required can be obtained on payment of a prescribed fee and satisfying other procedure requirements.

Withholding of Grades: The grades of a candidate may be withheld if he/she has not cleared his/her dues or if there is a disciplinary case pending against him/her or for any other reason.

16. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be declared to be eligible for the award of the BE / BTech Degree provided the candidate has

i. Successfully completed all the courses under the different categories, as specified in the regulations.

ii. Successfully gained the required number of total credits as specified in the curriculum corresponding to the candidate's programme within the stipulated time (vide clause 5).

iii. Successfully passed any additional courses prescribed by the respective Board of Studies whenever readmitted under regulations other than R-2020 (vide clause 11.3)

iv. No disciplinary action pending against him / her.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 First Class with Distinction:

17.1.1 A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50

(OR)

17.1.2 A candidate who joins from other institutions on transfer and who gets readmitted and has to move from one regulations to another regulations and who qualifies for the award of the degree (vide clause 16) and satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Submission of equivalent course list approved by the respective Board of studies.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 9.00

17.2 First Class:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class:

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry candidates) within ten consecutive semesters (eight consecutive semesters for lateral entry candidates) excluding authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from the examination (vide clause 10) shall not be considered as an

appearance.

- Should have secured a CGPA of not less than 7.00

17.3 Second Class:

All other candidates (not covered in clauses 17.1 and 17.2) who qualify for the award of the degree (vide clause 16) shall be declared to have passed the examination in Second Class.

17.4 A candidate who is absent for end semester examination in a course / project work after having registered for the same shall be considered to have appeared for that examination for the purpose of classification.

17.5 Honours Degree:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have earned the BE/BTech degree with Honours (vide clause 16 and clause 4.2.2):

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 8.00

18. MALPRACTICES IN TESTS AND EXAMINATIONS

If a candidate indulges in malpractice in any of the tests or end semester examinations, he/she shall be liable for punitive action as per the examination rules prescribed by the college from time to time.

19. AMENDMENTS

Notwithstanding anything contained in this manual, the Kongu Engineering College through the Academic council of the Kongu Engineering College, reserves the right to modify/amend without notice, the Regulations, Curricula, Syllabi, Scheme of Examinations, procedures, requirements, and rules pertaining to its BE / BTech programme.

******

B.E. DEGREE IN MECHANICAL ENGINEERING
CURRICULUM UNDER REGULATIONS 2020
(For the candidates admitted from academic year 2020-21 onwards)

SEMESTER – I									
Course Code	**Course Title**	**Hours/ Week**			**Credit**	**Maximum Marks**			**Cate gory**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
	Theory/Theory with Practical								
20EGT11	English Language Skills	3	0	0	3	50	50	100	HS
20MAC11	Matrices and Differential Equations	3	1*	2*	4	50	50	100	BS
20PHT11	Applied Physics	3	0	0	3	50	50	100	BS
20CYT11	Applied Chemistry	3	0	0	3	50	50	100	BS
20MEC11	Engineering Drawing	2	0	2	3	50	50	100	ES
20MET11	Engineering Mechanics	3	1	0	4	50	50	100	PC
	Practical								
20PHL11	Physical Sciences Laboratory I	0	0	2	1	50	50	100	BS
20MEL11	Engineering Practices Laboratory	0	0	2	1	50	50	100	ES
20VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
20MNT11	Student Induction Program #	-	-	-	0	100	0	100	MC
Total Credits to be earned					**23**				

Induction Training Program (including, Indian Constitution and Essence of Indian Knowledge Tradition, etc.) to be conducted at the beginning of the semester for 2 week. *Alternate week

SEMESTER – II									
Course Code	**Course Title**	**Hours/ Week**			**Credit**	**Maximum Marks**			**Cate gory**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20EGT21	Advanced Communication Skills	3	0	0	3	50	50	100	HS
20MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
20PHT21	Materials Science	3	0	0	3	50	50	100	BS
20CYT22	Chemistry for Mechanical Systems	3	0	0	3	50	50	100	BS
20MET22	Basics of Electrical and Electronics Engineering	3	0	0	3	50	50	100	ES
20MET21/ 20CSC31	Manufacturing Technology	3	0	0	3/4	50	50	100	PC /ES
	Programming in C	3	0	2					
Practical									
20PHL21	Physical Sciences Laboratory II	0	0	2	1	50	50	100	BS
20MEL21	Electrical and Electronics Engineering Laboratory	0	0	2	1	50	50	100	ES
Total Credits to be earned					**21/22**				

*Alternate week

SEMESTER – III									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20MAT31	Probability and Partial Differential Equations	3	1	0	4	50	50	100	BS
20CSC31 /20CSC41	Programming in C / Python Programming	3	0	2	4	50	50	100	ES
20MEC31	Fluid Mechanics and Hydraulic Machines	3	0	2	4	50	50	100	ES
20MET31	Engineering Thermodynamics	3	0	0	3	50	50	100	PC
20MEC32 / 20MET21	Engineering Materials and Metallurgy / Manufacturing Technology	3	0	2/0	4/3	50	50	100	PC
20MET32	Material Removal Processes	3	0	0	3	50	50	100	PC
Practical / Employability Enhancement									
20MEL31	Production Technology Laboratory	0	0	2	1	50	50	100	PC
20MEL32	Machine Drawing Laboratory	0	0	2	1	50	50	100	PC
20MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Total Credits to be earned					**24/23**				

SEMESTER – IV									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20MAT41	Statistics and Numerical Methods	3	1	0	4	50	50	100	BS
20CSC41/ 20MEC32	Python Programming / Engineering Materials and Metallurgy	3	0	2	4	50	50	100	ES/ PC
20MET41	Strength of Materials	3	1	0	4	50	50	100	PC
20MET42	Thermal Engineering	3	0	0	3	50	50	100	PC
	Open Elective I	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
20MEL41	Material Property Testing Laboratory	0	0	2	1	50	50	100	PC
20MEL42	Thermal Engineering and Renewable Energy Laboratory	0	0	2	1	50	50	100	PC
20EGL31	English for Workplace Communication Laboratory	0	0	2	1	50	50	100	HS
20GET31	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					**24**				

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20MET51	Kinematics of Machinery	3	0	0	3	50	50	100	PC
20MET52	Heat and Mass Transfer	3	0	0	3	50	50	100	PC
20MET53	Metrology and Measurements	3	0	0	3	50	50	100	PC
	Professional Elective I	3	0	0	3	50	50	100	PE
	Open Elective II	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
20MEL51	Heat Transfer Laboratory	0	0	2	1	50	50	100	PC
20MEL52	Computer Aided Drawing Laboratory	0	0	2	1	50	50	100	PC
20MEL53	Metrology and Measurements and Automobile Engineering Laboratory	0	0	2	1	50	50	100	PC
20GEL51/ 20GEI51	Professional Skills Training I / Industrial Training I *	--	--	--	2	100	0	100	EC
Total Credits to be earned					**21**				

* 80 hours of training

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20MET61	Dynamics of Machinery	3	0	0	3	50	50	100	PC
20MET62	Finite Element Analysis	3	0	0	3	50	50	100	PC
20MET63	Design of Machine Elements	3	0	0	3	50	50	100	PC
	Open Elective III	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
20MEL61	Dynamics Laboratory	0	0	2	1	50	50	100	PC
20MEL62	Simulation and Analysis Laboratory	0	0	2	1	100	0	100	PC
20MEL63	CAD/CAM Laboratory	0	0	2	1	100	0	100	PC
20GEL61/ 20GEI61	Professional Skills Training II / Industrial Training II *	--	--	--	2	100	0	100	EC
20GEP61	Comprehensive Test / Viva	--	---	---	2	100	0	100	EC
20MEP61	Project Work I	0	0	4	2	100	0	100	EC
Total Credits to be earned					**21**				

SEMESTER – VII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20GET71	Engineering Economics and Management	3	0	0	3	50	50	100	HS
20MEC71	Mechatronics and IoT	3	0	2	4	50	50	100	PC
	Professional Elective II	3	0	0	3	50	50	100	PE
	Professional Elective III	3	0	0	3	50	50	100	PE
	Professional Elective IV	3	0	0	3	50	50	100	PE
	Professional Elective V	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20MEP71	Project Work II Phase I	0	0	6	3	100	0	100	EC
Total Credits to be earned					22				

SEMESTER – VIII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
	Open Elective IV	3	0	0	3	50	50	100	OE
	Professional Elective VI	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20MEP81	Project Work II Phase II	---	---	14	7	50	50	100	EC
Total Credits to be earned					13				

Total Credits: 169

PROFESSIONAL ELECTIVE (PE)

S. No.	Course Code	Course Name	L	T	P	C	Sem	Domain/ Stream
		Elective – I						
1.	20MEE01	Fluid Power System	3	0	0	3	V	Design
2.	20MEE02	CAD/CAM/CIM	3	0	0	3	V	Design
3.	20MEE03	Automobile Engineering	3	0	0	3	V	Thermal
4.	20MEE04	Climate Change and New Energy Technology	3	0	0	3	V	Thermal
5.	20MEE05	Unconventional Machining Processes	3	0	0	3	V	Mfg.
6.	20MEE06	Design for Manufacture and Assembly	3	0	0	3	V	Mfg.
7.	20MEE07	Operations Research	3	0	0	3	V	Ind. Engg.
8.	20MEE08	Production Planning and Control	3	0	0	3	V	Ind. Engg.
		Elective – II						
9.	20MEE09	Design of Transmission Systems	3	0	0	3	VII	Design
10.	20MEE10	Vibration and Noise Control	3	0	0	3	VII	Design
11.	20MEE11	Production Tool Design	3	0	0	3	VII	Mfg.
12.	20MEE12	Manufacturing Information System	3	0	0	3	VII	Mfg.
13.	20MEE13	Gas Dynamics and Jet Propulsion	3	0	0	3	VII	Thermal
14.	20MEE14	Refrigeration and Air Conditioning	3	0	0	3	VII	Thermal
15.	20MEE15	Supply Chain Management	3	0	0	3	VII	Ind. Engg.
16.	20MEE16	Lean Six Sigma	3	0	0	3	VII	Ind. Engg.
		Elective – III						
17.	20MEE17	Fundamentals of Research	3	0	0	3	VII	General
18.	20MEE18	Piping Design	3	0	0	3	VII	Design
19.	20MEE19	Design of Jigs, Fixtures and Press Tools	3	0	0	3	VII	Design
20.	20MEE20	Fuels and Combustion Technology	3	0	0	3	VII	Thermal
21.	20MEE21	Computational Fluid Dynamics	3	0	0	3	VII	Thermal
22.	20MEE22	CNC Technology	3	0	0	3	VII	Mfg.
23.	20MEE23	Precision Engineering	3	0	0	3	VII	Mfg.
24.	20MEE24	Total Quality Management	3	0	0	3	VII	Ind. Engg.
25.	20MEE25	Project Management	3	0	0	3	VII	Ind. Engg.
		Elective – IV						
26..	20MEE26	Mechanics of Composite Materials	3	0	0	3	VII	Design
27..	20MEE27	Advanced Mechanics of Materials	3	0	0	3	VII	Design
28.	20MEE28	Turbomachines	3	0	0	3	VII	Thermal
29.	20MEE29	Design of Heat Exchangers	3	0	0	3	VII	Thermal
30.	20MEE30	Additive Manufacturing	3	0	0	3	VII	Mfg.

31.	20MEE31	Welding Technology	3	0	0	3	VII	Mfg.
32.	20MEE32	Quality Control and Reliability Engineering	3	0	0	3	VII	Ind. Engg.
33.	20MEE33	Industrial Engineering	3	0	0	3	VII	Ind. Engg.
		Elective – V						
34.	20MEE34	Introduction to Aircraft Systems	3	0	0	3	VII	Design
35.	20MEE35	Industrial Tribology	3	0	0	3	VII	Design
36.	20MEE36	Instrumentation in Thermal Engineering	3	0	0	3	VII	Thermal
37.	20MEE37	Energy Auditing and Management	3	0	0	3	VII	Thermal
38.	20MEE38	Modelling and Analysis of Manufacturing Systems	3	0	0	3	VII	Mfg.
39.	20MEE39	Micro Electro Mechanical Systems	3	0	0	3	VII	Mfg.
40.	20MEE40	Maintenance Engineering	3	0	0	3	VII	Ind. Engg.
41.	20MEE41	Industrial Safety Engineering	3	0	0	3	VII	Ind. Engg.
42.	20MEE42	Hybrid Vehicle Technology	3	0	0	3	VII	General
		Elective – VI						
43.	20MEE43	Introduction to Aircraft Structures	3	0	0	3	VIII	Design
44.	20MEE44	Principles of Farm Machineries	3	0	0	3	VIII	Design
45.	20MEE45	Power Plant Engineering	3	0	0	3	VIII	Thermal
46.	20MEE46	Energy Conservation in HVAC System	3	0	0	3	VIII	Thermal
47.	20MEE47	Nanotechnology for Mechanical Engineers	3	0	0	3	VIII	Mfg.
48.	20MEE48	Non Destructive Evaluation Techniques	3	0	0	3	VIII	Mfg.
49.	20MEE49	Industrial Marketing	3	0	0	3	VIII	Ind. Engg.
Total Credits to be earned						**18**		

***** Domain/Stream Abbreviations: Mfg – Manufacturing, Ind. Engg. – Industrial Engineering,

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20MEO01	Renewable Energy Sources	3	0	2	4	IV
2.	20MEO02	Design of Experiments	3	0	2	4	V
3.	20MEO03	Fundamentals of Ergonomics	3	0	0	3	VI
4.	20MEO04	Principles of Management and Industrial Psychology	3	0	0	3	VI
5.	20MEO05	Safety Measures for Engineers	3	0	0	3	VIII
6.	20MEO06	Energy Conservation in Thermal Equipments	3	0	0	3	VIII

The total credits for the BE (Mechanical Engineering Branch) programme is 169 with the following curriculum breakdown structure:

S.No.	Category		Credits	% out of total credits
1.	Humanities and Social Sciences	HS	13	7.7
2.	Basic Sciences	BS	30	17.8
3.	Engineering Sciences	ES	20	11.8
4.	Professional Core	PC	56	33.1
5.	Professional Electives	PE	18	10.7
6.	Open Electives	OE	14	8.3
7.	Employability Enhancement Courses	EC	18	10.7
8.	Mandatory Courses(Induction Programme, Environmental Science)	MC	0	-
		Total :	169	100 %

20EGT11 ENGLISH LANGUAGE SKILLS

(Common to all Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	HS	3	0	0	3

Preamble	This course is designed to impart required levels of fluency in using the English Language at A2/B1 Level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – I**	**9**
Listening - Talking about past experiences - listening to descriptions - Speaking - Exchanging personal information - Talking about cities and transportation - Reading - Life and achievements of a famous personality - Global transport systems - Writing - Childhood experiences - Process Description – Grammar & Vocabulary – Past tense – Expressions of quantity – Indirect questions.		
Unit - II	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – II**	**9**
Listening - Information about hotels and accommodation - Recipes and food items - Speaking - Life style changes and making comparisons - Talking about food - Reading - Habit formation and changing habits - International cuisine - Writing - Personal email - emails about food and recipes – Grammar & Vocabulary – Evaluations and Comparisons with adjectives – Simple past and present perfect tenses.		
Unit - III	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – III**	**9**
Listening - Information about travel - descriptions / conversations about family life - Speaking - Vacations and Holidays - Requests, complaints and offering explanations - Reading - Tourist places and travel experiences - Group behaviour and politeness - Writing - Personal letter about travelling - Writing guidelines and checklists – Grammar & Vocabulary – Future tense – Modals – Two-part verbs.		
Unit - IV	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – IV**	**9**
Listening - Descriptions about festivals - Presentations on technology - Speaking - About technology - festivals, special events and traditions - Reading - Sports, hobbies and past time - About different cultures - Writing - Product Description - Writing web content – Grammar & Vocabulary – Infinitives and Gerunds for uses and purposes – Imperatives for giving suggestions – Relative clauses of time.		
Unit - V	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – V**	**9**
Listening - Talking about changes - Job preferences - Speaking - Comparing different periods or phases in life – Changes that happen - Skills and abilities, Personality Development - Employability Skills – Reading - Reading about life experiences - Emotions and feelings – Job preferences – Jobs and Personality – Writing - Writing about one's past, present and future – Researching job options – Choosing the right job – Grammar & Vocabulary – Time contrasts – Conditional sentences with "if clauses" – Gerunds – short responses.		

Total: 45

TEXT BOOK:

1. Jack C. Richards, Jonathan Hull, and Susan Proctor, "Interchange - Student's Book 2", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1. Sanjay Kumar and Pushp Lata, "Communication Skills", 2nd Edition, Oxford University Press, New Delhi, 2015.
2. Pamela Hartmann and Brenda Wegmann, "New Interactions English Language Learning and Assessment Platform (Level Intro - Level IV)", McGraw Hill India, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use language effectively and accurately acquiring vocabulary from real-life context	Applying (K3)
CO2	listen/view and comprehend different spoken discourses / excerpts in different accents	Applying (K3)
CO3	read different genres of texts adopting various reading strategies	Analyzing (K4)
CO4	write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide range of vocabulary, organizing their ideas logically on a topic	Creating (K6)
CO5	speak clearly, confidently, comprehensibly and communicate with others using appropriate communicative strategies	Creating (K6)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1						2			2	3	2	2		
CO2									2	3		1		
CO3						1				3	1	1		
CO4										3		1		
CO5									2	3		2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		16	30	37		17	100
CAT2		17	30	37		16	100
CAT3		13	33	37		17	100
ESE		7	21	37		35	100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MAC11 - MATRICES AND DIFFERENTIAL EQUATIONS

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	3	1*	2*	4

Preamble	To provide the skills to the students for solving different real time problems by applying matrices and differential equations.	
Unit - I	**Matrices:**	**9**
Introduction – Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) – Cayley - Hamilton theorem (Statement and applications only) – Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of Quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation.		
Unit - II	**Ordinary Differential Equations:**	**9**
Introduction – Solutions of First order differential equations: Exact differential equations – Leibnitz's Linear Equation – Bernoulli's equation – Clairaut's equation.		
Unit - III	**Ordinary Differential Equations of Higher Order:**	**9**
Linear differential equations of second and higher order with constant coefficients - Particular Integrals for the types: e^{ax} – cosax / sinax – x^n – $e^{ax}x^n$, e^{ax}sinbx and e^{ax}cosbx – x^nsinax and x^ncosax – Differential Equations with variable coefficients: Euler-Cauchy's equation – Legendre's equation.		
Unit - IV	**Applications of Ordinary Differential Equations:**	**9**
Method of variation of parameters – Simultaneous first order linear equations with constant coefficients – Applications of differential equations: Simple harmonic motion – Electric circuits (Differential equations and associated conditions need to be given).		
Unit - V	**Laplace Transform** & **Inverse Laplace Transform:**	**9**
Laplace Transform: Conditions for existence – Transform of elementary functions – Basic properties – Derivatives and integrals of transforms – Transforms of derivatives and integrals – Transform of unit step function – Transform of periodic functions. Inverse Laplace transform: Inverse Laplace transform of elementary functions – Partial fraction method – Convolution theorem (Statement only) – Solution of linear ODE of second order with constant coefficients.		

List of Exercises / Experiments:

1.	Introduction to MATLAB
2.	Computation of eigen values and eigen vectors
3.	Plotting and visualizing single variable functions
4.	Solving first and second order ordinary differential equations
5.	Solution of Simultaneous first order ODEs
6.	Solving second order ODE by variation of parameters
7.	Determining Laplace and inverse Laplace transform of basic functions
8.	Solution of Second order ODE by employing Laplace transforms

***Alternate week**

Lecture: 45, Tutorial and Practical:15, Total:60

TEXT BOOK:

1.	Ravish R. Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1.	Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2011.
2.	Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics – I", 2nd Edition, Pearson India Education, New Delhi, 2018.
4.	MATLAB Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve engineering problems which needs matrix computations.	Applying (K3)
CO2	identify the appropriate method for solving first order ordinary differential equations.	Applying (K3)
CO3	solve higher order linear differential equations with constant and variable coefficients.	Applying (K3)
CO4	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems.	Applying (K3)
CO5	apply Laplace Transform to find solutions of Linear Ordinary Differential Equations	Applying (K3)
CO6	know the basics of MATLAB and computing eigen values and eigen vectors of real matrix by MATLAB.	Understanding (K2), Manipulation (S2)
CO7	solve ordinary differential equations with constant and variable coefficients and simultaneous first order ordinary differential equations using MATLAB.	Applying (K3), Manipulation (S2)
CO8	compute Laplace and inverse Laplace Transform of basic functions and solve Second Order ODE by using Laplace Transform with MATLAB.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	1										
CO2	3	3	2	1										
CO3	3	3	2	1										
CO4	3	3	2											
CO5	3	3	2	1										
CO6					3									
CO7					3									
CO8					3									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20PHT11 - APPLIED PHYSICS

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	3	0	0	3

Preamble	This course aims to impart the essential concepts of propagation of elastic waves, acoustics, ultrasonics, laser and fiber optics, quantum physics, crystal structure and crystal defects. It also describes the physical phenomena related to the aforementioned concepts and their applications in engineering and provides motivation towards innovations	
Unit - I	**Propagation of Elastic Waves:**	**9**
Oscillatory Motion: Introduction to simple harmonic motion - Damping velocity - Damping coefficient - Differential equation of simple harmonic motion - Velocity and acceleration - Restoring force - Vibration of a spring and mass system - Frequency response - Phase response - Resonance - Wave motion: Definition of a plane progressive wave - Attenuation of waves - Differential equation of a plane progressive wave - Phase velocity - Phase and phase difference - Solution of the differential equation of a plane progressive wave.		
Unit - II	**Acoustics and Ultrasonics:**	**9**
Acoustics: Introduction - Reverberation and reverberation time - Growth and decay of sound - Sabine's formula for reverberation time – Determination of sound absorption coefficient – Design of an auditorium: Factors affecting acoustics of buildings and the remedies. Ultrasonics: Introduction – Properties of ultrasonic waves – Generation of ultrasonic waves: Magnetostrictive generator and Piezoelectric generator - Determination of velocity of ultrasonics in a liquid: Acoustic grating – Industrial application: Non-destructive testing - Other applications of ultrasonic waves (qualitative).		
Unit - III	**Laser and Fiber Optics:**	**9**
Laser and Applications: Introduction – Interaction of light with matter - Three quantum process: Stimulated absorption, spontaneous emission and stimulated emission - Population inversion - Einstein's coefficients and their relations - Pumping methods - Nd:YAG laser - CO_2 laser - Holography. Fiber Optics and Applications: Introduction - Numerical aperture and acceptance angle - Classification of optical fibers based on refractive index, modes and materials - Fiber optics communication system (qualitative) - Fiber optic sensors: Temperature and displacement sensors.		
Unit - IV	**Quantum Physics:**	**9**
Introduction - Blackbody radiation - Planck's quantum hypothesis - Compton scattering (qualitative) - de Broglie's hypothesis - Properties of matter waves - Application of Heisenberg uncertainty principle - Schrodinger's time independent and time dependent wave equations - Physical significance of wave function - The free particle - Potential energy step - Infinite potential well (one - dimensional).		
Unit - V	**Crystal Physics:**	**9**
Introduction - Classification of solids - Space lattice - Crystal structure - Unit cell - Bravais lattice - Single and polycrystalline materials - Lattice planes - Miller indices - Indices of crystal direction - Interplanar spacing in cubic system - Hexagonal close packed crystal structure and c/a ratio - Symmetry -Symmetry elements in cubic crystal - Crystal imperfections: line, surface and volume imperfections - Features of crystal imperfections (qualitative).		

Total: 45

TEXT BOOK:

1. Avadhanulu M.N., Kshirsagar P.G. and Arun Murthy T.V.S., "A Textbook of Engineering Physics",11th Edition, S. Chand & Company Pvt. Ltd., New Delhi, 2019.

REFERENCES:

1. Purnima Khare and Swarup A.,"Engineering Physics: Fundamentals and Modern Applications", 1st Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2009.
2. Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
3. Tamilarasan K. and Prabu K., "Engineering Physics – I", 3rd Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the concepts of oscillatory and wave motion to comprehend the phenomena related to the propagation of elastic waves.	Applying (K3)
CO2	apply the concepts of growth and decay of sound energy in a hall to compute Sabine's formula to recognize the requirements of acoustically good buildings, and to describe the production of ultrasonic wave, working of acoustic grating & non-destructive testing using ultrasonic waves.	Applying (K3)
CO3	apply the concepts of stimulated emission to explain the working and the applications of laser in engineering and technology, and to apply the principle of propagation of light through optical fiber to compute acceptance angle and numerical aperture to comprehend the loss in optical fiber, fiber optic communication system and working of fiber optic sensors.	Applying (K3)
CO4	use the concepts of quantum mechanics to describe the behavior of electrons in a metal by solving Schrodinger's wave equation for particle motion in infinite potential well.	Applying (K3)
CO5	utilize the concepts of the seven crystal systems to obtain interplanar spacing in cubic lattice and c/a ratio of HCP crystal structure, and to comprehend symmetry elements, reciprocal lattice and the types of crystal imperfections and their impacts.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	35	45				100
CAT3	25	35	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20CYT11 - APPLIED CHEMISTRY

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	3	0	0	3

Preamble	Applied Chemistry course explores the basic principles and advancements of chemistry in the field of engineering and technology. It aims to impart the fundamentals of chemistry towards innovations in science and technology and also for societal applications.	
Unit - I	**Water Technology:**	**9**
Introduction - sources of water - impurities in water - types of water - hardness of water- expression of hardness (simple problems) - units of hardness –estimation of hardness of water by EDTA method – determination of alkalinity - disadvantages of using hard water in Industries - boiler troubles - scale and sludge, boiler corrosion, caustic embrittlement, priming and foaming - softening of water: i) Internal treatment process - carbonate and calgon conditioning ii) External treatment method -demineralization process iii) Treatment of water for municipal water supply (Removal of suspended particles and disinfection methods, Break-point of chlorination).		
Unit - II	**Electrochemistry:**	**9**
Introduction – electrochemical cells - applications of electrochemical series - reference electrode - standard calomel electrode - ion selective electrode - glass electrode - concentration cells - electrode and electrolyte concentration cells (simple problems) - applications- potentiometric titrations - acid-base, redox, precipitation titrations - advantages- conductometric titrations - strong acid vs strong base, weak acid vs strong base, mixture of weak and strong acid vs strong base- advantages of conductometric titrations.		
Unit - III	**Corrosion and its Control:**	**9**
Introduction – causes and effects of corrosion - types of corrosion - chemical corrosion – Pilling Bed-worth rule - electrochemical corrosion –types **-** galvanic corrosion, concentration cell corrosion – other types of corrosion -stress, intergranular and microbiological corrosion- galvanic series - factors influencing rate of corrosion – corrosion control methods - design and material selection, anodic protection, corrosion inhibitors, protective coatings - i) metallic coatings : hot dipping (tinning and galvanizing) ii) non-metallic coating : anodizing iii) organic coating : paints – constituents and their functions.		
Unit - IV	**Fuels and Combustion:**	**9**
Introduction – classification of fuels - characteristics of a good fuel - combustion - calorific values – gross and net calorific values - Dulong's formula (simple problems) - Flue gas analysis by Orsat's method - ignition temperature - spontaneous ignition temperature - explosive range - solid fuels - coal and its varieties – proximate and ultimate analysis – significance – metallurgical coke - Otto-Hoffman byproduct method - liquid fuel - refining of petroleum – manufacture of synthetic petrol - hydrogenation of coal - Bergius process - knocking - octane number – cetane number - gaseous fuel - water gas.		
Unit - V	**Polymers:**	**9**
Introduction – terminology - classification - polymerization - types of polymerization (definition only)- polymerisation techniques- bulk, solution, suspension and emulsion polymerisation - plastics- difference between thermoplastics and thermosetting plastics - compounding of plastics- plastic moulding methods - compression, injection, extrusion and blow moulding methods - industrial polymers: preparation, properties and applications of PVC, PAN, polyurethane, polyesters –biodegradable polymers-classification and applications.		

Total: 45

TEXT BOOK:

1. Wiley Editorial Board, "Wiley Engineering Chemistry", 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019.

REFERENCES:

1. Palanisamy P.N., Manikandan P., Geetha A.& Manjula Rani K., "Applied Chemistry", 6th Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2019.
2. Payal B. Joshi, Shashank Deep, "Engineering Chemistry", Oxford University Press, New Delhi, 2019.
3. Palanna O., "Engineering Chemistry", McGraw Hill Education, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the suitable water softening methods to avoid boiler troubles.	Applying (K3)
CO2	apply the principle of electrochemistry for various applications.	Applying (K3)
CO3	make use of corrosion control methods to solve corrosion related problems.	Applying (K3)
CO4	illustrate the quality of fuels from its characteristics.	Understanding (K2)
CO5	explain the types of polymers, plastics and fabrication methods.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	1												
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEC11 – ENGINEERING DRAWING

(Common to Civil, Mechanical, Mechatronics, Automobile Engineering, Chemical & Food Technology Branches)

Programme & Branch	BE(Civil, Mech, MTS, Auto) &BTech(Chem, FT)	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	ES	2	0	2	3

Preamble	To impart knowledge on orthographic, isometric projections, sectional views and development of surfaces by solving different application oriented problems.	
Unit - I	**General Principles of Orthographic Projection:**	**9**
Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning - Projections of Points, Lines and Planes - General principles of orthographic projection - First angle projection - Layout of views - Projection of points located in all quadrant and straight lines located in the first quadrant - Determination of true lengths and true inclinations and location of traces - Projection of polygonal surface and circular lamina inclined to both reference planes.		
Unit - II	**Projections of Solid:**	**9**
Projections of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.		
Unit - III	**Sectioning of Solids:**	**9**
Sectioning of solids - prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other - Obtaining true shape of section.		
Unit - IV	**Development of Surfaces:**	**9**
Development of lateral surfaces of simple solids like prisms, pyramids, cylinders and cones – development of simple truncated solids involving prisms, pyramids, cylinders and cones.		
Unit - V	**Isometric Projection and Introduction to AutoCAD:**	**9**
Principles of isometric projection - Isometric scale - Isometric projections of simple and truncated solids like prisms, pyramids, cylinders and cones - Conversion of isometric projection into orthographic projection - Introduction to AutoCAD.		

Lecture:30, Practical:30, Total:60

TEXT BOOK:

1. Venugopal K. and Prabhu Raja V., "Engineering Graphics", 15th Edition, New Age International Pvt. Ltd., New Delhi, 2018.

REFERENCES:

1. Basant Agrawal, Agrawal C.M., "Engineering Drawing", 2nd Edition, McGraw Hill Education, 2019.
2. Gopalakrishnana K.R. "Engineering Drawing", Volume. I & II, Subhas Publications, Bengaluru, 2014.
3. Parthasarathy N.S., Vela Murali. "Engineering Drawing", 1st Edition, Oxford University Press, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret international standards of drawings and sketch the projections of points, lines and planes.	Understanding (K2)
CO2	draw the projections of 3D primitive objects like prisms, pyramids, cylinders and cones.	Applying (K3)
CO3	construct the various sectional views of solids like prisms, pyramids, cylinders and cones.	Applying (K3)
CO4	develop the lateral surfaces of simple and truncated solids.	Applying (K3)
CO5	sketch the isometric projections of simple and truncated solids and convert isometric drawing in to orthographic projection.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2								3	2	2	2	3
CO2	3	2	1	1						3	2	3	2	3
CO3	3	2	1	1						3	2	3	2	3
CO4	3	2	1	1						3	2	3	2	3
CO5	3	2	1	1						3	2	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	25	35	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET11 - ENGINEERING MECHANICS

Programme & Branch	BE – Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	1	0	4

Preamble	This course provides introduction to the basic concepts of forces, inertia, centroid and moments of area along with their effects on motion. It introduces the phenomenon of friction and its effects. It familiarizes students to cognitive learning in applied mechanics and develops problem-solving skills in both theoretical and engineering oriented problems.	
Unit - I	**Statics of Particles:**	**9+3**
Introduction –Laws of Mechanics – Parallelogram and Triangular Law of forces – Principle of Transmissibility – Coplanar Forces – Resolution and Composition of force -Free body diagram–Equilibrium of a particle in plane – Forces in space - Vectorial representation of forces–Equilibrium of a particle in space.		
Unit - II	**Statics of Rigid Bodies:**	**9+3**
Moments: Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar component of moments – Varignon's theorem– Equivalent systems of forces – Single equivalent force. Types of supports and their reactions – Requirements of stable equilibrium – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions. Trusses: Method of joints- Method of sections. Principle of virtual work.		
Unit - III	**Properties of Surfaces and Solids:**	**9+3**
Determination of Areas and Volumes – First moment of area and Centroid of sections – T section- I section- Angle section- Hollow section from primary simpler sections – Second moment of plane areas – Parallel axis theorem and Perpendicular axis theorem - T section - I section- Angle section- Hollow section – Polar moment of Inertia – Product of Inertia- Principal Moment of Inertia of plane area- Mass moment of inertia – Relation to area moments of inertia.		
Unit - IV	**Friction and Rectilinear motion of particles:**	**9+3**
Friction: Surface Friction – Laws of dry friction – Sliding friction – Static and Kinetic friction– Ladder friction – Wedge friction – Belt friction. Rectilinear motion of particles: Displacement- velocity and acceleration and their relationship – Relative motion- Curvilinear motion – Projectile motion.		
Unit - V	**Dynamics of Particles and Kinematics of Rigid body:**	**9+3**
Dynamics of Particles: Newton's law, Work - Energy and Impulse - Momentum equations of particles – Impact of elastic bodies. Kinematics of Rigid body: Translation - Rotation about a fixed axis–General plane motion. Kinetics of rigid body.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Dubey N.H., "Engineering Mechanics: Statics and Dynamics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1. Beer Ferdinand P., Russel Johnston Jr., David F. Mazure, Philip J. Cornwell, Sanjeev Sanghi, "Vector Mechanics for Engineers: Statics and Dynamics", 12th Edition, McGraw Hill Education, Chennai, 2019.
2. Hibbeler R.C., "Engineering Mechanics", 14th Edition, Pearson Education, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	represent the forces in vector components (both 2D and 3D) and apply equilibrium conditions	Applying (K3)
CO2	calculate the moment produced by various force systems and conclude the static equilibrium equations for rigid body system	Analyzing (K4)
CO3	compute the centroid, centre of gravity and moment of inertia of geometrical shapes and solids respectively	Applying (K3)
CO4	manipulate the effect of dry friction and its applications	Applying (K3)
CO5	apply the different principles to study the motion of a body and analyse their constitutive equations	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1								1		3
CO2	3	2	1	1								1		3
CO3	3	2	1	1								1		3
CO4	3	2	1	1								1		3
CO5	3	2	1	1								1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	50	20			100
CAT2	10	20	50	20			100
CAT3	10	20	50	20			100
ESE	10	20	50	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20PHL11 – PHYSICAL SCIENCES LABORATORY I

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	BS	0	0	2	1

Preamble	This course aims to impart hands on training in the determination of the physical parameters such as Young's modulus, rigidity modulus, frequency of vibration, velocity of ultrasonic waves, compressibility of water, wavelength of laser, acceptance angle and the numerical aperture of an optical fiber, and to develop the skills in handling different basic instruments and also aims to impart the basic concepts of volumetric, conductometric and pH meter experiments and thereby, to improve the analytical capability.

List of Exercises / Experiments:

1.	Determination of the Young's modulus of the material of a given beam using uniform bending method.
2.	Determination of the rigidity modulus of the material of a given wire using torsional pendulum.
3.	Determination of frequency of electrically vibrating rod by forming standing waves using Melde's apparatus.
4.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using ultrasonic interferometer.
5.	Determination of (i) the wavelength of a semiconductor laser and (ii) the acceptance angle and the numerical aperture of a given optical fiber.
6.	Estimation of total, temporary and permanent hardness of water by EDTA method.
7.	Estimation of $Ca^{2+}$and Mg^{2+}hardness separately by EDTA method.
8.	Estimation of alkalinity of the given water sample.
9.	Conductometric titration -Mixture of acids.
10.	Estimation of hydrochloric acid using pH meter.

Total: 30

REFERENCES:

1.	Tamilarasan K. and Prabu K.,"Physics Laboratory Manual', 1st Edition, SCM Publishers, Erode, 2020.
2.	Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Rajaganapathy Publishers, Erode, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine the Young's modulus of a material using the concepts of elasticity and bending moment of a beam and to determine the rigidity modulus of a wire using the concepts of twisting couple and to compute the frequency of electrically vibrating rod using the concept of standing waves formed in fixed vibrating string.	Applying (K3), Precision (S3)
CO2	determine the wavelength of a semiconductor laser beam using the concept of diffraction of light, and to compute the acceptance angle and the numerical aperture of an optical fiber using the concepts of total internal reflection and divergence of light in air and estimate the amount of hardness for the given water sample by EDTA method, and the amount of alkalinity for the given water sample.	Applying (K3), Precision (S3)
CO3	demonstrate the conductivity meter and pH meter to estimate the amount of the given solution.	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1				3										
CO2				3										
CO3				3										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

20MEL11 – ENGINEERING PRACTICES LABORATORY

(Common to Civil, Mechanical, Mechatronics, Automobile Engineering, Chemical & Food Technology Branches)

Programme & Branch	BE (Civil, Mech, MTS, Auto) & BTech (Chem, FT)	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	ES	0	0	2	1

Preamble	This course is designed to provide a hands-on experience in basic of mechanical and electrical engineering practices.

List of Exercises / Experiments:

	PART A – MECHANICAL ENGINEERING
1.	To prepare square or rectangular shaped MS plates using power tools for cutting, polishing and shaping to the required dimensions.
2.	To carryout drilling, tapping and assembly on the given MS plates.
3.	To carryout thread forming on a GI/PVC pipes and prepare water leak proof water line from overhead tank.
4.	To prepare a wood or plywood box/tray/any innovative models using modern power tools like cutting machine, router, jigsaw, power screw driver etc.
5.	Welding practice through arc welding / simulator
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
1.	Safety Aspects of Electrical Engineering, Electrical Symbols, Components Identification, Fuse selection and installation, Circuit Breakers selection
2.	Wiring circuit for fluorescent lamp and Stair case wiring
3.	Measurement of Earth resistance
4.	Soldering of Simple Circuits and trouble shooting
5.	Implementation of half wave and full wave Rectifier using diodes

Total: 30

REFERENCES /MANUAL / SOFTWARE:

1.	Engineering Practices Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	plan the sequence of operations for effective completion of the planned models/ innovative articles	Creating (K6), Precision (S3)
CO2	identify and use appropriate modern power tools and complete the exercises/models accurately	Applying (K3), Precision (S3)
CO3	select fuses and Circuit breakers	Understanding (K2), Manipulation (S2)
CO4	perform house wiring and realize the importance of earthing	Applying (K3), Manipulation (S2)
CO5	trouble shoot the electrical and electronic circuits	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3	3	2	1			3	3		3		
CO2	2		3	3	2				3	3		3		
CO3	3		3	3	1				2	2		3		
CO4	3		3	3	1				2	3		3		
CO5	3		3	3	1				2	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20VEC11 – YOGA AND VALUES FOR HOLISTIC DEVELOPMENT

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	HS	1	0	1	1

Preamble	Providing Value Education to improve the Students' character - understanding yogic life and physical health - maintaining youthfulness - Measure and method in five aspects of life	
Unit - I	**Physical Health:**	**2**
Manavalakalai (SKY) Yoga: Introduction - Education as a means for youth empowerment - Greatness of Education - Yoga for youth Empowerment. **Simplified Physical Exercises:** Need and Objectives of Simplified Physical Exercise - Hand, Leg, Breathing, Eye exercises - Kapalabathi, Makarasana Part I, Makarasana Part II, Body Massage, Acu pressure, Relaxation exercises - Benefits. **Yogasanas:** Pranamasana - Hastha Uttanasana - Pada Hasthasana - Aswa Sanjalana Asana - Thuvipatha asva Sanjalana asana - Astanga Namaskara - Bhujangasana - Atha Muktha Savasana - Aswa Sanjalana Asana - Pada Hasthasana - Hastha Uttanasana - Pranamasana. **Pranayama:** Naddi suddi - Clearance Practice - Benefits.		
Unit - II	**Life Force:**	**2**
Reasons for Diseases: Body Function - Reason for Diseases and Prevention - Natural reasons (Genetic / imprints, Planetary Position, Natural calamities and climatic changes) - Unnatural reasons (Food habits, Thoughts, Deeds). **Philosophy of Kaya kalpa:** Enriching Bio-Magnetism - Physical body - Sexual vital fluid - Life force - Bio-Magnetism - Mind. **Maintaining youthfulness:** Postponing old age - Transformation of food into seven components - Importance of sexual vital fluid - Measure and method in five aspects of life - Controlling undue Passion. **Kayakalpa practice:** Aswini Mudra - Ojas breath - Benefits of Kaya Kalpa.		
Unit - III	**Mental Health:**	**2**
Mental Frequencies: Beta, Apha, Theta and Delta wave - Agna Meditation explanation - benefits. **Shanti meditation:** Shanthi Meditation explanation – benefits. **Thuriya Meditation:** Thuriya Meditation explanation – benefits. **Benefits of Blessing:** Self blessing (Auto suggestion) - Family blessing - Blessing the others - World blessing - Divine protection.		
Unit - IV	**Values:**	**2**
Human Values: Self control - Self confidence - Honesty Contentment - Humility – Modesty - Tolerance - Adjustment - Sacrifice – Forgiveness - Purity (Body, Dress, Environment) - Physical purity - Mental purity - Spiritual purity. **Social Values:** Non violence – Service. Patriotism – Equality. Respect for parents and elders - care and protection - Respect for teacher. Punctuality - Time Management.		
Unit - V	**Morality (Virtues):**	**2**
Importance of Introspection: I - Mine (Ego, Possessiveness). Six Evil Temperaments - Greed - Anger - Miserliness - Immoral sexual passion - Inferiority and superiority Complex – Vengeance. Maneuvering of Six Temperaments: Contentment - Tolerance - Charity - Chastity - Equality - Pardon (Forgiveness). Five essential Qualities acquired through Meditation: Perspicacity - Magnanimity - Receptivity - Adaptability - Creativity (Improved Memory Power).		

Lecture:10, Practical:10, Total:20

TEXT BOOK:

1. Thathuvagnani Vethathiri Maharishi, "Yoga for Youth Empowerment", Vethathiri Publications, 2019.

REFERENCES:

1. Thathuvagnani Vethathiri Maharishi, "Yoga for Modern Age", Vethathiri Publications, 2019.
2. Thathuvagnani Vethathiri Maharishi, "Simplified Physical Exercises", Vethathiri Publications, 2019.
3. Neelam Sharma, "Holistic Education and Yoga", Shipra Publications, 2017.
4. Dr. Joseph Murphy, "The Power of Your Subconscious Mind", Pushpak Publication, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the importance of physical health and practice simplified physical yoga exercise.	Applying (K3)
CO2	understand the importance of Kayakalpa exercise to enrich Bio-Magnetism and practice it.	Applying (K3)
CO3	understand the significance of meditation and do meditation to get sound mind.	Applying (K3)
CO4	understand the human and social values to provide service to society.	Applying (K3)
CO5	understand the evil temperaments and five essential qualities acquired through meditation	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		2	1			1		
CO2						3		2				1		
CO3						3		3				1		
CO4						3		2	1			1		
CO5						3		3				1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	NA						
CAT2	NA						
CAT3			100				100
ESE	NA						

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EGT21 ADVANCED COMMUNICATION SKILLS

(Common to all Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	20EGT11 – English Language Skills	2	HS	3	0	0	3

Preamble	This course is designed to impart required levels of fluency in using the English Language at B1Level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase –VI**	**9**
Listening – Job and career related descriptions and conversations – requests of different kinds and the responses – **Speaking -** Career choices and professional skills – making requests and responding to requests – **Reading** – Using texts about jobs and careers – about different societies and cultural differences – **Writing** – Resumes, CVs and job oriented advertisements – business and career related emails – **Grammar &Vocabulary** – Gerunds and elements of comparison – requests and indirect requests.		
Unit - II	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VII**	**9**
Listening – Expository and narrative descriptions – information about different cultures, nations and societies. **Speaking** – Narrating and describing – talking about other countries and other cultures – **Reading** – Using texts about media and information technology – living abroad and experiencing different cultures – **Writing** – Blog writing – brochures and tourist pamphlets – **Grammar & Vocabulary** – The past tense forms - noun phrases and relative clauses.		
Unit - III	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VIII**	**9**
Listening – Consumerism – product description – complaints and redressal – environmental issues – ecology – saving the planet – **Speaking** – Talking about problems, issues, complaints – solutions and redressal – talking about environmental issues – **Reading** – Using texts on segregating wastes – recycling and reusing – texts on environmental issues – **Writing** – Online reviews, articles and writing web content – **Grammar & Vocabulary** – Phrases and sentences used for describing problems – passives – prepositions and infinitives.		
Unit - IV	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – IX**	**9**
Listening – Education, learning and the choice of courses – various services needed in daily life – self-improvement for success in life – **Speaking** - Discussions about educational and career oriented issues – talking about everyday services – giving advice and self improvement – **Reading** – Reading about learning strategies and learning styles – using texts about personality development – **Writing** – Writing about hobbies – pastime and individual skills – writing short articles on everyday life and personality development – **Grammar & Vocabulary** – Using of "would" and certain gerund forms – use of modals, verbs, gerunds, negative questions and infinitives.		
Unit - V	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – X**	**9**
Listening – Historical narratives – biographies and learning about the future – important life events, milestones and happenings of the past – **Speaking** – Talking about the past, present and the future – talking about important events in life – **Reading** – Texts about new technologies and future science – using texts about social organization, culture and social practices – **Writing** – Biographical sketches – historical events – famous personalities, stages of life and getting along with people – **Grammar & Vocabulary** – Future tense forms – time clauses and certain "if clauses".		

Total: 45

TEXT BOOK:

1. Jack C. Richards, Jonathan Hull, and Susan Proctor, "Interchange - Student's Book 3", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1. Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook based on AICTE Syllabus", Oxford University Press, 2018.
2. Board of Editors, "Skills Annexe: Functional English for Success", Orient BlackSwan, Hyderabad, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use functional grammar for improving communication skills	Applying (K3)
CO2	listen and comprehend different spoken excerpts critically and infer Unspoken and implied meanings.	Applying (K3)
CO3	read different genres of texts, infer implied meanings and critically analyze and evaluate them for ideas as well as for method of presentation.	Analyzing (K4)
CO4	write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.	Creating (K6)
CO5	speak effectively, to express opinions clearly, initiate and sustain a discussion and also negotiate using appropriate communicative strategies.	Creating (K6)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2			1	3	1	1		
CO2									2	3		1		
CO3						1				3	1	1		
CO4										3		2		
CO5									2	3		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		13	30	33	-	17	100
CAT2		13	33	37	-	17	100
CAT3		20	30	33	-	17	100
ESE		6	40	36	-	18	100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MAC21 - MULTIVARIABLE CALCULUS AND COMPLEX ANALYSIS

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	BS	3	1*	2*	4

Preamble	To impart the knowledge of partial derivatives, evaluation of real and complex integrals, vector calculus and analytic functions to the students for solving the problems related to various engineering disciplines.	
Unit - I	**Functions of Several Variables:**	**9**
Functions of two or more variables – Partial derivatives – Total differential – Taylor's series for functions of two variables – Maxima and minima – Constrained maxima and minima – Lagrange's multiplier method		
Unit - II	**Multiple Integrals:**	**9**
Double integration in cartesian coordinates – Change of order of integration – Application: Area between two curves – Triple integration in cartesian coordinates –Volume as triple integrals		
Unit - III	**Vector Calculus:**	**9**
Directional derivative – Gradient of a scalar point function – Divergence of a vector point function – Curl of a vector – Solenoidal and Irrotational vectors – Green's, Stoke's and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them**.**		
Unit - IV	**Analytic Functions:**	**9**
Functions of a complex variable – Analytic functions – Necessary and sufficient conditions (excluding proof) – Cauchy–Riemann equations (Statement only) – Properties of analytic function (Statement only) – Harmonic function – Construction of analytic function – Conformal mapping: w = z + a, az, 1/z – Bilinear transformation.		
Unit - V	**Complex Integration:**	**9**
Introduction – Cauchy's theorem (without proof) – Cauchy's integral formula – Taylor's and Laurent series – Singularities – Classification – Cauchy's residue theorem (without proof) – Applications: Evaluation of definite integrals involving sine and cosine functions over the circular contour.		

List of Exercises / Experiments:

1.	Finding ordinary and partial derivatives
2.	Computing extremes of a single variable function
3.	Evaluating double and triple integrals
4.	Finding the area between two curves
5.	Computing gradient, divergence and curl of point functions
6.	Applying Milne-Thomson method for constructing analytic function
7.	Determination of Mobius transformation for the given set of points
8.	Finding poles and residues of an analytic function

***Alternate week**

Lecture: 45, Tutorial and Practical:15, Total:60

TEXT BOOK:

1. Ravish R. Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1. Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2011.
2. Dass H K, "Higher Engineering Mathematics", 3rd Revised Edition, S.Chand and Co., New Delhi, 2014.
3. Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics – I", 2nd Edition, Pearson India Education, New Delhi, 2018.
4. MATLAB Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	compute extremal values which arise in function of several variables.	Applying (K3)
CO2	solve Problems involving Double and Triple integrals.	Understanding (K2)
CO3	apply the concept of vectors in engineering problems.	Applying (K3)
CO4	identify, construct and apply analytic functions in electrostatics and fluid flow problems.	Applying (K3)
CO5	evaluate complex integrals which are extensively applied in engineering.	Applying (K3)
CO6	compute maxima and minima of a single variable function, gradient, curl and divergence of a vector function using MATLAB.	Understanding (K2), Manipulation (S2)
CO7	evaluate Double, Triple integrals and determine area between two curves using MATLAB	Applying (K3), Manipulation (S2)
CO8	construct analytic function, find bilinear transformation and compute poles and residues using MATLAB.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3												
CO2	3	3	2											
CO3	3	3												
CO4	3	3												
CO5	3	3	2											
CO6					3									
CO7					3									
CO8					3									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20PHT21 - MATERIALS SCIENCE

(Common to Civil Engineering & Mechanical Engineering Branches)

Programme & Branch	BE-Civil Engineering & BE- Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	2	BS	3	0	0	3

Preamble	This course aims to impart the knowledge on the physics of conductors, semiconductors, magnetic materials, superconductors, dielectrics, smart and nano materials. It also describes the select characterization techniques and the applications of aforementioned materials in Civil and Mechanical Engineering and provides motivation towards innovations.	
Unit - I	**Conducting Materials:**	**9**
Conductors - Classical free electron theory of metals - Electrical conductivity - Thermal conductivity - Wiedemann-Franz law - Lorentz number - Draw backs of classical free electron theory - Quantum free electron theory - Quantum statistics: Fermi distribution function and Effect of temperature on Fermi function and Fermi energy - Density of energy states - Carrier concentration in metals.		
Unit - II	**Semiconducting Materials:**	**9**
Intrinsic semiconductor: Intrinsic carrier concentration, Fermi level in intrinsic semiconductor, Variation of intrinsic conductivity with temperature and Determination of band gap - Extrinsic semiconductors: Carrier concentration in N-type and P-type semiconductors, Fermi level in extrinsic semiconductors, Variation of Fermi level with temperature and impurity concentration - Homojunction laser: Construction and working - Hall effect: Theory and experimental determination of Hall coefficient and Applications.		
Unit - III	**Magnetic, Superconducting and Dielectric Materials:**	**9**
Magnetic Materials: Introduction - Domain theory of ferromagnetism - Hysteresis loss - Soft and hard magnetic materials - Application of magnetic materials: Transformer core - Superconductors: Properties of superconductors - Type I and Type II superconductors - Application of superconductors: Magnetic levitation - Dielectric materials: Dielectric constant – Types of polarization (qualitative) - Dielectric loss – Dielectric breakdown – Applications of dielectric materials.		
Unit - IV	**Smart and Nano Materials:**	**9**
Smart Materials: Metallic glasses: Preparation by melt spinning, properties and applications - Shape memory alloys: Characteristics and applications. Nanomaterials: Properties of nanomaterials – Quantum confinement: Zero dimensional, one dimensional and two dimensional nanostructures - Production techniques: Electron beam lithography, Nano imprint lithography, Nano pen lithography, Physical vapor deposition methods and sol-gel method - Applications of nano materials.		
Unit - V	**Materials Characterization:**	**9**
Importance of materials characterization - X-ray diffraction (qualitative) - X-ray photoelectron spectroscopy - Scanning electron microscopes and Energy dispersive X-ray analysis: principle, construction and working - Transmission electron microscope: principle, construction and working - Raman spectroscopy (qualitative) - Thermal analysis: Thermo gravimetric analysis – Differential scanning calorimetry.		

Total:45

TEXT BOOK:

1. Avadhanulu M.N., Kshirsagar P.G. and Arun Murthy T.V.S., "A Textbook of Engineering Physics",11th Edition, S.Chand & Company Pvt. Ltd., New Delhi, 2019 for Unit I – Unit IV.
2. Sam Zhang, Lin Li and Ashok Kumar, "Materials Characterization Techniques", 1st Edition, CRC Press, Boca Raton, 2008, for Unit V.

REFERENCES:

1. Pillai S.O. and Sivakami Pillai, "Rudiments of Materials Science", 3rd Edition, New Age International Publishers, New Delhi, 2012.
2. Charles Kittel, "Introduction to Solid State Physics", 8th Edition, John Wiley & Sons, New Jersey, 2004.
3. Tamilarasan K. and Prabu K., "Materials Science", 1st Edition, McGraw Hill Education Pvt. Ltd.,New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the concepts of classical and quantum free electron theory of metals to compute the electrical conductivity, thermal conductivity and carrier concentration in metals.	Applying (K3)
CO2	use the concepts of density of states to compute the carrier concentration, electrical conductivity and band gap of intrinsic semiconductor and to compute the carrier concentration of extrinsic semiconductors and to explain the working of semiconductor laser, Hall effect and its applications.	Applying (K3)
CO3	apply the domain theory of ferromagnetism to explain hysteresis, to apply the concept of formation copper pair to comprehend the properties and applications of superconductors, and to apply the concept of electric dipole moment and electric polarization to comprehend the select polarization mechanisms in dielectrics and to describe the related phenomenon.	Applying (K3)
CO4	utilize appropriate methods to prepare select smart materials (metallic glasses and shape memory alloys) and nano-materials, and to comprehend their properties and applications.	Applying (K3)
CO5	apply the concepts of X-ray diffraction, matter waves, Raman effect and thermograph to describe the principle and working of select material characterization techniques.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	35	45				100
CAT3	30	30	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20CYT22 - CHEMISTRY FOR MECHANICAL SYSTEMS

Programme & Branch	BE - Mechanical Engineeing, BE - Mechatronics Engineering & BE - Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Chemistry	2	BS	3	0	0	3

Preamble	This course aims to provide knowledge for mechanical, mechatronics and automobile engineering students on the requirements and properties of few important materials and create awareness among the present generation about the various energy sources.	
Unit - I	**Chemistry of Materials :**	**9**
Lubricants – functions - requirements – classification with examples - properties : viscosity, viscosity index, flash and fire point, cloud and pour point, oiliness, aniline point and carbon residue - **Explosives** – requirements - classification - manufacture of important explosives (TNT, GTN and RDX) - **Rocket propellants** - properties and classification - **Refractory bricks** - criteria of a good refractory material - classification – properties: refractoriness, RUL, porosity, thermal spalling, thermal conductivity and dimension stability - general method of manufacturing of refractories- **Insulators** - classification with examples: thermal insulators and electrical insulators - characteristics of insulating materials.		
Unit - II	**Energy storing Devices:**	**9**
Batteries -Introduction – Cells – Batteries – discharging and charging of battery - characteristics of battery -Types of Batteries – Primary batteries – silver button cell- Secondary battery – Ni-Cd battery. **Fuel Cells:** Importance and classification of fuel cells - description, principle, components, applications and environmental aspects of fuel cells: alkaline fuel cells, phosphoric acid, molten carbonate and direct methanol fuel cells.		
Unit - III	**Analytical Techniques:**	**9**
Introduction - Beer Lambert's law - principle, instrumentation and applications of UV-Vis Spectroscopy, Colorimetry, Infra Red Spectroscopy, Flame Photometry, Atomic Absorption Spectroscopy.		
Unit - IV	**Renewable Energy Resources:**	**9**
Introduction – global energy consumption scenario- types of energy resources - nuclear energy - nuclear power reactor - breeder reactors - applications and disadvantages of nuclear energy - design, working, advantages and disadvantages of solar energy, hydropower, wind energy, geothermal energy, tidal and wave power, ocean thermal energy - biomass and biofuels - hydrogen as an alternate fuel - hydrogen production - advantages ,disadvantages and applications - nanotechnology for energy sector.		
Unit - V	**Industrial Metal Finishing:**	**9**
Introduction – technological importance of metal finishing- methods of metal finishing - manufacturing of electronic component-PCB fabrication- essential of metal finishing: polarization, decomposition potential and overpotential - surface preparation - **Electroplating** – process - effect of plating variables on the nature of electrodeposit - electroplating of chromium and silver. **Electroless plating** - electroless copper plating on printed circuit board - electroless nickel plating process -Distinction between electroplating and electroless plating- advantages of electroless plating.		

Total: 45

TEXT BOOK:

1. Wiley Editorial Board, "Wiley Engineering Chemistry", 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019.

REFERENCES:

1. Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K. & Kowshalya V.N., "Environmental Science", Revised Edition, Pearson Education, New Delhi, 2019.
2. Palanna O., "Engineering Chemistry", McGraw Hill Education, New Delhi, 2017.
3. Payal B.Joshi & Shashank Deep, "Engineering Chemistry", Oxford University Press, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the knowledge of lubricants, refractories and insulators in mechanical systems.	Understanding (K2)
CO2	use the concepts of batteries, fuel cells and their applications in various fields.	Applying (K3)
CO3	apply the principle of various analytical techniques for specific applications	Applying (K3)
CO4	explain the role of renewable energy resources to attain sustainability	Understanding (K2)
CO5	employ the concept of coating techniques in industrial metal finishing	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	1												
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET21 - MANUFACTURING TECHNOLOGY

Programme & Branch	BE – Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	2/3	PC	3	0	0	3

Preamble	To provide the basic concepts and techniques of metal casting processes, deformation processes, special welding processes and overview of manufacturing processes.	
Unit - I	**Metal-Casting Processes:**	**9**
Introduction – Classification – Types of casting processes – Pattern: Types – Material – Allowances – Molding Sand: Preparation for sand casting – Properties – Cores: Types – Applications – Heating – Pouring – Cooling – Solidification of pure metals and alloys – Directional solidification – Design: Runner – Riser – Gate.		
Unit - II	**Special Casting Processes:**	**9**
Expendable mold casting processes: Shell molding – Vacuum molding – Expanded polystyrene process – Investment casting – Plastic mold casting – Ceramic mold casting – Permanent mold casting: Die casting – Centrifugal casting – Continuous casting – Squeeze casting – Slush casting – Defects in casting.		
Unit - III	**Welding Processes:**	**9**
Introduction – Fusion welding processes: Arc welding – Gas welding – Resistance spot welding – Electron beam welding – Laser beam welding – Electro slag welding – Thermit welding – Solid state welding processes: Friction stir welding – Forge welding – Diffusion welding – Explosive welding – Friction welding – Ultrasonic welding – Soldering and Brazing.		
Unit - IV	**Metal Forming Processes:**	**9**
Bulk deformation processes – Hot working and cold working processes –Rolling process – Types: Transverse rolling – Thread rolling – Shape rolling – Ring rolling – Tube piercing – Skewrolling – Forging process – Types: Open die forging – Closed die forging – Upsetting – Swaging – Radial forging – Roll forging – Extrusion process – Types: Direct extrusion – Indirect extrusion – Hydrostatic extrusion – Drawing process – Types: Wire drawing – Deep drawing – Rod drawing – Tube drawing – Sheet metal operations: Shearing – Blanking – Punching – Slotting – Perforating – Notching – Trimming – Shaving – Bending operations: Flanging – Hemming – Seaming – Curling – Ironing – Coining – Embossing.		
Unit - V	**Powder Metallurgy and Plastic Processing:**	**9**
Introduction – Production of metallic powders – Processing methods – Compaction methods – Design consideration in powder metallurgy – Product of powder metallurgy – Plastic forming: Properties of plastics – Additives in plastics – Plastic materials – Extrusion – Injection molding – Compression molding – Transfer molding – Extrusion blow molding – Rotational molding – Thermoforming		

Total:45

TEXT BOOK:

1. Rao P.N. “Manufacturing Technology- Foundry, Forming and Welding”, Volume 1, 4th Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2013.

REFERENCES:

1. SeropeKalpakjian, Steven R. Schmid. “Manufacturing Engineering and Technology”, 6th Edition, Pearson Education Limited, New Delhi, 2013.
2. Kaushish J.P. “Manufacturing Processes”, 2nd Edition, Prentice Hall of India Learning Private Limited, New Delhi, 2013.
3. Sharma P.C. “Manufacturing Technology-I”, 5th Edition, S.Chand and Company Private Limited, New Delhi, 2010.
4. Hajra Choudhury S.K., Hajra choudhury A.K., Nirjhar roy “Elements of Workshop Technology - Vol. I”, 14th Edition, Media Promoters & Publishers Private Limited, Mumbai, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the principle involved in metal-casting processes	Remembering (K1)
CO2	describe the principle and processes involved in special casting process	Understanding (K2)
CO3	demonstrate the principle involved in various welding techniques	Understanding (K2)
CO4	illustrate the mechanism of different kinds of metal forming processes	Applying (K3)
CO5	explain the concept of powder metallurgy and processes related to plastic forming	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				2					1			3
CO2	3	1				2					1		2	3
CO3	3	1				2					1		3	3
CO4	3	1				2					1			3
CO5	3					2					1		3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	60	20				100
ESE	10	70	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET22 – BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	ES	3	0	0	3

Preamble	This course is aimed to introduce the fundamental concepts and principles in Electrical and Electronics	
Unit - I	**Introduction:**	**9**
Electric Potential, Current, Power and Energy -Renewable and Non Renewable sources of Energy-Structure of Electric Power System - Electrical Safety Aspects as per IE rules. **Electric Circuits :** Solving simple DC Circuits using KVL and KCL- Single phase AC circuit fundamentals – Power, Power factor – solving simple AC circuits – 3 phase AC circuits (qualitative analysis).		
Unit - II	**DC Motors and Transformers:**	**9**
DC Motors: Principle of Operation- types – back emf – torque equation - speed torque characteristics – losses and efficiency – speed control of DC motor –Applications. Transformers: Single phase Transformers – Construction and working principle – Types, emf equation		
Unit - III	**AC Motors and Industrial Applications:**	**9**
AC Motors: 3 phase Induction Motor -construction– Principle of operation – types – torque equation - speed torque characteristics – Single phase Induction Motor – Principle of operation- types. Synchronous Motors – construction - Principle of Operation. Industrial Applications: Motor Selection – factors to be considered – power rating – types of Duty – selection of motors for machine tool applications, centrifugal pumps.		
Unit - IV	**Electronic Devices and Circuits:**	**9**
Electronic Devices: Construction, principle of operation, types and Characteristics: PN junction diode, -zener diode - BJT- Light emitting diode - Applications. **Electronic Circuits:** (Qualitative analysis only) Half wave and full wave rectifier, capacitive filter, zener voltage regulator, UPS and SMPS (Block Diagram approach).		
Unit - V	**Digital Electronics and Linear Integrated Circuits:**	**9**
Digital Electronics: Logic gates, Half adder, full adder, Full subtractor, Flip flops and Asynchronous Binary Ripple Counter. **Linear Integrated Circuits:** Operational amplifiers, Ideal op-amp characteristics, Inverting and Non-inverting amplifier (Qualitative analysis), op-amp applications.		

Total: 45

TEXT BOOK:

1. Muthusubramanian R., Salivahanan S., "Basic Electrical and Electronics Engineering", 1st Edition, Tata McGraw Hill Publishers, 2009, for Units I,II,IV,V.
2. Dubey G.K., "Fundamentals of Electrical Drives", 2nd Edition, Narosa Publishing House, New Delhi, 2010, for Unit III.

REFERENCES:

1. Jegathesan V., Vinoth Kumar K. and Saravanakumar R., "Basic Electrical and Electronics Engineering", 1st Edition, Wiley India, 2011.
2. Mehta.V.K and Rohit Mehta, "Principles of Electrical Engineering and Electronics", S.Chand & Co. Limited, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the basic concept of electrical systems and solve simple DC and AC circuits	Applying (K3)
CO2	interpret the construction and operation of DC motors and transformers	Understanding (K2)
CO3	discuss the operation, types and characteristics of AC motors and its selection factors for industries.	Understanding (K2)
CO4	explain the construction and operation of basic electronic devices and circuits	Understanding (K2)
CO5	describe the basic concepts and operation of adder, subtractors, flip flops and operational amplifiers.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1									2	3
CO2	3	1											1	2
CO3	3	1											1	2
CO4	3	1											1	2
CO5	3	1											1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	50	20				100
CAT2	40	60					100
CAT3	40	60					100
ESE	30	50	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20PHL21 - PHYSICAL SCIENCES LABORATORY II

Programme & Branch	BE - Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	BS	0	0	2	1

Preamble	This course aims to impart hands on training in the determination of physical parameters such as specific resistance, band gap, thermal conductivity, thickness of a thin film and particle size and to develop the skills in handling different basic instruments. Also, this course aims to impart the significance of Cl^-, Cr^{6+}, DO, Cu^{2+} and Polymeric material in mechanical systems and thereby, to improve the analytical capability.

List of Exercises / Experiments:

1.	Determination of the specific resistance of a conductor using Carey Foster's Bridge.
2.	Determination of the band gap of a semiconductor using post office box.
3.	Determination of the thermal conductivity of a dielectric material using Lee's disc arrangement.
4.	Determination of the thickness of a nano crystalline thin film using Air-wedge arrangement.
5.	Determination of the particle size of given powder using a Laser.
6.	Estimation of chloride ion in the given water sample using Argentometric method.
7.	Estimation of chromium (Cr^{6+}) in wastewater sample.
8.	Determination of dissolved oxygen in the given wastewater sample.
9.	Estimation of molecular weight of the polymer using viscometer.
10.	Estimation of copper in the given solution by Iodometric method.

Total: 30

REFERENCES:

1. Tamilarasan K. and Prabu K., "Physics Laboratory Manual", 1st Edition, SCM Publishers, Erode, 2020.
2. Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Kalaikathir Publishers, Coimbatore, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	determine the specific resistance of conducting materials and the band gap of semiconducting materials using the concept of electrical conductivity and determine the thermal conductivity of dielectrics using the concept of heat conduction through materials.	Applying (K3), Precision (S3)
CO2	determine the thickness of nano-crystalline thin films using the concept of interference of light, and to determine the particle size of powder material using the concept of diffraction of light. Demonstrate the viscometer to estimate the molecular weight of the polymer and to determine the amount of chloride and copper in the given solution.	Applying (K3), Precision (S3)
CO3	estimate the amount of chromium and DO in the given wastewater.	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			3											
CO2			3											
CO3			3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MEL21 – ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	ES	0	0	2	1
Preamble							

List of Exercises / Experiments:

1.	Resistor color coding and verification of Ohm's Law and Kirchhoff's Laws
2.	Computation of Current in a Loop using Mesh analysis
3.	Speed control of DC shunt motor
4.	Load test on single phase transformer
5.	Load test on three phase induction motor
6.	Speed control of Three phase induction motor using PWM inverter
7.	Characteristics of BJT
8.	Implementation of Half wave and Full wave Rectifier with simple Capacitor Filter
9.	Verification of logic gates
10.	Op-amp based Inverting and Non-Inverting amplifiers

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	select and apply various laws for the specific electric circuits	Applying (K3), Manipulation (S2)
CO2	perform suitable tests and analyze the performance of rotating machines and transformers	Analyzing (K4), Manipulation (S2)
CO3	interpret the operation and characteristics of electronic devices (BJT, OP-AMP, rectifier and gates)	Analyzing (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1									2	3
CO2	2	3	2	2	1								3	2
CO3	3	2	1	1									2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MAT31 - PROBABILITY AND PARTIAL DIFFERENTIAL EQUATIONS

(Common to AUTO, CIVIL, MECH, MTS, CHEM & FT branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	BS	3	1	0	4

Preamble	To provide the skills for solving the real time engineering problems involving partial differential equations and impart knowledge in applying probability concepts in their respective fields and express functions in terms of Fourier series.	
Unit - I	**Random Variables:**	**9+3**
Introduction to Probability – Definition of random variable – Discrete and Continuous random variables – Probability Mass and Probability density functions – Mathematical expectation and Variance – Moments – Moment generating functions.		
Unit - II	**Standard Probability Distributions:**	**9+3**
Discrete Distributions: Binomial distribution – Poisson distribution – Geometric distribution – Continuous Distributions: Uniform distribution – Exponential distribution – Normal distribution.		
Unit - III	**Fourier Series:**	**9+3**
Dirichlet's conditions – General Fourier series – Change of interval – Odd and even functions – Half range Sine series – Half range Cosine series – Harmonic analysis.		
Unit - IV	**Partial Differential Equations:**	**9+3**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange's linear equation – Solution of homogeneous linear partial differential equations of higher order with constant coefficients.		
Unit - V	**Applications of Partial Differential Equations:**	**9+3**
Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (excluding insulated edges).		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. Ravish R Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, Limited, 2019.
2. Veerarajan T., "Transforms and Partial Differential Equations", 3rd Reprint, Tata Mc Graw Hill Education Pvt. Ltd., New Delhi, 2013.
3. Jay L. Devore., "Probability and Statistics for Engineering and the Sciences", 9th Edition, Cengage Learning, USA, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the concept of random variables.	Applying (K3)
CO2	implement the exact distribution for solving engineering problems.	Applying (K3)
CO3	express the given function or data in terms of Fourier series.	Applying (K3)
CO4	formulate and solve higher order partial differential equations	Applying (K3)
CO5	apply Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1											
CO2	3	3	2											
CO3	3	2												
CO4	3	3	1											
CO5	3	3	2											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	10	80	-	-	-	100
CAT2	10	10	80	-	-	-	100
CAT3	10	10	80	-	-	-	100
ESE	10	20	70	-	-	-	100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20CSC31 - PROGRAMMING IN C
(Common to all BE/BTech Engineering & Technology branches except CSE, IT)

Programme & Branch	All BE/BTech Engineering & Technology branches except CSE, IT	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2/3	ES	3	0	2	4

Preamble	The course is designed for use by freshmen students taking their first course in programming. It deals with the techniques needed to practice computational thinking, the art of using computers to solve problems and the ways the computers can be used to solve problems. This course also focuses on developing programming skills using C language.	
Unit - I	**Introduction to Computer and Problem Solving:**	**9**
Overview of computers : Types, Generations, Characteristics, Basic computer Organization – Problem solving techniques: Algorithms - Flowcharts – Pseudo codes – Structuring the logic: Sequential, selection and repetitive structure		
Unit - II	**Introduction to C and Control Statements:**	**9**
The structure of a C program – Compiling and executing C program – C Tokens – Character set in C – Keywords – identifiers- Basic data Types – Variables – constants – Input/Output statements – operators - decision making and looping statements		
Unit - III	**Arrays and Functions:**	**9**
Declaring, initializing and accessing arrays – operations on arrays – Two dimensional arrays and their operations. Functions : Introduction- Using functions, function declaration and definition – function call – return statement – passing parameters to functions: basic data types and arrays – storage classes – recursive functions		
Unit - IV	**Strings and Pointers:**	**9**
Strings :Introduction – operations on strings : finding length, concatenation, comparing and copying – string and character manipulation functions, Arrays of strings. Pointers : declaring pointer variables – pointer expression and arithmetic, passing arguments to function using pointers -pointers and 1D arrays –arrays vs pointers , pointers and strings,		
Unit - V	**User-defined Data Types and File Handling:**	**9**
User-defined data types: Structure: Introduction – nested structures– arrays of structure – structure and functions -unions – enumerated data type. File Handling : Introduction - opening and closing files – reading and writing data to files -Manipulating file position indicator : fseek(), ftell() and rewind()		

List of Exercises:

1.	Writing algorithms and drawing flowcharts using Raptor Tool for problems involving sequential, Selection and repetition structures
2.	Programs for demonstrating the use of different types of operators like arithmetic, logical, relational and ternary operators
3.	Programs using decision making and repetitive statements
4.	Programs for demonstrating one-dimensional and two-dimensional numeric array
5.	Programs to demonstrate modular programming concepts using functions and strings (Using built-in and user-defined functions)
6.	Programs to illustrate the use of structures and pointers
7.	Programs to implement file operations

Lecture:45, Practical : 30, Total:75

TEXT BOOK:

1.	Reema Thareja, “Programming in C ”, 2nd Edition, Oxford University Press, New Delhi, 2018.

REFERENCES:

1.	Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2018.
2.	Sumitabha Das, “Computer Fundamentals and C Programming”, 1st Edition, McGraw Hill, 2018.
3.	Balagurusamy E., "Programming in ANSI C", 7th Edition, McGraw Hill Education, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	outline the basics of computers and apply problem solving techniques to express the solution for the given problem	Applying (K3)
CO2:	identify the appropriate looping and control statements in C and develop applications using these statements	Applying (K3)
CO3:	develop simple C programs using the concepts of arrays and modular programming	Applying (K3)
CO4:	apply the concepts of pointers and develop C programs using strings and pointers	Applying (K3)
CO5:	make use of user defined data types and file concept to solve given problems	Applying (K3)
CO6:	demonstrate the execution of flowcharts for the given problem using Raptor	Applying (K3), Precision (S3)
CO7:	demonstrate the application of sequential, selective and repetitive control structures	Applying (K3), Precision (S3)
CO8:	develop solutions to the given problem using derived /user defined data types and functions and also using file concepts	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs														
COs /POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1											
CO2	3	2	2											
CO3	3	2	2											
CO4	3	2	2											
CO5	3	2	2											
CO6	3	2	2	2	1					1				
CO7	3	2	2	2	1					1				
CO8	3	2	2	2	1					1				
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	50				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	20	30	50				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEC31 – FLUID MECHANICS AND HYDRAULIC MACHINES

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	3	ES	3	0	2	4

Preamble	This course provides an introduction to the properties and behavior of fluids under static and dynamic conditions. It introduces dimensional analysis and performance analysis of hydraulic machines.	
Unit - I	**Fluid Properties and Statics:**	**9**
Fluid Properties: Definition of Fluid - Classifications – Properties – Mass Density - Specific Weight - Specific Gravity – Viscosity – Compressibility - Vapour Pressure - Surface Tension – Capillarity. Fluid Statics: Pascal's Law – Pressure Variation in a Fluid at Rest – Absolute Pressure – Gauge Pressure – Atmospheric Pressure - Vacuum Pressures – Simple Manometer - Differential Manometer – Hydrostatic Forces – Buoyancy – Floatation – Metacenter.		
Unit - II	**Fluid Kinematics and Dynamics:**	**9**
Fluid Kinematics: Control Volume -Types of Fluid Flows – Continuity Equation in Two and Three Dimensions (Cartesian Co-ordinates) – Velocity and Acceleration of Fluid Particle – Velocity Potential Function and Stream Function. Fluid Dynamics: Momentum – Energy - Euler's Equation of Motion along a Streamline – Bernoulli's Equation and Applications – Venturimeter – Orificemeter - Pitot tube.		
Unit - III	**Flow through Pipes and Dimensionless Number:**	**9**
Flow through Pipes: Flow of Viscous Fluid through Circular Pipe – Loss of Energy in Pipes – Loss of Energy due to Friction (Darcy-Weisbach and Chezy's formula) – Minor Energy losses – Pipes in series - Pipes in parallel –Boundary Layer Concepts. Dimensionless Number: Dimensional analysis, Dimensionless number.		
Unit - IV	**Impact of Jet and Hydraulic Turbines:**	**9**
Impact of Jet: Impact of Jets – Work done and Force Exerted by a Liquid on Stationary and Moving Flat Vanes – Efficiency - Work done - Force Exerted by a Liquid on Unsymmetrical Moving Curved Vane – Velocity Triangles. Hydraulic Turbines: Classifications – Design - Work done and efficiencies of Pelton Wheel Turbine - Francis turbine - Kaplan turbine – Velocity Triangles – Specific Speed of Turbines.		
Unit - V	**Hydraulic Pumps:**	**9**
Definitions of Heads - Efficiencies and Work done of a Centrifugal pump – Velocity Triangles – Working principles of Single acting and Double Acting Reciprocating pump – Basic principles of indicator diagram – Cavitation – Specific Speed of Pumps.		

List of Exercises / Experiments :

1. Verification of Bernoulli's Law using Bernoulli's apparatus.
2. Determination of Co-efficient of Discharge using Venturimeter / Orificemeter.
3. Identify Major / Minor Loss of Energy in Flow through Pipes.
4. Performance Test on Pelton Turbine / Francis Turbine (constant head method).
5. Evaluate the Performance Characteristics of Centrifugal Pump / Reciprocating Pump.

Lecture: 45, Practical: 30, Total: 75

TEXT BOOK:

1. Sukumar Pati. "Fluid Mechanics and Hydraulic Machines". 9th Edition, Mc Graw Hill Education, Chennai, 2017.

REFERENCES:

1. Hibbeler R.C., "Fluid Mechanics in SI units", 1st Edition, Pearson India Education Services Pvt. Ltd., Noida, 2017.
2. Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 10th Edition, Laxmi Publications, New Delhi, 2018.
3. Laboratory Manual.

	COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**
CO1	outline the fluid flow properties and study the pressure measurement	Understanding (K2)
CO2	solve the problems related to kinematics and dynamics of fluid flow.	Applying (K3)
CO3	calculate the energy losses in flow through pipes.	Applying (K3)
CO4	interpret the work done and efficiencies of various hydraulic turbines.	Applying (K3)
CO5	determine the work done and efficiencies by the various hydraulic pumps.	Applying (K3)
CO6	perform experiments on flow measuring devices	Applying (K3), Manipulation (S2)
CO7	identify the loss of head in open and closed flows system	Applying (K3), Manipulation (S2)
CO8	determine and plot the performance characteristics of hydraulic turbines and hydraulic pumps	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1										3		3
CO2	2	2										2		3
CO3	3	3										3		3
CO4	3	3								1		3		3
CO5	3	3								1		3		3
CO6	3	2	2	3	2				3	2		1	2	3
CO7	3	2	2	3	2				3	2		1	2	3
CO8	3	2	2	3	2				3	2		1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	35	50				100
CAT2	15	35	50				100
CAT3	15	35	50				100
ESE	10	30	60				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEC32 – ENGINEERING MATERIALS AND METALLURGY

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	3/4	PC	3	0	2	4

Preamble	This course deals with the physics, structure-property relationship and allied applications of ferrous metals, non-ferrous metals, alloys, polymers, ceramics, bio-materials, composite materials and nano materials. It also describes the different heat treatment process and their influence on the physico-mechanical properties of metals.	
Unit - I	**Ferrous Metals:**	**9**
Classification of Engineering Materials – Comparison between Metals and Non-Metals -Alloys – Solid Solutions – Principles of Alloy Formation - Substitutional and Interstitial – Phase Diagrams - Lever Rule – Isomorphous - Eutectic – Eutectoid - Peritectic and Peritectoid Reactions - Iron – Iron Carbide Equilibrium Diagram - Classification of Steel and Cast Iron – Microstructure - Properties and Applications - Ferrite and Austenite Stabilizers.		
Unit - II	**Ferrous and Non-Ferrous Alloys:**	**9**
Effect of Alloying Elements – Manganese – Silicon – Chromium – Molybdenum – Vanadium - Titanium and Tungsten on the Technical Properties of Steel - Stainless and Tool Steels – High Strength Low Alloy (HSLA) - Maraging Steels - Aluminium and its Alloys – Precipitation Strengthening Treatment - Copper and its Alloys - Magnesium and its Alloys.		
Unit - III	**Heat Treatment:**	**9**
Definition – Purpose of Heat Treatments – Nucleation, grain growth and kinetics - Full Annealing - Stress Relief - Recrystallization and Spheroidizing – Normalizing - Quenching - Hardening and Tempering of Steel - Isothermal Transformation Diagrams – Cooling Curves Superimposed on Time Temperature Transformation (TTT) Diagram - Critical Cooling Rate (CCR) Austempering - Martempering - Hardenability - Jominy End Quench Test. Case Hardening- Carburizing - Nitriding - Cyaniding - Carbonitriding – Flame and Induction Hardening.		
Unit - IV	**Polymers and Ceramics:**	**9**
Polymers – Types- Thermoset and Thermoplastics – Glass Transition and Melting Temperature of Polymers – Structures - Properties and Applications of Polyethylene (PE) - Polypropylene (PP) - Polystyrene (PS) - Polyvinyl chloride (PVC) - Poly methyl methaacrylate (PMMA) - Polyethylene terephthalate (PET) - Polycarbonate (PC) - Polyamide (PA) - Polyimide (PI) - Polyamide-imide (PAI) - Polyphenylene oxide (PPO) - Polyphenylene sulfide (PPS) - Polyether ether ketone (PEEK) - Poly tetra fluro ethylene (PTFE) - Urea and Phenol Formaldehydes. Engineering Ceramics –Properties and applications of Alumina (Al_2O_3) - Silicon Carbide (SiC) - Silicon Nitride (Si_3N_4) - Partially Stabilized Zirconia (PSZ) and Sialon.		
Unit - V	**Stress-Strain Relationship of Materials and Introduction to New Materials:**	**9**
Comparative Stress-Strain Diagram of Cast iron - Steel - Aluminium - Copper - Brass - Al_2O_3 - Glass - Commodity Plastics - High Performance Plastics and Rubber – Hyperelastic - Elastoplastic – Viscoelastic – Anisotropic materials - Composite Materials - Fiber and Particulate Reinforced Matrices - Biomaterials - General Overview of Components in the Human Body used to Construct Tissue - Implantable Materials - Temporary and Permanent Implants - Bio-degradable Materials - Nanomaterials - Overview of Nanostructured Materials - Hybrid nanomaterials.		

List of Exercises / Experiments :

1. Microstructural Analysis of Low Carbon and Eutectoid Steel.
2. Microstructural Analysis of Grey Cast Iron and Spheroidal Cast Iron.
3. Microstructural Analysis of Pure Copper, Aluminum and Magnesium.
4. Microstructural Analysis of Pure Copper, Aluminum and Magnesium based Alloys.
5. Microstructural Analysis of Metal Matrix Composites.
6. Microscopic Fracture Surface Analysis of Non-ferrous and Non-metals.

Lecture: 45, Practical: 30, Total: 75

TEXT BOOK:

1. Balasubramaniam R. “Callister’s Materials Science and Engineering”. 2nd Edition, Wiley India Pvt. Ltd., 2017 for Units I,II,III,IV.
2. Sina Ebnesajjad. “Handbook of Biopolymers and Biodegradable Plastics: Properties, Processing and Applications”, 1st Edition, Elsevier, Amsterdam, Netherlands, 2012 for Unit V.

REFERENCES:

1. Sidney H. Avner. “Introduction to Physical Metallurgy”. 2nd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2017.
2. Premamoy Ghosh., “Polymer Science and Technology: Plastics, Rubbers, Blends and Composites”. 3rd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the microstructure - composition and properties of ferrous metals	Understanding (K2)
CO2	interpret the effect of alloying elements on the technical properties of ferrous and non-ferrous metals	Understanding (K2)
CO3	apply the principles of heat-treatment processes	Applying (K3)
CO4	demonstrate the structure-property relationship and allied applications of polymers and ceramics	Applying (K3)
CO5	draw the stress-strain relationship for several classes of materials and interpret the development of new materials	Applying (K3)
CO6	perform microstructural analysis of ferrous and non-ferrous metals.	Analyzing (K4), Precision (S3)
CO7	perform microstructural analysis of composite materials	Precision (S3), Analyzing (K4)
CO8	analyse the fracture surface of ferrous and nonferrous metals	Precision (S3), Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												3
CO2		3		1										3
CO3	1	2		3										3
CO4	3			3										3
CO5	2						2					1		3
CO6	3	2		2	2				2	2			3	3
CO7	3	2		2	2				2	2			3	3
CO8	3	2		2	2				2	2			3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	10	50	40				100
CAT3	10	50	40				100
ESE	10	40	50				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET31 – ENGINEERING THERMODYNAMICS

(Use of Steam Tables and Psychrometric Chart are permitted for the End Semester Examination)

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	3	0	0	3

Preamble	This course aims to transfer the fundamental knowledge on thermodynamic laws and their relevant practical applications. In addition, this course covers the properties of steam, gases and atmospheric air.	
Unit - I	**Basic Concepts and First Law of Thermodynamics:**	**9**
Basic Concepts: Microscopic and Macroscopic Approaches - Concept of Continuum - Thermodynamic System – Closed System – Open System - Isolated System - Property - State – Path - Process - Quasi-Static Process - Specific Heat Capacities - Internal Energy – Enthalpy – Work - Modes of Work - Zeroth Law of Thermodynamics - Concept of Temperature and Heat. First Law of Thermodynamics: Law - Application to Closed and Open Systems - Steady Flow Energy Equation (SFEE) with Reference to Thermal Equipment.		
Unit - II	**Second Law of Thermodynamics:**	**9**
Kelvin–Planck Statement - Clausius Statement - Efficiency - Carnot Cycle - Carnot's Theorem - Heat Engine - Reversed Carnot Cycle - COP – Refrigerator - Heat pump - Reversibility – Irreversibility - Thermodynamic Temperature Scale - Inequality of Clausius. Entropy - Concept of Entropy - Entropy of Ideal Gas - Principle of Increase of Entropy - Absolute Entropy - Basic Concepts of Availability.		
Unit - III	**Properties of Pure Substances:**	**9**
Properties of Pure Substances -Thermodynamic Properties of Pure Substances in Solid Phase - Liquid Phase - Vapour phase – Gibbs Phase Rule - p-v Diagram - p-T Diagram - T-s Diagram - h-s Diagram - pvT Surfaces. Steam - Formation of Steam **-** Thermodynamic Properties of Steam - Use of Steam Tables and Mollier Chart - Calculations of Work Done - Heat Transfer in Non-Flow and Flow Processes.		
Unit - IV	**Ideal and Real Gases:**	**9**
Concept of Ideal and Real Gases and its Properties - Equation of State - Avogadro's Law - Van der Waals Equation of State - Compressibility - Compressibility Chart - Dalton's Law of Partial Pressure - Gas Mixtures. Thermodynamic Relations - Exact Differentials - TdS Equations - Difference and ratio of Heat Capacities - Maxwell's Equations - Clausius-Clapeyron Equation - Joule-Kelvin Coefficient.		
Unit - V	**Psychrometry:**	**9**
Definition - Properties of Atmospheric Air - Calculations of Properties of Air - Vapour Mixtures - Psychrometric Chart - Psychrometric Processes - Sensible Heat Exchange Processes - Latent Heat Exchange Processes - Adiabatic Mixing - Evaporative Cooling.		

Total: 45

TEXT BOOK:

1. Nag P.K.. "Engineering Thermodynamics". 6th Edition, McGraw Hill Education Pvt. Ltd., Chennai, 2017.

REFERENCES:

1. Claus Borgnakke, Richard E. Sonntag. "Fundamentals of Thermodynamics". 8th Edition, Wiley, U.S., 2020.
2. Yunus A. Cengel and Michael A. Boles. "Thermodynamics: An Engineering Approach". 9th Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recognize the basic concepts of thermodynamic processes and first law of thermodynamics	Applying (K3)
CO2	solve the problems by applying the second law of thermodynamics	Applying (K3)
CO3	analyze the thermodynamic properties of pure substances using steam table	Analyzing (K4)
CO4	distinguish the behavior of real & ideal gases and derive the thermodynamic relations	Applying (K3)
CO5	apply the psychrometric concepts in various processes	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2										2		3
CO2	3	3										2		3
CO3	3	3	3				1			3		2		3
CO4	3	3	1									2		3
CO5	3	2	3				1			3		2		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	30	40	20			100
CAT3	10	40	50				100
ESE	10	30	50	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET32 – MATERIAL REMOVAL PROCESSES

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Practices Laboratory, Manufacturing Technology	3	PC	3	0	0	3

Preamble	This course depicts metal cutting principles, machine tools and its parts, components materials. It also describes the working principle of various unconventional machining processes.	
Unit - I	**Theory of Metal Cutting:**	**9**
Elements Of Cutting Process - Classification of Cutting Tools – Tool Materials – Nomenclature of Single Point Cutting Tool - Milling Tool - Drilling Tool. Mechanics of Metal Cutting: Chip Formation and its Types - Chip Breakers - Merchant Circle Diagram - Cutting Force Calculation – Cutting Fluids – Tool Wear – Tool Life –Taylor's Tool Life Equation - Economics of Metal Machining – Machinability.		
Unit - II	**Machining with Single Point Tool:**	**9**
Lathe Construction - Specification – Types of Lathe - Centre Lathe - Turret - Capstan Lathe – Lathe Accessories & Attachments: Tool Holders - Work Holders - Special Attachments. Lathe Operations: Thread Cutting - Methods of Taper Turning – Machining Time - Power Estimation – Tooling Layout – Automatic Lathe.		
Unit - III	**Machining with Multi Edged Tools:**	**9**
Drilling Machines: Types – Operations - Work Holders - Tool Holders. Milling Machines: Types - Fundamentals of Milling Processes - Operations - Types of Milling Cutters. Broaching Machines: Types - Broach Construction - Types of Operations - Broaching Methods. Grinding Machines: Specification of Grinding Wheel - Working Principle - Cylindrical Grinding – Dressing – Truing- Loading - Selection of Grinding Wheel – Finishing Operations.		
Unit - IV	**Tool Engineering:**	**9**
Classification of Jigs and Fixtures - Locating and Clamping Principles - Locating and Clamping Devices - Jig Bushes - Drilling Jigs - Milling Fixtures - Turning Fixtures – Vice Fixtures – Boring Fixtures - Grinding Fixtures - Broaching Fixtures - Materials for Jigs and Fixtures.		
Unit - V	**Unconventional Machining Processes:**	**9**
Need for Unconventional Machining Process - Classification Based on Nature of Energy – Introduction – Equipment – Materials – Applications - Advantages & Limitations - Effect of Process Parameters of Abrasive Jet Machining (AJM) - Abrasive Water Jet Machining (AWJM) - Ultrasonic Machining (USM) - Electro Chemical Machining (ECM) - Chemical Milling - Electric Discharge Machining (EDM) - Plasma Arc Machining (PAM) – Laser Beam Machining (LBM).		

Total: 45

TEXT BOOK:

1. Kaushish J. P., "Manufacturing Processes", 2nd Edition, PHI Learning Pvt. Ltd., Delhi, 2014.

REFERENCES:

1. Paul DeGarmo E., Black J.T. and Ronald A. Kohser. "Materials and Processes in Manufacturing". 11th Edition, John Wiley & Sons, New Delhi, 2011.
2. Rao P. N., "Manufacturing Technology", Volume - 2, 4th Edition, Tata McGraw Hill, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the basic concepts of metal cutting and perform cutting force and tool life calculations.	Applying (K3)
CO2	demonstrate the single point cutting tool operations using various lathe machine and calculate machining time.	Applying (K3)
CO3	depict the fundamental concepts of machining with multipoint tools.	Understanding (K2)
CO4	choose appropriate jigs and fixtures for different machining processes.	Applying (K3)
CO5	demonstrate the fundamental principles of material removal in unconventional machining processes.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1								2		3
CO2	2	1	1									2		3
CO3	2	1	1									2		3
CO4	3	2	1	1								2		3
CO5	2	1	1									2		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	50	40				100
CAT2	10	50	40				100
CAT3	10	50	40				100
ESE	15	45	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEL31 – PRODUCTION TECHNOLOGY LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology	3	PC	0	0	2	1
Preamble	The laboratory course provides hands on training for various manufacturing processes						

List of Exercises / Experiments :

1.	Prepare a Mold by using Solid/Split/Loose-piece Patterns and Mold for Hollow Objects with the help of Co.re
2.	Produce Different Weld by Gas Tungsten Arc Welding (GTAW)/ Gas Metal Arc Welding (GMAW) Operations.
3.	Perform Gas Cutting and Produce Different Weld by Gas Welding and Spot Welding Operations.
4.	Make a Square/Rectangular Rod by Hand Forging Operation.
5.	Demonstrate The Injection Molding Operation By Producing Different Plastic Components.
6.	Carryout Knurling and Taper Turning Operations using Centre Lathe.
7.	Execute External Thread Cutting Operation in Centre Lathe.
8.	Obtain a Dovetail/Keyway Shape Using Shaping Machine.
9.	Perform Grinding Operation on the Flat and Cylindrical Work Pieces using Surface and Cylindrical Grinding Machines.
10.	Make a Spur Gear/Keyway/Contour Shape using Milling Machines.
11.	Prepare a Convex Shape In A Flat Metal Work Piece using Slotting Machine.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Production Technology Laboratory Manual.
2.	Hajra Choudhury S.K., Hajra Choudhury A.K., Nirjhar Roy, "Elements of Workshop Technology - Vol. I", 14th Edition, Media Promoters & Publishers Private Limited, Mumbai, 2008.
3.	Hajra Choudhury S.K., Nirjhar Roy, "Elements of Workshop Technology-Volume-2", 15th Edition, Media Promoters & Publishers Pvt Ltd, Mumbai, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	prepare mold for given component	Applying (K3), Precision (S3)
CO2	select suitable welding and forging process for the given material and perform various operations	Applying (K3), Manipulation (S2)
CO3	produce different profiles on given material using lathe, milling, shaping and grinding	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1		1					2	1		2	2	3
CO2	3	1		1					2	1		2	2	3
CO3	3	1		1					2	1		2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MEL32 – MACHINE DRAWING LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Drawing	3	PC	0	0	2	1
Preamble	This course imparts the knowledge on National and International Standard of drawing and to communicate the necessary technical information required for manufacture and assembly of machine components.						

List of Exercises / Experiments:

1.	Study of GD&T Systems with BIS Standards.
2.	Study of Keys and Pins used in various Machine Elements.
3.	Draw the Conversion of Isometric View to Orthographic View of Simple Machine Components.
4.	Draw Orthographic views of Square and Hexagonal Bolt and Nut.
5.	Draw the Assembled Sectional views of Gib and Cotter Joint.
6.	Draw the Assembled Sectional views of Knuckle Joints.
7.	Draw the Assembled Sectional views of Flange coupling.
8.	Draw the Assembled Sectional views of Stuffing Box.
9.	Draw the Assembled Sectional views of Simple Eccentric.
10.	Draw the Assembled Sectional views of Machine Vice.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Bhatt N. D., Panchal V.M., "Machine Drawing", 50th Edition, Charotar Publishing House Pvt. Ltd., Gujarat, 2016.
2.	Sidheswar N., Kannaiah P., Sastry V.V., "Machine Drawing",27th Reprint, Tata-McGraw Hill Education, Chennai, 2004.
3.	Narayana K. L., Kannaiah P., and Reddy K.Venkata "Machine Drawing", 6th Edition, New Age International Publishers limited, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	demonstrate the basic concepts and BIS conventions of machine drawing	Applying (K3) Manipulation (S2)
CO2	demonstrate and evaluate the projections, sectioning, limits, fits and tolerance	Applying (K3) Manipulation (S2)
CO3	construct assembled sectional views of mechanical components conforming to BIS conventions	Applying (K3) Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3							2		2	3	1
CO2	3		3							2		2	3	1
CO3	3		3							2		2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MNT31 - ENVIRONMENTAL SCIENCE

Programme & Branch	All BE/BTech Engineering & Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	MC	2	0	0	0

Preamble	This course provides an approach to understand the various natural resources, ecosystem, bio-diversity, pollution control & monitoring methods for sustainable life and also to provide knowledge and to create awareness for engineering students on biological sciences.	
Unit - I	**Environmental Studies and Natural Resources:**	**5**
Introduction to Environmental Science – uses, over-exploitation and conservation of forest, water, mineral, food, energy and land resources–case studies		
Unit - II	**Ecosystem and Biodiversity:**	**5**
Ecosystems: concept and components of an ecosystem -structural and functional features – Functional attributes (Food chain and Food web only). Biodiversity: Introduction – Classification – Bio geographical classification of India- Value of biodiversity – Threats and Conservation of biodiversity - case studies.		
Unit - III	**Environmental Pollution:**	**5**
Environmental Pollution: Definition – causes, effects and control measures of: (a) Air pollution - Climate change, global warming, acid rain, ozone layer depletion (b)Water pollution (c) Soil pollution - Role of an individual in prevention of pollution - case studies.		
Unit - IV	**Environmental Monitoring:**	**5**
Sustainability -three pillars of sustainability- factors affecting environmental sustainability-approaches for sustainable development - Introduction to EIA - objectives of EIA - environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act.		
Unit - V	**Introduction to Biological Science:**	**5**
Functions of Carbohydrates, lipids, proteins and nucleic acids - Cells and its organelles - plasma membrane, mitochondria and nucleus- Heredity and DNA - organization of DNA in cells - Genes and chromosomes- Cell division -Types of cell division- mitosis & meiosis - Cell cycle and molecules that control cell cycle.		

Total: 25

TEXT BOOK:

1. Anubha Kaushik, and Kaushik C.P., “Environmental Science and Engineering”, 6th Multicolour Edition, New Age International Pvt. Ltd., New Delhi, 2018.
2. Lodish. H., Berk A., Zipurursky S.L., Matsudaria P., Baltimore D. and Darnell J., “Molecular Cell Biology”, 4th Edition, Freeman Press, 2000.

REFERENCES:

1. Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., “Environmental Science”, Pearson Education, New Delhi, Revised Edition 2019.
2. Satyanarayan, U.,& Chakrapani, U., “Textbook of Biochemistry”,1999 Ed. June 2017

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the various natural resources and role of individual for its conservation	Understanding (K2)
CO2	elaborate the features of ecosystem and biodiversity to find the need for conservation.	Understanding (K2)
CO3	manipulate the sources, effects and control methods of various environmental pollution.	Applying (K3)
CO4	make use of the knowledge of EIA and environmental legislation laws towards sustainability.	Applying (K3)
CO5	explain the functions of carbohydrates, lipids, proteins, nucleic acids, Cells and its organelles	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1					3							
CO2	2	1					3							
CO3	3	2	1				3							
CO4	3	2	1				3							
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	40	35				100
CAT2	25	40	35				100
CAT3	NA						100
ESE	NA						100

*±3% may be varied (CAT 1,2 – 50 marks)

20MAT41 – STATISTICS AND NUMERICAL METHODS

(Common to all Engineering and Technology Branches except ECE, CSE and IT)

Programme & Branch	B.E – Civil Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	BS	3	1	0	4

Preamble	To impart knowledge in testing of samples, ANOVA and interpolation. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations and solve linear and ordinary differential equations.	
Unit - I	**Testing of Hypothesis:**	**9+3**
Introduction – Critical region and level of significance – Types of Errors – Large sample tests: Z-test for single proportion and difference of two sample proportions – Z-test for single mean and difference of means – Small sample tests: Student's t-test for testing significance of single mean and difference of means – F-test for comparison of variances – Chi-square test: Test of goodness of fit – Test of independence of attributes.		
Unit - II	**Design of Experiments:**	**9+3**
Introduction – Analysis of variance – One way classification: Completely Randomized Design – Two way classification: Randomized Block Design – Three way classification: Latin Square Design.		
Unit - III	**Solution to Algebraic and Transcendental Equations:**	**9+3**
Method of false position – Newton-Raphson method – Solution of linear system of equations – Direct methods: Gauss elimination method and Gauss - Jordan method – Iterative methods: Gauss Jacobi and Gauss-Seidel methods.		
Unit - IV	**Interpolation, Numerical Differentiation and Integration:**	**9+3**
Interpolation: Interpolation with equal intervals: Newton's forward and backward difference formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula. Numerical Differentiation and Integration: Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule.		
Unit - V	**Numerical Solution of First order Ordinary Differential Equations:**	**9+3**
Single step methods: Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. Veerarajan T, Ramachandran T., "Statistics and Numerical Methods", 1st Edition, Tata McGraw Hill Publishing Company, New Delhi, 2018.

REFERENCES:

1. Walpole R.E., Myers R.H., Myers S.L. and Ye K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2012.
2. Jay L. Devore., "Probability and Statistics for Engineering and the Sciences", 9th Edition, Cengage Learning, USA, 2016.
3. Steven C. Chapra, Raymond P. Canale., "Numerical Methods for Engineers", 7th Edition, McGraw-Hill Education, 2014.
4. Ravish R.Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply statistical tests for solving engineering problems involving small and large sample tests.	Applying (K3)
CO2	handle experimental data with the knowledge of ANOVA.	Applying (K3)
CO3	apply various numerical techniques to solve algebraic and transcendental equations	Applying (K3)
CO4	compute intermediate values of given data, numerical derivatives and integral values	Applying (K3)
CO5	obtain the solution of first ordinary differential equations by numerical methods.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3										
CO2	3	2	1	3										
CO3	3	3	2											
CO4	3	2												
CO5	3	3	1											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	30	60				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20CSC41 – PYTHON PROGRAMMING
(Common to all BE/BTech Engineering & Technology branches except CSE, IT)

Programme & Branch	All BE/BTech Engineering & Technology branches except CSE, IT	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3/4	ES	3	0	2	4

Preamble	This course introduces the core python programming. It emphasizes on developing python programs with all data types, functions, classes, objects and numpy	
Unit - I	**Introduction:**	**9**
Introduction: Problem solving strategies – program design tools – Types of errors – Testing and Debugging- Basics: Literals – variables and identifiers – data types - input operation – comments – reserved words – indentation – Operators and Expressions – Decision Control Statements:Introduction – conditional statement – iterative statements – Nested Loops – break,continue and pass statements – else in loops.		
Unit - II	**Lists,Tuples and Dictionary:**	**9**
Lists,Tuples and Dictionary:Lists:Access, update, nested, cloning, operations, methods , comprehensions, looping - Tuple:Create, utility, access, update, delete, operations, assignments, returning multiple values, nested tuples, index and count method - Dictionary: Create, access, add and modify, delete, sort, looping, nested, built-in methods – list vs tuple vs dictionary.		
Unit - III	**Strings and Regular Expressions:**	**9**
Strings and Regular Expressions:Strings:Concatenation , append, multiply on strings – Immutable – formatting operator – Built-in string methods and functions – slice operation – functions – operators – comparing – iterating – string module – Regular Expressions – match, search, sub, findall and finditer functions – flag options.		
Unit - IV	**Functions and Modules:**	**9**
Functions and Modules: Functions:Introduction - definition – call – variable scope and lifetime – return statement – function arguments – lambda function – documentation strings – programming practices recursive function- Modules:Modules – packages – standard library methods – function redefinition.		
Unit - V	**Object Orientation, NumPy and Matplotlib:**	**9**
Object Orientation: Class and Objects:Class and objects – class methods and self – constructor – class and object variables – destructor – public and private data member.NumPy :NumPy Arrays – Computation on NumPy Arrays. Matplotlib : Line plots – Scatter Plots		

List of Exercises / Experiments :

1.	Programs using conditional and looping statements
2.	Implementation of list and tuple operations
3.	Implementation of dictionary operations
4.	Perform various string operations
5.	Use regular expressions for validating inputs
6.	Demonstration of different types of functions and parameter passing
7.	Develop programs using classes and objects
8.	Perform computation on Numpy arrays
9.	Draw different types of plots using Matplotlib

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1. Reema Thareja, "Python Programming using Problem Solving Approach", 3rd Edition, Oxford University Press, 2017.

REFERENCES:

1. Nageswara Rao, "Core Python Programming", 2nd Edition, DreamTech Press, New Delhi, 2018.
2. Jake Vander Plas , "Python Data Science Handbook Essential Tools for Working with Data", 1st Edition, O'Reilly Media, , 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of basic python constructs to write simple programs.	Applying (K3)
CO2	apply list, tuple and dictionary to handle variety of data.	Applying (K3)
CO3	apply strings and regular expression for searching in a string.	Applying (K3)
CO4	solve the problems using functions and modules.	Applying (K3)
CO5	understand the class and object and apply inheritance in programming.	Applying (K3)
CO6	implement the basic data types and control statements.	Applying (K3), Manipulation (S2)
CO7	demonstrate functions, regular expressions and object oriented concepts.	Applying (K3), Manipulation (S2)
CO8	perform numpy operations and analyse results using matplotlib	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
CO6	3	2	1	1										
CO7	3	2	1	1										
CO8	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	25	50				100
CAT2	20	20	60				100
CAT3	20	20	60				100
ESE	25	25	50				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET41 – STRENGTH OF MATERIALS

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Matrices and Differential Equations, Multivariable Calculus and Complex Analysis, Engineering Mechanics	4	PC	3	1	0	4

Preamble	The course provides the various properties of materials, deformable bodies, biaxial state of stress, thin cylinders, spherical shells, types of beams, bending stresses and deflection of beams. It also imparts design of columns, torsion on circular shaft and springs.	
Unit - I	**Deformation of Solids:**	**9+3**
Stability- Strength- Stiffness- Tensile- Compressive and Shear stresses - Strain - Poisson's ratio – Lateral Strain - Simple and Compound bars – Relation between Elastic Constants – Thermal Stresses. Strain Energy: Uniaxial Loads - Gradually Applied Load - Suddenly Applied Load and Impact Load.		
Unit - II	**Analysis of State of Stress:**	**9+3**
Biaxial State of Stress – Thin Cylinders and Shells – Deformation in Thin Cylinders and Spherical Shells. Biaxial Stresses: Stresses at a Point on Inclined Planes – Principal Planes and Stresses – Mohr's Circle for Biaxial Stress- Maximum Shear Stress.		
Unit - III	**Transverse Loading on Beams:**	**9+3**
Types - Transverse Loading in Beams - Shear Force and Bending Moment in Beams – Cantilevers - Simply Supported and Overhanging Beams - Point of Contraflexure. Stresses in Beams: Theory of Simple Bending – Analysis of Stress- Load Carrying Capacity.		
Unit - IV	**Deflection of Beams:**	**9+3**
Elastic Curve of Neutral Axis of the Beam Under Normal Loads – Evaluation of Beam Deflection and Slope - Double Integration Method and Macaulay's Method. Columns: End Condition – Equivalent Length of Column – Euler's Equation – Slenderness Ratio – Rankine's Formula for Columns.		
Unit - V	**Torsion on Circular Shafts and Springs:**	**9+3**
Torsion – Shear Stress Distribution – Hollow and Solid Circular Section - Torsional Rigidity – Torsional Stiffness -Torsion on Stepped Shaft. Torsion on Springs: Wahl's Correction Factor of Springs Stresses in Helical Springs Under Torsion Loads - Stiffness and Deflection of Springs Under Axial Load.		

Lecture: 45 - Tutorial: 15, Total: 60

TEXT BOOK:

1. Rajput R.K. "Strength of Materials". 7th Edition, S.Chand & Co., New Delhi, 2018.

REFERENCES:

1. Rattan S.S. "Strength of Materials". 3rd Edition, Tata McGraw Hill Education Private Ltd., New Delhi, 2016.
2. Timoshenko S.P. "Elements of Strength of Materials". 10th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2010.
3. Amrita Virtual Lab

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	calculate the stress, strain and strain energy of simple bars	Applying (K3)
CO2	analyze the biaxial state of stresses at a point in a body, thin cylinders and spherical shells	Analyzing (K4)
CO3	construct the shear force and bending moment diagrams and analyze the bending stresses of beams	Analyzing (K4)
CO4	estimate the slope and the deflection of beams and strengths of the columns	Analyzing (K4)
CO5	analyze the torsion behavior of shafts and coil springs	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										1		3
CO2	3	3										1		3
CO3	3	3										1		3
CO4	3	3										1		3
CO5	3	3										1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	40	20			100
CAT2	15	15	35	35			100
CAT3	15	15	35	35			100
ESE	15	15	35	35			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET42 – THERMAL ENGINEERING

(Use of Steam Tables and Refrigeration Tables are permitted for the End Semester Examination)

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics	4	PC	3	0	0	3

Preamble	This course provides an extensive knowledge on the working of different thermal utilities such as internal combustion engines, boilers, nozzles, turbines, air compressors and refrigeration & air-conditioning systems along with the performance calculations.	
Unit - I	**Internal Combustion Engines:**	**9**
Classifications – Internal Combustion Engine Components and their Functions - Two Stroke - Four Stroke - Petrol and Diesel Engine - Valve Timing and Port Timing Diagrams – Injection - Ignition - Lubrication and Cooling Systems - Knocking and Detonation - Performance Calculations - Exhaust Gas Analysis - Pollution Control Norms and Methods - Catalytic Converters - EGR and SCR.		
Unit - II	**Gas Power Cycles and Vapour power cycle:**	**9**
Gas Power Cycles: Otto Cycle - Diesel Cycle - Dual Cycle - Brayton Cycle - Calculation of Mean Effective Pressure and Air Standard Efficiency - Actual and Theoretical p-V Diagrams. Vapour Power Cycle: Rankine Cycle - Reheat - Regeneration.		
Unit - III	**Steam Boilers, Nozzles and Turbines:**	**9**
Steam Boilers: Classification - Fire Tube and Water Tube Boilers - Mountings and Accessories - High Pressure Boilers – Types – Benson – Lamont – Loeffler - Supercritical Boilers. Steam Nozzles: Flow of Steam through Nozzles – Shapes of Nozzle – Effect of Friction – Critical Pressure Ratio and Supersaturated Flow. Turbines: Impulse and Reaction Principles – Compounding and its Types - Velocity Diagrams for Single Stage Turbines - Governing of Turbines and its Types.		
Unit - IV	**Air Compressor:**	**9**
Classifications and Working Principle of Reciprocating Air Compressor – Work of Compression with and without Clearance - Various Efficiencies of Reciprocating Air Compressors - Multistage Air Compressor with Inter Cooling – Work Done on Multistage Air Compressor - Rotary Compressors – Types - Working Principle (Elementary Treatment Only).		
Unit - V	**Refrigeration and Air-Conditioning:**	**9**
Refrigeration: Working Principle of Vapour Compression Refrigeration System – Super Heating and Sub Cooling - Performance Calculations - Working Principle of Vapour Absorption System – NH_3-H_2O and LiBr-H_2O Systems (Elementary treatment only). Air-Conditioning: Types - Working Principle of Air-Conditioning Systems - Air Handling Unit (AHU) - Concept of RSHF – GSHF – ESHF - Cooling Load Calculations (Basic Problems in Summer and Winter Air-Conditioning).		

Total: 45

TEXT BOOK:

1. Rajput R.K. “Thermal Engineering”. 10th Edition, Laxmi Publications, New Delhi, 2018.

REFERENCES:

1. Sadhu Singh. “Thermal Engineering”. 1st Edition, Pearson Education, Noida, 2018.
2. Mahesh M. Rathore. “Thermal Engineering”. 1st Edition, McGraw Hill Publications, New Delhi, 2010.
3. Yunus A. Cengel and Michael A. Boles. “Thermodynamics: An Engineering Approach”. 9th Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the working principle of an internal combustion engine with its subsystems and also estimate the performance	Applying (K3)
CO2	apply the concept of thermodynamic processes in gas and vapour power cycles by using p-v, T-s and h-s diagrams	Applying (K3)
CO3	analyze the performance of boilers, nozzles and turbines	Analyzing (K4)
CO4	analyze the performance of air compressors	Analyzing (K4)
CO5	apply the concepts of thermodynamics in R&AC systems and perform the cooling load calculations.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3											3
CO2	3	3	3											3
CO3	3	3	3											3
CO4	3	3	3											3
CO5	3	3	3											3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	10	20	35	35			100
CAT3	10	30	30	30			100
ESE	10	30	35	25			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEL41 – MATERIAL PROPERTY TESTING LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Materials and Metallurgy Strength of Materials	4	PC	0	0	2	1
Preamble	The laboratory course provides the hands on experience and determination of essential mechanical properties of various materials.						

List of Exercises / Experiments:

1.	Tension Test of Mild Steel and Aluminium Specimens.
2.	Tension Test of Commodity and Industrial Thermoplastic Specimens
3.	Double Shear Test of Mild Steel and Aluminium Specimens.
4.	Torsion Test of Mild Steel Specimen.
5.	Impact Test of Metal Specimen (Izod and Charpy Test).
6.	Impact Test of Commodity and Industrial Thermoplastic Specimens (Izod and Charpy Test).
7.	Deflection Test of Cantilever Beam and Simply Supported Beam (Aluminium, Steel and Wood).
8.	Test on Helical Springs (Open and Closed Coil).
9.	Hardness Test for Ferrous and Non Ferrous Materials.
10.	Flexural Test of Commodity and Industrial Thermoplastic Specimens.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual.
2.	Rajput R.K. “Strength of Materials”. 7th Edition, S.Chand & Co., New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	determine the tensile strength of various materials.	Applying (K3), Manipulation (S2)
CO2	evaluate the compressive strength and hardness of various materials.	Applying (K3), Manipulation (S2)
CO3	estimate the torsion and flexural strength of various materials.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3	3				3	3			3	3
CO2	3	3		3	3				3	3			3	3
CO3	3	3		3	3				3	3			3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

20MEL42 – THERMAL ENGINEERING AND RENEWABLE ENERGY LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics	4	PC	0	0	2	1
Preamble	This course provides practical exposure to fuel properties measurement methods, performance testing methods of internal combustion engines and reciprocating air compressor and also testing methods of solar/wind energy systems.						

List of Exercises / Experiments:

	THERMAL ENGINEERING LABORATORY
1.	Draw a Valve Timing and Port Timing Diagram for Four Stroke and Two Stroke Engines.
2.	Determination of Flash and Fire Point of given Fuels using Open and Closed Cup Apparatus.
3.	Determination of Viscosity of given Oils using Redwood and Saybolt Viscometers.
4.	Performance Test on Single Cylinder Four Stroke Diesel Engines by Mechanical/Hydraulic/Eddy Current/ Electrical Loading.
5.	Heat Balance Test on Single Cylinder Four Stroke Diesel Engines By Mechanical/Hydraulic/Eddy Current/ Electrical Loading.
6.	Performance Test on Multistage Reciprocating Air Compressor.
	RENEWABLE ENERGY LABORATORY
1.	Analyze the Effect of the Variation of Speed, Tip Speed Ratio on the Coefficient of Power of Wind Turbine.
2.	Determination of the Thermal Energy Gain at the Focal Point of a Concentrating Collector.
3.	Determination of the Efficiency of Solar (Liquid/Air) Collector.
4.	Plot the Effect of Variation of Tilt Angle on the PV Module Output.
5.	Study on Rooftop Solar PV Plant and Weather Monitoring Station.
6.	Performance Test on Solar Evacuated Tube

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1. Laboratory Manuals.
2. Rajput R.K. “Thermal Engineering”. 10th Edition, Laxmi Publications, New Delhi, 2018.
3. https://vlab.amrita.edu/index.php?sub=77

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the characteristics of the fuels and test and plot the performance curves on multistage air compressor.	Analyzing (K4), Manipulation (S2)
CO2	examine the performance and heat balance study of various IC engines under different loading conditions	Analyzing (K4), Manipulation (S2)
CO3	determine the performance of Solar /Wind energy systems and analyze the data from rooftop solar PV plant..	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3				3	3			3	3
CO2	3	3	3		3				3	3			3	3
CO3	3	3	3		3				3	3			3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

20EGL31 - ENGLISH FOR WORKPLACE COMMUNICATION LABORATORY

(Common to all BE/BTech Engineering and Technology branches)

Prog. & Branch	All BE/BTech Engineering & Technology branches	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	4	HS	0	0	2	1

Preamble:	This course is designed to impart required levels of fluency in using the English Language at B1/B2 level in the CEFR through activities, hands-on training and application.	
Unit -I	**Listening:**	**6**
Techniques for effective listening and note taking; listening to audio scripts, podcasts and TED talks; listening to discourse samples of native speakers and imitating; improving pronunciation; introduction to the basics of phonetics and understanding different accents.		
Unit -II	**Reading:**	**6**
Speed reading skills; reading to gain knowledge; reading newspaper articles to improve writing; academic journals to enrich vocabulary and word power; reading aloud with proper stress and intonation; reading to draw inferences.		
Unit -III	**Soft Skills:**	**6**
Importance of soft skills at workplace - understanding soft skills through case studies - developing positive attitude; goal setting; time management; team work; telephone etiquette; developing professionalism, interpersonal skills and work ethics.		
Unit -IV	**Writing:**	**6**
Introduction to pre-writing, style and mechanics of writing; mind mapping; creating content from an outline; paragraph and resume writing; nuances of academic writing; writing Statement of Purpose (SOP), editing, revising and proof reading for clarity and readability; structural and grammatical accuracy.		
Unit -V	**Speaking:**	**6**
Verbal and non-verbal communication; fluency and spoken English; introducing oneself and others; making presentations on topics using prepared material; mock interviews; dynamics of Group Discussion.		

List of Exercises / Experiments :

1. Mock Interview
2. Presentation
3. Reading Aloud
4. Group Discussion
5. Soft Skills through Case Studies
6. Listening Test

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1. Jeff Butterfield, “Soft Skills for Everyone”, 1st Edition, Cengage Learning, New Delhi, 2011.
2. Bob Dignen, Steve Flinders and Simon Sweeney, “Professional English for Work and Life, English 365, Student’s Book 2”, 1st Edition, Cambridge University Press, New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	acquire effective listening and reading skills	Understanding (K2), Imitation (S1)
CO2:	acquire and demonstrate appropriate professional skills for the workplace	Applying (K3), Naturalization (S5)
CO3:	speak fluently and write meaningfully in English in the given context	Applying (K3), Articulation (S4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									2	3		2		
CO2									2	3		2		
CO3									3	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20GET31 – Universal Human Values

20MET51 – KINEMATICS OF MACHINERY

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Drawing, Engineering Mechanics	5	PC	3	0	0	3

Preamble	The course provides the analysis of velocity, acceleration and synthesis of various simple mechanisms. It also deals with various cam profile generations and studies on various gears and gear trains.	
Unit - I	**Basics of Mechanisms:**	**9**
Classification of Mechanisms – Basic Kinematic Concepts and Definitions – Degree of Freedom – Mobility – Kutzbach Criterion – Gruebler'S Criterion – Grashof'S Law – Kinematic Inversions of Four - Bar Chain and Slider Crank Chains – Limit Positions – Mechanical Advantage – Transmission Angle- Description of Common Mechanisms – Quick Return Mechanisms – Indexing Mechanisms - Ratcheting.		
Unit - II	**Kinematics of Mechanisms:**	**9**
Velocity and Acceleration of Simple Mechanisms by Relative Velocity Method – Velocity Analysis using Instantaneous Centre Method – Klien'S Construction for Slider Crank Mechanism – Coriolis Acceleration Component.		
Unit - III	**Synthesis of Mechanisms:**	**9**
Synthesis of Mechanism – Classification of Synthesis – Function Generation by Relative Pole Method – Graphical Synthesis of Slider Crank and Four bar Mechanisms for Two and Three Positions – Analytical Solution for Velocity and Acceleration of Slider Crank Mechanism – Introduction to Commercial Software Packages for the Development of Kinematic Models.		
Unit - IV	**Kinematics of CAM:**	**9**
Cams – Types of Cams And Followers – Displacement – Velocity and Acceleration Curves for Uniform Velocity – Uniform Acceleration and Retardation – SHM and Cycloidal Curves- Layout of Plate Cam Profile - Reciprocating and Oscillating Followers – Knife - Edge Follower – Roller and Flat Faced Followers. High Speed Cams: Circular Arc and Tangent Cams – Pressure Angle and Undercutting.		
Unit - V	**Kinematics of Gears:**	**9**
Theory of Gearing – Gear Nomenclature – Law of Gearing – Tooth Forms – Minimum Number Teeth – Length of Arc of Contact – Velocity and Torque Calculation- Contact Ratio and Interference. Gear Trains: Types –- Parallel Axis and Epicyclic Gear Trains.		

Total: 45

TEXT BOOK:

1. Rattan S.S. "Theory of Machines". 5th Edition, McGraw Hill Publishing Company, Chennai, 2019.

REFERENCES:

1. Shigley J.E. , Uicker J.J. "Theory of Machines and Mechanisms". 5th Edition, Oxford University Press, New Delhi, 2017.
2. Bevan Thomas. "Theory of Machines". 3rd Edition, C B S Publishers & Distributors, New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basic concepts of kinematics and working principle of simple mechanisms	Applying (K3)
CO2	compute the velocity and acceleration of simple mechanisms	Applying (K3)
CO3	synthesize simple mechanisms and understand the basics of computer aided analysis	Analyzing (K4)
CO4	portray the basic concepts of cam follower system and design of plate cam profiles	Applying (K3)
CO5	describe the basic concepts in kinematics of gearing and analyze the various types of gear trains	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3										3
CO2	3	3	3	3										3
CO3	3	3	3	3	1								1	3
CO4	3	3	3	3										3
CO5	3	3	3	3										3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	25	50				100
CAT2	20	20	30	30			100
CAT3	25	25	50				100
ESE	15	20	50	15			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET52 – HEAT AND MASS TRANSFER

(Use of HMT Data Book and Steam Table are permitted for the End Semester Examination)

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics Thermal Engineering	5	PC	3	0	0	3

Preamble	Heat and Mass Transfer course is designed to impart knowledge on three modes of heat transfer namely conduction, convection and radiation. This course aims to provide professional experience in solving the heat and mass transfer associated problems for the graduates of Mechanical Engineering.	
Unit - I	**Conduction Heat Transfer**	**9**
Fourier's Law of Conduction- Thermal Conductivity - Three Dimensional Heat Conduction Equation in Cartesian Coordinate System – One Dimensional Steady State Heat Conduction through Plane Wall, Cylinder and Sphere – Critical Radius of Insulation – Composite Wall and Cylinder – Conduction with Internal Heat Generation through Plane Wall, Cylinder and Sphere - Extended Surfaces: Types - Efficiency and Effectiveness of Fins – Transient Heat Conduction: Lumped Heat Analysis and Infinite Solids Approach - Heisler's chart.		
Unit - II	**Convection Heat Transfer**	**9**
Newton's Law of Cooling – Convective Heat Transfer Coefficients - Dimensional Analysis using Buckingham π-Theorem – Boundary Layer Profiles of Flow over Flat Plates and Flow through Pipes - Forced Convection – External Flow: Flow over Flat Plates, Cylinders and Spheres, Flow across Bank of Tubes – Internal Flow – Free Convection: Flow over Vertical Plates, Horizontal Plates, Cylinders and Spheres – Heat Transfer in Porous Media.		
Unit - III	**Radiation Heat Transfer**	**9**
Electro Magnetic Spectrum – Thermal Radiation- Concept of Black Body - Basic Laws of Black Body Radiation – Absorptivity, Reflectivity and Transmissivity – Gray Body Radiation – Emissivity – Kirchoff's Law of Radiation – Shape Factor and its Algebra – Radiosity and Irradiation – Electrical Analogy: Two and Three Surfaces Interaction – Radiation Shields – Introduction to Gas Radiation.		
Unit - IV	**Phase Change Heat Transfer and Heat Exchangers**	**9**
Phase Change Heat Transfer: Boiling – Pool boiling: Nucleate Boiling and Film boiling – Flow Boiling – Condensation: Drop-wise and Film-wise Condensation – Correlations in Boiling and Condensation. **Heat Exchangers:** Types of Heat Exchangers – Logarithmic Mean Temperature Difference (LMTD) Method – Effectiveness – Number of Transfer Units (NTU) Method – Overall Heat Transfer Coefficient – Fouling Factors – Theory of Compact Heat Exchangers.		
Unit - V	**Mass Transfer and Latest Trends in the field of Heat transfer**	**9**
Mass Transfer: Mass Transfer: Diffusion Mass Transfer – Fick's Law of Diffusion – Equimolar Counter Diffusion – Convective Mass Transfer – Heat and Mass Transfer Analogy. **Latest Trends:** Nano Fluids for Heat Transfer – Cooling of Electronic Components –Thermal Management in Electric Vehicles using IoT – Data study from Infra Red Thermography Images.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", 5th Edition, New Age International Publishers, New Delhi, 2017.	I,II,III,IV,V

REFERENCES:

1.	Holman J.P., Souvik Bhattacharyya, "Heat Transfer", 10th Edition, McGraw-Hill Education, India, 2017.
2.	Yunus A. Cengel, Afshin J. Ghajar, "Heat and Mass Transfer: Fundamentals and Applications", 6th Edition, McGraw Hill Education, India, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recognize the basic concepts and define the governing laws related to all modes of heat and mass transfer	Understanding (K2)
CO2	analyze conduction, convection and radiations based problems and interpret the solution	Analyzing (K4)
CO3	estimate the heat transfer coefficient involved in boiling and condensation using appropriate correlations	Analyzing (K4)
CO4	design and analyze the heat exchangers using LMTD and NTU approaches	Analyzing (K4)
CO5	solve the simple problems involving mass transfer with necessary correlations	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3								1		1		3
CO2	3	3								1		1		3
CO3	3	3					2			1		1		3
CO4	3	3					2			1		1		3
CO5	3	2			2		2			1		1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	30	20			100
CAT2	20	30	30	20			100
CAT3	20	30	30	20			100
ESE	20	30	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET53 – METROLOGY AND MEASUREMENTS

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20PHT11 Applied Physics	5	PC	3	0	0	3

Preamble	This course provides a comprehensive knowledge of sensors and transducers used in engineering field like the measurement of length, angle, temperature, pressure, flow etc. Knowledge of computer aided inspection helps the modern day automation requirements/applications. This course offers a platform for the design and implementation of measurement system.	
Unit - I	**Basics of Instruments**	**9**
Measurement - Definition and Methods - Generalized Measurement System - Units and Standards- Calibration- Primary- Secondary and Working Standards - National and International Standards - Types of Inputs - Order of Instruments - Static Characteristics - Accuracy - Error - Precision - Sensitivity - Linearity - Reproducibility - Repeatability - Resolution - Threshold - Drift - Stability - Tolerance - Range and Span - Dynamic Characteristics Study - Speed of Response - Response Time - Lag - Fidelity - Dynamic Error - Overshoot - Response of First Order Instrument for Step and Ramp Inputs.		
Unit - II	**Transducers**	**9**
Introduction to Transducers - Classification - Primary - Secondary and Tertiary - Mechanical - Bellows - Bourdon's Tube - Springs - Proving Rings - Diaphragm - Monometer - Bimetals - Electrical- Resistance - Inductance and Capacitance - Strain Gauges and its Orientation for Measurement - Vibration and Acceleration Measurement - Advantages and Limitation. Measurement of Force – Torque - Power - Temperature and Flow.		
Unit - III	**Gauges, Length and Angle Measurement**	**9**
Gauges types: Slip Gauges - Limit Gauges - Snap Gauges - Plug Gauges - Thread Gauge - Ring Gauge. Length Measurement: Vernier Caliper - Vernier Height Gauge - Vernier Depth Gauge - Micrometer and its Types - Design Aspects in Fixing Least Count of Vernier and Micrometer. Comparators – Mechanical - Pneumatic - Electrical. Angle Measurement- Protractors - Sine bars - Angle Dekkor - Optical Flats.		
Unit - IV	**Form Measurement**	**9**
Need of form measurements - Measurement of Screw Thread - External Thread Measurement - Measurement of Minor Diameter- Measurement of Effective Diameter - Pitch Measurement. Measurement of Gears – Pitch Measurement, Profile Measurement, Tooth Thickness Measurement - Gear Alignment Testing. Radius Measurement – Radius of Circle - Radius of Concave Surface. Surface Finish Measurement – Analysis of Surface Finish - Methods of Measuring Surface Finish. Straightness Measurement - Flatness Measurement - Roundness Measurement.		
Unit - V	**Computer Aided Inspection**	**9**
Precision Instruments Based on Laser Principles - Laser Interferometer - Application In Linear, Angular Measurements. Coordinate Measuring Machine – Constructional Features - Types and Applications – Video Measuring machine – Machine vision - Digital Devices - Computer Aided Inspection. Demonstration of Modern Measurement System for Industrial Applications.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Rajput R.K., "Mechanical Measurements and Instrumentation", 2nd Edition, S.K.Kataria & Sons Publishers, New Delhi, 2013.	I,II,III,IV,V

REFERENCES:

1.	Anand K. Bewoor, Vinay A. Kulkarani, "Metrology and Measurement", 1st Edition, McGraw Hill Publishing Co. Ltd., 2014.
2.	Alan S. Morries, RezaLangari,"Measurement and Instrumentation Theory and Application", 2nd Edition, Elsevier, London, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the basic concept of measurement system, calibration and characteristics of instruments.	Understanding (K2)
CO2	choose appropriate transducers for measurement system design.	Applying (K3)
CO3	illustrate various length and angle measuring instruments.	Understanding (K2)
CO4	carry out form measurements using various instruments.	Applying (K3)
CO5	asses the various measurements in industrial applications	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	1	3								2		3
CO2	3	3	1	3								2		3
CO3	3	3	1	3								2		3
CO4	3	3	1	3								2		3
CO5	3	3	1	3	2							2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	35	35	30				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	30	30	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEL51 – HEAT TRANSFER LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Thermal Engineering	5	PC	0	0	2	1
Preamble	This course provides the practical knowledge on various modes of heat transfer namely conduction, convection and radiation and also helps to understand the experimental methods for determining the performance of refrigeration and air-conditioning systems.						

List of Exercises / Experiments:

1.	Determination of Thermal Conductivity of the given Insulating Material using the Two Slab Guarded Hot Plate Method.
2.	Experimental Study on Unsteady State Heat Transfer.
3.	Determination of Thermal Conductivity of the Pipe Insulation – Lagged Pipe Apparatus and given Insulating Powder-Spherical Apparatus.
4.	Determination of Convective Heat Transfer Co-Efficient for a Vertical Tube in Natural Convection Mode.
5.	Determination of Convective Heat Transfer Co-Efficient for Flow Through inside Tube in Forced Convection Mode.
6.	Determination of the Fin Effectiveness and Efficiency in Free and Forced Convection Heat Transfer Modes.
7.	Determination of Stefan-Boltzmann Constant using Stefan-Boltzmann Apparatus.
8.	Determination of Emissivity of the given Test Specimen at various Temperatures using the Emissivity Measurement Apparatus.
9.	Determination of Heat Transfer Rate and Effectiveness of the given Double Pipe Heat Exchanger.
10.	Determination of Heat Transfer Rate and Effectiveness of the given Shell and Tube Heat Exchanger.
11.	Performance Test on Air Blower and Heat Pipe.
12.	Performance Test on Vapour Compression Refrigeration Test Rig.
13.	Performance Test on Air-Conditioning Test Rig.
14.	Determination of Critical Heat Flux using Critical Heat Flux Apparatus.

Practical: 30, Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Heat Transfer Laboratory Manual.
2.	Amrita Virtual Lab – Heat and Thermodynamics Virtual Lab, www.vlab.amrita.edu
3.	D. K Dixit, “Heat and Mass Transfer”, 1st Edition, McGraw Hill Education, India, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	conduct conduction, convection and radiation related experiments on the test set-up and virtual environment	Analyzing (K4), Precision (S3)
CO2	perform the test on heat exchangers and estimate the overall heat transfer coefficient and effectiveness	Analyzing (K4), Precision (S3)
CO3	execute the performance test on heat pipe, refrigeration & air-conditioning system	Analyzing (K4), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2				1	3		2	2	3
CO2	3	2	2	3	2				1	3		2	2	3
CO3	3	2	2	3	2				1	3		2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MEL52 - COMPUTER AIDED DRAWING LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20MEC11 Engineering Drawing	5	PC	0	0	2	1
Preamble	This course provides the practical knowledge on how to use the computer aided tools in drafting a component design and performing basic modeling of components						

List of Exercises / Experiments:

1.	Introduction to Computer Aided Modeling – 2D and 3D Modeling.
2.	Drawing of Simple 2D Sketch using basic Drawing and Editing commands using AutoCAD 2020.
3.	Performing Precise Drawings and Organizing Drawings using layers and Object Types in AutoCAD2020.
4.	Creating Complex Drawing using Advanced commands and blocks using AutoCAD 2020.
5.	Printing a Drawing with Annotations and Dimensions using AutoCAD 2020.
6.	Performing 2D Sketching in Creo 7.0.
7.	Performing Basic 3D Modeling in Creo 7.0 using basic options.
8.	Performing 2D Sketching in Solid works 2018.
9.	Performing Basic 3D Modeling in Solid works 2018 using basic options.
10.	Performing Basic 3D Modeling in CATIA V5/Autodesk Inventor using basic options.

Practical: 30, Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	AutoCAD 2020, CREO 7.0, SOLID WORKS 2018, CATIA V5-6 R2015, Autodesk Inventor

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	prepare drafting of component design using AutoCAD 2020 software	Applying (K3) Manipulation (S2)
CO2	perform 2D modeling using advanced modeling software packages	Applying (K3) Manipulation (S2)
CO3	perform basic 3D modeling using advanced modeling software packages	Applying (K3) Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3	1	3					2		2	3	3
CO2	3	1	3	1	3					2		2	3	3
CO3	3	1	3	1	3					2		2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MEL53 – METROLOGY & MEASUREMENTS AND AUTOMOBILE ENGINEERING LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20PHT11 Applied Physics Thermal Engineering	5	PC	0	0	2	1
Preamble	This course provides the practical knowledge/mechanism behind the various measurements like linear, angular, etc. Hands on experience on dismantling and assembling of various automobile systems and methods of fuel testing as well as emission analysis are also imparted through this course.						

List of Exercises / Experiments:

	METROLOGY & MEASUREMENTS LABORATORY
1.	Calibration of Linear Instrument with Sliding Principle and Measurement of the given Component by using Vernier Caliper, Vernier Height Gauge and Gear Tooth Vernier Caliper.
2.	Calibration of Mechanical and Electrical Comparator and Check the Dimensional Tolerance using Dial Gauge, Bore Gauge and LVDT.
3.	Calibration of Linear Instrument with Bolt and Nut Principle and Measurement of given Component by using Inside Micrometer, Outside Micrometer and Depth Micrometer.
4.	Measurement of Angle of given Component by using Sine bar and Bevel Protractor.
5.	Characteristics of Thermal Measurement of First Order Instrument by using Thermometer.
6.	Calibration of Optical Instrument and Measurement of given Component by using Profile Projector.
7.	A Study/Demonstration Experiment on Flatness and Straightness Checking by using Autocollimator.
8.	A Study/Demonstration Experiment on Measuring Cylinder and Cone Dimensions using Coordinate Measuring Machine.
9.	A Study/Demonstration Experiment on Measuring the Surface Roughness of Materials using Surface Roughness Tester.
	AUTOMOBILE ENGINEERING LABORATORY
1.	Dismantling and Assembly of Single/Multi Cylinder- Petrol/Diesel Engine
2.	Dismantling and Assembly of Clutch, Gear Boxes and Differential Unit
3.	Dismantling and Assembly of Braking Systems and Suspension System
4.	Measurement of Instantaneous Center and Turning Radius of Four Wheeler
5.	Estimation of Calorific Value of Fuels and Emission Test on IC Engines
6.	Study of Performance Test on Static and Dynamic Balancing of Wheel

Practical: 30, Total: 30

REFERENCES/MANUAL/SOFTWARE:

1. Laboratory Manuals
2. Dr.Kirpal Singh, "Automobile Engineering", 14th Edition, Volume I&II, Standard Publishers Distributor, New Delhi, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped** **(Highest Level)**
CO1	calibrate the measuring instruments and measure the dimension of the components	Applying (K3), Manipulation (S2)
CO2	determine the characteristics of instruments	Applying (K3), Manipulation (S2)
CO3	dismantle and assemble various automobile systems and manage the engineering aspects of fuels and vehicles	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3				3				3				3	3
CO2	3				3				3				3	3
CO3	3				3				3				3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20GEL51 - PROFESSIONAL SKILLS TRAINING I
(Common to all BE/ BTech / MSc / MCA /BSc Branches)

Programme & Branch	B.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	EC	0	0	80	2

Preamble	This subject is to enhance the employability skills and to develop career competency	
Unit - I	**Soft Skills – I**	**20**
Soft skills and its importance: Pleasure and pains of transition from an academic environment to work environment-Need for change-Fear, stress and competition in the professional world-Importance of positive attitude- Self motivation and continuous knowledge upgradation-Self-confidence. Professional grooming and practices: Basics of corporate culture-Key pillars of business etiquette- Basics of etiquette-Introductions and greetings-Rules of the handshake, earning respect, business manners-Telephone etiquette- Body Language.		
Unit - II	**Quantitative Aptitude & Logical Reasoning - I**	**30**
Problem solving level I: Number System-LCM &HCF-Divisibility test-Surds and indices-Logarithms- Ratio-proportions and variation-Partnership-Time speed and distance-Data interpretation-data representation. Logical reasoning: Family tree-Deductions-Logical connectives-Binary logic Linear arrangements- Circular and complex arrangement		
Unit - III	**Written Communication & Verbal Aptitude**	**30**
Writing Skills: Writing strategies and formats – Importance of Résumés – Writing a Cover letter – Writing a fresher's CV / Résumés – Responding to Job Advertisements – Professional e-mail Writing – Responding to e-mails and business letters – Technical Report writing – Interpretation of Technical Data (Transcoding) – Writing One-page Essays. Verbal Aptitude – Synonyms – Antonyms – Homonyms – One word substitution – Idioms and Phrases – Paired words – Analogies – Spelling test – Cloze test – using suitable verb forms – using appropriate articles and prepositions; Spotting Errors – Sentence Correction and Formation – Grammar Based questions (Transformation : Active-Passive & Direct-Indirect); Rearranging Jumbled Sentences & Jumbled paragraphs, Identifying Facts, Inferences and Judgements statements.		

Total: 80

TEXT BOOK:

1	Thorpe, Showick and Edgar Thorpe, "Objective English For Competitive Examination", 6th Edition, Pearson India Education Services Pvt Ltd, 2017.

REFERENCES:

1	Bailey Stephen, "Academic Writing: A practical guide for students", Routledge, New York, 2011.
2	Raman, Meenakshi and Sharma, Sangeeta**,** "Technical Communication - Principles and Practice", 3rd Edition, Oxford University Press, New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop the soft skills of learners to support them work efficiently in an organization as an individual and as a team	Applying (K3), Precision (S3)
CO2	solve real time problems using numerical ability and logical reasoning	Applying (K3), Precision (S3)
CO3	apply communication skills effectively to understand and deliver information in various written discourses grammatically with accuracy	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				3	3		3		3	2		
CO2	3	2				3	3		3		3	2		
CO3		2				3	3		3	3	3	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2		50	50				100
CAT3		50	50				100
ESE	**NA**						

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET61 – DYNAMICS OF MACHINERY

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics Kinematics of Machinery Strength of Materials	6	PC	3	0	0	3

Preamble	This course provides the knowledge on force analysis of various static & dynamic members, balancing of rotating & reciprocating masses in various types of engines. It also emphasis on analyzing the fluctuation in speed of governors, gyroscopic effect on various modes of transport systems, impact of free and forced vibration in various systems.	
Unit - I	**Force Analysis**	**9**
Static Force Analysis, Free Body Diagrams, Conditions of Two, Three and Four Force Members. Inertia Forces and D'Alembert'S Principle – Inertia Force Analysis in Reciprocating Engines – Crank Shaft Torque. Flywheels – Turning Moment Diagrams and Fluctuation of Energy of Reciprocating Engine Mechanisms, Coefficient of Fluctuation of Energy and Speed, Weight of Flywheel Required.		
Unit - II	**Balancing**	**9**
Static and Dynamic Balancing – Balancing of Rotating Masses – Balancing a Single Cylinder Engine – Balancing Multi-Cylinder Engines – Balancing of Radial Engine – Direct and Reverse Crank Method.		
Unit - III	**Governors and Gyroscope**	**9**
Types – Centrifugal Governors – Gravity Controlled and Spring Controlled Centrifugal Governors– Characteristics – Effect of Friction – Controlling Force. Gyroscopes – Gyroscopic Couples – Gyroscopic Effects in Automobiles, Ships and Aeroplanes.		
Unit - IV	**Free Vibration**	**9**
Basic Features of Vibratory Systems – Types – Single Degree of Freedom System – Transverse Vibration of Beams – Natural Frequency by Energy Method, Dunkerly'S Method - Critical Speed - Damped Free Vibration of Single Degree Freedom System -Types of Damping – Free Vibration with Viscous Damping, Critically Damped System, Under Damped System. Torsional Systems: Natural Frequency of Two and Three Rotor Systems.		
Unit - V	**Forced Vibration**	**9**
Response to Periodic Force – Harmonic Force – Force caused cy Unbalance – Support Motion - Logarithmic Decrement-Magnification Factor – Vibration Isolation and Transmissibility.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Rattan S.S., "Theory of Machines", 5th Edition, McGraw Hill Education Publishing Company Ltd., New Delhi, 2019.	I,II,III,IV,V

REFERENCES:

1.	Sadhu Singh, "Theory of Machines", 3rd Edition, Pearson Education India, New Delhi, 2012.
2.	Khurmi R.S. and Gupta J.K., "Theory of Machines", 14th Edition, S. Chand & Co. Ltd., New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve and apply the effect of static and dynamic forces acting on different mechanisms	Applying (K3)
CO2	solve and plot the static and dynamic balancing of various mechanical systems	Applying (K3)
CO3	solve and analyze the fluctuation effects in governors and the effects of gyroscopic couple in automobile, aeroplane and ship applications	Analyzing (K4)
CO4	solve and analyze the impact of free vibrations in the design of mechanical systems	Analyzing (K4)
CO5	solve and analyze the impact of the forced vibrations in the design of mechanical systems	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3										3
CO2	3	3	3	3										3
CO3	3	3	3	3										3
CO4	3	3	3	3										3
CO5	3	3	3	3										3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	30	30				100
CAT2	30	30	30	10			100
CAT3	30	30	20	20			100
ESE	30	30	20	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET62 - FINITE ELEMENT ANALYSIS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mathematics III Strength of Materials Heat and Mass Transfer	6	PC	3	0	0	3

Preamble	This course provides the knowledge on modeling techniques and use of numerical methods for solving a system of governing equations over the given discretized domain with the proper boundary conditions and loads. The course deals with the solving of various engineering problems for structural - thermal aspects and introduces advanced concepts.	
Unit - I	**Fundamental of Finite Element Analysis**	**9**
Historical Background – Matrix Approach – Coordinates – Numerical Simulation – Gauss Elimination Based Solvers – FEA General Procedure – Basic Element Shapes – Discretization Process – Node Numbering Scheme – Interpolation – Weighted Residual Method – Ritz Techniques – Applications of FEA.		
Unit - II	**One Dimensional Problems and Plane Truss**	**9**
One Dimensional Finite Element Modeling – Element Types – Linear Elements – Linear Element Shape Function – Finite Element Equation – Galerkin's Method – Solid Mechanics – Heat Transfer – Fin Pin and Composite Wall – Beam Element. Applications of Plane Truss.		
Unit - III	**Two Dimensional Problems**	**9**
Introduction to 2-D Finite Element Modeling – Constant Strain Triangular – Finite Element Formulation – Shape Functions – Strain Displacement and Stress Strain Relationship Matrix – Plane Stress and Plane Strain – Temperature Effects.		
Unit - IV	**Axisymmetric Continuum**	**9**
Axisymmetric Formulation – Element Stiffness Matrix and Force Vector – Body Forces and Temperature Effects – Stress Calculations – Boundary Conditions – Applications to Cylinders under Internal or External Pressure.		
Unit - V	**Iso-parametric Elements for Two Dimensional Continuum**	**9**
Natural Co-ordinate Systems – Isoparametric Elements – The Four Node Quadrilateral – Shape Functions – Element Stiffness Matrix and Force Vector – Jacobian Matrix – Stress Calculations – Numerical Integration – Gauss Quadrature. Introduction to Finite Element Analysis Programming.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Logan L. Daryl, "A first course in the Finite Element Method", 5th Edition, Cengage Learning India Pvt. Ltd., Delhi, 2012.	I,II,III,IV,V

REFERENCES:

1.	Rao S. S., "The Finite Element Method in Engineering", 5th Edition, Butterworth–Heinemann (An imprint of Elsevier), Elsevier India Pvt. Ltd., New Delhi, 2013.
2.	Reddy J. N., "An Introduction to the Finite Element Method", International Edition, McGraw Hill, New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the finite element theory procedures for various applications	Applying (K3)
CO2	analyze 1D structural and thermal problems with the finite element techniques	Analyzing (K4)
CO3	analyze the finite element theory of 2D problems	Analyzing (K4)
CO4	analyze the axisymmetric problem	Analyzing (K4)
CO5	apply the concepts of Iso-parametric formulation in 2D problems	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3								3	3
CO2	3	3	3	3	3								3	3
CO3	3	3	3	3	3								3	3
CO4	3	3	3	3	3								3	3
CO5	3	3	3	3	3								3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	15	50	20			100
CAT2	15	15	35	35			100
CAT3	15	15	35	35			100
ESE	15	15	40	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MET63 DESIGN OF MACHINE ELEMENTS

Use of PSG Data book is permitted for the End Semester Examination

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics Strength of Materials	6	PC	3	0	0	3

Preamble	Design of machine elements imparts the design of machine components like brackets, shaft, brakes, clutches, springs, bearing, flywheel and its failure criteria to meet the desired needs. It also explores the design of threaded fasteners and welded joints.	
Unit - I	**Steady Stresses and Variable Stresses in Machine Members**	**9**
Introduction to the Design Process – Factor influencing Machine Design, Selection of Materials based on Mechanical Properties – Direct Bending and Torsion Stress Equations – Calculation of Principal Stresses for various Load Combinations, Eccentric Loading – Factor of Safety -Theories of Failure – Stress Concentration – Design for Variable Loading – Soderberg, Goodman and Gerber Relations.		
Unit - II	**Design of Shafts and Brakes**	**9**
Design of Solid and Hollow Shafts based on Strength, Rigidity and Critical Speed – Design of Keys and Key Ways –Types of Brake - Simple and Compound - Internal and External Shoe Brakes – Disc Brakes (Description Only)		
Unit - III	**Design of Fasteners and Welded Joints**	**9**
Threaded Fasteners – Design of Bolted Joints Including Eccentric Loading – Design of Welded Joints – Axially Loaded Unsymmetrical Welded Joints - Eccentric Load in the Plane of Welds - Welded Joint Subjected to Bending Moment and Twisting Moment. Description on Designing of Riveted Joints.		
Unit - IV	**Design of Springs and Clutches**	**9**
Design of Helical and Leaf Springs - Theory of Disc and Torsional Springs under Constant Loads and varying loads – Concentric Springs – Description of Belleville Springs – Design of Plate Clutches – Axial Clutches – Cone Clutches – Internal Expanding Rim Clutches.		
Unit - V	**Design of Bearings and Flywheels**	**9**
Design of Bearings - Preloading, Design of Rolling Contact Bearings - Cubic Mean Load - Design of Journal Bearings - Mckee'S Equation - Calculation of Bearing Dimensions, Design of Flywheels. Solid Disc – Flywheel - Rimmed Flywheel - Stresses in Rimmed Flywheel.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Bhandari V.B., "Design of Machine Elements", 5th Edition, Tata McGraw-Hill, New Delhi, 2020.	I,II,III,IV,V

REFERENCES:

1.	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", 11th Edition, McGraw Hill International Education, New York, 2020.
2.	Norton R.L., "Design of Machinery", 5th Edition, McGraw Hill, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	design and specify the shape of the machine components subjected to steady stress and variable stress	Applying (K3)
CO2	design and selection of the shafts and brakes for different applications	Applying (K3)
CO3	design and selection of the screw fasteners and welded joints for different applications	Applying (K3)
CO4	design and selection of the helical, leaf springs and clutches for different applications	Applying (K3)
CO5	design and select the bearing, prediction of their life and design of flywheels for different applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3										3
CO2	3	3	3	3										3
CO3	3	3	3	3										3
CO4	3	3	3	3										3
CO5	3	3	3	3										3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	30	30				100
CAT2	40	30	30				100
CAT3	40	30	30				100
ESE	40	30	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEL61 – DYNAMICS LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics Kinematics of Machinery Dynamics of Machinery	6	PC	0	0	2	1
Preamble	This course provides the practical knowledge of mechanism behind the various dynamics systems including balancing of masses, governors, cams, gyroscopes, gear trains and speed reducers. It also provides the knowledge on the spring mass vibration systems and compound pendulum.						

List of Exercises / Experiments :

DYNAMICS LABORATORY	
1.	Determine the Natural Frequency of given Spring using Spring Mass System.
2.	Draw the Force and Couple Polygon for Static and Dynamic Balancing of Rotating Masses.
3.	Determine the Characteristics of Governor using Universal Governor Apparatus. (Porter, Proell and Watt Governor set up).
4.	Determine the Loss of Couple due to Friction using Gyroscopic Couple Apparatus.
5.	Determine the Efficiency of Worm Gear Box using Speed Reducer Apparatus.
6.	Generation of Cam Profile with Roller Follower and Knife Edge Follower using Cam Analysis Machine.
7.	Determine the Radius of Gyration of Compound Pendulum.
8.	Determine the Radius of Gyration of Bifilar Suspension.
9.	Determine the Natural and Critical Frequency of given Shaft using Whirling of Shaft Apparatus.
10.	Determine the Frequency of Transverse Forced Vibration of Cantilever Beam.
11.	Determine the Damping Ratio of Single Rotor System with Viscous Damping.
12.	Determine the Natural Frequency of Free - Free Beam.
13.	Determine the Transmissibility Ratio of given Eccentric Mass in Vibration Table

Practical: 30, Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual.
2.	Rattan S. S., "Theory of Machines", 5th Edition, McGraw Hill, Chennai, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	analyze the characteristics of spring, static and dynamics balancing of masses.	Applying (K3), Manipulation (S2)
CO2	analyze the characteristic behavior of gear box and governors	Applying (K3), Manipulation (S2)
CO3	solve and evaluate the vibratory systems, forced transmittance and damping ratio	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3										3
CO2	3	3	3	3										3
CO3	3	3	3	3										3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MEL62 - SIMULATION AND ANALYSIS LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Strength of Materials Fluid Mechanics and Hydraulic Machines Heat and Mass Transfer	6	PC	0	0	2	1
Preamble	This course provides the basic knowledge of deriving the boundary conditions of real time practical engineering problems in structure, thermal and flow. It also provides the best way of reducing the complex problems to simple one.						

List of Exercises / Experiments:

1.	Stresses and Deflections of Different Types of Beams With Various Types of Loads.
2.	Deflections of Different Types of Truss With Point Loads.
3.	Application of Plane Stress and Plane Strain Conditions.
4.	Modelling and Analysis of Tapered Structures
5.	Deflection of Tensile and Compressive Springs
6.	Axisymmetric Application.
7.	Heat Conduction and Convection Applications.
8.	Couple Field Analysis (Thermo – Structural Analysis).
9.	Contact Analysis of Two Bodies.
10.	Modal Analysis of Structural Members.
11.	Harmonic Response of Structural Members
12.	Bimetallic Layered Cantilever Plate with Structural Loading.
13.	Flow Through Pipes using Fluent.
14.	Incompressible Fluid Flow Analysis with and Without Obstacles.

Practical: 30, Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	ANSYS Software Manual.
2.	Rao S. S, "The Finite Element Method in Engineering", 5th Edition, Butterworth-Heinemann Ltd., USA, 2010.
3.	Robert D. Cook, Malkus, Witt & Plesha, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley India Pvt. Ltd., India, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the boundary conditions and analyze the given problem.	Analyzing (K4), Manipulation (S2)
CO2	perform structural, thermal, and fluid problems in Finite Element Analysis (FEA) and Finite Volume Method (FVM) software packages.	Analyzing (K4), Manipulation (S2)
CO3	validate the various FEA and FVM results based on theoretical or experimental results.	Analyzing (K4), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3					3		3	3	3
CO2	3	3	3	3	3					3		3	3	3
CO3	3	3	3	3	3					3		3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MEL63 – CAD/CAM LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20MEC11 Engineering Drawing Machine Drawing Material Removal Processes.	6	PC	0	0	2	1
Preamble	This course introduces several mechanical components and their modelling and assembly. Additionally, this course covers the development and execution of part programmes on CNC machines.						

List of Exercises / Experiments :

1.	Practice for (i) Sketching with different Sketching Tools and (ii) Datum Plane, Axis, Point and Coordinate Systems.
2.	3D Part Modeling Options – Protrusion and Cut (extrude, revolve). Exercises: Flange Coupling, Screw Jack.
3.	3D Part Modeling Options – Protrusion and Cut (sweep, blend, helical sweep). Exercises: Machine Vice, Knuckle Joint.
4.	Features Creation with Editing Operations – Move, Pattern, Mirror, Round, Chamfer and Rib. Exercises: Simple Eccentric
5.	Assembly of Machine Components.
6.	Conversion of 3D Solid Model to 2D Drawing – different views, sections, isometric view and dimensioning creations.
7.	Part Program Generation and Machining of given Component using MTAB XLTURN.
8.	Part Program Generation and Machining of given component using MTAB XLMILL.
9.	Part Program Generation and Machining of given component using CNC Turning Centre (JOBBER XL).
10.	Part Program Generation and Machining of given component using CNC Vertical Milling Centre (LMill 55).
11.	Simulation and CNC Code Generation for a given component using MASTERCAM (Lathe) and Interfacing with CNC Turning Centre.
12.	Simulation and CNC Code Generation for a given component using MASTERCAM (Mill) and Interfacing with CNC Machining Centre.

Practical: 30, Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	CREO 7.0, SOLID WORKS 2018, CATIA V5-6 R2015, MasterCAM X5.
2.	Groover M.P., "Automation, Production System and Computer Integrated Manufacturing", 3rd Edition, Prentice-Hall of India, New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the features, operations associated with CAD Parametric Modeling, Assembly and Drafting	Applying (K3), Manipulation (S2)
CO2	apply the advanced feature creation concept of CAD for Modeling, Assembly and Drafting	Applying (K3), Manipulation (S2)
CO3	develop, simulate, analyze, interface, and execute part program using CAM package and CNC production with JOBBER XL and LMill55 machines	Analyzing (K4), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	3					3			3	3
CO2	3	3	1	1	3					3			3	3
CO3	3	3	1	1	3					3			3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20GEL61 PROFESSIONAL SKILLS TRAINING II
(Common to all BE/ BTech / MSc/ MCA /BSc Branches)

Programme & Branch	B.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	EC	0	0	80	2

Preamble	This subject is to enhance the employability skills and to develop career competency	
Unit - I	**Soft Skills – I**	**20**
Group discussions: Advantages of group discussions-Structured GD- Team work: Value of team work in organizations- Definition of a team, why team-Elements of leadership, disadvantages of a team, stages of team formation- Group development activities. Facing an interview: Foundation in core subject- industry orientation / knowledge about the company- professional personality-Communication skills-Activities before Interview, upon entering interview room, during the interview and at the end Mock interviews.		
Unit - II	**Quantitative Aptitude & Logical Reasoning - II**	**30**
Problem solving level II: Money related problems-Mixtures-Symbol base problem-Clocks and calendars-Simple-linear-quadratic and polynomial equations-Special, equations-Inequalities-Sequence and series-Set theory-Permutations and combinations-Probability-Statistics-Data sufficiency- Geometry-Trigonometry-Heights and distances-Co-ordinate geometry-Mensuration. Logical reasoning: Conditionality and grouping-Sequencing and scheduling- Selections-Networks:-Codes; Cubes-Venn diagram in logical reasoning-Quant based reasoning-Flaw detection- Puzzles-Cryptarithms.		
Unit - III	**Reading & Speaking Skills**	**30**
Reading: Reading comprehension– Effective Reading strategies – Descriptive, Inferential, & Argumentative reading passages – Identifying and locating factual information within a text – global reading/skimming for general understanding – selective comprehension / scanning for specific information – detailed comprehension / intensive reading – understanding the development of an argument – identifying the writer's attitude and opinions – Reading news articles in business magazines, newspapers – Reading notices and book reviews –Interpreting graphic data & Advertisements. Speaking: Mock Interviews –Self-Introduction – Sharing of Real Time Experience; Conversational Practices –Role Play – Short Talks / TED Talks –Extempore; Giving a Presentation on Various Topics – Technical / Non-Technical Topics – Project Review Presentation – Oratory and Effective Public Speaking; Pair Discussion – Group Discussion – The process of Group Discussion – Strategies to be adopted – Skills Assessed – Telephonic Conversations & Skills – Negotiating Skills.		

Total: 80

TEXT BOOK:

1	Thorpe, Showick and Edgar Thorpe, "Objective English For Competitive Examination", 6th Edition, Pearson India Education Services Pvt Ltd, 2017.

REFERENCES:

1	Aruna Koneru, "Professional Speaking Skills," Oxford University Press India, 2015.
2	Thorpe, Showick and Edgar Thorpe, "Winning at Interviews," 5th edition, Pearson Education, India, 2013.
3	Rizvi, Ashraf M, "Effective Technical Communication," 2nd Edition, McGraw Hill Education India, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Develop the soft skills of learners to support them work efficiently in an organization as an individual and as a team	Applying (K3), Precision (S3)
CO2	Solve real time problems using numerical ability and logical reasoning	Applying (K3), Precision (S3)
CO3	Apply reading and speaking skills effectively for various academic and professional purposes	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	0	0	0	3	3	0	3	0	3	2		
CO2	3	2	0	0	0	3	3	0	3	0	3	2		
CO3	0	2	0	0	0	3	3	0	3	3	3	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2		50	50				100
CAT3		50	50				100
ESE							

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEP61 - PROJECT WORK 1

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fundamental knowledge on Design, Manufacturing and Thermal analysis	6	EC	0	0	4	2
Preamble	This course provides hands on experience to deploy the design, manufacturing thermal principles to develop a prototype or new/upgraded product to solve an existing engineering problem as a team.						

- Perform Adequate Literature Survey and Market Survey Related to Selected Field.
- Define the Problem and Objectives based on the Literature and Market Survey.
- Prepare a Methodology to Accomplish the Objective(s)
- Study the Economic, Technical and Operational feasibility.
- Develop a Conceptual and Detailed Design based on the Engineering Inputs.
- Develop a Prototype / Product as per the Perceived Design.
- Perform Test Runs and Analyze the Results.
- Present the Fully Developed Prototype / Product.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify, conceptualize and infer the engineering problems that need to be solved based on the literature collections	Understanding (K2)
CO2:	define the problem and prepare a methodology to solve an engineering problem.	Understanding (K2)
CO3:	develop a conceptual and detailed design using modern engineering tools.	Creating (K6)
CO4:	develop and analyze a fully functional mechanism / prototype using engineering principles.	Analyzing (K4)
CO5:	demonstrate the project work in the form of oral presentation, report and technical/patent/paper publications.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1		3	3	2	3	2	1	2		3
CO2	3	3	3	2		3	3	2	3	2	1	1		3
CO3	3	3	3	2	3	3	3	2	3	2	3	2	3	3
CO4	3	3	3	2	3	3	3	2	3	2	3	2	3	3
CO5	3	2			2	3	3	3	3	3	3	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20GET71 Engineering Economics and Management

20MEC71 - MECHATRONICS AND IoT

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PC	3	0	2	4

Preamble	This course provides the importance of sensors, actuators, control systems, controllers and IoT components involved in industrial automation System.	
Unit - I	**Automation and Mechanical Measurements**	**9**
Automation: Automation in Production System - Principles and Strategies of Automation - Basic Elements of an Automated System - Advanced Automation Functions - Levels of Automations. **Mechanical Measurements:** Measurement of Displacement - Velocity - Force - Strain - Temperature - Pressure – Flow.		
Unit - II	**Control System**	**9**
Open Loop and Closed Loop Control - Block Diagrams - Transfer Functions - Laplace Transforms - Mathematical Model of Physical System – Proportional Integral (PI) and Proportional Integral Derivative (PID) Controllers.		
Unit - III	**Microprocessor and Its Interfacing**	**9**
Organization of 8085 – Addressing Modes – Instruction Set – Simple Programs involving Logical - Branch/Call - Sorting - Evaluating Arithmetic Expressions and String Manipulation Instructions - A/D and D/A Converters.		
Unit - IV	**Programmable Logic Controller**	**9**
Introduction - Architecture of PLC – I/O Modules – Distributed I/O Modules – Programming of PLC - Conversion of Relay Logic to Ladder Logic Programming - Math Instructions - Logical Instructions - Timer and Counter – Selection of PLC.		
Unit - V	**Introduction to IoT and Machine learning**	**9**
Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT. Machine to Machine, Difference between IoT and M2M. Overview of machine learning. IoT applications and case studies.		
List of Exercises / Experiments :		
1. Measurement of displacement using LVDT and Capacitive Transducer.		
2. Measurement of Pressure, Force and Speed.		
3. Arithmetic Functions, Sum of N numbers using 8085 Microprocessor		
4. Arrange a Series of numbers in Ascending and Descending orders using 8085 Microprocessors		
5. To interface LED/Buzzer with Arduino/Raspberry Pi and write a Program to turn ON LED for 1 sec after every 2 seconds.		
6. To interface HC-SR04 Ultrasonic Sensor with Arduino and write a Program to print distance between the objects.		

Lecture: 45, Practical: 30, Total: 75

TEXT BOOK:

1.	Bolton W., "Mechatronics: A Multidisciplinary Approach", 4th Edition, Pearson Education, UK, 2016.	I,II,III,IV,V

REFERENCES:

1.	Francis H. Raven, "Automatic Control Engineering", 5th Edition, McGraw-Hill, New Delhi, 2018.
2.	Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On Approach", 1st Edition, Orient Blackswan Pvt. Ltd., New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the suitable sensors based on the functional requirement in industrial automation system	Applying (K3)
CO2	apply knowledge about the different forms of control system in real time interfacing	Applying (K3)
CO3	realize the programming and interfacing of 8085 microprocessor for automatic system design	Analyzing (k4)
CO4	analyze the operations of programmable logic controllers in automation industries	Analyzing (k4)
CO5	present the concepts of internet of things and machine learning	Understanding (K2)
CO6	perform the measurements of different physical parameters using I/O devices, sensors and communication modules	Applying (K3), Manipulation (S2)
CO7	write programming for 8085 microprocessors in suitable applications	Applying (K3), Manipulation (S2)
CO8	recognize the design and functional blocks of IoT systems	Understand (K2), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3		3								3	
CO2	3		3		3								3	
CO3	3		3		3								3	
CO4	3		3		3								3	
CO5	3		3		3								3	
CO6	3		3		3					3			3	
CO7	3		3		3					3			3	
CO8	3		3		3					3			3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	30	10			100
CAT3	20	40	30	10			100
ESE	20	30	35	15			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEP71 - PROJECT WORK 2 PHASE I

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fundamental knowledge on Design, Manufacturing and Thermal analysis	7	EC	0	0	6	3
Preamble	This course provides hands on experience to deploy the design, manufacturing thermal principles to develop a prototype or new/upgraded product to solve an existing engineering problem as a team.						

PROJECT WORK 2 PHASE I

- Development of Knowledge in a Field Related to Mechanical Engineering.
- Perform Adequate Literature Survey Related to Selected Field.
- Perform Market Survey Related to Selected Field.
- Define the Problem based on the Literature and Market Survey.
- Define the Objective(s).
- Study the Economic and Technical feasibility.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify, conceptualize and infer the engineering problems that need to be solved	Understanding (K2)
CO2:	identify and refer literature	Understanding (K2)
CO3:	carryout market survey and relate the features	Understanding (K2)
CO4:	define the problem and its underlying concepts	Applying (K3)
CO5:	derive the objectives, perform the feasibility studies and demonstrate the project work in the form of oral presentation along with the analysis reports	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				3	3	2	3	2	3	2		3
CO2	3	3				3	3	2	3	2	1	3		3
CO3	3	3				3	3	2	3	2	1	3		3
CO4	3	3			2	3	3	2	3	2			2	3
CO5	3	2			2	3	3	3	3	3	2	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MEP81 - PROJECT WORK 2 Phase II

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fundamental knowledge on Design, Manufacturing and Thermal analysis	8	EC	0	0	14	7
Preamble	This course provides hands on experience to deploy the design, manufacturing thermal principles to develop a prototype or new/upgraded product to solve an existing engineering problem as a team.						

PROJECT WORK 2 PHASE II

- Develop a Methodology to Accomplish the Objective(s).
- Design and Perform Engineering Tests based on ASTM Standards to Populate Results.
- Analyze the Test Results using Modern Tools/Software.
- Present the Optimized Technology/Process/Product.
- Demonstrate the project work in the form of oral presentation, report and technical/patent/paper publications.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify, conceptualize and define the engineering problem that needs to be solved	Applying (K3)
CO2:	write the objectives and prepare a methodology to solve an engineering problem	Applying (K3)
CO3:	design and develop a solution using modern tools	Creating (K6)
CO4:	evaluate the performance of the developed technology/process/product	Evaluating (K5)
CO5:	demonstrate the project work in the form of oral presentation, report and technical/patent/paper publications.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3				3	3	2	3	2	1	3		3
CO2	2	3	3	1	1	3	3	3	3		3	3	1	3
CO3	3		3	2	3			1	3	2	3	2	3	3
CO4	2	3	3		3	2	2	3	3	1		3	3	3
CO5					2				3	3		3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MEE01 - FLUID POWER SYSTEM

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fluid Mechanics and Hydraulic Machines	5	PE	3	0	0	3

Preamble	This course provides knowledge and skill to generate, control and transmission of power using both hydraulic and pneumatic systems. It offers designing of fluid power circuit for various industrial application, industrial circuits and sealing devices, service & maintenance.	
Unit - I	**Fundamentals of Hydraulic System**	**9**
Basics of Fluid Power System – Advantages and Applications of Fluid Power Systems – Fluid Properties – Pascal's Law and its Application – Losses in Pipes – Valves and Fittings – Fluid Power Symbols – Hydraulic Pumps - Gear – Vane and Piston Pumps – Pump Performance – Characteristics and Selection – Sizing of Pumps.		
Unit - II	**Control Components of Hydraulic System**	**9**
Direction Control Valves - Three Way Valve – Four Way Valve – Check Valve and Shuttle Valve – Actuation Mechanisms in DCV – Pressure Control Valves - Pressure Relief – Pressure Reducing – Counter Balance – Sequencing and Unloading Valves – Flow Control Valves and its Types – Proportional Valves – Servo Valves - Mechanical Type and Electrohydraulic Servo Valves.		
Unit - III	**Pneumatic System and Actuators**	**9**
Pneumatic System: Properties of Air – Perfect Gas Laws – Compressors - Piston – Screw and Vane Compressor – Fluid Conditioning Elements - Filter Regulator and Lubricator Unit – Pneumatic Silencers – After Coolers – Air Dryers – Air Control Valves. Actuators: Linear And Rotary Actuators – Types – Cushioning Mechanism in Cylinders – Sizing of Actuators.		
Unit - IV	**Fluid Power Circuit Design**	**9**
Basic Pneumatic Circuits – Pneumatic Vacuum Systems – Electrical Components and Electrical Controls for Fluid Power Circuits – Cascade Circuit Design Method (Two / Three Cylinder Circuits) – Introduction to Fluid Logic Devices and Applications – Accumulator – Types and Application Circuits – Pressure Intensifier Circuits – PLC Applications in Fluid Power Circuit.		
Unit - V	**Industrial Circuits and Maintenance**	**9**
Industrial Circuits: Speed Control Circuits – Regenerative Cylinder Circuits – Pump Unloading Circuit – Double Pump Circuit – Counter Balance Valve Circuit – Hydraulic Cylinder Sequencing Circuit – Automatic Cylinder Reciprocating Circuit – Cylinder Synchronizing Circuits – Fail Safe Circuits – Sealing Devices - Types and Materials – Safety Aspects – Installation. Maintenance: Maintenance and Trouble Shooting of Fluid Power Systems.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Esposito Anthony, "Fluid Power with Applications", 7th Edition, Pearson Higher Education, New York, 2015.	I,II,III,IV,V

REFERENCES:

1.	Jegadeesa T, "Hydraulics and Pneumatics", I.K International Publishing House Pvt. Ltd., New Delhi, 2015.
2.	Majumdar S. R , "Oil Hydraulic Systems – Principles and Maintenance", 2nd Edition, Tata McGraw-Hill, New Delhi, 2012.
3.	Majumdar S. R, "Pneumatic Systems – Principles and Maintenance", 2nd Edition, Tata McGraw-Hill, New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify fluid power components and their symbols as used in industry and also select suitable pump for hydraulic power pack	Understanding (K2)
CO2	choose appropriate control valves for fluid power applications	Applying (K3)
CO3	select pneumatic components and fluid power actuators for low-cost automation	Applying (K3)
CO4	design and construct a fluid power circuit for real time applications	Applying (K3)
CO5	design, construct, testing, installation , maintenance and troubleshooting of fluid power circuits for engineering applications	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3											
CO2	3	3	3											
CO3	3	3	3											
CO4	3	3	3											
CO5	3	3	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	30	50				100
CAT3	10	30	40	20			100
ESE	10	30	50	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE02 - CAD/CAM/CIM

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Drawing Material Removal Processes	5	PE	3	0	0	3

Preamble	This course impart knowledge on the role of CAD in design process, 2D & 3D transformations and visual realism like shading, coloring and solid modeling. It also describes Computer Numerical Control (CNC) Technology, structural members of CNC machines, Coding of part programming, different process planning approaches and Flexible Manufacturing System (FMS) with recent advancements.	
Unit - I	**Computer Aided Design (CAD)**	**9**
The Design Process and Role of CAD - Introduction to Computer Graphics - Output Primitives - Bresenham's Line and Circle Drawing Algorithms - Parametric Equations for Line and Circle - 2D & 3D Transformations - Translation - Scaling - Rotation - Homogeneous Coordinate.		
Unit - II	**Visual Realism**	**9**
Visual Realism: Hidden Line - Surface Algorithms - Shading and Coloring - Red Green Blue (RGB) - Hue Saturation Value (HSV) - Hue Lightness Saturation (HLS) - User Coordinate System (UCS) and World Coordinate System (WCS) -Solid Modeling - Constructive Solid Geometry (CSG) and Boundary Representation (B-Rep) Techniques - Parametric Modeling.		
Unit - III	**CNC Programming**	**9**
CNC Technology - Classification - Contouring - Interpolators - Open Loop and Closed Loop System - CNC Controller and Structural Members of CNC Machines - Function of Ball Screws – Automatic Tool Changer (ATC) - Feedback Devices -Fundamentals of Part Programming - Geometric Codes (G Codes) and - Miscellaneous Codes (M-Codes) - Cutter Location (CL) Data and Tool Path Simulation– Manual Programming - Canned Cycle and Subroutines. Code Generation from 3D Solid Models Using Master CAM Software.		
Unit - IV	**Computer Integrated Manufacturing (CIM)**	**9**
CIM Wheel - Role of Group Technology in CAD/CAM Integration - Artificial Intelligence in CIM - Part Families - Classification and Coding – Design and Classification Information System (D CLASS) and Metal Institute Classification (MI CLASS) and OPITZ Coding Systems.		
Unit - V	**Process Planning and FMS**	**9**
Process Planning: Variant and Generative Approaches – Computer Aided Process Planning (CAPP) and Computer Managed Process Planning (CMPP) Process Planning Systems - Shop Floor Control - Factory Data Collection System - Automatic Identification Methods – Bar Code Technology - Automated Data Collection System. FMS: Components of FMS – Types - FMS Workstation - Material Handling And Storage Systems - FMS Layout - Application and Benefits - Introduction to Rapid Prototyping - Communication Fundamentals - Local Area Networks - Topology.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Zeid Ibrahim & Sivasubramanian, "CAD/CAM Theory and Practice", 2nd Edition, Tata McGraw Hill, New Delhi, 2010.	I,II,III
2.	Groover M. P, "Automation, Production System and Computer Integrated Manufacturing", 3rd Edition, Prentice-Hall of India, New Delhi, 2016.	IV,V

REFERENCES:

1.	Hearn Donald & Baker M. Pauline, "Computer Graphic", 2nd Edition, Pearson Education, New Delhi, 2004.
2.	Radhakrishnan P & Subramanian S, "CAD/CAM/CIM", 3rd Edition, New Age International Publishers, New Delhi, 2008.
3.	Bedworth David, "Computer Integrated Design and Manufacturing", 1st Edition, McGraw-Hill, New Delhi, 1991.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the modeling algorithms and 2D & 3D transformations.	Applying (K3)
CO2	describe concepts behind visual realism and parametric modeling.	Understanding (K2)
CO3	generate the CNC part programs using G and M codes.	Applying(K3)
CO4	identify the part families and demonstrate different classification and coding systems.	Applying (K3)
CO5	demonstrate the concepts of FMS - CAPP and LAN implementations.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2						3		1	3	3
CO2	3	3								3		1	3	3
CO3	3	3	2	2	1					3		1	3	3
CO4	3	3			1					3		1	3	3
CO5	3	3	2	2						3		1	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE03 - AUTOMOBILE ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Thermal Engineering	5	PE	3	0	0	3

Preamble	This course deals with the structure and construction of automobiles and also, the working principles of functional components. In addition, an insight is provided about electric vehicles, pollution norms and safety standards.	
Unit - I	**Vehicle Structure and Engine**	**9**
Vehicle Structure: Types of Automobiles - Vehicle Construction - Chassis – Types - Frame and Body Types. Engine: Types - Components of Engine – Functions and Materials - Turbo Chargers - Superchargers - Turbo Lag - Introduction to Electronic Engine Management System.		
Unit - II	**Fuel Supply Systems and Electrical Systems**	**9**
Fuel Supply System: Carburetion and Simple Carburetor - Electronically Controlled Gasoline Fuel Injection System – Monopoint and Multi Point Fuel Injection Systems (MPFI) - Gasoline Direct Injection (GDI) - Fuel Stratified Injection (FSI). Diesel Engine Fuel Supply System – Types - Electronically Controlled Diesel Fuel Injection System – Common Rail Direct Injection (CRDI). Electrical Systems: General Layout of Electrical System – Different Sub Circuits - Lighting System.		
Unit – III	**Transmission Systems**	**9**
Transmission Systems: Clutch – Types and Construction - Gear Boxes – Types - Manual and Automatic - Selector Mechanism - Over Drives – Transfer Box - Fluid Flywheel - Torque Converter – Propeller Shaft – Slip Joint – Universal Joints – Differential Unit - Rear Axle – Hotchkiss Drive - Torque Tube Drive.		
Unit – IV	**Steering, Brakes and Suspension Systems**	**9**
Steering: Wheels and Tyres – Wheel Alignment Parameters - Types of Front Axle - Steering Geometry and Mechanism - Steering Gear Box and Types – Power Steering. Brakes: Types - Hydraulic and Pneumatic Braking Systems - Construction and Working - Antilock Braking System - Single Channel - Dual Channel – Electronic Brake force Distribution **(**EBD). Suspension Systems: Types – Independent Suspension Systems.		
Unit - V	**Electric Vehicles, Emission Control and Safety**	**9**
Electric Vehicles: Hybrid Vehicles - Electric Vehicles - Solar Powered Vehicles - Fuel Cells - Construction and Operation of Lead Acid Battery - Starting Motor and Drives. Emission Control: Global Standards - Indian Pollution Norms for Petrol & Diesel Vehicles. Safety: Safety Measures in Automobiles – Airbag – Passenger Safety – Vehicle Safety.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Dr.Kirpal Singh, "Automobile Engineering", 14th Edition, Volume I&II, Standard Publishers Distributor, New Delhi, 2018.	I,II,III,IV,V

REFERENCES:

1.	Crouse William H. and Anglin Donald L. , "Automotive Mechanism", 10th Edition, Tata McGraw-Hill, New Delhi, 2017.
2.	Rajput R.K. , "A Text book of Automobile Engineering", 2nd Edition, Laxmi Publication, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recognize the various automobile components, engine parts and engine management system	Understanding(K2)
CO2	describe the fuel supply systems and electrical systems in automobiles.	Applying(K3)
CO3	demonstrate the working of transmission system and its various elements	Applying(K3)
CO4	illustrate the working of suspension, steering and braking systems.	Applying(K3)
CO5	comprehend the pollution norms and safety measures and also illustrate the working of electric vehicles.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3				3								3
CO2	3	3				3								3
CO3	3	3				3								3
CO4	3	3				3								3
CO5	3	3				3								3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	50	10				100
CAT2	40	50	10				100
CAT3	40	50	10				100
ESE	40	50	10				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE04 – Climate Change and New Energy Technology

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Thermal Engineering	5	PE	3	0	0	3

Preamble	This course provides an overview on global and national climate change implications. In addition, the future energy technologies for sustainable development are also covered in this course.	
Unit - I	**Climate Change**	**9**
Preliminary Concepts of Climate Change - International Climate Policy - Causes of Climate Change - Enhanced Greenhouse Effect – Green House Gases in Atmosphere - Global Warming - Effects of Global Warming - Climate Change Scenario of India - Impact of Climate Change on Agriculture – Forest - Water Resources - Monsoon System of India.		
Unit – II	**Energy Transition**	**9**
Personal Energy Needs - Personal Carbon Dioxide Balance - Carbon Dioxide Sequestration - Combined Heat and Power System - Energy Transition in Heat Sector - Transport Sector - Electricity Sector - Direct and Indirect Emissions in Energy Sector - Net-zero Emissions - Carbon-free Technology.		
Unit – III	**Renewable Energy System**	**9**
Solar Thermal Systems - Domestic Solar Water Heating – Space Heating - Solar PV Systems - Designing Stand-alone Systems - Designing Grid-connected Systems - Renewable Power Plants – Solar Photovoltaic Power Plants - Concentrating Solar Thermal Power Plants - Grid-connected Wind Turbines - Geothermal Heat and Power Plants - Biomass Heat and Power Plants.		
Unit – IV	**Battery Technologies**	**9**
Introduction to Batteries – Electrochemical Principles and Reactions - Classification - Primary Batteries - Types - Service Time - Voltage Data - Service Life - Ohmic Load Curve - Effect of Operating Temperature on Service Life - Reserve Batteries – Types - Secondary Batteries – Types - Discharge Curves - Terminal Voltages - Plateau Voltage - Lead Acid Batteries – Construction – Application - Battery Performance Evaluation - Factors Affecting Battery Performance - Advanced Batteries for Electric Vehicles.		
Unit – V	**Energy Storage Technology**	**9**
Demand for Power Systems - Overview of Energy Storage Technologies - Energy Storage Methods – Thermal – Mechanical – Chemical – Electrochemical – Electrical Storage Systems - Efficiency of Energy Storage systems -Thermal Energy Storage(TES) using Phase Change Materials - Energy Conservation with TES - Planning and Implementation of TES - Environmental impact of TES systems.		

Lecture: 45, Total: 45

TEXT BOOK:

1. Volker V. Quaschning, “Renewable Energy and Climate Change”, 2nd Edition, Wiley Publications, USA, 2019
2. David Linden and Thomas.B.Reddy, “Hand Book of Batteries and Fuel cells”, 3rd Edition, McGraw Hill Book Company, New York, 2002.

REFERENCES:

1. G. N. Tiwari and M. K. Ghosal, “Fundamentals of Renewable Energy Sources”, 1st Edition, Alpha Science International Ltd., Oxford, 2007
2. Ibrahim Dincer and Marc A. Rosen, “Thermal Energy Storage: Systems and Applications”, 2nd Edition, Wiley Publications, USA, 2010

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the global and Indian climate change scenario	Applying (K3)
CO2	illustrate the energy transition mechanism in various sectors.	Applying (K3)
CO3	design renewable energy systems for heat and power.	Applying (K3)
CO4	classify the batteries and explain the performance evaluation methods for primary and secondary batteries	Applying (K3)
CO5	describe the working of various energy storage systems.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				3	3					2		3
CO2	3	2				3	3					2		3
CO3	3	2				3	3					2		3
CO4	3	2			2	3	3					2	2	3
CO5	3	2			2	3	3					2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	20	30	50				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE05 - UNCONVENTIONAL MACHINING PROCESSES

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Material Removal Processes Production Technology Laboratory	5	PE	3	0	0	3

Preamble	This course covers the fundamentals of various unconventional machining processes as well as the influence of process parameters on machining performance in diverse applications.	
Unit - I	**Introduction and Mechanical Energy Based Processes**	**9**
Unconventional Machining Processes–Needs–Classifications–Process Selection–Limitations–Advantages. Abrasive Jet Machining (AJM) – Water Jet Machining (WJM) – Abrasive Water Jet Machining (AWJM) - Ultrasonic Machining (USM) - Working Principles – Equipment Used – Process Parameters – MRR – Applications.		
Unit - II	**Electrical Energy Based Processes**	**9**
Electric Discharge Machining (EDM) - Working Principle - Equipment's -Process Parameters - Surface Finish and Material Removal Rate - Electrode / Tool – Power and Control Circuits-Tool Wear – Dielectric – Flushing – Wire Cut EDM – Applications.		
Unit - III	**Chemical and Electro-Chemical Energy Based Processes**	**9**
Chemical Machining (CHM) and Electro-Chemical Machining (ECM) - Etchants – Maskant - Techniques of Applying Maskants - Process Parameters – Surface Finish and MRR-Applications- Principles of ECM- Equipments-Surface Roughness and MRR - Electrical Circuit-Process Parameters-Applications.		
Unit - IV	**Thermal Energy Based Processes**	**9**
Laser Beam Machining (LBM) - Plasma Arc Machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types – Process Parameter - Beam Control Techniques-MRR – Applications.		
Unit - V	**Hybrid Processes and Advanced Finishing Processes**	**9**
Electro Chemical Grinding (ECG) – Electro Chemical De-burring (ECD) – Shaped Tube Electrolytic Machining (STEM) – Working Principle – Applications – Limitations. Advanced Finishing Processes: Abrasive Flow Machining (AFM) – Magnetic Abrasive Finishing (MAF) – Chemical Mechanical Polishing (CMP) – Working principle – Mechanism of material removal – Surface quality – Applications.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Vijay.K. Jain. “Advanced Machining Processes”. 1st Edition Allied Publishers Pvt. Ltd., New Delhi, 2015.	I,II,III,IV,V

REFERENCES:

1.	Pandey P.C. and Shan H.S. “Modern Machining Processes”. 1st Edition, Tata McGraw-Hill, New Delhi, 2017.
2.	Kapil Gupta, N.K.Jain and R.F.Laubscher, “Hybrid Machining Process: Perspectives on machining and finishing”, Springer International Publishing, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	present the need of non-traditional machining processes, classify them and recognize the role of mechanical energy in non-traditional machining processes.	Applying (K3)
CO2:	apply the knowledge on machining electrically conductive material through electrical energy in non-traditional machining processes.	Applying (K3)
CO3:	demonstrate the concept of machining the hard material using chemical energy and electrochemical energy.	Applying (K3)
CO4:	illustrate various thermal energy based non-traditional machining processes.	Applying (K3)
CO5:	illustrate the hybrid processes and advanced finishing processes used for various types of applications.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			2	1				2		1	2	3
CO2	3	1			2	1				2		1	2	3
CO3	3	1			2	1				2		1	2	3
CO4	3	1			2	1				2		1	2	3
CO5	3	1			2	1				2		1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	10	50	40				100
CAT3	10	50	40				100
ESE	10	50	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE06 - DESIGN FOR MANUFACTURE AND ASSEMBLY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology Engineering Materials and Metallurgy Material Removal Processes	5	PE	3	0	0	3

Preamble	This course provides the essential concepts behind manufacturing and assembly orient design. It also provides design guidelines for machining, casting and injection molding to achieve cost effective design.	
Unit - I	**Tolerance Analysis**	**9**
Geometric Tolerances – Tolerance Analysis – Worst Case Method – Assembly Limits – Design and Manufacturing Datum – Conversion of Design Datum into Manufacturing Datum – Tolerance Stacks – True Position Theory – Zero True Position Tolerance – Process Capability.		
Unit - II	**Materials Selection and Design for Assembly**	**9**
Principal Materials – Selection of Materials and Processes –Design – Possible Solutions – Evaluation Method. General Design Principles for Manufacturability – General Design Guidelines for Manual Assembly – Assembly Efficiency – Effects of Part Symmetry – Part Thickness and Weight on Handling Time – Types of Manual Assembly Methods – Design for High Speed Automatic Assembly And Robot Assembly.		
Unit - III	**Design for Machining**	**9**
Design Features to Facilities Machining – Single Point and Multipoint Cutting Tools – Choice and Shape of Work Material – Accuracy and Surface Finish – Design Recommendations for Turning and Milling Operations: Process Description – Suitable Materials. Guidelines for Machining of Rotational and Non-Rotational Components – Reduction of Machined Area – Design for Clampability – Design for Accessibility.		
Unit – IV	**Design for Injection Molding and Powder Metal Processing**	**9**
Injection Molding Materials – The Molding Cycle – Molding Systems and Molds – Cycle Time and Mold Cost Estimation – Estimation of Optimum Number of Cavities – Design Guidelines for Injection Molding. Design for Powder Metal Processing: Introduction to Powder Metal Processing – Materials and Manufacturing Cost – Design Guidelines for Powder Metal Parts.		
Unit - V	**Design for Sand and Die Casting**	**9**
Sand Casting Alloys – Sand Cores – Design Rules for Sand Castings – Identification of Uneconomical Design – Modifying The Design. Die Casting Alloys – The Die Casting Cycle – Determination of Number of Cavities and Appropriate Machine Size in Die Casting – Design Principles for Die Casting.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Boothroyd G, Dewhurst P & Knight W. A., "Product Design for Manufacture and Assembly", 3rd Edition, CRC Press, USA, 2011.	I,II,III,IV,V

REFERENCES:

1.	Peck Harry, "Designing for Manufacture", 1st Edition, Pitman Publications, London, 1983.
2.	Bralla J.G., "Design for Manufacturability Handbook", 2nd Edition, McGraw Hill Education, New York, 1999.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the dimensions of components and identify the suitable geometrical tolerances for manufacturing oriented design	Analyzing (K4)
CO2	select suitable materials for components and demonstrate the design considerations for assembly in different applications	Applying (K3)
CO3	provide suitable design recommendations for various machining operations	Understanding (K2)
CO4	analyze the design for injection molded components and demonstrate the design recommendations for powder metal processing	Analyzing (K4)
CO5	identify uneconomical design to modify design for sand and die castings	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	1							1	1	3
CO2	3	2	2									1		3
CO3	2	2	2									1		3
CO4	3	2	2									1		3
CO5	3	2	2									1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	20	20			100
CAT2	20	40	20	20			100
CAT3	20	40	20	20			100
ESE	20	40	20	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE07 - OPERATIONS RESEARCH

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Matrices and Differential Equations Multivariable Calculus and Complex Analysis Statistics and Numerical Methods	5	PE	3	0	0	3

Preamble	This course provides an in-depth insight into the concepts, theories and techniques of Operations Research. It also emphasis the role of operation research in planning, controlling and enhancing performance which could be successfully used for optimizing the managerial decisions.	
Unit - I	**Linear Models**	**9**
Introduction - Phases of OR Study – Formation of Linear Programming Problem (LPP) - Canonical form of LPP - Solutions to LPP - Graphical Solution - Simplex Algorithm - Artificial Variables Technique - Big M Method - Two Phase Method.		
Unit - II	**Transportation Problems, Assignment Problems and Sequencing Problems**	**9**
Transportation Problems: Mathematical Formulation-Basic Feasible Solutions – North-West Corner (NWC) – Least Cost Method (LCM) – Vogels Approximation Method (VAM). Optimality Test – Modified Distribution (MODI) Technique. Assignment Problems: Mathematical Formulation –Hungarian Algorithm. Sequencing Problems:1 Jobs N Machine, N Jobs 1 Machine, N Jobs 2 Machine, N Jobs 3 Machine, N Jobs M Machine and 2 Jobs N Machine Problems.		
Unit - III	**Network Models and Project Management**	**9**
Network Models: Shortest Route - Minimal Spanning Tree - Maximum Flow Models. Project Management: Construction of Networks-Activity and Event Based Diagrams –Program Evaluation and Review Technique(PERT) & Critical Path Method (CPM) Problems – Cost Analysis and Crashing of Networks.		
Unit - IV	**Inventory Models**	**9**
Types of Inventory – Economic Order Quantity (EOQ) - Deterministic Inventory Models - Price Break Problems - Stochastic Inventory Models - Multi Item Deterministic Models - Selective Inventory Control Techniques.		
Unit - V	**Queuing Models and Replacement Models**	**9**
Queuing Models: Queuing Systems and Structures - Notations - Parameter - Single Server and Multiserver Models - Poisson Input - Exponential Service - Constant Rate Service - Infinite Population. Replacement Models: Replacement of Items Due to Deterioration With and Without Time Value of Money - Individual and Group Replacement Policy		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Gupta P.K. & Hira D.S., "Operations Research", 7th Edition, S. Chand Publishing, New Delhi, 2014.	I,II,III,IV,V

REFERENCES:

1.	Taha & Hamdy A., "Operation Research: An Introduction", 10th Edition, Pearson Education, Chennai, 2017.
2.	Hiller Frederick S. , Lieberman Gerald J., Bodhibrata Nag & Preetam Basu, "Introduction to Operations Research", 10th Edition, McGraw-Hill Education, Bengaluru, 2017.
3.	Vohra N.D., "Quantitative Techniques in Management", 5th Edition, McGraw Hill Education, Noida, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	formulate and solve linear programming problems	Applying (K3)
CO2	develop solutions to transportation, assignment and sequencing problems	Applying (K3)
CO3	construct networks and analyze optimality for various applications	Analyzing (K4)
CO4	identify inventory models and solve for optimality	Analyzing (K4)
CO5	assess queuing characteristics and compute the optimum replacement period for capital equipments and items that fail suddenly	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3		1						1		1	2
CO2	3	2	3		1						1		1	2
CO3	3	2	3	2	1						1		1	2
CO4	3	2	3	2	1						1		1	2
CO5	3	2	3	2	1						1		1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	20	30	30			100
CAT3	20	20	30	30			100
ESE	10	20	40	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE08 - PRODUCTION PLANNING AND CONTROL

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PE	3	0	0	3

Preamble	This course offers insight on various functions and decision making process involved in planning and controlling of production activities adopted in industry.	
Unit - I	**Introduction**	**9**
Definition − Objectives and Functions of Production Planning and Control − Elements of Production Control − Types of Production − Organization of Production Planning and Control Department − Internal Organization of Department – Break Even Analysis – Economics of a New Design – Aesthetic Aspect.		
Unit - II	**Forecasting, Product Planning and Process Planning**	**9**
Forecasting: Demand Forecasting, Forecasting Techniques. Product Planning: Extending The Original Product Information-Value Analysis-Problems in Lack of Product Planning. Process Planning: Pre Requisite Information Needed for Process Planning - Steps in Process Planning - Quantity Determination in Batch Production-Machine Capacity - Balancing.		
Unit - III	**Routing and Scheduling**	**9**
Routing: Definition − Routing Procedure − Route Sheets − Bill of Material − Factors Affecting Routing Procedure Scheduling: Definition − Difference with Loading - Scheduling Policies – Techniques - Standard Scheduling Methods - Aggregate Planning - Chase Planning - Expediting - Controlling Aspects.		
Unit - IV	**Dispatching**	**9**
Dispatching activities − Dispatching procedure − Follow up − definition − Reason for existence of functions - Manufacturing lead time - Techniques for aligning completion times and due dates − Applications of computer in production planning and control.		
Unit - V	**Inventory Control and Trends in PPC**	**9**
Inventory Control: Inventory management − functions of inventories − Purpose of holding stock - Effect of demand on inventories – Deterministic models: Always Better Control (ABC) analysis – Inventory Production Quantity – Economic Order Quantity (EOQ) model − safety stock inventory control systems. **Trends in PPC**: Enterprises Resource Planning (ERP) - Line of Balance (LOB) – Just in Time (JIT) and KANBAN system.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Jain K.C. & Agarwal L.N, "Production Planning and Control & Industrial Management", 8th Edition, Khanna Publishers, New Delhi, Reprint 2019.	I,II,III,IV,V

REFERENCES:

1.	Upendra Kachru, "Production and Operations Management – Text and Cases", 1st Edition, Excel Books, New Delhi, 2009.
2.	Norman Gaither G. & Frazier., "Operations Management", 9th Edition, Thomson learning, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the role of Production Planning and control activities in manufacturing and services.	Understanding (K2)
CO2	demonstrate the sequences of process planning operations for various resources	Applying (K3)
CO3	integrate the flow of product in machineries through scheduling	Analyzing (K4)
CO4	integrate the product lead time and its related parameters using dispatching technique	Applying (K3)
CO5	appraise various inventory management techniques and apply in real manufacturing scenario	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3											3
CO2	3	1	3	3										3
CO3	3		3	3										3
CO4	3		3	3										3
CO5	3		3	3										3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	40	30				100
CAT2	15	15	35	35			100
CAT3	15	15	35	35			100
ESE	15	20	30	35			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE09 - DESIGN OF TRANSMISSION SYSTEM

(Use of PSG Data book is permitted for the End Semester Examination)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Strength of Materials, Design of Machine Elements	7	PE	3	0	0	3

Preamble	This course imparts the knowledge on design of various transmission devices like belt, chain, rope, gear and gear box which aid in effective working of mechanical systems. Apart from these, this course give detailed view about design of power screws, lead screw and coupling as per standards.	
Unit - I	**Design of Belt, Rope and Chain Drives**	**9**
Design of Belt, Rope and Chain Drives: Classification of Belt Drives – Selection of Flat Belts and Pulleys – Selection of V Belts and Pulleys – Selection of Wire Ropes and Pulleys – Selection of Transmission Chains and Sprockets		
Unit - II	**Design of Spur Gears and Helical Gears**	**9**
Design of Spur Gears: Gear Terminology – Speed Ratios and Number of Teeth – Force Analysis – Tooth Stresses – Dynamic Effects – Fatigue Strength – Factor of Safety – Gear Materials – Module and Face Width – Power Rating Calculations Based on Strength and Wear Considerations. Design of Helical Gears: Parallel Axis Helical Gears – Pressure Angle in the Normal and Transverse Plane – Equivalent Number of Teeth – Forces and Stresses – Estimating the Size of the Helical Gears		
Unit - III	**Design of Bevel Gears and Worm Gears**	**9**
Design of Bevel Gears: Straight Bevel Gear – Terminology – Tooth Forces and Stresses – Equivalent Number of Teeth – Estimating the Dimensions of Pair of Straight Bevel Gears. Design of Worm Gears: Merits and Demerits – Terminology – Thermal Capacity – Materials – Forces and Stresses – Efficiency – Estimating the Size of the Worm Gear Pair		
Unit - IV	**Design of Gear Boxes**	**9**
Design of Gear Boxes: Geometric Progression – Standard Step Ratio – Ray Diagram – Kinematic Layouts – Design of Sliding Mesh Gear Box – Constant Mesh Gear Box – Design of Multi Speed Gear Box		
Unit - V	**Design of Power Screws , Lead screw and Coupling**	**9**
Design of Power Screws-Lead Screws-Jack Screw . Design of Rigid and Flexible Couplings .		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Prabhu T. J., "Design of Transmission Elements", 5th Edition, New age International publisher, Chennai, 2019.	I,II,III,IV,V

REFERENCES:

1.	Bhandari V. B., "Design of Machine Elements", 4th Edition, Tata McGraw-Hill, New Delhi, 2016.
2.	Shigley J. E. & Mischke C. R., "Mechanical Engineering Design", 11th Edition, McGraw Hill International Education, New York, 2019.
3.	Norton R. L., "Design of Machinery", 6th Edition, McGraw Hill, New Delhi, 2019.

STANDARDS:

1. IS 4460 : Parts 1 to 3 : 1995 - Gears – Spur and Helical Gears – Calculation of Load Capacity
2. IS 7443 : 2002, Methods of Load Rating of Worm Gears
3. IS 15151: 2002, Belt Drives – Pulleys and V-Ribbed belts for Industrial applications – PH, PJ, PK, Pl and PM Profiles : Dimensions
4. IS 2122: Part 1: 1973, Code of practice for selection, storage, installation and maintenance of belting for power transmission: Part 1 Flat Belt Drives.
5. IS 2122: Part 2: 1991, Code of practice for selection, storage, installation and maintenance of belting for power transmission: Part 2 V-Belt Drives.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make proper assumptions and perform analysis and select appropriate belt drives and chain drives	Analyzing (K4)
CO2	find suitable dimensions of spur and helical gear drives for given application	Analyzing (K4)
CO3	design the bevel gear, worm gear for the suitable loading conditions	Analyzing (K4)
CO4	draw and analyze the speed calculation of different stages in a gear box	Analyzing (K4)
CO5	design the power screw, lead screw and coupling with necessary specification	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3											3
CO2	3	3	3											3
CO3	3	3	3											3
CO4	3	3	3											3
CO5	3	3	3											3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	15	40	30			100
CAT2	15	15	40	30			100
CAT3	15	15	40	30			100
ESE	15	15	40	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE10 - VIBRATION AND NOISE CONTROL

Programme& Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Matrices and Differential Equations Multivariable Calculus and Complex Analysis Dynamics of Machinery, Strength of Materials	7	PE	3	0	0	3

Preamble	This course imparts the knowledge on natural frequency of vibration system, vibration measuring instruments and sensors, basics source of noise, measurement of sound and its control.	
Unit - I	**Basics of Vibration and One degree of Freedom System**	**9**
Introduction, Classification of Vibration: Free and Forced Vibration, Undamped and Damped Vibration, Linear and Non-Linear Vibration, Response of Damped and Undamped Systems Under Harmonic Force, Analysis of Single Degree and Two Degree of Freedom Systems, Torsional Vibration, Determination of Natural Frequencies.		
Unit - II	**Two Degree of Freedom System and Vibration Control**	**9**
Vibration of Two Degree of Freedom System-Semi Definite System-Forced Vibration of Two Degree of Freedom System.-Spring Coupled and Mass Coupled system Vibration Absorber-Vibration Isolation.		
Unit - III	**Vibration Measurement and Analysis**	**9**
Vibration Measuring Instruments- Types of Exciters- Types of Sensors. Vibration Test- Free and Forced Vibration Tests. Case Studies. Balancing – Single and Double Plane Balancing. Modal Analysis.		
Unit - IV	**Basics of Noise**	**9**
Introduction, Amplitude, Frequency, Wavelength and Sound Pressure Level, Addition, Subtraction and Averaging Decibel Levels, Noise Dose Level, Legislation, Measurement and Analysis of Noise, Measurement Environment, Equipment, Frequency Analysis, Tracking Analysis, Sound Quality Analysis.		
Unit - V	**Source of Noise and Control**	**9**
Methods for Control of Engine Noise, Combustion Noise, Mechanical Noise, Predictive Analysis, Palliative Treatments and Enclosures, Automotive Noise Control Principles, Sound in Enclosures, Sound Energy Absorption, Sound Transmission through Barriers.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Singh V.P. "Mechanical Vibrations". 3rd Edition, Dhanpat Rai & Co. Ltd., New Delhi, 2014.	I,II,III
2.	Pujara Kewal, "Vibrations and Noise for Engineers", 4th Edition, Dhanpat Rai & Sons, New Delhi, 2018.	I, IV, V

REFERENCES:

1.	Rao Singiresu S., "Mechanical Vibrations", 6th Edition, Pearson Education, New Delhi, 2018.
2.	Rao J.S., and Gupth K., "Introductory Course on Theory and Practice of Mechanical Vibrations", 6th Edition, New Age International Publishers, New Delhi, 1999.
3.	Ramaurthi, V., "Mechanical Vibration Practice and Noise Control", Narosa Book Distributors Pvt Ltd, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve and identify the frequency response of single degree of freedom system	Analyzing (K4)
CO2	solve and design vibration absorber for the two degrees of freedom system	Analyzing (K4)
CO3	analyze and understand the vibration measuring instruments and machine signature	Analyzing (K4)
CO4	analyze the noise related parameters	Analyzing (K4)
CO5	identify and analyze the sources of noise and control	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3			1								3
CO2	3	3	3			1								3
CO3	3	2				1				2				3
CO4	3	2				1				2				3
CO5	3	2				1				2				3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	15	40	30			100
CAT2	15	15	40	30			100
CAT3	15	15	40	30			100
ESE	15	15	40	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE11 – PRODUCTION TOOL DESIGN

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Material Removal Processes Production Technology Laboratory	7	PE	3	0	0	3

Preamble	This course covers the design principles of cutting tool materials, gauges, dies, jigs and fixtures employed for both conventional and numerically controlled machining processes.	
Unit - I	**Introduction to Tooling and Materials**	**9**
Introduction – Design Procedure – Drafting and Design Techniques. Tool Making Practices - Introduction of Tool Materials – Properties – Ferrous Tooling Materials – Cast Iron – Mild or Low Carbon Steel – Non Metallic Tooling Materials – Non Ferrous Tooling Materials - Heat Treatment – Factors Affecting Heat Treatment –Heat Treatment and Tool Design.		
Unit - II	**Design of Cutting Tool**	**9**
General Considerations of Tool Design – Design of Form Tools – Types of Form Tools – Circular form Tools – Profile Design – Geometrical Method – Analytical Method – Flat form Tool Design – Grinding the form Tool – Profile for a Tapered Surface – Tangential Type of form Tool – Design of Milling Cutter – Types of Milling Cutters – Profile Sharpened – form Relieved Milling Cutters – Design of Profile Sharpened Milling Cutters – Design of form Relieved Milling Cutters – Design of Broach – Gear Cutting Tools – Gear form Cutting Tools – Gear Generation Cutting Tools – Design of Gear Cutting Hob – Gear Shaper Tools - Thread Cutting Tools –Thread Cutting Dies – Thread Rolling Tools – Design of Thread Cutting Taps - Design of Reamer – Reamer Design – Length – Flutes – Rake Angle and Relief Angle – Grinding of Reamer.		
Unit - III	**Design of Drill Jigs and Fixtures**	**9**
Principles of Location – Locating Methods and Devices – Principles of Clamping – Drill Jigs – Chip Formation in Drilling – General Considerations in the Design of Drill Jigs – Drill Bushings – Methods of Construction – Drill Jigs and Modern Manufacturing. Fixtures and Economics – Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures		
Unit - IV	**Design of Gauges and Dies**	**9**
Introduction to Gauges – Fixed Gauges – Gauge Tolerances – The Selection of Material for Gauges – Indicating Gauges – Automatic Gauges – Gauge Design – Design of Limit Gauges - Types of Die Construction – Die-Design Fundamentals – Blanking and Piercing Die Construction – Pilots – Strippers and Pressure Pads- Presswork Materials – Strip Layout – Short-Run Tooling for Piercing – Bending Dies – Forming Dies – Drawing Operations.		
Unit - V	**Design of Fixtures for Numerically Controlled Machine**	**9**
The Need for Numerical Control – A Basic Explanation of Numeric Control – Numerical Control Systems in use Today – Fixture Design for Numerically Controlled Machine Tools – Cutting Tools for Numerical Control – Tool Holding Methods for Numerical Control – Automatic Tool Changers and Tool Positioners – Tool Presetting – Introduction – General Explanation of the Brown and Sharp Machine – Tooling for Automatic Screw Machines.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Donaldson Cyrll, LeCain H. George, Goold V.C., "Tool Design", 4th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2014.	I,III,IV,V
2.	B J Ranganath ,"Metal Cutting and Tool Design",2nd Edition, Vikas Publishing House Pvt., Ltd,, New Delhi,2011.	II

REFERENCES:

1.	E.J.H. Jones,"Production Engineering Jig and Tool Design", 8th Edition, The Butterworth Group, London,1972.
2.	Mikell P. Groover, "Fundamentals of Modern Manufacturing", 4th Edition John Wiley & Sons, Singapore, 2004.
3.	N K Mehta, Machine Tool Design and Numerical Control, 3rd Edition, ata McGraw-Hill Publishing Company Ltd., New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	implement the concepts and working principles of latest developments in tool design	Applying (K3)
CO2	determine the various design tool materials	Applying (K3)
CO3	summarize the design and development of drilling jigs and fixtures	Applying (K3)
CO4	design the gauges and select the dies for press working	Applying (K3)
CO5	describe the principles of numerically controlled machine tool	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3											3
CO2	3	3	3											3
CO3	3	3	3											3
CO4	3	3	3											3
CO5	3	3	3											3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	15	40	45				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE12 - MANUFACTURING INFORMATION SYSTEM

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology Production Technology Laboratory	7	PE	3	0	0	3

Preamble	The course provides the importance of databases and its application in manufacturing systems. In addition it explores on the organization conversant with order policies, data base terminologies, designing and manufacturing considerations.	
Unit - I	**Introduction to Evolution of Order Policies**	**9**
Introduction – Goals for Manufacturing-Evolution of Order Policies - from Material Requirement Planning (MRP) to Manufacturing Resource Planning (MRP II) - Role of Production Organization - Operation Control.		
Unit - II	**Database Concepts**	**9**
Data Modelling for Database-Records and Files - Abstraction and Data Integration - Three Level Architecture for Data Base Management System (DBMS)-Components of DBMS-Advantages and Disadvantages of DBMS.		
Unit - III	**Designing of Database**	**9**
Relationship Among Entities-Entity Relationship (ER) Diagram-Data Models-Relational - Network - Hierarchical - Relational Model – Concepts-Principles-Keys-Relational Operations-Functional Dependency-Normalization-Query languages.		
Unit - IV	**Manufacturing Consideration**	**9**
The product and its Structure-Inventory and Process Flow-Shop Floor Control-Data Structure and Procedure-Various Models - Order Scheduling Module-Input/Output Analysis Module (IOM) -Stock Status Database-Complete IOM Database.		
Unit - V	**Information System for Manufacturing**	**9**
Parts Oriented Production Information System – Concepts and Structure-Computerized Production Scheduling-Online Production Control Systems – Computerized Production Management System and Manufacturing Information Systems – Case Study.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Luca G. Sartori. , “Manufacturing Information Systems”, Addison Wesley Publishing Company, England, 1988.	I,IV,V
2.	Date C.J. “An Introduction to Database Systems”. 8th Edition, Addison Wesley, United States, 2003.	II,III

REFERENCES:

1.	Orlicky G. “Material Requirements Planning”. 3th Edition, McGraw-Hill, New York, 2011.	
2.	Kerr Roger M. “Knowledge Based Manufacturing Management: Applications of Artificial Intelligence to the Effective Management of Manufacturing Companies”. Addison Wesley, Boston, MA, 1991.	

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the evolution of order practices.	Understanding (K2)
CO2	report the concept of DBMS	Applying (K3)
CO3	illustrate the concept involved in designing of data base.	Applying (K3)
CO4	describe about shop floor control and inventory management in an organization.	Applying (K3)
CO5	describe the concept and parameters involved in computerized production planning and control.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3								3	3
CO2	3				3								3	3
CO3	3				3								3	3
CO4	3													3
CO5	3				3								2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	45	40				100
CAT2	10	40	50				100
CAT3	20	35	45				100
ESE	20	35	45				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE13 - GAS DYNAMICS AND JET PROPULSION

(Use of Gas Tables are permitted for the End Semester Examination)

Programme& Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics Thermal Engineering	7	PE	3	0	0	3

Preamble	This course deals with concepts of compressible fluid flow in variable and constant area ducts. The principles behind aircraft and space propulsion systems along with their performance calculations are covered through this course.	
Unit - I	**Fundamentals of Compressible Flow and Isentropic Flow through Variable Area Ducts**	**9**
Fundamentals of Compressible Flow: Adiabatic Energy and Momentum Equations for Compressible Fluid Flows - Stagnation State - Critical State - Mach Number - Reference Velocities - Various Regions of Flow - Mach Cone - Mach Angle - Effect of Mach Number on Compressibility. Isentropic Flow through Variable Area Ducts: T-s and h-s Diagrams for Nozzle and Diffuser - Area Ratio as a Function of Mach Number - Mass Flow Rate Through Nozzles and Diffusers.		
Unit - II	**Flow Through Constant Area Ducts**	**9**
Flow in Constant Area Ducts with Friction - Fanno Curves and Fanno Flow Equation - Variation of Flow Properties - Variation of Mach Number with Duct Length - Flow in Constant Area Ducts with Heat Transfer - Rayleigh Line and Rayleigh Flow Equation - Variation of Flow Properties - Maximum Heat Transfer.		
Unit - III	**Flow Across Shock**	**9**
Generation of Shock in Shock Tubes - Desirable and Undesirable Effects of Shock -Governing Equations of Normal Shock - Variation of Flow Parameters Across the Normal Shock - Prandtl Meyer Equation - Impossibility of Shock in Subsonic Flows - Strength of Shock Wave - Introduction to Oblique Shock.		
Unit - IV	**Aircraft Propulsion**	**9**
Types of Jet Engines - Energy Flow through Jet Engines - Study of Turbojet Engine Components – Diffuser – Compressor - Combustion Chamber - Turbine and Exhaust Systems - Performance of Turbo Jet Engines – Thrust - Thrust Power - Propulsive and Overall Efficiencies - Ram Jet and Pulse Jet Engines.		
Unit - V	**Rocket Propulsion**	**9**
Types of Rocket Engines - Solid Propellant Rocket - Liquid Propellant Rocket and Hybrid Rocket - Thrust Equation - Effective Jet Velocity - Specific Impulse - Rocket Engine Performance - Solid and Liquid Propellants - Comparison of Different Propulsion Systems - Stages of a Rocket during Course of Travel.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Yahya S.M. , "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", 6th Edition, New Age International Publishers, New Delhi, 2018.	I,II,III,IV,V

REFERENCES:

1.	Rathakrishnan E. , "Gas Dynamics", 7th Edition, Prentice Hall of India, Delhi, 2020.
2.	Ahmed F. El-Sayed. , "Fundamentals of Aircraft and Rocket Propulsion", 1st Edition, Springer, Spain, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basic terms involved in compressible fluid flow and jet propulsion	Understanding (K2)
CO2	analyze the compressible flow through variable area ducts and report the change in properties	Analyzing (K4)
CO3	examine the flow through constant area ducts and distinguish between Fanno and Rayleigh flows	Analyzing (K4)
CO4	evaluate the flow associated with normal shock and report the variation in properties	Analyzing (K4)
CO5	breakdown the elements of aircraft and rocket propulsion system and calculate the performance parameters of the engines	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3											3
CO2	3	3	3											3
CO3	3	3	3											3
CO4	3	3	3											3
CO5	3	3	3											3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	35	35			100
CAT2	10	20	40	30			100
CAT3	10	20	40	30			100
ESE	10	20	40	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE14 - REFRIGERATION AND AIR CONDITIONING

(Use of Approved Refrigeration and Air-Conditioning Data Book is permitted for Examination)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics Thermal Engineering	7	PE	3	0	0	3

Preamble	This course imparts knowledge on the working cycles of refrigeration and the processes involved in air-conditioning systems. The method of selection of refrigerants and usage of psychrometric charts are also covered through this course.	
Unit - I	**Review of Fundamentals and Refrigeration Cycles**	**9**
Review of Fundamentals: First and Second Laws of Thermodynamics - Heat Engines-Heat Pumps- Refrigeration Systems-COP-Condition for Maximum COP-Ton of Refrigeration. Refrigeration Cycles: Reverse Carnot Cycle -Bell Coleman Cycle- Ejector Refrigeration – Magnetic Refrigeration – Vortex and Pulse Tube Refrigeration.		
Unit - II	**Refrigeration Systems**	**9**
Vapor Compression Refrigeration Cycle- Superheating-Subcooling-Multistage-Multi Evaporator-Cascade System- Vapour Absorption Refrigeration System –Aqua Ammonia-LiBr Water Systems- COP Estimation of VAR System-Steam Jet Refrigeration-Thermoelectric Refrigeration-Thermionic Refrigeration and its Application.		
Unit - III	**Refrigerants and System Components**	**9**
Refrigerants: Refrigerants-Classification of Refrigerants-Refrigerant Properties- Environmental Impact- Montreal / Kyoto Protocols-Eco Friendly Refrigerants-GWP-ODP. Different Types of Refrigeration Tools-Charging Unit-Recovery Unit-Vacuum Pumps. System Components: Compressor-Types-Performance Characteristics of Reciprocating Compressors-Capacity Control-Types of Evaporators & Condensers and their Functional Aspects-Expansion Devices and their Behavior with Fluctuating Load-Methods of Defrosting.		
Unit - IV	**Psychrometry and Duct Design**	**9**
Psychrometry: Properties of Air-Psychrometric Processes - Sensible Cooling and Heating-Humidification and Dehumidification-Psychrometric Calculations for Simple Air Conditioning System. Duct Design: Dynamic and Frictional Pressure Drop in Ducts- Methods of Duct Design -Fan Total Pressure - Fan Characteristics in Duct Systems – Air Conditioning System Controls.		
Unit – V	**Air Conditioning System**	**9**
Requirements of Comfort Air Conditioning - Summer-Winter Air Conditioning-Working Principles -Centralized Air Conditioning Systems-Air Handling Unit-Split - Ductable Split-Transport Air Conditioning Systems - Indoor Air Quality-Heating-Cooling Load Calculations-Summer & Winter-Energy Efficiency Ratio (EER) Calculations.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Arora C.P. , "Refrigeration and Air Conditioning", 4th Edition, Tata McGraw Hill, New Delhi, 2008.	I,II,III,IV,V

REFERENCES:

1.	Prasad Manohar., "Refrigeration and Air Conditioning", 3rd Edition, New Age International Pvt. Ltd, New Delhi, 2014.
2.	Roy J. Dossat. , "Principles of Refrigeration", 4th Edition, Pearson Education Asia, New Delhi, 2009.
3.	Hundy G. F, Trott A. R. &Welch. T.C., "Refrigeration and Air Conditioning", 4th Edition, Butterworth- Heinemann, England, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the thermodynamic refrigeration cycles.	Analyzing (K4)
CO2	illustrate the working of refrigeration systems with their practical applications.	Applying (K3)
CO3	analyze the characteristics of refrigerants and explain the functions of refrigeration system components	Analyzing (K4)
CO4	perform calculations for psychrometric applications using Psychrometry chart	Applying (K3)
CO5	appraise cooling load calculation for air-conditioning system and also design the air-conditioning system	Analyzing (K4)

Mapping of COs with POs and PSOs														
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3												1
CO2	3	3												1
CO3	3	3				1	1							1
CO4	3	3												1
CO5	3	3												1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30			100
CAT2	10	20	40	30			100
CAT3	10	20	40	30			100
ESE	10	20	40	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE15 - SUPPLY CHAIN MANAGEMENT

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	The course provides insight on the fundamentals, tools and techniques of supply chain and logistic networks	
Unit - I	**Introduction**	**9**
Role of Logistics and Supply Chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply Chain Strategies – Drivers of Supply Chain Performance and Obstacles.		
Unit - II	**Supply Chain Network Design**	**9**
Role of Distribution in Supply Chain – Factors Influencing Distribution Network Design – Design Options for Distribution Network Distribution Network in Practice-Role of Network Design in Supply Chain – Framework for Network Decisions.		
Unit - III	**Logistics In Supply Chain**	**9**
Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation.		
Unit - IV	**Sourcing and Coordination In Supply Chain**	**9**
Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.		
Unit - V	**Supply chain and Information Technology (IT)**	**9**
The role IT in supply chain- The supply chain IT frame work - Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and Operation", Pearson Education, 7 th edition 2018.	I,II,III,IV,V

REFERENCES:

1.	Simchi – Levi Davi, "Designing and Managing the Supply Chain", Tata McGraw Hill Publishing Company Ltd, New Delhi, 3rd edition 2019.
2.	V.V.Sople, "Supply Chain Management, text and cases", Pearson Education South Asia,2012
3.	Srinivasan, G, "Quantitative Models in Operations and Supply Chain Management", Prentice Hall India Pvt Limited, India, 2018

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the building blocks, functions and drivers of supply chain management	Understand (K2)
CO2	summarize the factors involved in network design	Understand (K2)
CO3	construct the role of logistics in industrial supply chain	Applying (K3)
CO4	interpret the role of coordination in supply chain	Understand (K2)
CO5	contrast the necessity of IT in different cases of supply chain	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3		3					1			3	2
CO2	3	2	3		3					1			3	2
CO3	3	2	3		3					1			3	2
CO4	3	2	3		3					1			3	2
CO5	3	2	3		3					1			3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	45	55					100
CAT2	30	35	35				100
CAT3	30	35	35				100
ESE	30	35	35				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE16 – LEAN SIX SIGMA

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	This course delivers the implementation concept of lean, six sigma, project selection, process toolsand design tools in industries.	
Unit - I	**Introduction to Lean and Six Sigma**	**9**
Definition-Purpose, Features of lean, Top seven wastes and Need for lean management. The philosophy of lean management - Creating a lean enterprise, Elements of lean, Lean principles, Lean metric and Hidden time traps. Introduction to quality - Definition of six sigma, Origin,Concept and Critical success factors for six sigma.		
Unit - II	**Integration of Lean and Six Sigma**	**9**
Evolution, synergy, definition, principles, scope and features of Lean Six Sigma (LSS). Laws of LSS - Elements of LSS - LSS model and benefits of LSS. Initiation - Top management commitment – Infrastructure and deployment planning, Process focus, Organizational structures. Measures – Rewards and Recognition, Infrastructure tools and Structure of transforming.		
Unit - III	**Project Selection and Team Building**	**9**
Resource and project selection, Selection of black belts, Training of black belts and Champions and Identification of potential projects. Top down (Balanced score card) and bottom up approach – Methods of selecting projects - Benefit/effort graph, Process mapping, Value stream mapping, Predicting and Improving team performance, Nine team roles and Team leadership.		
Unit - IV	**Design Measure Analyze Improve Control (DMAIC) Process and Tools**	**9**
The DMAIC process - Toll gate reviews. The DMAIC tools - Project definition form and SIPOC diagram. Measure tools-Process mapping, Lead time/cycle time, Cause and effect matrix. Generating and organizing tools- Brainstorming, Nominal group technique and Multi-voting. Data collection and accuracy tools- Check sheet, Gage Repeatability and Reproducibility-Understanding and Eliminating variation - run charts. Analyze tools - scatter plots, ANOVA, Regression analysis and Time trap analysis.		
Unit - V	**Institutionalizing and Design for Six Sigma**	**9**
Institutionalizing lean six sigma – Improving design velocity, Creating cycle time base line, Valuing projects, Gating the projects, Reducing product line complexity. Design for lean six sigma -Quality Function Deployment(QFD), Theory of Inventive Problem solving (TRIZ), Robust Design-Case study presentations.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Michael L. George, “Lean Six Sigma”, 5th Edition, McGraw-Hill., Europe, 2002.	I,II,III,IV,V

REFERENCES:

1.	Salman Taghizadegan, “Essentials of Lean Six Sigma”, 4th Edition Elsevier, 2010.
2.	Matthew John Franchetti, "Lean Six Sigma for Engineers and Managers: With Applied Case Studies", 1st Edition, CRC Press, 2021.
3.	Erick Jones, "Quality Management for Organizations Using Lean Six Sigma Techniques", 1st Edition, CRC Press, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	rephrase the concept of lean six sigma and its significance in industry.	Understanding (K2)
CO2	interpret the various laws of lean six sigma	Understanding (K2)
CO3	construct the concepts of team building	Applying (K3)
CO4	categorize the lean six sigma tools and its importance in industry	Analyzing (K4)
CO5	examine productivity improvement tool through the six sigma principles.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3	3				3			3	3	3
CO2	3	3		3	3				3			3	3	3
CO3	3	3		3	3				3			3	3	3
CO4	3	3		3	3				3			3	3	3
CO5	3	3		3	3				3			3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	45	55					100
CAT2	25	35	40				100
CAT3	15	20	30	35			100
ESE	20	20	35	25			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE17 - FUNDAMENTALS OF RESEARCH

Programme& Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course familiarize the fundamental concepts/techniques adopted in research, problem formulation and also disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit - I	**Introduction to Research**	**9**
Types and Process of Research - Outcome of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords.		
Unit - II	**Literature Review**	**9**
Literature Collection - Methods - Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit - III	**Research Methodology**	**9**
Appropriate Choice of Algorithms/Methodologies/Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations. Data analysis, Design of Experiments, Experimental skills, Safety in Laboratory.		
Unit - IV	**Journals and Papers**	**9**
Journals in Science/Engineering - Indexing and Impact factor of Journals. Plagiarism and Research Ethics. Intellectual property. Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study – Systematic Approach to Prepare Review / Research papers.		
Unit - V	**Reports and Presentations**	**9**
How to Write a Report - Language and Style - Format of Project Report - Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc. - Different Reference Formats. Presentation using PPTs. Research Tools.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Walliman, Nicholas. “Research Methods: The basics”. Routledge, 2017.	I,II,III,IV,V

REFERENCES:

1.	Melville S, Goddard W. “Research Methodology: An Introduction For Science and Engineering Students”. Kenwyn: Juta & Co Ltd., 1996.
2.	Kumar, Ranjit. “Research Methodology: A step-by-step guide for beginners”. SAGE Publications Limited, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	list the various stages in research and categorize the quality of research problem	Analyzing (K4)
CO2	formulate a research problem from published literature/journal papers	Analyzing (K4)
CO3	select appropriate research method for a defined problem	Applying (K3)
CO4	prepare review / research paper, select suitable journal and submit a paper.	Applying (K3)
CO5	prepare research report and presentation	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	3	3			3		3		2	3	3
CO2	2	3	1	3	3			3		3		2	3	3
CO3	2	3	1	3	3			3		3		2	3	3
CO4	2	3	1	3	3			3		3		2	3	3
CO5	2	3	1	3	3			3		3		2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		40	35	25			100
CAT2		50	50				100
CAT3		50	50				100
ESE		40	40	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE18 - PIPING DESIGN

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Materials and Metallurgy Strength of Materials	7	PE	3	0	0	3

Preamble	This course imparts the fundamentals of piping design involving various piping components and layouts with respect to industry requirements	
Unit - I	**Introduction to Piping and Classification of Pipes**	**9**
Introduction to Piping: Evolution of Piping – Piping and Pipeline Codes – ASME B31 Codes – Boiler and Pressure Vessel Codes – ASME B16 Standards – API Standards and Recommended Practices. Classification of Pipes: Process – Line – Structural – Manufacturing Methods.		
Unit - II	**Piping Materials**	**9**
Ferrous Pipe – Non-ferrous Pipe – Fabrication of Steel Pipe – Fabrication of Pipe Fittings and Components – Mechanical Properties – Procurement		
Unit - III	**Pressure Design for Piping**	**9**
Thin Wall Approximation – Pipeline Design Equation – Pressure Design of Plant Piping – Yield and Burst Pressure – Pressure Rating – High Pressure Design – Design Pressure – Buckling Pressure		
Unit - IV	**Basic Piping Components and Equipment**	**9**
Basic Piping Components: Fittings – Elbows – Weld Tee – Couplings – Reducers – Cap – Flanged Fittings and use of Fittings. Flanges: Types – P-T Ratings – Facings. Major Valves: Types – Operations – Applicability – Gaskets – Bolts and Nuts. Piping Equipment: Horizontal Vessels/Accumulators – Fractionating Columns – Pumps – Heat Exchangers – Re-boiler – Heaters/Boilers – Tanks – Cooling Towers.		
Unit - V	**Piping Layouts and Pipe Ways**	**9**
Piping Layouts: Spacing of Pipe Supports – Design Standards – Selection of Pipe Supports – Design of Support – Design of Steel Frames – Anchorage to Concrete – Layout Rules for Good Practice. Pipe Ways: Types – Trenched Piping – Underground Piping – Subsea Pipelines – Welding of Pipe.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Sahu G. K., "Handbook of Piping Design", 2nd Edition, New Age International Publishers, New Delhi, 2008.	I,II,III
2.	George A. Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair", 1st Edition, CRC Press, New York, 2003	IV,V

REFERENCES:

1.	Rudomino B., "Steam Power Plant Piping Design", 1st Edition, MIR Publishers, Moscow, 1979.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify and apply standard codes during piping practice	Applying (K3)
CO2	choose suitable pipe material for a given application environment	Applying (K3)
CO3	employ an appropriate pipe design for desired working pressure needs	Applying (K3)
CO4	illustrate various pipe fittings and piping equipment used in industries	Applying (K3)
CO5	prepare pipe layouts and explain various pipe ways	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	1										3
CO2	3	2	2	1										3
CO3	3	2	2	1										3
CO4	3	2	2	1										3
CO5	3	2	2	1										3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE19 - DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology Strength of Materials Design of Machine Elements	7	PE	3	0	0	3

Preamble	This course provides the fundamental aspects of various types of work holding devices and designing of jigs, fixtures, press, strip layouts, dies for industrial applications.	
Unit - I	**Introduction to Jigs and Fixture**	**9**
Tool Design Objectives - Production Devices –Inspection Devices- Materials used in Jigs and Fixtures – Types of Jigs - Types of Fixtures – Mechanical - Pneumatic Actuation - Hydraulic Actuation- Analysis of Clamping Force- Tolerance and Error Analysis.		
Unit - II	**Jigs**	**9**
Drill Bushes - Different Types of Jigs-Plate Latch- Channel- Box- Post- Angle Plate- Angular Post- Turnover- Pot Jigs Automatic Drill Jigs-Rack and Pinion Operated- Air Operated Jig Components- Design of Jigs.		
Unit - III	**Fixtures**	**9**
General Principles - Boring- Lathe- Milling and Broaching Fixtures- Grinding- Planning and Shaping Fixtures Assembly- Inspection and Welding fixtures- Modular Fixtures-Design of Fixtures		
Unit - IV	**Press Working Terminologies and Elements of Press**	**9**
Press Working Terminology: Presses and Press Accessories-Computation of Capacities and Tonnage Requirements. Elements of Press: Progressive- Combination and Compound- Die Block-Die Shoe- Bolster Plate-Punch Plate – Punch Holder-Guide Pins – Bushes- strippers – Knockouts-Stops –Pilots-Selection of Standard Die sets-Strip Layout Calculations.		
Unit – V	**Design of Dies**	**9**
Design of Progressive and Compound Dies – Blanking and Piercing Operations- Bending Dies Design –Forming and Drawing Die Design-Design of Drawing Dies. Design Considerations: Forging- Extrusion- Casting-Plastic Dies.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Edward G. Hoffman, “Jigs & Fixture Design”, 5th Edition, Thomson-Delmar Learning, Singapore, 2004.	I , II
2.	Elanchezhian.C., Sunder Selwyn.T., Vijaya Ramnath. B., “Design of Jigs, Fixtures and Press Tools”, 1st Edition, Eswar Press, Chennai, 2004.	III,IV ,V

REFERENCES:

1.	Donaldson C, George H. Lecain, Joyjeet Ghose, Goold V.C, "Tool Design", 4th Edition, Tata McGraw-Hill, New Delhi, 2010.
2.	Joshi P.H., "Jigs & Fixtures", 3rd Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2012.
3.	Kempster, "Jigs & Fixtures Design", 5th Edition, Cengage India, Uttar Pradesh, India, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the fundamentals of various work holding devices and analyze the related forces	Applying (K3)
CO2	identify and design the jigs for various components.	Analyzing (K4)
CO3	identify and design the fixtures for various components.	Analyzing (K4)
CO4	demonstrate the function of various parts of dies and design the strip layout for various press works.	Analyzing (K4)
CO5	design and select the various types of dies.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1											3
CO2	2	2	3	2										3
CO3	2	2	3	2										3
CO4	2	2	3	2										3
CO5	2	2	3	2										3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	15	40	30			100
CAT2	15	15	40	30			100
CAT3	15	15	40	30			100
ESE	15	15	40	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE20 - FUELS AND COMBUSTION TECHNOLOGY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics	7	PE	3	0	0	3

Preamble	This course provides an overview of various fuel properties and their composition. It also describes combustion thermodynamics, sources of pollution and their controlling measures.	
Unit - I	**Fuel Characteristics**	**9**
Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels - Fuels Analysis- Proximate and Ultimate Analysis - Moisture Determination - Calorific Value - Gross and Net Calorific Values - Calorimetry - DuLong's Formula for Calorific Value Estimation - Flue Gas Analysis - Orsat Apparatus - Adiabatic Flame Temperature.		
Unit - II	**Solid Fuels and Liquid Fuels**	**9**
Solid Fuels: Wood and Wood charcoal-Origin of Coal- Composition of Coal - Analysis and Properties of different Grades of Coal-Preparation and Storage of Coal-Coal washing - Briquetting. Liquid Fuels: Origin of Petroleum Fuels-Production -Composition-Petroleum Refining- Various Grades of Petro-Products-Properties and Testing - Gasification of Liquid Fuels.		
Unit – III	**Gaseous Fuels**	**9**
Classification - Composition and Properties – Fractional Distillation – Gas Calorimeter- Rich and Lean Natural gases and LPG - Producer gas - Water gas – Hydrogen – Acetylene.		
Unit – IV	**Stoichiometry and Kinetics**	**9**
Stoichiometry: Mass Basis and Volume Basis - Excess Air Calculation - Fuel and Flue Gas Compositions - Calculations - Rapid Methods. Kinetics: Combustion Processes -Stationary Flame - Flameless Combustion - Submerged Combustion- Mechanism of Combustion - Ignition and Ignition Energy - Spontaneous Combustion - Flame Propagation.		
Unit - V	**Air Pollution**	**9**
Types- Combustion Generated Air Pollution - Effects of Air Pollution - Fossil Fuel Generated Pollution and its Control - Automobiles Generated Pollution and Power Plants Generated Pollution and its Control.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Samir Sarkar., "Fuels & Combustion", 3rd Edition, CRC Press, India, 2010.	I,II,III,IV,V

REFERENCES:

1.	Mishra D.P., "Fundamentals of Combustion", 1st Edition, PHI Learning Pvt Ltd, India, 2010.
2.	Bhatt B.I, Thakore S.B., "Stoichiometry", 5th Edition, Tata McGraw Hill Education Private Ltd, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	characterize the fuels using standard methods	Analyzing (K4)
CO2	interpret the composition and their properties of solid & liquid fuels	Applying (K3)
CO3	illustrate the composition of various gaseous fuels & their properties	Applying (K3)
CO4	describe the stoichiometry and kinetics of combustion	Analyzing (K4)
CO5	recognize the various possible pollutants from fossil fuels and its control methods	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												3
CO2	3	2												3
CO3	3	2												3
CO4	3	2												3
CO5	3					1								3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	25	40	25			100
CAT2	20	40	40				100
CAT3	20	40	30	10			100
ESE	20	30	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE21 - COMPUTATIONAL FLUID DYNAMICS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fluid Mechanics and Hydraulic Machines, Heat and Mass Transfer	7	PE	3	0	0	3

Preamble	This course deals with the application of numerical methods in solving fluid flow and heat transfer problems. Grid generation techniques and turbulence models are covered extensively through this course.	
Unit - I	**Governing Equations and Boundary Conditions**	**9**
Governing Equations: Basics of Computational Fluid Dynamics – Governing Equations – Continuity - Momentum and Energy Equations – General Transport Equation. Boundary Conditions: Physical Boundary Conditions – Discretization – Mathematical Behavior of PDEs on CFD –Elliptic - Parabolic - Hyperbolic Equations.		
Unit - II	**Finite Difference Method**	**9**
Finite Difference Method – Taylors Series – Forward - Central - Backward Differences – Explicit Method – Implicit Method – Tridiagonal Matrix-Application of the TDMA to Two-Dimensional Problems– ADI Method –Solution Methodology for Parabolic and Elliptic Equations – Errors.		
Unit – III	**Finite Volume Method**	**9**
Finite Volume Formulation for Steady-State – One and Two - Dimensional Diffusion Problems –Parabolic Equations – Explicit - Implicit Schemes - Unsteady Heat Conduction on Elliptic and Parabolic Equations - Steady State One-Dimensional Convection and Diffusion problems – Central - Upwind Differencing Schemes- Hybrid - Power-Law - QUICK Schemes –Properties of Discretization Schemes.		
Unit – IV	**Grids**	**9**
Types of Grid – Grid Generation – Grid Transformation – Calculation of Flow Field Variable – Staggered Grid – Pressure and Velocity Correction – SIMPLE Algorithm – SIMPLER Algorithm - SIMPLEC Algorithm – PISO Algorithm..		
Unit - V	**Turbulence Models**	**9**
Turbulence – Effect of Turbulence on Time Averaged Navier Stokes Equation – Characteristics of Simple Turbulent Flow – Flat Plate Boundary Layer – Pipe Flow – Turbulence Models – Mixing Length Model – K-ε Models – Reynolds Stress Equation Model – Algebraic Stress Model.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Versteeg H. K. & Malalasekera W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd Edition, Pearson Education Ltd., UK, 2007.	I,II,III,IV,V

REFERENCES:

1.	Anderson John D., "Computational Fluid Dynamics: Basic with Applications", 1st Edition, Tata McGraw-Hill, India, 2012.
2.	Ghoshdastidar P. S., "Computational Fluid Dynamics and Heat Transfer", 1st Edition, Cengage Learning India Pvt. Ltd., Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	derive the governing equations and use the boundary conditions for fluid dynamic problems.	Applying(K3)
CO2	apply finite difference methods to solve the one dimensional and two dimensional problems.	Applying (K3)
CO3	formulate the finite volume equations for convection diffusion problems	Applying(K3)
CO4	perform the grid generation and grid transformation operations and calculate the flow field variables.	Applying (K3)
CO5	recognize the characteristics of turbulence models and apply the models to physical problems.	Applying(K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2										2		2
CO2	3	3												2
CO3	3	3	2		2								3	2
CO4	3	2	2		2								3	2
CO5	3	2	2		2							1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE22 - CNC TECHNOLOGY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Material Removal Processes	7	PE	3	0	0	3

Preamble	The course focus on Computer Numerical Control (CNC) machines and tools with automation processes in manufacturing industry, considerable improvements in consistency, error free and quality of machine components.	
Unit - I	**Basic Concepts of Metal Cutting and CNC Machines**	**9**
Introduction – Mechanics of Chip Formation-Mechanics of Oblique Cutting - Cutting Forces and Power- Tool Life – Surface Finish-Machinability. Classification – Construction Details- Structure- Configuration of CNC System – Interfacing – Monitoring – Diagnostics – Machine Data – Compensations for Machine Accuracy – Direct Numerical Control (DNC) Machine – Adaptive Control CNC Systems.		
Unit - II	**Drives and Controls**	**9**
Drive Mechanism- Gearbox- Spindle Drives- Axes Drives - Magnetic Levitation and Linear Motors- Timing Belts and Pulleys- Spindle Bearing – Arrangement and Installation- Slide Ways- Re-Circulating Ball Screws – Backlash Measurement and Compensation- Linear Motion Guide Ways.		
Unit - III	**Part Programming of CNC Machines**	**9**
Part Program Terminology - G And M Codes – Types of Interpolation- CNC Part Programming – Manual Part Programming (Turning And Milling) - Various Programming Techniques – Automatically Programmed Tool (APT) Programming for Various Machines in ISO And FANUC - CAM Packages for CNC Machines.		
Unit - IV	**Tooling For CNC Machines**	**9**
Interchangeable Tooling System – Preset and Qualified Tools – Coolant Feed Tooling System – Modular Fixturing – Quick Change Tooling System – Automatic Head Changers – Tooling Requirements for Turning and Machining Centers – Tool Holders – Tool Assemblies – Tool Magazines – Automatic Tool Changer (ATC) Mechanisms – Automatic Pallet Changer Tool Management- Principles of Location- Clamping and Work Holding Devices.		
Unit - V	**Economics of CNC Machines and Retrofitting**	**9**
Factors Influencing Selection of CNC Machines – Cost of Operation of CNC Machines – Practical Aspects of Introducing CNC Machines in Industries – Maintenance Features of CNC Machines – Preventive Maintenance- Other Maintenance Requirements- Retrofitting - Necessary for Retrofitting - Advantages.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Kalpakjian S. and Schmid S.R., "Manufacturing Engineering and Technology", 7th Edition, Pearson Education India, New Delhi, 2018.	I
2.	Radhakrishnan P, "Computer Numerical Control Machines", 1st Edition, New Central Book Agency, Kolkata, 2013.	I,II,III,IV,V

REFERENCES:

1.	HMT Limited, "Mechatronics", 1st Edition, Tata McGraw-Hill, New Delhi, 2000.
2.	Thyer G.E, "Computer Numeric Control of Machine Tools", 2nd Edition, Butterworth- Heinemann, Burlington, 1991.
3.	Adithan M. and Pabla B.S., "CNC Machines", 3rd Edition, New Age International Pvt. Ltd., New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	estimate the parameters of metal cutting and comprehend the basic components involved in a CNC system	Applying (K3)
CO2	choose the appropriate drives and controls for CNC machines	Understanding (K2)
CO3	develop part programming for various machining process	Applying (K3)
CO4	select various tooling systems and fixtures for CNC machines	Understanding (K2)
CO5	compute operation and maintenance cost of CNC machines	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3							3				3
CO2	3	3	3							3				3
CO3	3	3	3							3				3
CO4	3	3	3							3				3
CO5	3	3	3							3				3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	40	30				100
CAT2	30	30	40				100
CAT3	30	40	30				100
ESE	30	30	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE23 - PRECISION ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Material Removal Processes Metrology and Measurement	7	PE	3	0	0	3

Preamble	This course deals with precision manufacturing, micro machining and fundamental design requirements of precision machine tools. It also provides insights on machine surface characteristics and error detection methods.	
Unit - I	**Precision Manufacturing**	**9**
Introduction - Need for Precision Manufacturing - Taniguchi Diagram - Four Classes of Achievable Machining Accuracy – Normal Precision - High-Precision - Ultra-Precision Processes and Nanotechnology.		
Unit - II	**Precision Machining and Unconventional Micromachining Techniques**	**9**
Overview of Micro and Nano Machining - Conventional Micro Machining Techniques - Micro-Turning - Micro-Milling - Micro-Grinding - Ultra-Precision Diamond Turning. Unconventional Micromachining Techniques: Abrasive Jet and Water Jet Micromachining - Ultrasonic Micromachining - Micro Electrical Discharge Machining - Photochemical Machining - Electro Chemical Micromachining - Laser Beam Micromachining - Electron Beam Micromachining - Focused Ion Beam Micromachining.		
Unit - III	**Machine Design For Precision Manufacturing**	**9**
Philosophy of Precision Machine Design - Ultra-Precision Machine Elements: Guide Ways - Drive Systems - Friction Drive - Linear Motor Drive - Spindle Drive. Bearings: Principle - Construction and Application of Rolling - Hydrodynamic and Hydrostatic Bearings - Aerostatic Bearings - Magnetic Bearings.		
Unit - IV	**Mechanical and Thermal Errors**	**9**
Sources of Error - Principles of Measurement - Errors Due to Machine Elements – Bearings – Spindles - Kinematic Design - Structural Compliance – Vibration - Thermal Effects - Environmental Control of Precision Machinery. Error Mapping and Error Budgets.		
Unit - V	**Dimensional Metrology for Micro Machining**	**9**
Machine Vision - Laser Tracking Systems - Laser Scanners, White Light Interference 3D Microscopes - Focus-Based Optical Metrology- Fringe Projection Method - Measurement of Typical Nano Features. Surface Metrology: 3D Surface Topography – Need - Measurement – Chromatic Confocal Microscopy – Interferometer - Non-Optical Scanning Microscopy – Scanning Electron Microscopes - Scanning Probe Microscopes - Parameters for Characterizing 3D Surface Topography.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Jain V.K., "Micro-manufacturing Processes", 1st Edition, CRC Press, Taylor and Francis Group, 2012.	I, V
2.	David Dornfeld, Dae-Eun Lee, "Precision Manufacturing", 1st Edition, Springer Boston,2008.	II, III, IV

REFERENCES:

1.	Venktesh V.C., SudinIzman., "Precision Engineering", 2nd Edition, Tata McGraw-Hill, New Delhi, 2007.
2.	Jain V.K., "Introduction to Micromachining", 2nd Edition, Narosa Publishers, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the concepts of precision engineering and machining accuracy	Understanding (K2)
CO2	demonstrate the working principle of different precision machining process.	Applying (K3)
CO3	choose the basic design requirements for the construction of precision machine tools.	Applying (K3)
CO4	identify various errors affecting the accuracy of precision manufacturing	Applying (K3)
CO5	apply a suitable measurement technique to measure and characterize the features of precision machined components.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3									1				3
CO2	3									1		1		3
CO3	1	2	3							1				2
CO4	1	3	2							1				2
CO5	2	1	3							1				3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	50	25				100
CAT2	25	25	50				100
CAT3	25	25	50				100
ESE	25	30	45				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

21MEE24 - TOTAL QUALITY MANAGEMENT

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	This course deals with quality concepts and Total Quality Management (TQM) principles focusing on process quality to assure product quality to the customers. It also deals with the basic and modern quality management tools including ISO standards	
Unit - I	**Quality Concepts and Principles**	**9**
Definition of Quality, Dimensions of Quality, Quality Planning, Quality Assurance and Control, Quality Costs With Case Studies, Elements/Principles of TQM - Historical Review, Leadership-Qualities/Habits, Quality Council, Quality Statements, Strategic Planning – Importance - Case Studies, Deming Philosophy, Barriers to TQM Implementation.		
Unit - II	**TQM-Principles and Strategies**	**9**
Customer Satisfaction –Customer Perception of Quality - Customer Complaints - Customer Retention, Employee Involvement – Motivation - Empowerment - Teams - Recognition and Reward- Performance Appraisal, Continuous Process Improvement –Juran's Trilogy - PDSA Cycle - 5S – Kaizen, Supplier Partnership – Partnering - Sourcing - Supplier Selection - Supplier Rating - Relationship Development, Performance Measures-Purpose- Methods-Cases.		
Unit - III	**Control Charts for Process Control**	**9**
Basic Seven Tools of Quality and its Role in Quality Control, Statistical Fundamentals –Measures of Central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for Variables and Attributes - Process Capability- Case Study- Introduction to Six Sigma.		
Unit - IV	**TQM-Modern Tools:**	**9**
New Seven Tools of Quality, Benchmarking-Need - Types and Process, Quality Function Deployment-House Of Quality (HOQ) Construction - Case Studies, Introduction to Taguchi's Robust Design-Quality Loss Function – Design of Experiments (DOE), Total Productive Maintenance (TPM)-Uptime Enhancement, Failure Mode and Effect Analysis(FMEA)-Risk Priority Number (RPN) - Process - Case Studies.		
Unit - V	**Quality Systems**	**9**
Need For ISO 9000 and Other Quality Systems - ISO 9000 : 2015 Quality System –Elements - Implementation of Quality System - Documentation - Quality Auditing, Introduction to ISO 14000- IATF 16949 - TL 9000-IEC 17025 - ISO 18000 - ISO 20000 - ISO 22000. Process of Implementing ISO - Barriers in TQM Implementation.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, Urdhwareshe Rashmi. "Total Quality Management", 5th Edition, Pearson Education, Noida, 2018.	I,II,III,IV,V

REFERENCES:

1.	Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education, New Delhi, 2017.
2.	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, Cengage Learning, 2012.
3	David Goetsch & Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", 8th Edition, Pearson, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the evolution of TQM principles.	Applying (K3)
CO2	illustrate the principles and strategies of TQM	Applying (K3)
CO3	make use of various tools and techniques of quality management	Analyzing (K4)
CO4	apply various quality tools and techniques in both manufacturing and service industry	Applying (K3)
CO5	explain the concepts of quality management system and ISO.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1				2	2	3	2	2	1	1		3
CO2	1	1				3	2	3	3	3	1	1	2	3
CO3	3	2	2	2	2	2		1	2	2	1	1	1	3
CO4	2	2	2	2	2	2		1	2	2	1	1	2	3
CO5						3	3	2	3	2	1	1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	45	30				100
CAT2	20	30	30	20			100
CAT3	25	45	30				100
ESE	20	30	35	15			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE25 - PROJECT MANAGEMENT

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	This course provides market analysis, financial analysis and systems approach in industrial case study projects. It provides different industrial management techniques for various applications.	
Unit - I	**Introduction**	**9**
An Overview – Types - Characteristics of Projects – Project Life Cycle- Identification of Investment Opportunities - Screening and Selection-Project Appraisal.		
Unit - II	**Market and Demand Analysis**	**9**
Market Survey-Demand Forecasting Methods-Technical Analysis – Manufacturing Process - Materials-Product Mix-Plant Location-Project Charts and Layouts.		
Unit - III	**Financial Management**	**9**
Budgeting Techniques - Net Present Value- Profitability Index Internal Rate of Return- Payback Period- Accounting Rate of Return.		
Unit - IV	**Mathematical Techniques for Project Management**	**9**
Mathematical Techniques for Project evaluation – Linear Programming - Goal Programming - Network Technique for Project Management – CPM - PERT- Multiple Projects and Constraints- Scheduling.		
Unit - V	**Project Implementation**	**9**
Organization Systems for Project Implementation- Work Breakdown-Coordination and Control- Project Management Software.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Prasanna Chandra, "Projects – Planning, Analysis, Financing, Implementation and Review", 9th Edition, Tata McGraw Hill, New Delhi, 2019.	I,II,III,IV,V

REFERENCES:

1.	Choudhury S,"Project Management". 32nd reprint, Tata McGraw Hill Education Private Limited, India, 2009.
2.	Mike Field & Laurie Keller, "Project Management", 3rd Edition, Thompson Business Press, Washington, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	discuss the importance of projects in society	Understanding (K2)
CO2	describe the market - demand analysis and Technical analysis of projects	Understanding (K2)
CO3	perform financial analysis of projects	Applying (K3)
CO4	evaluate the project using mathematical tools	Analyzing (K4)
CO5	categorise the different phases of project implementation	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			3			1			3		3	3
CO2	3	3			3						3		3	3
CO3	3	3			3						3		3	3
CO4	3	3			3						3		3	3
CO5	3	2			3						3		3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50					100
CAT2	25	25	50				100
CAT3	20	20	30	30			100
ESE	20	25	35	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE26 - MECHANICS OF COMPOSITE MATERIALS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics Engineering Materials and Metallurgy Strength of Materials	7	PE	3	0	0	3

Preamble	This course involves the basic concept, manufacturing, characterization and design of composite materials for various static and dynamic applications.	
Unit - I	**Basics of Fibers, Matrices and Composites**	**9**
Basics of Fibers: Definition – Need – General Characteristics and Applications. Fibers: Glass- Carbon- Ceramic-Aramid-Polymer and Natural Fibers. Matrices: Polymer- Ceramic and Metal Matrices – Characteristics of Fibers and Matrices- Fiber Surface Treatments- Fillers and Additives.		
Unit - II	**Composite Manufacturing**	**9**
Hand Layup – Spray up - Bag Molding – Compression Molding – Pultrusion – Filament Winding –Resin Film Infusion - Elastic Reservoir Molding - Tube Rolling – Quality Inspection Methods- Processing of Metal Matrix Composites (MMC) – Diffusion Bonding – Stir Casting – Squeeze Casting and Powder Metallurgy Technique.		
Unit - III	**Composite Performance and Analysis**	**9**
Static Mechanical Properties – Dynamics Mechanical Analysis–Thermogravimetric Analysis- Fatigue and Impact Properties – Environmental Effects – Long Term Properties -Service Life Predication- Fracture Behavior and Damage Tolerance.		
Unit - IV	**Composite Mechanics**	**9**
Fiber Content - Density and Void Content- Rule of Mixture -Volume and Mass Fractions - Evaluation of Four Elastic Moduli Based on Strength of Materials Approach and Semi-Empirical Model-Longitudinal Young's Modulus-Transverse Young's Modulus–Major Poisson's Ratio-in-Plane Shear Modulus- Ultimate Strengths of a Unidirectional Lamina- Characteristics of Fiber-Reinforced Lamina–Laminates–Lamination Theory.		
Unit - V	**Design of Composites**	**9**
Failure Predictions - Theories of Failure - Laminate Design Consideration - Design Criteria - Design Allowable - Design Guidelines - Joint Design-Bolted and Bonded Joints - Design Examples-Design of a Tension Member – Design of a Compression Member –Design of a Beam-Design of a Torsional Member - Application of Finite Element Method (FEM) for Design and Analysis of Laminated Composites.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Mallick P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", 3rd Edition, CRC Press Taylor and Francis, New York, 2007.	I,II,III,IV,V

REFERENCES:

1.	Autar K. Kaw, "Mechanics of Composite Materials", 2nd Edition, CRC Press, New York, 2006.
2.	Bhagwan D. Agarwal, Lawrence J. Broutman & Chandrashekhar K., "Analysis and Performance of Fiber Composites", 4th Edition, John Wiley & Sons, New York, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the fundamentals of fibers, matrices, additives and composites	Applying (K3)
CO2	describe the various manufacturing processes involved in the fabrication of composite material.	Applying (K3)
CO3	evaluate the performance of composite materials.	Applying (K3)
CO4	calculate the physio-mechanical properties of composite materials.	Applying (K3)
CO5	design appropriate fiber reinforced composites for suitable applications.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											1	3
CO2	3	3											1	3
CO3	3	3	3										1	3
CO4	3	3	3	2									1	3
CO5	3	3	3	2									1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	25	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	20	30	50				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE27 - ADVANCED MECHANICS OF MATERIALS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics Strength of Materials	7	PE	3	0	0	3

Preamble	This course imparts the knowledge on three-dimensional theory of elasticity, stress and strain interactions, and compatibility equations ,shear center calculation, unsymmetrical section bending stresses, stress analysis on curved beams, the torsion on non-circular members, and membrane stresses in shells, rotating disc and the beam on elastic foundation.	
Unit - I	**Theory of Elasticity**	**9**
Theory of Stresses- Infinitesimal and Finite Strains - Strain-Displacement Relationships- Compatibility - Stress-Strain Relationship- Elastic Constants - Stress and Displacement Functions- Plane Stress Problems in Cartesian and Polar Coordinates– Boundary Conditions - Representations of Three - Dimensional Stress of a Tension-Generalized Hooke's Law – St.Vennant's Principle – Plane Strain - Plane Stress – Airy's Stress Function.		
Unit - II	**Shear Centre**	**9**
Location of Shear Center for Various Sections – Shear Flow. Unsymmetrical Bending: Stresses and Deflection in Beams Subjected to Unsymmetrical Loading – Kern of a Section.		
Unit - III	**Stresses on Curved Beams**	**9**
Curved Flexural Members - Analysis of Stresses in Beams with Large Curvature – Stress Distribution in Curved Beams – Stresses in Crane Hooks and C Clamps - Closed Ring Subjected to Concentrated Load and Uniform Load – Chain Link.		
Unit – IV	**Stresses Due to Rotation**	**9**
Stresses Due to Rotation – Radial and Tangential Stresses in Solid Disc and Ring of Uniform Thickness and Varying Thickness – Allowable Speed.		
Unit – V	**Beams on Elastic Foundation**	**9**
Infinite Beam Subjected to Concentrated Load – Boundary Conditions – Infinite Beam Subjected to a Distributed Load Segment – Triangular Load - Semi Infinite Beam Subjected to Loads at the Ends and Concentrated Load near the Ends – Short Beams.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Sadhu Singh, "Applied Stress Analysis", 19th Edition, Khanna Publishers, New Delhi, 2009.	I
2.	Rattan S.S., "Strength of Materials", 3rd Edition, McGraw Hill Education, New York, 2017.	II,III,IV,V

REFERENCES:

1.	Timoshenko S.P., "Strength of Materials", 3rd Edition, CBS Publishers, New Delhi, 2002.
2.	Timoshenko S.P. & Goodier J.N., "Theory of Elasticity", 3rd Edition, McGraw Hill Education, New York, 2017.
3.	Rajput R. K. , "Strength of Materials", 6th Edition, S. Chand & Co, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	calculate the stress and strain at a point in a three dimensional mode.	Analyzing (K4)
CO2	calculate analytically the shear centre and stresses in unsymmetrical bending.	Analyzing (K4)
CO3	determine the stresses and deflections on Curved beams	Analyzing (K4)
CO4	analytically solve the stresses due to rotation	Analyzing (K4)
CO5	solve the stresses in beams under elastic foundation	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3												3
CO2	3	3		3										3
CO3	3	3		3										3
CO4	3	3		3										3
CO5	3	3		3										3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	30	30			100
CAT2	20	20	30	30			100
CAT3	20	20	30	30			100
ESE	20	20	30	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE28 - TURBOMACHINES

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Thermal Engineering	7	PE	3	0	0	3

Preamble	This course provides the knowledge on the energy transfer principles of centrifugal fans, blowers, centrifugal & axial flow compressors and axial & radial flow turbines. Efficiency calculations for the rotating machineries based on velocity triangles are also covered.	
Unit - I	**Principles**	**9**
Energy Transfer between Fluid and Rotor-Classification of Fluid Machinery-Dimensionless Parameters-Specific Speed – Applications-Stage Velocity Triangles-Work and Efficiency.		
Unit - II	**Centrifugal Fans and Blowers**	**9**
Types- Stage and Design Parameters-Flow Analysis in Impeller Blades-Volute and Diffusers – Losses - Characteristic Curves and Selection - Fan Drives and Fan Noise.		
Unit - III	**Centrifugal Compressor**	**9**
Construction Details - Impeller Flow Losses - Slip Factor - Diffuser Analysis - Losses and Performance Curves.		
Unit - IV	**Axial Flow Compressor**	**9**
Stage Velocity Diagrams – Enthalpy - Entropy Diagrams - Stage Losses and Efficiency –Work done - Simple Stage Design Problems and Performance Characteristics.		
Unit - V	**Axial and Radial Flow Turbines**	**9**
Stage Velocity Diagrams - Reaction Stages - Losses and Coefficients - Blade Design Principles - Testing and Performance Characteristics.		

Lecture:45, Total:45

TEXT BOOK:

1.	Yahya S. M., "Turbines, Compressors and Fans", 4th Edition, Tata McGraw- Hill, New Delhi, 2017.	I,II,III,IV,V

REFERENCES:

1.	Seppo A. Korpela "Principles of Turbomachinery", 2nd Edition, John Wiley& Sons, USA, 2019.
2.	Erick Dick, "Fundamentals of Turbomachines", 1st Edition, Springer, Netherlands, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basic principles and classification of turbo machinery	Understanding (K2)
CO2	illustrate the principles and applications of the centrifugal Fans and Blowers	Applying (K3)
CO3	design and analyze the performance of the centrifugal compressor	Analyzing (K4)
CO4	elaborate the principles and applications of the axial flow compressor	Applying (K3)
CO5	explain the principles and applications of the axial and radial flow turbines	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3											3
CO2	3	3	3											3
CO3	3	3	3											3
CO4	3	3	3											3
CO5	3	3	3											3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	50				100
CAT2	10	30	50	10			100
CAT3	10	40	50				100
ESE	10	30	50	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE29 - DESIGN OF HEAT EXCHANGERS

(*Use of Design of Heat Exchanger Data Book is permitted for the End Semester Examination)*

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics, Fluid Mechanics and Hydraulic Machines, Heat and Mass Transfer	7	PE	3	0	0	3

Preamble	The course provides the fundamental aspects on designing different types of heat exchangers. The global standards and factors to be considered in the design process of heat exchangers are covered extensively.	
Unit – I	**Fundamentals of Heat Exchangers**	**9**
Introduction - Types - Application - Overall Heat Transfer Coefficient –Fouling - Effect of Fouling on Heat Transfer - Fouling Factor - Techniques to Control Fouling - Logarithmic Mean Temperature Difference (LMTD) Method - Effectiveness-Number of Transfer Units (NTU) Method of Heat Exchanger Analysis - Selection of Heat Exchangers.		
Unit – II	**Design of Double Pipe Heat Exchangers**	**9**
Introduction - Thermal and Hydraulic Design of Inner Tube and Annulus - Hairpin Heat Exchanger with Bare and Multi Tube Finned Inner Tube - Parallel-Series Arrangements of Hairpins - Total Pressure Drop.		
Unit – III	**Design of Shell and Tube Heat Exchangers**	**9**
Introduction - Basic Components - Classification - Basic Design Procedure - Tubular Exchanger Manufacturers Association (TEMA) Code - Heat Transfer and Pressure Drop Analysis on Shell Side and Tube Side - Bell Delaware Method.		
Unit – IV	**Design of Compact Heat Exchangers**	**9**
Introduction - Heat Transfer Enhancement - Plate Fin Heat Exchangers - Tube Fin Heat Exchangers - Heat Transfer and Pressure Drop Analysis of Finned Tube and Plate Fin Heat Exchangers.		
Unit – V	**Design of Condensers and Evaporators**	**9**
Introduction - Classification - Thermal Design of Shell and Tube Condensers - Thermal Analysis of Evaporators - Condensers and Evaporators for Refrigeration and Air Conditioning - Standards for Condensers and Evaporators.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Sadik Kakac, Hongtan Liu & Anchasa Pramuanjaroenkij. , "Heat Exchangers: Selection, Rating, and Thermal Design", 4th Edition, CRC Press, USA, 2020.	I,II,III,IV,V

REFERENCES:

1.	Kuppan Thulukkanam, "Heat Exchanger Design Handbook", 2nd Edition, CRC Press, USA, 2013.
2.	Ramesh K. Shah, Dusan P. Sekulic. , "Fundamentals of Heat Exchanger Design", 1st Edition, John Wiley & Sons Inc, USA, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the basic methodologies of different types of heat exchangers.	Applying (K3)
CO2	design and analyze the thermal performance of double pipe heat exchangers.	Analyzing (K4)
CO3	design and analyze the thermal performance of shell and tube heat exchangers.	Analyzing (K4)
CO4	design and analyze the thermal performance of compact heat exchangers.	Analyzing (K4)
CO5	design and analyze the thermal performance of condensers and evaporators.	Analyzing (K4)

Mapping of COs with POs and PSOs														
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3												3
CO2	3	3	3											3
CO3	3	3	3											3
CO4	3	3	3											3
CO5	3	3	3											3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	30	30	25			100
CAT2	5	15	40	40			100
CAT3	5	15	40	40			100
ESE	10	10	40	40			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE30 - ADDITIVE MANUFACTURING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology Engineering Materials and Metallurgy	7	PE	3	0	0	3

Preamble	This course provides scientific as well as technological aspects of various additive and formative rapid manufacturing processes for mass customization.	
Unit - I	**Introduction to Additive Manufacturing**	**9**
Evolution - Fundamental Fabrication Processes - CAD for RPT - Product Design and Rapid Product Development - Need for Time Compression in Product Development - Conceptual Design - Detail Design - Prototype Fundamentals - Fundamentals of Rapid Prototype (RP) Systems – RP Process Chain - 3D Modeling - 3D Solid Modeling Software and their Role in RPT - Data Format - STL files- History of RP Systems - Classification of RP Systems - Benefits of RPT.		
Unit - II	**Liquid based RP systems**	**9**
Stereo Lithography Apparatus (SLA) - Principle, Photo Polymers - Post Processes - Process Parameters - Machine Details - Advantages. Solid Ground Curing (SGC) - Principle - Process Parameters - Process Details - Machine Details - Limitations. Solid Creation System (SCS) - Principle - Process Parameters - Process Details - Machine Details - Applications.		
Unit - III	**Solid based RP systems**	**9**
Fusion Deposition Modeling (FDM) - Principle - Raw materials - BASS - Water Soluble Support System - Process Parameters - Machine Details - Advantages and Limitations. Laminated Object Manufacturing (LOM) - Principle - Process Parameters - Process Details - Advantages and Limitations - Solid Deposition Manufacturing (SDM) - Principle - Process Parameters - Process Details - Machine Details - Applications.		
Unit - IV	**Powder based RP systems**	**9**
Selective Laser Sintering (SLS) - Principle - Process Parameters - Process Details - Machine Details - Advantages and Applications. 3-Dimensional Printers (3DP) - Principle - Process Parameters - Process Details - Machine Details - Advantages and Limitations - Laser Engineered Net Shaping (LENS) - Principle - Process details - Advantages and Applications.		
Unit - V	**Rapid Tooling and Applications of RP**	**9**
Design for Additive Manufacturing, Rapid Tooling - Direct Rapid Tooling - Indirect Rapid Tooling - Soft Tooling and Hard Tooling. Applications of RP in Product design - Automotive Industry and Medical Field - Conversion of CT/MRI Scan Data - Customized Implant - Case Studies -Reverse Engineering.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Chua.C.K., Leong K.F. & Lim C.S., "Rapid Prototyping: Principles and Applications", World Scientific, NewJersy, 2010.	I,II,III,IV,V

REFERENCES:

1.	Pham D.T. and Dimov S.S., "Rapid Manufacturing", Springer -Verlag, London, 2011.
2.	Amitabha Ghosh., "Rapid Manufacturing a brief Introduction", Affiliated East West Press, New Delhi, 2011.
3.	Dr. Sabrie Soloman, “3D Printing and Design”, 1st Edition, Khanna Publishing House, Delhi, 2020

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the concepts of rapid prototyping in product design and development.	Applying (K3)
CO2	select the suitable liquid based rapid prototyping system for a specific application.	Applying (K3)
CO3	identify the suitable solid based rapid prototyping system for a specific application.	Applying (K3)
CO4	choose the suitable powder based rapid prototyping system for a specific application.	Applying (K3)
CO5	apply the concepts of rapid prototyping in product design and development.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	1	2	2						2	2	2	2
CO2	2	3	1	2	2						2	2	2	2
CO3	2	3	1	2	2						2	2	2	2
CO4	2	3	1	2	2						2	2	2	2
CO5	2	3	1	2	2						2	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	30	40	30				100
CAT3	20	45	35				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE31 - WELDING TECHNOLOGY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology Engineering Materials and Metallurgy	7	PE	3	0	0	3

Preamble	This course provides the knowledge on various advanced welding processes, welded joint designs and testing of weldment.	
Unit - I	**Welding Principles, Gas and Arc Welding Processes**	**9**
Classifications of Welding Processes – Power Sources –Arc Characteristics – V-I Characteristics – Metal Transfer Modes – Electrodes and Fluxes – Types of Weld Joints –Weld Position – Gas Welding: Oxy-Acetylene Welding – Oxy-Hydrogen Welding – Arc Welding: Shielded Metal Arc Welding – Submerged Arc Welding – Gas Tungsten Arc Welding – Gas Metal Arc Welding – Plasma Arc Welding – Electro Slag Welding – Electro-Gas Welding Process – Advantages – Limitations and its Applications.		
Unit - II	**Resistance Welding Processes**	**9**
Spot Welding – Seam Welding – Projection Welding – Resistance Butt Welding –Flash Butt Welding – Percussion Welding – High Frequency Resistance Welding Process – High Frequency Induction Welding Process – Advantages – Limitations and its Applications.		
Unit - III	**Solid State Welding Processes**	**9**
Forge Welding – Friction Welding – Friction Stir Welding - Explosive Welding – Ultrasonic Welding –Cold Welding – Diffusion Bonding – Roll Welding – Hot Pressure Welding Processes – Advantages -– Limitations and its Applications.		
Unit - IV	**Special Welding Processes and Design of Weld Joints**	**9**
Thermit Welding – Atomic Hydrogen Welding –Electron Beam Welding – Laser Beam Welding – Under Water Welding – Welding Symbols – Welding Dimension – Design of Various Welded Joints: Weldability of Aluminium, Copper, Cast Iron and Stainless Steels.		
Unit - V	**Testing of Weldments, Codes & Standards and Welding Automation**	**9**
Destructive Tests: Tensile Test – Ductility Test – Toughness Test – Fatigue Test – Non-Destructive Test: Visual Inspection – Liquid Penetrant Test –Magnetic Particle Test – Radiographic Test – Ultrasonic Testing of Weldments. **Codes and Standards:** Introduction to Codes and Standards – Welding and Welder Qualification – Procedure Qualification Record – Welding Procedure Specification – Welder Performance Qualification – Welding Automation in Aerospace, Nuclear and Surface Transport Vehicles.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	David Phillips. H, "Welding Engineering: An Introduction", 1st Edition, John Wiley & Sons, Ltd., United States, 2016.	I,II,III,IV,V

REFERENCES:

1.	Parmer R.S., "Welding Engineering and Technology", 3rd Edition, Khanna Publishers, New Delhi, 2015.
3.	Nadkarni S.V., "Modern Arc Welding Technology", 1st Edition, Oxford IBH Publishers, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the working principle of welding process and selecting parameters for the given applications.	Understanding (K2)
CO2	demonstrate the basic concepts of different resistance welding process and select an appropriate technique for industrial requirement.	Understanding (K2)
CO3	demonstrate the basic concepts of various solid state welding processes and apply appropriate technique based on specified applications.	Applying (K3)
CO4	illustrate the need for special welding techniques and analyze the welding joints of different materials.	Analyzing (K4)
CO5	select weld codes, standards and procedure to examine the weldment for industrial application.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		1										3
CO2	3	3												3
CO3	3	3												3
CO4	3	3												3
CO5	3	3	1		1								2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	10	30	30	30			100
ESE	10	40	20	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE32 - QUALITY CONTROL AND RELIABILITY ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	The course deals with basic concepts of quality, various tools and techniques involved in improving the customer satisfaction of the product. It also deals concepts of reliability and testing procedure of product	
Unit - I	**Introduction**	**9**
Definition of Quality - Basic Concept of Quality - Definition of Statistical Quality Control (SQC) - Benefits and Limitation of SQC- Quality Assurance-Quality Control Quality Cost-Variation in Process- Causes of Variation- Six Sigma Concepts.		
Unit - II	**Process Control for Variables and Attributes**	**9**
Theory of Control Chart- Uses of Control Chart – Control Chart for Variables – X chart - R chart and σ chart -Process Capability – Process Capability Studies and Simple Problems- Control Chart for Attributes –Control Chart for Non Conformities– p Chart - np Chart – C and U charts - State of Control and Process Out of Control Identification in charts - Pattern Study.		
Unit - III	**Acceptance Sampling**	**9**
Lot-by-Lot Sampling – Types – Probability of Acceptance in Single - Double - Multiple Sampling Techniques – O.C. Curves – Producer's Risk and Consumer's Risk. (Acceptable Quality Limit) AQL - Lot Tolerance Percent Defective (LTPD) - Average Outgoing Quality Limit (AOQL) Concepts-Standard Sampling Plans for AQL and LTPD - Uses of Standard Sampling Plans.		
Unit - IV	**Reliability Engineering**	**9**
Life Testing – Objective – Failure Data Analysis- Mean Failure Rate- Mean Time to Failure- Mean Time Between Failure- Hazard Rate – Weibull Model- System Reliability Series - Parallel and Mixed Configuration – Simple Problems. Maintainability and Availability – Simple Problems- Acceptance Sampling Based on Reliability Test – Operating Characteristic (O.C) Curves.		
Unit - V	**Reliability Improvements**	**9**
Reliability Improvements Techniques- Use of Pareto Analysis – Design for Reliability – Redundancy Unit and Standby Redundancy – Optimization in Reliability – Product Design – Product Analysis – Product Development – Product Life Cycles.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Douglas.C. Montgomery, "Introduction to Statistical Quality Control", 8th Edition, John Wiley, United States, 2019.	I,II,III,IV
2.	Srinath L.S, "Reliability Engineering", 4th Edition, Affiliated East West Press, 2005.	V

REFERENCES:

1.	Robert James Oakland, John S Oakland, "Statistical Process Control", 7th Edition, Taylor & Francis, 2018.
2.	Patrick O'Connor and Andre Kleyner, "Practical Reliability Engineering", 5th Edition , Wiley , 2011.
3.	Eugene Grant , Richard Leavenworth "Statistical Quality Control", 7th Edition , McGraw-Hill ,2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret basics concepts of quality and variation in process	Understanding (K2)
CO2	distinguish and plot the different types of control charts for variables and attributes	Analyzing (K4)
CO3	identify the consumer's and producer's risk in sampling	Analyzing (K4)
CO4	exhibit the knowledge on fundamental concepts of reliability	Analyzing (K4)
CO5	apply the different techniques of reliability improvements.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3		2								3	3
CO2	3		3		2								3	3
CO3	3	1	3	1	2								3	3
CO4	3	1	3		2								3	3
CO5	3	1	3	1	2								3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	30	10			100
CAT2	15	20	30	35			100
CAT3	20	20	35	25			100
ESE	20	20	35	25			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE33 –INDUSTRIAL ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	The course deals with fundamental aspects of various Industrial Engineering tools like work study, resource planning, forecasting techniques and value engineering that involves improving the efficiency of an organization.	
Unit - I	**Work Study**	**9**
Method Study- Basic Procedure-Selection-Recording of Process –Critical Analysis- Development –Implementation –Micro Motion and Macro motion study – Principles of Motion Economy-Work Measurement –Techniques of Work Measurement –Time Study – Computation of Standard Time-Work Sampling –Synthetic Data –Predetermined Motion Time Standards-Job Evaluation- Merit Rating-Ergonomics and Safety.		
Unit - II	**Process Control for Production Planning and Control**	**9**
Need for PPC-Objectives–Functions-Information Required for PPC-Production-Organization-Manufacturing Methods -Types of Production System-Characteristics of Flow - Job - Batch - Productivity-Factors Affecting Productivity–Plant Layout-Layout Classification- Layout Design Procedures- Computerized Relative Allocation of Facilities Technique (CRAFT) – Automated Layout Design Program (ALDEP) - Computerized Relationship Planning (CORELAP)- Productivity Measures –Problems–Production control-Loading-Sequencing-Scheduling-Dispatching.		
Unit - III	**Forecasting and Facility Planning**	**9**
Need for Forecasting-Demand Patterns-Forecasting Models–Judgmental Techniques- Time Series Analysis- Moving Average-Exponential Smoothing-Regression and Correlation Method-Forecast Error-Costs and Accuracy of Forecasts. Facility Location-Factors Influencing Plant Location-Single and Multi Facility Location Problems.		
Unit - IV	**Material Requirement Planning and Capacity Planning**	**9**
Material Requirement Planning (MRP): Objectives-Terminologies –Systems–Outputs –Management Information to MRP – Manufacturing Resource Planning-Capacity Requirement Planning-Measures of Capacity–Capacity–Need– **Capacity Planning:** Influencing –-Aggregate Planning-Guidelines Master Production Schedule- Introduction to Enterprise Resource Planning (ERP)-Strategy-Need-Benefit-Modules- Introduction to Lean Manufacturing – Comparison with conventional manufacturing.		
Unit - V	**Production Cost Estimation**	**9**
Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure-Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost. Estimation of few Types of Jobs from forming and machining operations.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Martand T Telsang , "Industrial Engineering and Production Management", 3rd Edition, S. Chand and Company, New Delhi, 2018.	I,II,III,IV
2.	Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.	V

REFERENCES:

1.	Buffa Elwood S., and Sarin Rakesh K, "Modern Production/Operations Management", 8th Edition, Wiley, New York, 2007.
2.	Chase, Jacobs and Aquilano, "Operations Management for Competitive Advantage", 11th Edition Tata McGraw-Hill, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the various principles & techniques of industrial engineering	Applying (K3)
CO2	interpret the concept of production, planning and control techniques.	Understanding (K2)
CO3	analyze the data and forecast the demand of future	Analyzing (K4)
CO4	explain the various resource in an organization.	Understanding (K2)
CO5	examine the different types of cost estimation in industry	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	3										3
CO2	3	3	1										2	3
CO3	3	3		3	3								2	3
CO4	3	3	1	3	3						2		2	3
CO5	3	3		3	3						2		2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	25	25	30			100
CAT3	20	30	25	25			100
ESE	20	30	25	25			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE34 - INTRODUCTION TO AIRCRAFT SYSTEMS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics Fluid Mechanics and Hydraulic Machines Strength of Materials	7	PE	3	0	0	3

Preamble	This course provides knowledge on various aircraft systems, basic principles of flight and its control, aircraft performance and various maneuvers	
Unit - I	**Introduction to Aircrafts**	**9**
Basic Components of an Aircraft- Structural Members- Aircraft Axis System- Aircraft Motions- Control Surfaces and High lift Devices - Types of Aircrafts - Lighter than Air/Heavier than Air Aircrafts Conventional Design Configurations Based on Power Plant Location- Wing Vertical Location- Intake Location- Tail Unit Arrangements- Landing Gear Arrangements- Unconventional Configurations-Biplane- Variable Sweep- Canard Layout- Twin Boom Layouts- Span Loaders- Advantages and Disadvantages of these Configurations.		
Unit - II	**Aircraft Systems**	**9**
Aircraft Systems Types of Aircraft Systems - Mechanical Systems-Engine Control System- Fuel System- Hydraulic System- Electrical Systems- Electronic Systems and Avionics Systems.		
Unit - III	**Basic Principles of Flight**	**9**
Aerofoil Nomenclature- Types of Aerofoil- Wing Section- Aerodynamic Center - -Aspect Ratio- Significance of Speed of Sound- Air Speed and Ground Speed- Properties of Atmosphere- Lifting surfaces-Lift and Drag- Angle of Attack- Pressure Distribution Over a Wing Section- Centre of Pressure and its Effects- Generation of Lift- Drag- Pitching Moments- Types of Drag- Lift Curve- Drag Curve- Lift/Drag Ratio Curve- Factors Affecting Lift and Drag.		
Unit - IV	**Stability and Control**	**9**
Stability and Control: Degree of Stability- Lateral- Longitudinal and Directional Stability- Controls of Aircraft- Taxying – Landing - Gliding and Turning.		
Unit - V	**Aircraft Performance and Maneuvers**	**9**
Taking off- CLIMBING- Power Curves- Maximum and Minimum Speeds of Horizontal Flight- Effects of Changes of Engine Power- Effects of Weight on Performance- Effects of Altitude on Power Curves- Forces acting on an Aeroplane During a Turn- Correct and Incorrect Angles of Bank- Aerobatics- Inverted Maneuvers- Maneuverability.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Kermode A.C, "Mechanics of Flight", 11th Edition, Pearson Education, New Delhi, 2006.	I,II,III,IV,V

REFERENCES:

1.	Shevell, "Fundamentals of Flight", 2nd Edition, Pearson Education, New Delhi, 1988.
2.	John David Anderson, "Introduction to Flight", McGraw-Hill Higher Education, New Delhi, 2005.
3.	Ian Moir & Allan Seabridge, "Aircraft Systems: Mechanical - Electrical and Avionics Subsystems Integration", Willey international, England, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the various aircrafts, components and its types	Understanding (K2)
CO2	describe various aircraft systems and its functioning	Understanding (K2)
CO3	demonstrate the flight mechanics and infer the principles	Applying (K3)
CO4	delineate the stability and control of aircrafts with various actuation mechanisms	Applying (K3)
CO5	analyze the performance and control of various aircrafts with respect to various working condition	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3				1			1		1		3
CO2	2		3				1			1		1		3
CO3	2	2	3				1			1		1		3
CO4	2		3				1			1		1		3
CO5	2		3				1			1		1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50					100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	20	30	50				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE35 - INDUSTRIAL TRIBOLOGY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fluid Mechanics and Hydraulic Machines Design of Machine Elements.	7	PE	3	0	0	3

Preamble	This course deals with the fundamentals of friction, wear, lubrication and design aspects of bearing.	
Unit - I	**Surfaces and Friction**	**9**
Topography of Engineering Surfaces–Contact Between Solids –Sources of Sliding Friction – Friction Characteristics of Metals –Friction of Non-Metals–Friction of Ceramics and Polymers –Rolling Friction –Source of Rolling Friction – Stick Slip Motion.		
Unit - II	**Wear and Lubrication**	**9**
Types of Wear –Simple Theory of Sliding Wear Mechanism –Adhesive and Abrasive Wear –Corrosive Wear –Surface Fatigue Wear – Brittle Fracture –Wear of Ceramics and Polymers. Types and Properties of Lubricants –Testing Methods.		
Unit - III	**Film Lubrication Theory**	**9**
Hydrodynamic Lubrication – Fluid Film in Simple Shear–Viscous Flow Between Very Close Parallel Plates-Reynolds Equation for Film Lubrication –Solid Lubrication–Hydrostatic Lubrication.		
Unit - IV	**Journal Bearings**	**9**
Bearing Geometry– Pressure Distribution – Load Capacity – Friction Force – Coefficient of Friction – Lubricant Flow rate – Practical and Operational Aspects of Journal Bearings –Thermal Effects in Bearings – The Sommerfield Diagram.		
Unit - V	**Bearing Materials**	**9**
Surface Treatments – Reduction of Friction – Wear Resistant Coatings –Materials for Rolling Element Bearings –Materials for Fluid Film Bearings –Materials for Marginally Lubricated and Dry Bearings.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Gwidon W. Stachowiak & Andrew W. Batchelor, "Engineering Tribology", 4th Edition, Butterworth-Heinmann, UK, 2013.	I,II,III,IV,V

REFERENCES:

1.	Williams J. A., "Engineering Tribology", 1st Edition, Oxford University Press, New Delhi, 2005.
2.	Cameron A., "Basic Lubrication Theory", 3rd Edition, Ellis Horwood Ltd. Publishers, UK, 1983.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	elaborate the surface topography and physic-chemical aspects of solid surfaces.	Understanding (K2)
CO2	demonstrate the different wear mechanisms and lubrication aspects on solid metal surfaces.	Applying (K3)
CO3	compare and analyze the hydrodynamic and hydrostatic lubrication.	Analyzing (K4)
CO4	apply the procedure and design journal bearings for different applications.	Applying (K3)
CO5	characterize the materials for bearings for different applications.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3										
CO2	3	3	3	3										
CO3	3	3	3	3										
CO4	3	3	3	3										
CO5	3	3	3	3										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	10	30	40	20			100
CAT3	20	40	40				100
ESE	10	40	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE36 - INSTRUMENTATION IN THERMAL ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mechatronics and IoT, Metrology and Measurements	7	PE	3	0	0	3

Preamble	This course introduces the characteristics of measuring instruments, techniques and importance of error and uncertainty analysis. Modern measurement techniques for gas properties are specifically covered through this course.	
Unit – I	**Measurement Characteristics**	**9**
Instrument Classification-Characteristics of Instruments-Static and Dynamic Responses-Experimental Error Analysis-Systematic and Random Errors-Statistical Analysis-Uncertainty-Experimental Planning and Selection of Measuring Instruments-Reliability of Instruments.		
Unit – II	**Microprocessors and Computers in Measurement**	**9**
Data Logging and Acquisition -Use of Sensors for Error Reduction- Elements of Microcomputer Interfacing- Intelligent Instruments in Use.		
Unit – III	**Measurement of Physical Quantities**	**9**
Measurement of Thermo-Physical Properties-Temperature-Pressure-Flow- Use of Sensors for Physical Variables.		
Unit – IV	**Advanced Measurement Techniques**	**9**
Shadowgraph-Schlieren-Interferometer-Laser Doppler Anemometer-Hot Wire Anemometer-Heat Flux Sensors-Telemetry in Measurement.		
Unit – V	**Measurement Analyzers**	**9**
Chemical-Thermal-Magnetic-Optical Gas Analyzers-Measurement of Smoke-Dust and Moisture-Gas Chromatography-Spectrometry-Measurement of pH.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Holman J.P., "Experimental Methods for Engineers", 8th Edition, McGraw-Hill, New York, 2012.	I,II,III,IV,V

REFERENCES:

1.	Barnery G.C.V., "Intelligent Instrumentation", 2nd Edition, Prentice Hall of India, New Delhi, 1988.
2.	Bolton W, "Industrial Control & Instrumentation", 2nd Edition, Universities Press, Pvt. Ltd, Hyderabad, 2004.
3.	Rangan C.S., Sarma G.R., Mani V.S.V., "Instrumentation Devices and Systems", 2ndEdition, McGraw-Hill, New Delhi, 2008

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	classify the instruments and perform error analysis.	Applying (K3)
CO2	illustrate the integration of microprocessors and computers with physical instruments.	Applying (K3)
CO3	describe the measurement methods of thermo-physical properties.	Applying (K3)
CO4	illustrate the principles of modern measurement techniques.	Applying (K3)
CO5	explain the principles of exhaust gas analysis.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			3							3	3	3
CO2	3	3			3							3	3	3
CO3	3	3			3							3	3	3
CO4	3	3			3							3	3	3
CO5	3	3			3							3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	35	40	25				100
CAT2	25	30	45				100
CAT3	20	35	45				100
ESE	30	30	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE37 - ENERGY AUDITING AND MANAGEMENT

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics Thermal Engineering Heat and Mass Transfer	7	PE	3	0	0	3

Preamble	This course provides insights on energy conservation measures in thermal & electrical utilities, energy audit and energy monitoring procedures to be followed by Energy Managers in industries.	
Unit - I	**Energy Audit**	**9**
Introduction - Types - Methodology-Energy Management-Definition and Objectives-Managerial Functions and Responsibilities of Energy Manager- Top Management Commitment and Support for Energy Action Planning-Management Tools for Effective Implementation- Utility Rate Structures- Portable and Online Instruments for Survey-Energy Monitoring and Targeting- EMIS.		
Unit - II	**Energy Conservation and Water Management**	**9**
Energy Conservation: Introduction – Energy Conservation Programme (ENCON) - Need for Energy Conservation- Energy Efficiency-Development of Energy Balance-Energy Conservation in Domestic Sector-Standards and Labeling of Appliances. **Water Management**: Water Audit-Indoor and Outdoor Water Management.		
Unit - III	**Energy Audit Applied to Buildings**	**9**
Building Envelope Analysis– Internal Heat Gain - Thermal Comfort - Air Quality and Air Tightness-Thermal Insulation-Reflective and Radiant Barriers -Energy Conservation Building Code (ECBC) and its Guidelines-Star Rating-Energy Saving Measures in New Buildings-IOT in Building Energy Management.		
Unit - IV	**Electrical System Audit**	**9**
Load Management - Power Factor - Efficiency Improvements-Harmonics- Energy Performance Assessment of Electric Motors and Variable Speed Drives-Energy Efficient Motors- Lighting System Audit –Terminology- Light Sources and Lamp Types - Electronic Ballasts - Energy Saving Opportunities in Lighting - Case Study.		
Unit - V	**Energy Efficiency in Thermal Utilities**	**9**
Performance Assessment of Thermodynamic Systems – Boilers –Furnaces – Compressors - HVAC Systems - Water Pumps - Fans - Blowers-Heat Exchangers.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Sonal Desai, "Handbook of Energy Audit", 1st Edition, McGraw Hill Education, New Delhi,2015	I,II,III,IV,V

REFERENCES:

1.	Albert Thumann, Terry Niehus &,William J. Younger, "Handbook of Energy Audits", 9th Edition, Fairmont Press, Lilburn, 2013
2.	Stephen A. Roosa, Steve Doty &Wayne C. Turner, "Energy Management Handbook", 9th Edition, River Publishers, New York, 2018.
3.	"Guide Books (Volume - 1 to Volume - 4) for National Certification Examination for Energy Auditors and Energy Managers", 4th Edition, India, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the energy audit procedures.	Understanding (K2)
CO2	apply the various techniques and standards for energy conservation.	Applying (K3)
CO3	apply the energy audit principles in buildings.	Applying (K3)
CO4	explain the procedure for conducting electrical audit.	Applying (K3)
CO5	assess the performance of thermal utilities.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3				3	1	1	3			2		3	3
CO2	3		2		3	1	1	3					3	3
CO3	3		2		3	1	1	3		1			3	3
CO4	3	2			3	1	1	3		1			3	3
CO5	3	2	2		3			3					3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30				100
CAT2	30	30	40				100
CAT3	30	30	40				100
ESE	30	30	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE38 – MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS

Programme & Branch	B.E. Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Industrial Engineering	7	PE	3	0	0	3

Preamble	This course provides the knowledge on design and analysis methodologies for the purpose of computing quantity and quality related performance measures in manufacturing systems.	
Unit - I	**Manufacturing Systems and Models**	**9**
Types and Principles of Manufacturing Systems, Types and uses of Manufacturing Models, Physical Models, Mathematical Models, Model Uses, Model Building.		
Unit - II	**Material Flow Systems (Assembly lines, Transfer lines & Shop Scheduling):**	**9**
Assembly Lines - Reliable Serial Systems, Approaches to Line Balancing, Sequencing Mixed Models. Transfer Lines and General Serial Systems - Paced Lines without Buffers, Unpaced Lines. Shop Scheduling with many Products.		
Unit - III	**Material Flow Systems (FMS, GT & Facility Layout):**	**9**
Flexible Manufacturing Systems - System Components, Planning and Control. Group Technology - Assigning Machines to Groups, Assigning Parts to Machines. Facility Layout - Quadratic Assignments Problem Approach, Graphic Theoretic Approach.		
Unit - IV	**Supporting Components:**	**9**
Machine Setup and Operation Sequencing - Integrated Assignment and Sequencing. Material Handling Systems - Conveyor Analysis, AGV Systems. Warehousing - Storage and Retrieval Systems, Order Picking.		
Unit - V	**Generic Modeling Approaches:**	**9**
Analytical Queuing Models, A Single Workstation, Open Networks, Closed Networks. Empirical Simulation Models - Event Models, Process Models, Simulation System, Example Manufacturing System.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Ronald G. Askin, and Charles R. Standridge, “Modeling and Analysis of Manufacturing Systems”, John Wiley & Sons, New York, 1993.	I,II,III,IV,V

REFERENCES:

1.	Mengchu Zhou, “Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach”, World Scientific Publishing Co. Pvt. Ltd., 2000.
2.	Groover, Mikell P., “Automation, Production Systems, and Computer-Integrated Manufacturing”, Pearson Education India, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	summarize type of manufacturing systems and models	Understanding (K2)
CO2	construct the assembly lines, transfer lines and shop scheduling	Applying (K3)
CO3	manipulate the flexible manufacturing systems, group technology and facility layouts	Applying (K3)
CO4	describe materials handling systems	Understanding (K2)
CO5	solve the generic modeling system approaches	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3										3	3
CO2	3		3										3	3
CO3	3		3										3	3
CO4	3		3										3	3
CO5	3		3										3	3

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	40	30	30				100
CAT3	40	40	20				100
ESE	40	30	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE39 - MICRO ELECTRO MECHANICAL SYSTEMS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics, Engineering Mechanics, Mechatronics and IoT	7	PE	3	0	0	3

Preamble	This course provides introduction to the basic concepts of sensors, actuators and scaling laws of micro system. It introduces the phenomenon of fabrication, manufacturing and packaging of micro System. It familiarizes students to design and develop a micro product for various applications.	
Unit - I	**Microsystems**	**9**
Overview-Microsystems - Working Principle of Microsystems - Scaling LAWS - Scaling in Geometry - Scaling in Rigid Body Dynamics - Scaling in Electrostatic Forces - Scaling in Electromagnetic Forces - Scaling in Electricity - Scaling in Fluid Mechanics - Scaling in Heat Transfer.		
Unit - II	**Micro sensors and Actuators**	**9**
Micro Sensors - Micro Actuation Techniques – Micro pump – Micro motors – Micro valves – Micro grippers - Micro Accelerometers.		
Unit - III	**Micro System Fabrication**	**9**
Substrates - Single Crystal Silicon Wafer Formation - MEMS Materials - Photolithography - Ion Implantation - Diffusion – Oxidation – Chemical Vapour Deposition (CVD) - Physical Vapor Deposition - Deposition by Epitaxy - Etching Process.		
Unit - IV	**Micro System Manufacturing**	**9**
Bulk Micro manufacturing - Surface Micromachining – Lithographic Galvano Forming Abforming (LIGA) – Stepped Lithographic Galvano Forming Abforming (SLIGA). Micro system packaging - Materials - Die level - Device level - System level - Packaging techniques - Surface bonding - Wire bonding - Sealing - Design considerations.		
Unit - V	**Micro System Applications**	**9**
Applications of micro system - Automotive - Bio medical - Aerospace - Telecommunications field. Basic exposure to software for MEMS design - Micro system Design using CAD tool.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Tai-Ran Hsu., "MEMS and Microsystems: Design and Manufacture", 2nd Edition, John Wiley and Sons, New York, 2017.	I,II,III,IV,V

REFERENCES:

1.	Marc Madou., "Fundamentals of Micro fabrication", 2nd Edition, CRC press, New York, 2011.
2.	Zhang, Dan, Wei & Bin (Eds.), "Advanced Mechatronics and MEMS Devices II", 1st Edition, Springer, Switzerland, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	express Scaling laws of micro system.	Applying (K3)
CO2	interpret the concepts of micro sensors and micro actuators.	Understanding (K2)
CO3	choose the fabrication process of microsystem.	Applying (K3)
CO4	demonstrate the micro manufacturing process and packaging techniques.	Applying (K3)
CO5	infer the various applications of micro system.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	
CO2	3												3	
CO3	3												3	
CO4	3												3	
CO5	3												3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	50	30				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE40 - MAINTENANCE ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	The course describes the industrial maintenance system with recent trends of maintenance activities. It also deals reliability of components and its safety adopted in industries.	
Unit - I	**Principles and Maintenance System Planning**	**9**
Introduction to Repair and Maintenance – Maintenance as Business –Objectives and Principles of Planned Maintenance Activity – Importance and Benefits of Sound Maintenance Systems- Maintenance Systems – Reactive - Preventive or Proactive Systems – Maintainability – Inherent and Overall Availability – Mean Time Between Failures - Mean Time to Repairs and Mean Down Time - Hazard Rate.		
Unit - II	**Maintenance Techniques**	**9**
Total Productive Maintenance (TPM) –Relationship Between Overall Equipment Effectiveness (OEE) and World Class Maintenance – Seven Modern Tools – Applications - Ladder of Maintenance Improvement– Computerized Online Health Monitoring of Machine– Data Acquisition for Effective Management of Computerized Maintenance Management System (CMMS) - Logic Tree Analysis -Criticality Matrix.		
Unit - III	**Condition Based Maintenance**	**9**
Condition Monitoring Techniques -Vibration Analysis–Ultrasonic Detection Techniques -Thermograph - Lubrication Methods and its Analysis – Motor Condition Monitoring (MCM)- Cost Comparison With and Without Condition Monitoring (CM)- On-load Testing and off-Load Testing Methods – Temperature Sensitive Tapes – Pistol Thermometers – Wear-Debris Analysis.		
Unit - IV	**Failure Analysis and Repair Methods of Basic Elements**	**9**
Failure Analysis : Defect/Failure Definition; Failure - Rate –Mode -Reporting – Date Collection- Failure Analysis - Tools –Fault Tree Analysis - Event Tree Analysis-Root Cause Analysis – Failure Mode and Effect Analysis (FMEA) – Failure Mode Effect Criticality Analysis (FMECA) - Electrical Stress Analysis **Repair methods:** Sideways- Spindles- Gears- Lead Screws and Bearings – Repair Methods for Material Handling Equipment – Equipment Records –Job Order Systems.		
Unit - V	**Reliability Engineering and Safety in Maintenance**	**9**
Reliability Engineering: Reliability – Definition - Failure Data - Failure Density - Failure Rate - Mean Failure Rate - Types of Failures - Failure Rate Curve. System Reliability- Series - Parallel and Mixed Configuration – Reliability Increasing Techniques. **Safety in maintenance:** Definition – Methods of Enhancing Safety – Modern Industrial Scenarios- Safety Tools – Case Studies – Quantification Of Safety - Code and Standards- Hazards and its Management.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Srivastava S.K., "Maintenance Engineering (Principles - Practices and Management)", 2st Edition, S. Chand & Co., New Delhi, 2014.	I,II,III,IV,V

REFERENCES:

1.	Bhattacharya S.N., "Installation, Servicing and Maintenance", S. Chand & Co., New Delhi, 2013.
2.	Venkataraman.K., "Maintenance Engineering and Management", PHI Learning Pvt. Ltd., New Delhi, 2010.
3.	Srinath L.S., "Reliability Engineering", East-West Press, New Delhi, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the principles and functions of maintenance in industry.	Applying (K3)
CO2	plan and implement maintenance management systems.	Applying (K3)
CO3	interpret the various condition based maintenance principles.	Applying (K3)
CO4	identify and analyze failures of various equipments in an industry	Analyzing (K4)
CO5	synthesize the functional concepts of reliability and safety engineering.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3				3						3		3
CO2	3	3				3						3		3
CO3	3	3				3						3		3
CO4	3	3			1	3						3	1	3
CO5	3	3				3						3		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	25	50				100
CAT2	25	25	50				100
CAT3	20	25	25	30			100
ESE	20	30	25	25			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE41 - INDUSTRIAL SAFETY ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	The course explores the awareness and knowledge on safety aspects, procedures and guidelines to be followed in the industry while performing various types of operations in industry.	
Unit - I	**Safety Management**	**9**
Evolution of Management Thoughts- Need for Safety- Progress in Modern Safety Concept -Safety Management and its Responsibilities- Planning for Safety-Formulation of Safety Policy- Job Safety Analysis- Safety Sampling Technique -Plant Safety Inspection- Major Accident Hazard Control- Hazard and Operability (HAZOP) Study- Hazard Ranking (DOW and MOND index)- Safety Organization- Safety Audit -Safety Education and Training-Good Housekeeping- Personal Protection and First aid.		
Unit - II	**Accident Causation and Prevention**	**9**
Nature and Causes of Accidents - Incidents of Accident- Factors - Root Cause Analysis - Heinrich's and Frank Bird's Domino Theory. Accident Prevention Steps - Organization- Fact Finding- Analysis of Facts- Selection of Remedy- Application of Remedy- Monitoring- Models- Kepner-Tregoe Model- Error Reduction Model- Performance Cycle Model- Updated Safety Management Model-5 E's of Accident Prevention. Case Study of Major Accidents Performance Cycle Model- Updated Safety Management Model-5 E's of Accident Prevention. Case Study of Major Accidents		
Unit - III	**Safe handling of materials and tools**	**9**
Operation Safety- Personal Protective Equipment -Safe Methods of Lifting & Handling-Safe Use of Accessories of Manual Handling- Safety in Mechanical Handling-Lifting Machines- Tackles-Cranes-Conveyors-Trucks-Causes and Control of Tool Accidents-Safe Use of Hand and Power Tools. Machine Guarding-Basic Need & Importance- Principles of Machine Guarding-Materials for Guard Construction- Electrical Safety- Reactor Control and Explosion Prevention System- Radiation Shielding and Control- Radiation Measuring Instruments- Noise and Vibration Measurement and Control- Air Pollution Control- Air Sampling and Pollution Measuring Instruments.		
Unit - IV	**Safety in engineering industry**	**9**
Safety in Mechanical Working - Safety Measures in Machining Process- Safety in Use of Power Tools-Safety in Welding and Cutting- Safety in Foundry Shops - Safety Measures in Heat and Cold Process - Safety in Usage of Dies - Safe Operations and Maintenance of Machines - General Health Hazards and Control Measures in Engineering Industry - Hazard Communication System - Storage Vessels and their Safety Aspects- Safety in Boilers- Safe Storage & Handling of Gas Cylinders-Safety in Laboratory –Safe Transfer and Transportation of Chemicals.		
Unit - V	**Fire and explosion**	**9**
Nature, Stages and Spread of Fire -Classification of Fire and Extinguishers-Statutory Provisions and Indian Standards-NFPA Code- Design for Fire Safety- Fire Detection and Alarm Systems- Fire Load Determination- Fire Suppression or Extinguishing Systems- Control of Fire and Explosion in Flammable Substances - Explosive Testing - Thermal Sensitivity Analysis - Accelerated Rate Calorimeter- Ignition Test - Electrical Fires- Fire Emergency Action Plan & Drill Rig Explosion -Types-Inspection, Maintenance and Training for Fire Protection.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Mistry. K.U "Fundamentals of Industrial safety and health" Second Edition, Siddharth Prakashan Publisher,Gujarat,2008.	I,II,III,IV,V

REFERENCES:

1.	Jane Bluent, Nigel & Balchin C., "Health and Safety in Welding and Allied Processes", 5th Edition, Wood Head Publishing, England, 2002.
2.	Rao S, Jain R.K. & Saluja H.L., "Electrical Safety - Fire Safety Engineering and Safety Management", 2nd Edition, Khanna Publishers, Delhi, 1997.
3.	Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
4.	Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK, Second Edition 1990 (Vol.I, II & III)

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the significance of safety in industry.	Understanding (K2)
CO2	investigate the factors causing accidents and prevent them from occurring.	Analyzing(K4)
CO3	choose the safe operating practices in material handling and tool usage.	Applying (K3)
CO4	identify the safety measures in the engineering industry	Applying (K3)
CO5	employ the prevention strategies for fire and explosion.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3												3
CO2	3	3	3											3
CO3	3	3												3
CO4	3	3												3
CO5	3	3	3											3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	40	10			100
CAT2	20	30	25	25			100
CAT3	20	30	50				100
ESE	20	30	35	15			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE42 - HYBRID VEHICLE TECHNOLOGY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	This course gives brief ideas on hybrid vehicle architecture, power train modeling, electrical motor characteristics, energy storage technology and driving cycle simulation.	
Unit - I	**Introduction and Components of Hybrid Vehicles**	**9**
Introduction: General Architectures- Vehicle System Components and Analysis- Controls of Hybrid Vehicle **Components of Hybrid Vehicles:** Prime Mover- Electric Motor with DC/DC Converter and Inverter- Energy Storage System- Transmission System in Hybrid Vehicle.		
Unit - II	**Hybrid Vehicles System Modeling**	**9**
Internal Combustion Engine- Electric Motor- Battery System- Transmission System- Final Drive and Wheel- Vehicle Body- PID-Based Driver Model.		
Unit – III	**Power Electronics and Electric Motor Drives**	**9**
Power Electronics: Power Electronic Devices- DC/DC Converter- DC–AC Inverter **Electric Motor Drives:** BLDC Motor and Control- AC Induction Motor and Control- Plug-In Battery Charger Design- Plug-in Hybrid Vehicle Battery System and Charging Characteristics.		
Unit – IV	**Energy Storages System Modeling and Control**	**9**
Methods of Determining State of Charge- Estimation of Battery Power Availability- Battery Life Prediction- Cell Balancing- Estimation of Cell Core Temperature- Battery System Efficiency.		
Unit - V	**Simulation of Driving Cycles**	**9**
Simulation System- Typical Test Driving Cycles- Preliminary Sizing of Main Components of Hybrid Vehicle- Fuel Economy and Emissions Simulation Calculations.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Wei Liu, "Introduction to Hybrid Vehicle System Modeling and Control", 1st Edition, John Wiley & Sons, Inc., New Jersey, 2013.	I,II,III,IV,V

REFERENCES:

1.	Mehrdad Ehsani, Yimin Gao,Stefano Longo, Kambiz Ebrahimi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles ", 2nd Edition, CRC Press, Boca Raton, 2018
2.	Iqbal Husain, "Electric and Hybrid Vehicles", 3rd Edition, CRC Press, Boca Raton, 2021

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	summarize about the layout and sub systems of hybrid vehicles	Applying (K3)
CO2	explain the architecture of various models of hybrid Vehicles Systems	Applying (K3)
CO3	classify and explain electronic devices and motor drives	Applying (K3)
CO4	estimate the parameters influencing the energy storage Systems	Applying (K3)
CO5	infer the results from simulation of driving cycles	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3					3							3
CO2	3	3					3							3
CO3	3	3					3							3
CO4	3	3					3							3
CO5	3	3					3							3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	30	40	30				100
CAT3	20	40	40				100
ESE	10	50	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE43 - INTRODUCTION TO AIRCRAFT STRUCTURES

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics Strength of Materials Design of Machine Elements	8	PE	3	0	0	3

Preamble	The course offers the fundamentals of aircraft design process, materials , properties, failures, structural members, joints, associated vibrations and flutter	
Unit - I	**Overview of the Aircraft Design Process, Aircraft Loads, Aircraft Structures Description**	**9**
Introduction- Phases of Aircraft Design- Aircraft Conceptual Design Process- Conceptual Stage- Preliminary Design- Detailed Design-Design Methodologies-Airworthiness- Definition- Airworthiness Regulations- Regulatory Bodies-Type of Certification- General Requirements- Requirements Related to Aircraft Design Covers- Performance and Flight Requirements- Airframe Requirements-Landing Requirements- Fatigue and Failsafe Requirements- Emergency Provisions- Emergency Landing Requirements-Aerodynamic Loads- Inertial Loads- Loads due to engine- Actuator Loads-Maneuver Loads- VN diagrams-Gust Loads-Ground Loads-Ground Conditions- Miscellaneous Loads- Types of Structural Members of Fuselage and Wing Section and Empennage Ribs- Spars- Frames-Stringers- Longeron- Splices- Types of Structural Joints- Type of Loads on Structural Joints.		
Unit - II	**Aircraft Materials and Properties**	**9**
Introduction- Basic Construction- Material Forms-Metallic Materials and Forms- Alloy Designations-Mechanical Properties- Strength-Static- Stress Strain Curves.		
Unit - III	**Static and Fatigue Failures**	**9**
Fatigue Properties-Crack Growth- Brief Review of Principal Stresses-Principal Strains- Mohr's Circle for Stress and Strain- Fatigue Failures- Fatigue Theory- Introduction to Low Cycle Fatigue- Stress Life and Strain Life Techniques- Mean Stress Effects- Multi-Axial Effects- Isothermal and Thermomechanical Fatigue- Introduction to High Cycle Fatigue.		
Unit - IV	**Box Beams, Buckling of Thin Sheets**	**9**
Box Beams- Introduction- Shear Flow Due to Shear-Shear Flow Due to Torsion-Bredt Batho- Single and Multicell Boxes- Buckling of Thin Sheets- Buckling of Flat Plate in Compression and Shear- Buckling of Curved Plates in Compression and Shear- Buckling of Stiffened Panels-Post Buckling- Effective Width- Concept of Diagonal Tension-Buckling Under Combined Loads.		
Unit - V	**Aircraft Structural Joints, Advanced materials, Vibrations and Flutter**	**9**
Introduction to Fasteners- Splices- Eccentric joints-Bolt Group Analysis-Welded joints- Bonded joints- Lug Analysis- Tension Fitting and Clips-Introduction to Composite Materials- Matrices-Fibers-Forms- Characteristics of Composite Materials-Study of Vibration and Flutter.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Daniel P.Raymer, "Aircraft Design-A Conceptual Approach", 6th Edition, AIAA Education, series, USA, 2012.	I,II,III,IV,V

REFERENCES:

1.	Michael Niu, "Airframe Structural Design", 2nd Edition, Conmilit Press, Hong Kong, 1988.
2.	Megson T.H.G, "Aircraft Structures For Engineering Students", 6th Edition, Butterworth Heinemann, USA, 2017.
3.	Peery, "Aircraft Structures", 1st Edition, Dover publications, New York, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	brief about overview of the aircraft design process, aircraft loads, aircraft structures description	Understanding (K2)
CO2	select and identify aircraft materials and their properties	Applying (K3)
CO3	predict static and fatigue failures of aircraft members	Analyzing (K3)
CO4	analyze the shear flow in box beams and buckling of thin sheets	Analyzing (K4)
CO5	identify the nature of aircraft structural joints, vibrations and flutter of aircraft	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3				1			1		3		2
CO2	3		3				1			1		3		2
CO3	3		3				1			1		3		2
CO4	3		3				1			1		3		2
CO5	3		3				1			1		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	15	15	35	35			100
CAT3	15	15	35	35			100
ESE	15	15	40	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE44 – Principles of Farm Machineries

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Automobile Engineering Manufacturing Technology	8	PE	3	0	0	3

Preamble	This course explores the nature of soil conditions with the appropriate fertilizer applicators and principles of farm equipment including harvesting tools and machines.	
Unit - I	**Introduction to Farm Machines and Soil**	**9**
Introduction to Farm Machines: Objectives of Farm Mechanisms - Classification of Farm Machines - Materials for Construction of Farm Machines - Principles of Operation and Selection of Machines for Production of Crops - Field Capacities & Economics. **Soil:** Nature and Origin of Soil- Soil Forming Rocks and Minerals - Soil Classification and Composition - Soil Forming Processes.		
Unit - II	**Tillage**	**9**
Primary and Secondary Tillage Equipment - Forces Acting on Tillage Tools - Field Operation Patterns - Draft Measurement of Tillage Equipment - Earth Moving Equipment - Construction & Working Principles of Bulldozer - Trencher - Excavators - Sowing - Planting and Transplanting Equipment their Calibration and Adjustments.		
Unit - III	**Fertilizer Application Equipment**	**9**
Selection - Calibration - Construction Features - Different Components and Adjustment of Weed Control - Plant Protection Equipment - Sprayers and Dusters		
Unit - IV	**Principles and Types of Cutting Mechanisms**	**9**
Construction and Adjustments of Shear and Impact Type Cutting Mechanisms - Crop Harvesting Machinery: Mowers - Windrowers - Reapers - Reaper Binders and Forage Harvesters - Forage Chopping and Handling Equipment - Threshing Mechanics - Types of Threshers - Straw Combines - Grain Combines - Maize Harvesting - Shelling Equipment - Root Crop Harvesting Equipment - Cotton Picking and Sugarcane Harvesting Equipment.		
Unit - V	**Principles of Harvesting Tools and Machines**	**9**
Horticultural Tools and Gadgets - Testing of Farm Machine - Test Codes and Procedure - Interpretation of Test Results - Selection and Management of Farm Machines for Optimum Performance - Workplace Layout for Men and Women.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Kepner R. A., Bainer Roy and Barger E. L, "Principals of Farm Machinery", 3rd Edition, CBS Publishers and Distributors, New Delhi, 2005.	I,II,III,IV,V

REFERENCES:

1.	Boson E.S.., "Theory, Construction and Calculation of Agricultural Machines", 1st Edition, Scientific Publishers, New Delhi, 2016.
2.	Ghosh R.K. and Swain S., "Practical Agricultural Engineering", 1st Edition, Naya Prokash, Calcutta, 1993.
3.	Donnel Hunt, " Farm Power and Machinery Management", 10th Edition, Medtech, Ames, USA, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the nature of soil condition and different types of farming equipments	Understanding (K2)
CO2	illustrate the working of tillage equipments	Applying (K3)
CO3	identify the fertilizer application equipments and explain its working construction	Applying (K3)
CO4	explain the cutting mechanisms for various crops	Applying (K3)
CO5	demonstrate the principle of harvesting equipments for various crop	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													3
CO2	3													3
CO3	3													3
CO4	3													3
CO5	3													3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	45	35				100
CAT3	20	45	35				100
ESE	20	45	35				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE45 - POWER PLANT ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics Thermal Engineering	8	PE	3	0	0	3

Preamble	This course imparts knowledge on layout and working of various power plants and also the terminologies involved in economic analysis of the power plants.	
Unit - I	**Energy Scenario and Thermal Power Plant**	**9**
Energy Scenario: Indian and Global Energy Scenario - Environmental Issues of Present Day Power Generation. **Thermal Power Plant:** Layout of Thermal Power Plant – Selection Criteria –Boilers- Fluidized Bed Boilers – Boiler Trial and Testing - Fuel and Ash Handling Systems -Pulverizer - Stokers – Dust Collectors - Cooling Towers – Feed Water Treatment – Distributed Control System (DCS).		
Unit - II	**Gas Turbine Power Plant and Diesel Power Plant**	**9**
Gas Turbine Power Plant: Gas Turbine Cycles - Thermodynamic Analysis of Cycles - Reheating - Regeneration and Intercooling - Layout of Gas Turbine Power Plant- Selection Criteria - Binary and Combined Cycle - IGCC. **Diesel Power Plant:** Layout –Types - Selection Criteria– Selection of Engine.		
Unit – III	**Nuclear Power Plant and Hydel Power Plant**	**9**
Nuclear Power Plant: Layout - Selection Criteria – Types of Reactors - Radioactivity – Fission Process – Reaction Rates – Diffusion Theory -Elastic Scattering and Slowing Down – Global Standards in Waste Disposal and Nuclear Safety. **Hydel Power Plant:** Layout - Selection Criteria - Selection of Turbines -Micro Hydel Developments.		
Unit – IV	**Other Types of Power Generation**	**9**
MHD Power Generation –Solar Thermal and PV System- WECS - Types – Biomass -Geo thermal –OTEC- Micro Fuel Cells and Portable Power - Comparative Analysis of Combined Heat and Power Cycles.		
Unit - V	**Power Plant Economics**	**9**
Cost of Electric Energy – Load Duration Curves-Fixed and Operating Costs – Energy Rates – Types of Tariffs – Economics of Load Sharing - Comparison -Selection and Economics of Various Power Plants – Energy Auditing – Types - Energy Auditing for Thermal Power Plant – Waste Heat Recovery Boilers in Cement, Sugar and Steel Plants.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Rajput R.K, "Power Plant Engineering", 5th Edition, Laxmi Publications, New Delhi, 2016.	I,II,III,IV,V

REFERENCES:

1.	Arora S.C. and Domkundwar S., "A Course in Power Plant Engineering", 5th Edition, Dhanpat Rai, New Delhi, 2012.
2.	Nag P.K, "Power Plant Engineering", 4th Edition, Tata McGraw-Hill, New Delhi, 2014.
3.	Hegde R.K, "Power Plant Engineering", 1st Edition, Pearson India Education Services Pvt. Ltd, Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the layout and working of various sub circuits involved in steam power plant	Applying (K3)
CO2	explain the working of gas and diesel power plants with layouts	Applying (K3)
CO3	explain the basic theory of nuclear processes and working of Nuclear and Hydel power plants with their layouts	Applying (K3)
CO4	describe the concepts of utilizing renewable energy sources for power generation	Applying (K3)
CO5	identify the various terminologies related to power plant economics and perform cost analysis in power generation	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3			3	3					3		3
CO2	3	3	3			3	3					3		3
CO3	3	3	3			3	3					3		3
CO4	3	3	3			3	3					3		3
CO5	3	3	3			3	3				1	3		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	10	40	50				100
CAT3	10	30	40	20			100
ESE	10	40	40	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE46 - ENERGY CONSERVATION IN HVAC SYSTEM

(*Use of Refrigeration and Air-Conditioning Table and Psychrometry chart are permitted for the End Semester Examination)*

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics Thermal Engineering	8	PE	3	0	0	3

Preamble	This course provides significant information on energy conservation, energy audit and management practices adoptable for Heating, Ventilation and Air-Conditioning (HVAC) systems.	
Unit - I	**Fundamentals of Thermodynamics**	**9**
Introduction to Energy Conservation – Second Law of Thermodynamics – Exergy Analysis – Reversibility and Irreversibility – Air Conditioning Systems and Cycles – Heat pumps – Psychrometry.		
Unit - II	**Climates and Buildings**	**9**
Climate – Types - Factors that Determine Climate - Climatic Variations – Thermal Properties and Energy Content of Building Materials – Effect of Geographic Locations – Building Aesthetics and Infiltration.		
Unit - III	**Indoor Environmental Requirements**	**9**
Thermal Comfort – Ventilation and Air Quality – Air Conditioning Requirement –Energy Management Options – Energy Audit and Energy Targeting – Design Consideration in Different Climatic Conditions.		
Unit - IV	**Heating and Ventilation Systems**	**9**
Energy Conservation and Feasibility Analysis – Conventional Ventilation Systems – Constant Volume and Variable Volume Induction Systems – Indoor Air Quality – Duct Design and Installation.		
Unit - V	**Air conditioning Systems**	**9**
Energy Conservation in Air Handling Units – Fans - Air Condition Apparatus– Window Air Condition System – Central Air Condition System – Energy Efficient Motors – Cooling Load Estimation – Bypass Factor - Room Sensible Heat Factor – Grand Sensible Heat Factor – Effective Room Sensible Heat Factor.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Faye C.McQuiston, Jerald D.Paeker and Jeffrey D.Spitler, "Heating, Ventilating, and Air Conditioning", 6th Edition, John Wiley & Sons Inc., Singapore, 2005.	I,II,III,IV,V

REFERENCES:

1.	Shan K. Wang , "Hand Book of Air conditioning and Refrigeration", 2nd Edition, McGraw-Hill, New York, 2000.
2.	Jan F. Kreider & Peter S. Curtiss, "Heating and Cooling of Buildings: Design for Efficiency", 2nd Edition, CRC Press, New York, 2010.
3.	ASHRAE Handbook, "HVAC Systems and Equipment 2011, HVAC Applications", ASHRAE Inc., Atlanta, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	define the fundamental thermodynamic principles.	Understanding (K2)
CO2	determine the thermal properties and energy content of building materials.	Analyzing (K4)
CO3	prepare the requirement of indoor environmental conditions based on standards.	Applying (K3)
CO4	analyze the duct design in heating and ventilation systems.	Analyzing (K4)
CO5	perform the cooling load calculations involved in air-conditioning systems.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3											3
CO2	3	3	3		3	3	3							3
CO3	3	3	3		3	3	3						3	3
CO4	3	3	3		3	3	3						3	3
CO5	3	3	3		3	3	3						3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	45	25				100
CAT2	20	30	25	25			100
CAT3	20	20	30	30			100
ESE	15	20	35	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE47 - NANOTECHNOLOGY FOR MECHANICAL ENGINEERS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	The course imparts the basics of Nanotechnology. It emphasize on the fabrication procedures, characterization techniques, technical properties and applications of several nanostructured materials.	
Unit - I	**Fundamentals of Nanotechnology**	**9**
Nanoscience and Nanotechnology – Fundamentals - Classification and General Themes of Nanotechnology - Nanoscale Science - Fabrication and Processing Technology - Size Dependence of Materials Properties - Characterization Tools - Properties of Nanomaterials - Structural Properties - Thermal Properties - Chemical Properties - Mechanical Properties - Magnetic Properties - Optical Properties - Electronic Properties - Biological Properties.		
Unit - II	**Nanoscale Fabrication and Characterization**	**9**
Nanoscale Fabrication - Bottom-up Approach - Chemical Synthesis - Self-Assembly - Top-down approach – Photolithography - Electron Beam Lithography - Focused Ion Beam Lithography - Extreme Ultraviolet Lithography – Nano Imprint Lithography - X-ray Lithography - Soft Lithography. Characterization of Nanomaterials - Atomic Structure and Chemical Composition - Vibrational Spectroscopies - Ultraviolet–Visible Spectroscopies - Electron Microscopy - Zeta Potential Analyzer - Laser Granulometry.		
Unit - III	**Metal Based Nanomaterials and Fluidics**	**9**
Classifications of Nanostructured Materials – Nanopowders - Metal Nanopowders - Metal Oxide Nanopowders - Nanoporous Materials - Silica - Transition Metal Oxides - Metal Sulfides – Metal Aluminum Phosphates - Silicon Nitrides - Aluminum Oxides – Nanodusts – Nanowires - Zinc oxide Nanostructures - Micro and Nano Fluidics - Synthesis – Properties – Applications.		
Unit - IV	**Carbon Nanomaterials**	**9**
Carbon Allotropes - Molecule Structures - Physical and Chemical Properties - Synthesis Methods - Electric Arc Method - Laser Ablation Method - Solar Energy Method. Carbon Nanotubes – Structure and Synthesis - Arc Discharge Method - Laser Ablation Method - Chemical Vapor Deposition Method. Properties - Electrical Conductivity - Optical Activity - Vibrational Properties - Mechanical Strength - Specific Heat and Thermal Conductivity – Applications - Defects in Carbon Nanotubes - Fullerenes - Synthesis – Properties – Applications.		
Unit - V	**Nanocomposites**	**9**
Nanoscale Reinforcements – Synthesis and Properties: Nano Clays - Equi-axed Nanoparticles. Ceramic Matrix Nanocomposites, Metal Matrix Nanocomposites Magnetic Nanocomposites. Polymeric Nanocomposites, - Synthesis methods - Sol-gel Processing - Chemical Vapor Deposition - Mechanical Alloying - Thermal Spraying. Metal Matrix Nanocomposites - Magnetic Nanocomposites. Polymeric Nanocomposites - Synthesis - Melt Mixing Method - Solution Mixing - Thermal Spray Method - Properties - Mechanical Properties - Abrasion and Wear Resistance - Permeability - Thermal Stability - Flammability - Rubber Matrix Nanocomposites - Nano-Bio-Composites - Smart and Intelligent Nanocomposites.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Vijay K Varadan, Sivathanu Pillai A, Debashish Mukherji, Mayank Dwivedi, Linfeng Chen, "Nanoscience and Nanotechnology in Engineering ", 1st Edition, World Scientific, Singapore, 2010.	I,II,III,IV,V

REFERENCES:

1.	Maria Stepanova, Steven Dew, "Nanofabrication Techniques and Principles", 1st Edition, Springer International Publishing, Switzerland, 2012.
2.	Thangadurai, T.D., Manjubaashini, N., Thomas, S., Maria, H.J, "Nanostructured Materials", 1st Edition, Springer International Publishing, Switzerland, 2020.
3.	Paulo Davim J. and Constantinos A. Charitidis, "Nanocomposites - Materials, Manufacturing and Engineering", 1st Edition, De Gruyter, Germany, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the fundamental of nanotechnology	Understanding (K2)
CO2	present the different techniques involved in nanoscale fabrication and characterization	Understanding (K2)
CO3	demonstrate the synthesis route, properties and applications of metal based nanomaterials and fluidics	Applying (K3)
CO4	describe the synthesis route and correlate the structure – property relationship of carbon nanomaterials	Applying (K3)
CO5	select appropriate materials and fabrication techniques to prepare nanocomposites for desired applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												2
CO2	3				3								3	2
CO3	3	3	1	2	3								3	3
CO4	3	3	1	2	3								3	3
CO5	3	2	1		3	1							3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60	-	-	-	-	100
CAT2	20	40	40	-	-	-	100
CAT3	20	40	40	-	-	-	100
ESE	30	40	30	-	-	-	100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE48 – NON-DESTRUCTIVE EVALUATION TECHNIQUES

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Materials and Metallurgy Metrology and Measurements Manufacturing Technology	8	PE	3	0	0	3

Preamble	This course provides the principle and procedures of various non-destructive testing methods used for different engineering inspections to evaluate the defects.	
Unit - I	**Introduction and Liquid Penetrant Testing**	**9**
Non-Destructive Testing (NDT) and its Importance - NDT vs Destructive Testing - Preparation of Test Materials - Visual Examination - Basic Principles - Optical Aids Used and Applications. Liquid Penetrant - Principles - Procedure for Penetrant Testing - Light Sources and Special Lighting - Calibration - Penetrant Testing Methods - Post Emulsification - Developers - Properties of Liquid Penetrant - Sensitivity - Applications and Limitations - Standards.		
Unit - II	**Magnetic Particle Testing**	**9**
Principles - Theory of Magnetism - Characteristics of Magnetic Fields - Magnetizing Techniques - Circular and Longitudinal Magnetization Techniques - Procedures - Equipment Calibration - Sensitivity - Principles and Methods of Demagnetization - Residual Magnetism - Applications and Limitations - Standards - Case studies.		
Unit - III	**Ultrasonic Testing**	**9**
Properties of Sound Beam - Transducers - Inspection Methods - Techniques for Normal and Angle Beam Inspection - Flaw Characterization - Equipment - Methods of Display - A Scan - B Scan - C Scan - Immersion testing - Calibration - Advanced Ultrasonic Testing Methods - Phased Array Ultrasonic Testing (PAUT) & Time of Fight Diffraction (TOFD) - Standards - Application - Advantages and Limitations.		
Unit - IV	**Radiography**	**9**
Electromagnetic Radiation Sources - X-ray Production & Gamma Ray Sources - Properties - Radiation - Attenuation and Effects in Film - Exposure Charts - Radiographic Imaging - Inspection Techniques - Image Quality Indicators (IQI) - Applications and Limitations - Safety in Industrial Radiography -Neuron Radiography - Standards - Case Studies.		
Unit - V	**Eddy Current and Selection of NDT Methods**	**9**
Eddy Current: Principles - Instrumentation - Techniques - Probe - Sensitivity - Advanced Test Methods - Applications & Limitations - Standards - Other Techniques - Acoustic Emission Testing - Principle - Techniques - Instrumentations - Applications and Standards - Homography Thermography - Principles - Equipments - Techniques - Applications and Standards - Leak Testing Methods - Detection and Standards. **Selection of NDT Methods:** Defects in Material - Selection of NDT Method and Instrumentation - Some Case Studies.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Baldev Raj, Jayakumar T. & Thavasimuthu M., "Practical Non Destructive Testing", 3rd Edition, Narosa Publishing House, New Delhi, 2019.	I,II,III,IV,V

REFERENCES:

1.	Hull Barry & John Vernon., "Non Destructive Testing", 3rd Edition, Macmillan, London, 2015.
2.	Hellier C., "Handbook of Non-Destructive Evaluation", 3rd Edition, McGraw-Hill Education, 2020.
3.	Shull Peter J., "Non Destructive Evaluation: Theory - Techniques and Applications", Marcel Dekkar Inc., New York, USA, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	depict the importance of non-destructive testing methods and impart knowledge on liquid penetrant and visual inspection methods.	Applying (K3)
CO2	demonstrate the various magnetic particle testing methods.	Understanding (K2)
CO3	illustrate the principle of ultrasonic testing and its modern methods.	Applying (K3)
CO4	demonstrate Radiographic principles and testing of defects.	Applying (K3)
CO5	discuss on other non-destructive testing techniques and select appropriate method for defect identification.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				2					1		1	3	2
CO2	3				2					1		1	3	2
CO3	3				3					1		1	3	2
CO4	3				3					1		1	3	2
CO5	3	2			3					1		1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	40	45				100
CAT2	15	40	45				100
CAT3	20	25	30	25			100
ESE	20	25	35	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEE49 - INDUSTRIAL MARKETING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	This course deals with the behaviour of customers and marketing strategies. It improves the skills for solving the real time engineering marketing strategies and useful to design the channel of market and product development.	
Unit - I	**Introduction**	**9**
Introduction to Industrial Markets - Marketing System - Concepts - Characteristics – Definition Exchange Processes – Characteristics of Industrial and Consumer Markets –Market Demand – Cross Elasticity of Demand-Business Ethics.		
Unit - II	**Industrial Purchasing**	**9**
Types of Industrial Customers - Purchasing Practices - Industrial Buyer Behaviour – Industrial Buying Situation – Decision Making Units – Models of Organizational Buying Behaviour- Modern Purchasing Terminologies.		
Unit – III	**Marketing Planning and Research**	**9**
Marketing Planning: Business Marketing – Marketing Planning – Corporate Strategic Planning – Target Marketing - Marketing Information Systems. **Marketing Research:** Market Evaluation - Role of IT in Marketing Information Systems - Definition and Process of Marketing Research - Research Instruments.		
Unit - IV	**Product Development and Pricing**	**9**
Industrial Products and Services Definition - New Industrial Product Development – Product Life Cycle - Marketing Strategies - Industrial Pricing Characteristics- Influencing Factors in Pricing Decisions of Industrial Markets-Classification of Costs-Pricing Strategies.		
Unit - V	**Channel Design**	**9**
Economic Performances and Channel Management Decisions- Industrial Logistics System- Role and Characteristics of Industrial Distributors- Sales Promotion – Personal Selling - Sales Force Management – Advertising in Marketing – Industrial Communication Programs.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Hawaldar, K. Krishna, "Industrial Marketing", 4th Edition, Tata McGraw Hill, New Delhi, 2015.	I,II,III,IV,V

REFERENCES:

1.	Philip Kotler, Gary Armstrong & Prafulla Agnihotri, "Principles of Marketing", 17th Edition , Pearson Education, 2018
2.	Robert R. Reeder, Briety & Betty H. Reeder, "Industrial Marketing", 4th Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain industrial marketing system and concepts	Understanding (K2)
CO2	analyze industrial markets models of organizational buying behaviour.	Analyzing (K4)
CO3	examine the importance of marketing information systems and marketing research processes.	Analyzing (K4)
CO4	discuss industrial products and recall the factors influencing its pricing decisions.	Analyzing (K4)
CO5	dissever channel design process and appraise industrial	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2					3	3	2						2
CO2	2	2				3	3	2		1				2
CO3	2	2				3	3	2		1				2
CO4	2	2				3	3	2		1				2
CO5	2	2				3	3	2		1				2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	25	30	30			100
CAT2	15	30	35	20			100
CAT3	20	25	25	30			100
ESE	15	25	30	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEO01 - RENEWABLE ENERGY SOURCES

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	OE	3	0	2	4

Preamble	This course discusses various technologies behind renewable energy conversion process and the challenges in integrating power from renewable energy plants with grid.	
Unit – I	**Grid Integration of Renewable Energy**	**9**
Global Energy Use- Energy Status in India -Lifetime of Fossil Fuels- Energy Conversion Technologies - Thermodynamic Efficiency – Variability – Intermittency - Dispatchability - Electric Grid Infrastructure - Integrating Renewable Energy into the Grid - Growing a More Efficient Grid - Smart Grid - Secure Communication in the Smart Grid.		
Unit – II	**Solar Energy and Wind Energy**	**9**
Solar Energy: Solar Radiation – Measurements of Solar Radiation and Sunshine - Solar Thermal Collectors –Flat Plate and Concentrating Collectors - Fundamentals of Solar Photo Voltaic Conversion – Solar PV Systems-Types- Design of a Standalone Solar PV System - Solar PV and Thermal Applications - Building Integrated Solar- Leadership in Energy Environment Design (LEED) Certification- Challenges - Economics. **Wind Energy**: Basic Terms – Types - Horizontal Axis Wind Turbine-Vertical Axis Wind Turbine - Building Integrated Wind Turbines - Wind Turbine Generator and its Performance - Wind Turbine Applications - Recent Developments in Offshore Wind Turbines and Energy Storage - Hybrid Systems - Challenges - Economics.		
Unit - III	**Bioenergy**	**9**
Biomass Resources - Biomass Conversion Technologies - Factors Affecting Biogas Production -Biogas Plant – Types – KVIC Model - Deenbandhu Model - Cogeneration Plant in Rice Mill- Ethanol Production - Energy Recovery from Urban Waste. Transportation – Challenges - Economics.		
Unit - IV	**Geothermal Energy and Ocean Energy**	**9**
Geothermal Energy: Geothermal Resources-Structure of Earth's Interior - Electricity Production - Conversion Technology - Challenges - Economics. **Ocean Energy:** Tidal Plants – Types - Energy Estimation - Grid Interfacing of Tidal Power - Wave Energy Conversion Machines – Types – Buoy - Dolphin - Oscillating Duck -Challenges - Economics.		
Unit – V	**Direct Energy Conversion Systems and New Energy Sources**	**9**
Direct Energy Conversion Systems: MHD Generators – Thermoelectric Power Generation. **New Energy Sources**: Hydrogen – Generation – Storage - Transport and Utilization - Applications - Power Generation – Transport - Hydrogen Economy - Safety Issues - Fuel Cell – Principle –Types.		

List of Exercises / Experiments:

1.	Evaluate the cut in speed of the wind turbine.
2.	Analyze the effect of the variation of Tip speed ratio on the Coefficient of power of wind turbine.
3.	Study the air flow over an aerofoil in a Wind Tunnel.
4.	Determine the thermal energy gain at the focal point of a concentrating collector.
5.	Determine the efficiency of solar (Liquid/Air) collector.
6.	Plot the effect of variation of tilt angle on the PV module output.
7.	Plot the effect of variation of Solar intensity on the PV module output.
8.	Study on rooftop Solar PV plant.
9.	Study on weather monitoring station.
10.	Innovative model development based on Renewable Energy Sources.

Lecture: 45, Practical: 30, Total: 75

TEXT BOOK:

1.	Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay, William A. Peters. , "Sustainable Energy: Choosing Among Options", 2nd Edition, MIT Press, USA, 2012.	I,II,III,IV,V

REFERENCES:

1.	John Twidell,Tony Weir, "Renewable Energy Resources", 3rd Edition, Routledge,New York, 2015.
2.	Kothari D.P., Singal K.C., Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2011.
3.	Rai G.D., "Non-Conventional Energy Sources", 6th Edition, Khanna Publishers, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the concepts behind the integration of renewable energy into the grid.	Understanding (K2)
CO2	describe the working and applications of solar and wind energy systems.	Applying (K3)
CO3	describe the bio-energy production techniques.	Applying (K3)
CO4	describe the working of geothermal energy and Ocean energy conversion systems.	Understanding (K2)
CO5	the direct energy conversion systems and new energy sources.	Understanding (K2)
CO6	conduct the experiments in solar PV and solar collectors.	Applying (K3), Manipulation (S2)
CO7	evaluate the cut in speed, tip speed ratio and coefficient of power in wind electric generators.	Applying (K3), Manipulation (S2)
CO8	analyse the data from weather monitoring station and develop small scale innovative models.	Analyzing (K4), Articulation (S4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3					3							
CO2	3	3					3							
CO3	3	3					3							
CO4	3	3					3							
CO5	3	3					3							
CO6	3	3		3					3	3			2	3
CO7	3	3		3					3	3			2	3
CO8	3	3		3					3	3			2	3

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	40	30				100
CAT2	30	30	40				100
CAT3	50	50					100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEO02 - DESIGN OF EXPERIMENTS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	0	2	4

Preamble	The course explores the fundamentals of experimental design, single factor and multifactor experiments. In addition, the course deals with design of experiments, which includes the optimization techniques like ANOVA, Factorial Design, Response Surface Methodology, Taguchi Method.	
Unit - I	**Experimental Design Fundamentals**	**9**
Importance of Experiments - Experimental Strategies-Basic Principles of Design-Terminology-ANOVA-Steps in Experimentation-Sample Size-Normal Probability Plot-Linear Regression Model.		
Unit - II	**Multifactor Experimental Design**	**9**
Classical Experiments: Factorial Experiments-Terminology-Factor Levels - Interactions-Treatment Combination-Randomization-Two Level Experimental Designs for Two Factors and Three Factors. Three Level Experimental Designs for Two Factors and Three Factors-Factor Effects-Factor Interactions-Fractional Factorial Design-Saturated Designs-Central Composite Designs-Illustration Through Numerical Examples.		
Unit - III	**Analysis and Interpretation Methods**	**9**
Measures of Variability-Ranking Method-Column Effect Method-Plotting Method-Analysis of Variance (ANOVA) in Factorial Experiments-YATE's Algorithm for ANOVA-Regression Analysis-Mathematical Models from Experimental Data-Illustration Through Numerical Examples.		
Unit - IV	**Special Experimental Designs**	**9**
Fractional Factorial Design-Nested Designs-Split Plot Design-Introduction- Response Surface Methodology-Experiments with Random Factors-Rules for Expected Mean Squares- Approximate F-Tests.		
Unit - V	**Taguchi Methods**	**9**
Steps in Experimentation-Design using Orthogonal Arrays-Data Analysis-Robust Design- Control And Noise Factors-S/N Ratios-Parameter Design-Case Studies.		

List of Exercises / Experiments :

1.	Design of experiments for turning operations by the Taguchi method.
2.	Design of experiments for milling operations by Taguchi method.
3.	Optimize the parameters that affect the quality of CNC turning operation by the Taguchi method.
4.	Optimize the parameters that affect the quality of CNC milling operation by the Taguchi method.
5.	Process parameter optimization in turning using the central composite design method.
6.	Process parameter optimization in turning using the Box–Behnken design method.
7.	Process parameter optimization in surface grinding by Response Surface Method
8.	Mathematical model development for turning operation
9.	Mathematical model development for milling operation.
10.	Mathematical model development for drilling operation.

Lecture: 45, Practical: 30, Total: 75

TEXT BOOK:

1.	Douglas C. Montgomery, "Design and Analysis of Experiments", 10th Edition, John Wiley and Sons, United States, 2019.	I,II,III,IV,V

REFERENCES:

1.	Phillip J.Rose., "Taguchi Techniques for Quality Engineering", 2nd Edition, McGraw Hill, New Delhi, 2005.
2.	Nicolo Belavendram., "Quality by Design; Taguchi Techniques for Industrial Perimentation", Prentice Hall, London, 1995.
3.	Krishnaiah, K and Shahabudeen, P., "Applied Design of Experiments and Taguchi Methods", PHI Learning Private Ltd., New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	present the fundamental concepts in experimental design.	Understanding (K2)
CO2	identify and design single and multifactor experiments.	Applying (K3)
CO3	select different analysis and interpretation methods for experimental results.	Analyzing (K4)
CO4	apply the concepts of special experiment designs.	Analyzing (K4)
CO5	apply and analyze the concepts of Taguchi experiment design for practical problems.	Analyzing (K4)
CO6	design and conduct experiments using Taguchi method.	Analyzing (K4) Manipulation (S2)
CO7	design and analyze the experimental results using response surface method	Analyzing (K4), Manipulation (S2)
CO8	develop mathematical model using regression analysis.	Applying (K3), Articulation (S4)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3											
CO2	3	3	3	3										
CO3	3	3	3	3										
CO4	3	3	3	3										
CO5	3	3	3	3										
CO6	3	3	3	3	3						3		3	3
CO7	3	3	3	3	3						3		3	3
CO8	3	3	3	3	3						3		3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	30	55				100
CAT2	10	15	50	25			100
CAT3	10	20	30	40			100
ESE	10	20	35	35			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEO03 - FUNDAMENTALS OF ERGONOMICS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	0	3

Preamble	This course provides the basic concepts of ergonomics and various tools and techniques involved in designing comfortable and safe workplace.	
Unit - I	**Introducing Ergonomics**	**9**
Fundamentals of Ergonomics / Human Factors - Disciplines - Physical - Cognitive and Organizational - Needs of Ergonomics in Workplace - Ergonomic Principles - Applications - Ergonomic Evaluation - Questionnaire Survey.		
Unit - II	**Anthropometry**	**9**
Human Body - Structure and Function - Types of Anthropometric Data - Application of Anthropometry in Design - Anthropometric Measuring Techniques - Statistical Treatment of Data and Percentile Calculations		
Unit - III	**Posture and Movement**	**9**
Posture : Biomechanical Background - Physiological Background - Sitting - Standing Change of Posture - Hand and Arm Postures **Movement:** Lifting - Carrying - Pulling - Pushing - Repetitive Motions - Rapid Upper Limb Assessment (RULA) – Rapid Entire Body Assessment (REBA) and Ovako Working Posture Assessment (OWAS) Method.		
Unit - IV	**Work Counter Behavior and Perception**	**9**
Work Counter: Environmental Issues - Physical Work Capacity - Factors Affecting work Capacity - Communication and Cognitive Issues - Information Processing and **Perception:** Interaction with Machines - Mental Workload.		
Unit - V	**Work system Evaluation and Safety**	**9**
Work system Evaluation : Contribution of Ergonomics to Workstation Design - Analysis of Workplace Design - Work Envelopes - Workplace Evaluation Tools - Case Studies **Safety :** Occupational / Ergonomic Safety and Stress at Various Workplace - Health Management Rules - Scope of Ergonomics in India-Case Studies.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Bridger, Robert. “Introduction to Human Factors and Ergonomics”, United Kingdom, CRC Press, 2017	I,II,III,IV,V

REFERENCES:

1.	Pamela McCauley-Bush, "Ergonomics: Foundational Principles, Applications, and Technologies", 1st Edition, Taylor & Francis, CRC Press, New York, 2011.
2.	Dul, Jan, and Weerdmeester, Bernard. “Ergonomics for Beginners: A Quick Reference Guide”, 3rd Edition. United Kingdom, Taylor & Francis, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	define ergonomics and its components.	Understanding (K2)
CO2	make use of statistical treatment of data in designing the components of office and shop floor.	Applying (K3)
CO3	examine the common risk factors and areas for ergonomic improvement.	Analyzing (K4)
CO4	apply ergonomic principles in assigning task to the workers	Applying (K3)
CO5	plan the essential elements for an effective ergonomics programme.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1		2							2	2	1
CO2	2		2	2	2							1	2	1
CO3	2			1	2	2	2					2	2	1
CO4	2		2		2	1	1					1	2	1
CO5	2				2							2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	45	30				100
CAT2	20	30	30	20			100
CAT3	20	25	25	30			100
ESE	10	40	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEO04 - PRINCIPLES OF MANAGEMENT AND INDUSTRIAL PSYCHOLOGY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	0	3

Preamble	The course provides the principles, theory and practice of management followed in organizations. In addition, it covers the skills to meet the challenges of management, human behavior in a diverse and complex environment.	
Unit - I	**Principles of Management**	**9**
Definition and Significance of Management - Evolution of Modern Management - Scientific Management - Development of Management Thought - Approaches to the study of Management - Basic Functions of Management - Introduction.		
Unit - II	**Functions of Management**	**9**
Planning - Objectives and Strategies - Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Decentralization - Organizational culture - Staffing - Selection and training - Placement - Performance appraisal - Career Strategy - Organizational Development - Leading - Managing Human Factor - Leadership - Communication - Controlling - Process of Controlling - Controlling Techniques - Productivity and Operations Management - Preventive Control - Industrial Safety.		
Unit - III	**Organizational Behavior**	**9**
Definition - Organization - Managerial Role and Functions - Organizational Approaches - Individual Behavior - Causes - Environmental Effect - Behavior and Performance - Perception - Organizational Implications - Personality - Contributing factors - Dimension - Need Theories - Process Theories - Job Satisfaction - Learning and Behavior - Learning Curves - Work Design and Approaches.		
Unit - IV	**Industrial Psychology and Group Dynamics**	**9**
Industrial Psychology : Introduction - Concept and Meaning - Characteristics and Scope - Historical Development - Individual Behavior **Group Dynamics**: Group Behavior - Features of Group - Formation and Development - Types of Groups - Group Structure and Cohesiveness.		
Unit - V	**Interpersonal Relationship**	**9**
Leadership - Concept and Meaning - Principles and Theories - Managing Emotions - Emotional Intelligence - Building Interpersonal Relations - Managing the Boss - Dealing with Subordinates.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Harold Koontz & Heinz Weihrich., "Essentials of Management: An International, Innovation and Leadership Perspective", 11th Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2020.	I,II,III
2.	Michael G Aamodt., "Industrial Psychology", 7th Edition, Cengage Learning, India, 2013.	IV,V

REFERENCES:

1.	Chandran J.S., "Organizational Behaviour", 3rd Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the theory and the practice of management.	Understanding (K2)
CO2	demonstrate knowledge and understanding of the functions of management.	Understanding (K2)
CO3	define organizational behavior and explain how managers create organizational culture.	Applying (K3)
CO4	develop an intuitive understanding of the science of human behavior and the art of managing groups.	Understanding (K2)
CO5	develop ability for solving problems involving employee - industry relationship.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	3	3	1			3
CO2						3		3	3	3				3
CO3						3		3	3	3				3
CO4						3		3	3	3				3
CO5						3		3	3	3				3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	45	55					100
CAT2	25	45	30				100
CAT3	20	25	30	25			100
ESE	25	30	25	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEO05 - SAFETY MEASURES FOR ENGINEERS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	The course explores the knowledge on safety aspects, procedures and guidelines to be followed in various industries, while performing various types of activities in electrical, chemical industries with appropriate personal personnel protection equipments and risk assessment procedures.	
Unit - I	**Safety Management and Accident Prevention**	**9**
Safety Management: Need for Safety - Safety and Productivity - Safety Management Techniques - Job Safety Analysis - Safety Sampling Technique - Incident Recall Technique - Plant Safety Inspection – **Accident Prevention:** Nature and Causes of Accidents - Accident Proneness - Cost of Accident - Accident Prevention Methods - Accident Reporting and Investigation - Safety Education and Training		
Unit - II	**Electrical and Fire Safety**	**9**
Usefulness and Hazards of Electricity - Statutory Provisions - Indian Standards - Effects of Electrical Parameters on Human Body - Safety Measures for Electric work - Overload and Other Protections - Portable Electrical Apparatus - Electric Work in Hazardous Atmosphere - Static Electricity - Energy Conservation and Safety Fire Phenomena - Classification of Fire and Extinguishers - Statutory and other standards - Design for Fire Safety - Fire Prevention and Protection System - Explosion Phenomena - Inspection, Maintenance and Training for Fire Protection		
Unit – III	**Safety in Chemical Industry**	**9**
Types of Chemical Industry - Statutory Provisions - Indian Standards – Types of Chemical Hazards & Controls – Material (Property) Hazards and Controls – Storage Hazards & Controls - Process Hazards & Controls - Utility Hazards & Controls - Pollution Hazards & Controls - Instrumentation for Safe Plant Operations - Safe Transfer of Chemicals - Inspection, Testing & Maintenance - Work Permits of Hazardous Work		
Unit – IV	**Personnel Protection Equipment (PPE)**	**9**
Need and Limitation - Statutory Provisions - Indian & Other standards - Selection and Classification - Non Respiratory Equipment - Respiratory Equipment - Training, Maintenance, Precaution and Care of PPE - Detection Equipment - PPE Testing Procedures & Standards		
Unit - V	**Risk Assessment**	**9**
Basic Concepts of Risk - Safety Appraisal, Analysis and Control Techniques - Accident Investigation, Analysis and Reporting - Hazard and Risk Assessment Techniques - Reliability Engineering - Major Accident Hazard (MAH) Control - On-site and Off-site Emergency Plans		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Mistry K.U., "Fundamentals of Industrial Safety and Health", 2nd Edition, Siddharth Prakashan, Ahmedabad, 2008.	I,II,III,IV,V

REFERENCES:

1.	John Cadick, Mary Capelli Schellpfeffer & Dennis Neitzell, "Electrical Safety Handbook", 4th Edition, McGraw-Hill Education, 2012.
2.	Davies V.J. & Thomasin K., "Construction Safety Hand Book", 2nd Edition, Thomas Telford Ltd., London, 1996.
3.	Rao S, Jain R.K. & Saluja H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", 2nd Edition, Khanna Publishers, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	perceive the safety management concepts and accident prevention methods.	Understanding (K2)
CO2	apply appropriate measuring and /or insulating equipment, use of fire extinguishers and safe earthing practices.	Applying (K3)
CO3	identify the hazards in chemical industries during transporting, storing and processing to ensure safe plant operations	Applying (K3)
CO4	select the PPE based on the type of industry and standards.	Applying (K3)
CO5	implement the techniques like risk assessment disaster management and emergency preparedness with the proper knowledge on accident prevention.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			2		3	3	3						
CO2	3			2		3	3	3						
CO3	3			3		3	3	3						
CO4	3			1		3	3	3						
CO5	3			3		3	3	3						

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	45	40				100
CAT2	20	40	40				100
CAT3	20	20	30	30			100
ESE	15	25	30	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MEO06 - ENERGY CONSERVATION IN THERMAL EQUIPMENTS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	This course provides the knowledge on the methods to conserve energy in thermal equipments after a detailed evaluation of the performance parameters.	
Unit - I	**Basics of Energy**	**9**
Energy – Forms of Energy – Power – Units – Estimation of Energy Requirement – Electricity – Voltage – Current – Resistance – Measurement of Electrical Quantities - Energy Efficiency and Conservation – Plant Energy Performance – Production Factor – Company Energy Performance – Energy Audit and Survey Instruments - Energy related CO_2 emissions – Strategies for Energy Savings in Industries.		
Unit - II	**Energy Conservation in Steam System**	**9**
Steam Phase Diagram - Steam Distribution - Steam Pipe Design and Sizing – Steam Traps – Selection – Operation – Maintenance - Performance Assessment Methods -– Energy Saving Opportunities.		
Unit – III	**Energy Conservation in Boilers and Furnaces**	**9**
Boiler: Water Treatment – Water for Steam Raising – Hot Water Systems – Heat transfer Coefficients – Boiler Performance Assessment using Direct and Indirect Method – Energy Conservation Opportunities. **Furnace:** Performance Evaluation – General Fuel Economy Measures- Estimation of fuel savings.		
Unit – IV	**Energy Conservation in Air conditioners**	**9**
Load Characteristics and Calculation- Factors Affecting Cooling Rate- Air conditioner – Working – Types – Efficiency – Sizing - Energy Conservation Opportunities – Energy Monitoring and Control System.		
Unit - V	**Cogeneration**	**9**
Need – Classification – Commercial Cogeneration Systems – Factors and Technical Parameters Influencing the Selection of Cogeneration Systems – Energy Savings through Cogeneration Systems- Relative Merits of Cogeneration Systems – Performance Assessment.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Guide Books for National Certification Examination for Energy Managers and Auditors, 4th Edition, Bureau of Energy Efficiency,2015.	I,II,III,IV,V

REFERENCES:

1.	Sonal Desai, "Handbook of Energy Audit", 1st Edition, McGraw Hill Education, New Delhi, 2015.
2.	Stephan A Roosa, Steve Doty, Wayne C Turner, "Energy Management Handbook", 9th Edition, River Publishers, New York, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the basics of energy with a view of conserving it.	Understanding (K2)
CO2	identify the energy conservation opportunities in steam system.	Applying (K3)
CO3	categorize the energy conservation opportunities in boilers and furnaces.	Applying (K3)
CO4	recognize the energy conservation opportunities in air conditioners.	Applying (K3)
CO5	quantify the energy savings due to cogeneration	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3												
CO2	3	3												
CO3	3	3												
CO4	3	3												
CO5	3	3												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	50	20				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	15	50	35				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**