KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI - 2018

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted during 2018 - 2019 and onwards)

BACHELOR OF ENGINEERING DEGREE
IN
MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

KONGU
Assuring the Best

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KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

INSTITUTE VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

INSTITUTE MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Provide value based quality education for the development of students as competent and responsible citizens.
- Contribute to the nation and beyond through research and development
- Continuously improve our services

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To be a centre of excellence for development and dissemination of knowledge in Mechanical Engineering for the Nation and beyond.

MISSION

Department of Mechanical Engineering is committed to:

MS1: Establish itself as an excellent academic centre through expert pedagogical methods and modern laboratories to produce world class mechanical engineers.

MS2: Disseminate knowledge through seminar, conferences and continuing education programs.

MS3: Make tie-ups with industries, research centres and renowned institutions to synergize the benefit.

MS4: Contribute towards the upliftment of the society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of Mechanical Engineering will

PEO1: Practice Mechanical Engineering in the general stems of design, manufacture, service and allied engineering sectors.

PEO2: Habituate continuous learning and carryout research and development in science, engineering and technology that support career growth.

PEO3: Exhibit ethical code of conduct in a professional manner to solve real-time multidisciplinary engineering problems.

PEO4: Demonstrate managerial and leadership capabilities that support economic development of firms as well as society.

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3	PEO4
MS1	3	3	3	3
MS2	2	3	2	1
MS3	2	3	2	2
MS4	1	1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)

Graduates of Mechanical Engineering will**:**

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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

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

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

PO12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of Mechanical Engineering will**:**	
PSO1	**Modern tool usage:** use the techniques, skills and modern engineering tools necessary for engineering practice.
PSO2	**Domain Knowledge:** work professionally in thermal, manufacturing and mechanical system areas including the design and realization of such systems with the use of computational tools.

MAPPING OF PEOs WITH POs AND PSOs

PEO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
PEO1	3	3	3	2	2	2	2	1	1	2	2	2	2	3
PEO2	3	3	3	3	3	3	2	1	1	2	2	2	3	3
PEO3	3	3	3	2	2	1	2	3	1	2	1	2	2	2
PEO4	2	1	2	1	2	3	1	2	2	2	3	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(Autonomous)

REGULATIONS 2018
(Revision: 4)

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 2018 – 2019 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
BTech	Chemical Engineering
	Information Technology
	Food Technology

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/industrial 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/Industrial Training, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship in Industry or elsewhere

viii. Audit Courses (AC)

ix. Mandatory Courses (MC)

4.2 Credit Assignment

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 programme shall vary from 168 to 173 as per the chosen programme of study.

4.3 Employability Enhancement Courses

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

4.3.1 Professional Skills Training/Industrial 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 and 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 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 courses or dropping of already registered additional elective 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) and 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.

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Comprehensive Test and Viva, 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:

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

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 the continuous assessment shall be for 100 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidates' records maintained.

7.5.1 The apportionment of continuous assessment marks for each course shall be decided by the course coordinator based on rubrics of that particular course.

Type	Max. Marks	Remarks
Assessment based on rubrics for each experiment	50	Absolute Mark System
Assessment Test	50	
Total	100	Rounded off to one decimal place

7.6 Project Work II / Project Work I 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/ Project Work I 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	Super visor	Review Committee (excluding Super visor)	Super visor	Review Committee (excluding Super visor)	Super visor	Ext. Exr.	Super visor	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 end semester examination of 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 supervisor 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	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee	Supervisor	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 4^{th} semester vacation and during 5^{th} semester. Phase II training shall be conducted for minimum of 80 hours in 5^{th} semester vacation and during 6^{th} semester. The evaluation procedure shall be approved by the Principal.

7.9 Comprehensive Test and 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 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 Universal Human Values

The course imparting the human values shall be taught for all candidates who have joined in various branches of all BE/BTech programmes. This course shall carry a maximum of 100 marks and shall be evaluated through continuous assessment tests only vide clause 7.1. The candidate(s) can earn 2 credits by successfully completing this course. Two continuous assessment tests will be conducted and the average marks will be taken for the GPA and CGPA calculations.

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 and satisfy the attendance requirements.

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.

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.

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-2018 (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 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.

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.

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.

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CURRICULUM BREAKDOWN STRUCTURE										
Summary of Credit Distribution										
Category	**Semester**								**Total number of credits**	**Curriculum Content (% of total number of credits of the program)**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
HS	**3**	**4**		**1**	**2**		**3**		**13**	**7.6**
BS	**11**	**11**	**4**	**4**					**30**	**17.4**
ES	**7**	**3**	**4**						**14**	**8.1**
PC		**3**	**16**	**21**	**16**	**12**			**68**	**39.5**
PE						**3**	**9**	**3**	**15**	**8.7**
OE					**4**	**4**	**3**	**3**	**14**	**8.1**
EC					**2**	**4**	**6**	**6**	**18**	**10.5**
Semester wise Total	**21**	**21**	**24**	**26**	**24**	**23**	**21**	**12**	**172**	**100.00**

Category	Abbreviation
Lecture hours per week	**L**
Tutorial hours per week	**T**
Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week	**P**
Credits	**C**

CATEGORISATION OF COURSES							
HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT (HS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18EGT11	English for Communication I	3	0	0	3	I
2.	18EGT21	English for Communication II	3	0	0	3	II
3.	18VEC11	Value Education	2	0	1	1	II
4.	18EGL31	English for workplace communication	0	0	2	1	IV
5.	18GET51	Universal Human Values	2	0	0	2	V
6.	18MBT71	Engineering Economics and Management	3	0	0	3	VII
Total Credits to be earned						**13**	

BASIC SCIENCE (BS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18MAC11	Mathematics I	3	1*	2*	4	I
2.	18PHC11	Applied Physics	3	0	2*	3.5	I
3.	18CYC11	Applied Chemistry	3	0	2*	3.5	I
4.	18MAC21	Mathematics II	3	1*	2*	4	II
5.	18PHC22	Materials Science	3	0	2*	3.5	II
6.	18CYC22	Environmental Chemistry in Mechanical Systems	3	0	2*	3.5	II
7.	18MAC31	Mathematics III	3	1*	2*	4	III
8.	18MAC41	Statistics and Numerical Methods	3	1*	2*	4	IV
Total Credits to be earned						**30**	

ENGINEERING SCIENCE (ES)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18GET11	Introduction to Engineering	3	0	0	3	I
2.	18MEC11	Engineering Drawing	2	0	2	3	I
3.	18MEL11	Engineering Practices Laboratory	0	0	2	1	I
4.	18CSC11	Problem Solving and Programming	2	0	2	3	II
5.	18EET35	Electrical Drives and Industrial Electronics	3	0	0	3	III
6.	18EEL34	Electrical Engineering Laboratory	0	0	2	1	III
Total Credits to be earned						**14**	

PROFESSIONAL CORE (PC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream***
1.	18MET21	Manufacturing Technology	3	0	0	3	II	Mfg
2.	18MET31	Engineering Mechanics	3	1	0	4	III	Design
3.	18MET32	Engineering Thermodynamics	3	1	0	4	III	Thermal
4.	18MET33	Fluid Mechanics and Hydraulic Machines	3	0	0	3	III	Thermal
5.	18MET34	Engineering Materials and Metallurgy	3	0	0	3	III	Mfg
6.	18MEL31	Fluid Mechanics and Hydraulic Machines Laboratory	0	0	2	1	III	Thermal
7.	18MEL32	Manufacturing Technology Laboratory	0	0	2	1	III	Mfg

8.	18MET41	Strength of Materials	3	1	0	4	IV	Design
9.	18MET42	Thermal Engineering	3	1	0	4	IV	Thermal
10.	18MET43	Kinematics of Machinery	3	1	0	4	IV	Design
11.	18MET44	Material Removal Processes	3	0	0	3	IV	Mfg
12.	18MET45	Instrumentation and Control	3	0	0	3	IV	Design
13.	18MEL41	Material Removal Processes Laboratory	0	0	2	1	IV	Mfg
14.	18MEL42	Advanced Materials Testing Laboratory	0	0	2	1	IV	Design
15.	18MEL43	Thermal Engineering Laboratory	0	0	2	1	IV	Thermal
16.	18MET51	Heat and Mass Transfer	3	1	0	4	V	Thermal
17.	18MET52	Dynamics of Machinery	3	0	0	3	V	Design
18.	18MET53	Machine Drawing	3	0	0	3	V	Design
19.	18MET54	Design of Machine Elements	3	0	0	3	V	Design
20.	18MEL51	Heat Transfer Laboratory	0	0	2	1	V	Thermal
21.	18MEL52	Metrology and Dynamics Laboratory	0	0	2	1	V	Design
22.	18MEL53	CAD Laboratory	0	0	2	1	V	Design
23.	18MET61	Mechatronics and IoT	3	0	0	3	VI	Design
24.	18MET62	Design of Transmission System	3	0	0	3	VI	Design
25.	18MET63	Finite Element Analysis	3	0	0	3	VI	Design
26.	18MEL61	Mechatronics and IoT Laboratory	0	0	2	1	VI	Design
27.	18MEL62	CAM Laboratory	0	0	2	1	VI	Mfg
28.	18MEL63	Simulation and Analysis Laboratory	0	0	2	1	VI	Design
Total Credits to be earned						**68**		

PROFESSIONAL ELECTIVE (PE)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
		Elective – I						
1.	18MEE01	Fluid Power System	3	0	0	3	VI	Design
2.	18MEE02	CAD/CAM/CIM	3	0	0	3	VI	Design
3.	18MEE03	Gas Dynamics and Jet Propulsion	3	0	0	3	VI	Thermal
4.	18MEE04	Refrigeration and Air Conditioning	3	0	0	3	VI	Thermal
5.	18MEE05	Unconventional Machining Processes	3	0	0	3	VI	Mfg.
6.	18MEE06	Design for Manufacture and Assembly	3	0	0	3	VI	Mfg.

7.	18MEE07	Operations Research	3	0	0	3	VI	Ind. Engg.
8.	18MEE08	Production Planning and Control	3	0	0	3	VI	Ind. Engg.
		Elective – II						
9.	18GEE01	Fundamentals of Research	3	0	0	3	VII	General
10.	18MEE09	Piping Design	3	0	0	3	VII	Design
11.	18MEE10	Design of Jigs, Fixtures and Press Tools	3	0	0	3	VII	Design
12.	18MEE11	Fuels and Combustion Technology	3	0	0	3	VII	Thermal
13.	18MEE12	Computational Fluid Dynamics	3	0	0	3	VII	Thermal
14.	18MEE13	CNC Technology	3	0	0	3	VII	Mfg.
15.	18MEE14	Precision Engineering	3	0	0	3	VII	Mfg.
16.	18MEE15	Total Quality Management	3	0	0	3	VII	Ind. Engg.
17.	18MEE16	Project Management	3	0	0	3	VII	Ind. Engg.
		Elective – III						
18.	18MEE17	Mechanics of Composite Materials	3	0	0	3	VII	Design
19.	18MEE18	Advanced Structure of Materials	3	0	0	3	VII	Design
20.	18MEE19	Automobile Engineering	3	0	0	3	VII	Thermal
21.	18MEE20	Design of Heat Exchangers	3	0	0	3	VII	Thermal
22.	18MEE21	Additive Manufacturing	3	0	0	3	VII	Mfg.
23.	18MEE22	Welding Technology	3	0	0	3	VII	Mfg.
24.	18MEE23	Quality and Reliability Engineering	3	0	0	3	VII	Ind. Engg.
25.	18MEE24	Industrial Engineering and Cost Analysis	3	0	0	3	VII	Ind. Engg.
		Elective – IV						
26.	18MEE25	Introduction to Aircraft Systems	3	0	0	3	VII	Design
27.	18MEE26	Industrial Tribology	3	0	0	3	VII	Design
28.	18MEE27	Instrumentation in Thermal Engineering	3	0	0	3	VII	Thermal
29.	18MEE28	Energy Auditing and Management	3	0	0	3	VII	Thermal
30.	18MEE29	Manufacturing Information System	3	0	0	3	VII	Mfg.
31.	18MEE30	Micro Electro Mechanical Systems	3	0	0	3	VII	Mfg.
32.	18MEE31	Maintenance Engineering	3	0	0	3	VII	Ind. Engg.
33.	18MEE32	Industrial Safety Engineering	3	0	0	3	VII	Ind. Engg.
34.	18MEE33	Hybrid Vehicle Technology	3	0	0	3	VII	General
		Elective – V						
35.	18MBE49	Entrepreneurship Development	3	0	0	3	VIII	Ind. Engg.

36.	18MEE34	Introduction to Aircraft Structures	3	0	0	3	VIII	Design
37.	18MEE35	Principles of Farm Machineries	3	0	0	3	VIII	Design
38.	18MEE36	Power Plant Engineering	3	0	0	3	VIII	Thermal
39.	18MEE37	Energy Conservation in HVAC System	3	0	0	3	VIII	Thermal
40.	18MEE38	Nanoscience and Technology for Mechanical Engineers	3	0	0	3	VIII	Mfg.
41.	18MEE39	Non-Destructive Evaluation Techniques	3	0	0	3	VIII	Mfg.
42.	18MEE40	Industrial Marketing	3	0	0	3	VIII	Ind. Engg.
Total Credits to be earned						**15**		

EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18GEL51/ 18GEI51	Professional Skills Training I / Industrial Training I	0	0	0	2	V
2.	18GEL61/ 18GEI61	Professional Skills Training II / Industrial Training II	0	0	0	2	VI
3.	18MEP61	Project Work I Phase I	0	0	4	2	VI
4.	18GEP71	Comprehensive Test and Viva	0	0	0	2	VII
5.	18MEP71	Project Work I Phase II	0	0	8	4	VII
6.	18MEP81	Project Work II / Internship	0	0	12	6	VIII
Total Credits to be earned						**18**	

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

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)

S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18MEO01	Renewable Energy Sources	3	0	2	4	V
2.	18MEO02	Design of Experiments	3	0	2	4	VI
3.	18MEO03	Fundamentals of Ergonomics	3	0	0	3	VII
4.	18MEO04	Principles of Management and Industrial Psychology	3	0	0	3	VII
5.	18MEO05	Safety Measures for Engineers	3	0	0	3	VIII
6.	18MEO06	Energy Conservation in Thermal Equipments	3	0	0	3	VIII

OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS (OE)

S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**OFFERED BY**
		SEMESTER V					
7.	18MAO01	Mathematical Foundations of Machine Learning	3	1	0	4	MATHS
8.	18PHO01	Thin film Technology	3	1	0	4	PHYSICS

9.	18CYO01	Corrosion Science and Engineering	3	1	0	4	CHEMISTRY
10.	18CEO01	Remote Sensing and its Applications	3	0	2	4	CIVIL
11.	18MTO01	Design of Mechatronics Systems	3	1	0	4	MTS
12.	18AUO01	Automotive Engineering	3	0	2	4	AUTO
13.	18ECO01	PCB Design and Fabrication	3	0	2	4	ECE
14.	18ECO02	Neural Networks and Fuzzy Logic for Engineering Applications	3	0	2	4	ECE
15.	18EEO01	Electrical Wiring and Lighting	3	1	0	4	EEE
16.	18EEO02	Solar and Wind Energy Systems	3	1	0	4	EEE
17.	18EIO01	Neural Networks and Deep Learning	3	1	0	4	EIE
18.	18CSO01	Data Structures and its Applications	3	0	2	4	CSE
19.	18CSO02	Formal Languages and Automata Theory	3	1	0	4	CSE
20.	18CSO03	Computational Science for Engineers	3	1	0	4	CSE
21.	18ITO01	Python Programming	3	0	2	4	IT
22.	18ITO02	Advanced Java Programming	3	0	2	4	IT
23.	18CHO01	Polymer Technology	3	1	0	4	CHEM
24.	18CHO02	Introduction to Drugs and Pharmaceuticals Technology	3	1	0	4	CHEM
25.	18FTO01	Food Processing Technology	3	1	0	4	FT
26.	18FTO02	Baking Technology	3	0	2	4	FT
		SEMESTER VI					
27.	18MAO02	Graph Theory and Its Applications	3	1	0	4	MATHS
28.	18MAO03	Number Theory and Cryptography	3	1	0	4	MATHS
29.	18CYO02	Instrumental Methods of Analysis	3	1	0	4	CHEMISTRY
30.	18CEO02	Disaster Management	3	1	0	4	CIVIL
31.	18MTO02	Factory Automation	3	0	2	4	MTS
32.	18MTO03	Data Acquisition and Virtual Instrumentation	3	0	2	4	MTS
33.	18AUO02	Autonomous Vehicles	3	1	0	4	AUTO
34.	18ECO03	Principles of Quantum Computing	3	0	2	4	ECE
35.	18EEO03	Energy Conservation and Management	3	1	0	4	EEE
36.	18EIO02	Digital Image Processing and Its Applications	3	1	0	4	EIE
37.	18EIO03	Industrial Automation	3	1	0	4	EIE
38.	18CSO04	Web Engineering	3	0	2	4	CSE
39.	18CSO05	Foundations of Data Analytics	3	1	0	4	CSE
40.	18CSO06	Nature Inspired Optimization Techniques	3	1	0	4	CSE
41.	18CSO07	Introducing Data Science	3	1	0	4	CSE

42.	18ITO03	Java Programming	3	1	0	4	IT
43.	18ITO04	Next Generation Databases	3	1	0	4	IT
44.	18CHO03	Bio Energy Resources	3	1	0	4	CHEM
45.	18CHO04	Fundamentals of Nanoscience and Nanotechnology	3	1	0	4	CHEM
46.	18FTO03	Processing of Milk and Milk Products	3	0	2	4	FT
47.	18FTO04	Processing of Fruits and Vegetables	3	0	2	4	FT
		SEMESTER VII					
48.	18MAO04	Advanced Linear Algebra	3	0	0	3	MATHS
49.	18MAO05	Optimization Techniques	3	0	0	3	MATHS
50.	18PHO02	Structural and Optical Characterization of Materials	3	0	0	3	PHYSICS
51.	18CYO03	Waste and Hazardous Waste Management	3	0	0	3	CHEMISTRY
52.	18CEO03	Introduction to Smart Cities	3	0	0	3	CIVIL
53.	18CEO04	Environmental Health and Safety	3	0	0	3	CIVIL
54.	18MTO04	3D Printing and Design	3	0	0	3	MTS
55.	18MTO05	Drone System Technology	3	0	0	3	MTS
56.	18AUO03	Alternate Fuels for Automobile	3	0	0	3	AUTO
57.	18ECO04	Electronic Hardware and Troubleshooting	2	0	2	3	ECE
58.	18ECO05	Principles of Communication Techniques	3	0	0	3	ECE
59.	18EEO04	Micro Grid and Smart Grid	3	0	0	3	EEE
60.	18EEO05	Electrical Safety	3	0	0	3	EEE
61.	18EIO04	Biomedical Instrumentation and Applications	3	0	0	3	EIE
62.	18EIO05	PLC Programming and Its Applications	3	0	0	3	EIE
63.	18CSO08	Artificial Intelligence and its Applications	3	0	0	3	CSE
64.	18ITO05	Business Continuity Planning	3	0	0	3	IT
65.	18ITO06	Mobile Application Development	3	0	0	3	IT
66.	18CHO05	Enzyme Engineering	3	0	0	3	CHEM
67.	18CHO06	Nuclear Engineering	3	0	0	3	CHEM
68.	18FTO05	Principles of Food safety	3	0	0	3	FT
69.	18FTO06	Food and Nutrition	3	0	0	3	FT
		SEMESTER VIII					
70.	18CEO05	Infrastructure Planning and Management	3	0	0	3	CIVIL
71.	18CEO06	Environmental Laws and Policy	3	0	0	3	CIVIL
72.	18MTO06	Robotics	3	0	0	3	MTS
73.	18MTO07	Virtual and Augment Reality in Industry 4.0	3	0	0	3	MTS

74.	18AUO04	Automotive Electronics	3	0	0	3	AUTO
75.	18AUO05	Vehicle Maintenance	3	0	0	3	AUTO
76.	18ECO06	Bioinspired Computing Technologies	2	0	2	3	ECE
77.	18EEO06	Electric Vehicle	3	0	0	3	EEE
78.	18EIO06	Measurements and Instrumentation	3	0	0	3	EIE
79.	18EIO07	Graphical Programming using Virtual Instrumentation	3	0	0	3	EIE
80.	18CSO09	Applied Machine Learning	3	0	0	3	CSE
81.	18CSO10	Fundamentals of Blockchain	3	0	0	3	CSE
82.	18CSO11	Fundamentals of Internet of Things	3	0	0	3	CSE
83.	18ITO07	Essentials of Information Technology	3	0	0	3	IT
84.	18ITO08	Virtual and Augmented Reality Frameworks	3	0	0	3	IT
85.	18CHO07	Fertilizer Technology	3	0	0	3	CHEM
86.	18FTO07	Food Ingredients	3	0	0	3	FT
87.	18FTO08	Fundamentals of Food Packaging and Storage	3	0	0	3	FT

GENERAL OPEN ELECTIVE
(Common to All BE/BTech branches)

		GENERAL OPEN ELECTIVE	L	T	P	C	Offering Department	Semester
88.	18GEO01	German Language Level 1	4	0	0	4	ECE	V/ VI/ VII/ VIII
89.	18GEO02	Japanese Language Level 1	4	0	0	4	ECE	V/ VI/ VII/ VIII
90.	18GEO03	Design Thinking for Engineers	3	0	0	3	CSE	VI
91.	18GEO04	Innovation and Business Model Development	3	0	0	3	MTS	VIII
92.	18GEO05	German Language Level 2	4	0	0	4	ECE	V/ VI/ VII/ VIII
93.	18GEO06	German Language Level 3	3	0	0	3	ECE	V/ VI/ VII/ VIII
94.	18GEO07	German Language Level 4	3	0	0	3	ECE	V/ VI/ VII/ VIII
95.	18GEO08	Japanese Language Level 2	4	0	0	4	ECE	V/ VI/ VII / VIII
96.	18GEO09	Japanese Language Level 3	3	0	0	3	ECE	V/ VI/ VII / VIII
97.	18GEO10	Japanese Language Level 4	3	0	0	3	ECE	V/ VI/ VII / VIII
98.	18GEO11	NCC Studies (Army Wing) – I	3	0	2	4	EEE	V/ VI
99.	18GEO12	NCC Studies (Air Wing) – I	3	0	2	4	IT	V / VI

KEC R2018: SCHEDULING OF COURSES – B.E. (Mechanical Engineering) Total Credits : 172

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Credits
I	18EGT11 English for Communi-cation I (3-0-0-3)	18MAC11 Mathematics I (3-1*-2*-4)	18PHC11 Applied Physics (3-0-2*-3.5)	18CYC11 Applied Chemistry (3-0-2*-3.5)	18GET11 Introduction to Engineering (3-0-0-3)	18MEC11 Engineering Drawing (2-0-2-3)	18MEL11 Engineering Practices Laboratory (0-0-2-1)				**21**
II	18EGT21 English for Communi-cation II (3-0-0-3)	18MAC21 Mathematics II (3-1*-2*-4)	18PHC22 Materials Science (3-0-2*-3.5)	18CYC22 Environmental Chemistry in Mechanical Systems (3-0-2*-3.5)	18CSC11 Problem Solving and Programming (2-0-2-3)	18MET21 Manufacturing Technology (3-0-0-3)	18VEC11 Value Education (2-0-1-1)				**21**
III	18MAC31 Mathematics III (3-1*-2*-4)	18MET31 Engineering Mechanics (3-1-0-4)	18MET32 Engineering Thermo dynamics (3-1-0-4)	18MET33 Fluid Mechanics and Hydraulic Machines (3-0-0-3)	18MET34 Engineering Materials and Metallurgy (3-0-0-3)	18EET35 Electrical Drives and Industrial Electronics (3-0-0-3)	18MEL31 Fluid Mechanics and Hydraulic Machines Lab (0-0-2-1)	18MEL32 Manufacturing Technology Laboratory (0-0-2-1)	18EEL34 Electrical Engineering Laboratory (0-0-2-1)		**24**
IV	18MAC41 Statistics and Numerical Methods (3-1-2*-4)	18MET41 Strength of Materials (3-1-0-4)	18MET42 Thermal Engineering (3-1-0-4)	18MET43 Kinematics of Machinery (3-1-0-4)	18MET44 Material Removal Processes (3-0-0-3)	18MET45 Instrumentatio n and Control System (3-0-0-3)	18MEL41 Material Removal Processes Lab (0-0-2-1)	18MEL42 Advanced Materials Testing Lab (0-0-2-1)	18MEL43 Thermal Engineering Lab (0-0-2-1)	18EGL31 English for Workplace Communica-tion (0-0-2-1)	**26**
V	18MET51 Heat and Mass Transfer (3-1-0-4)	18MET52 Dynamics of Machinery (3-0-0-3)	18MET53 Machine Drawing (3-0-0-3)	18MET54 Design of Machine Elements (3-0-0-3)	Open Elective I (3-1/0-0/2-4)	18MEL51 Heat Transfer Laboratory (0-0-2-1)	18MEL52 Metrology and Dynamics Laboratory (0-0-2-1)	18MEL53 CAD Laboratory (0-0-2-1)	18GEL51/ 18GEI51 Professional Skills Training I / Industrial Training I (0-0-0-2)	18GET51 Universal Human Values (2-0-0-2)	**24**
VI	18MET61 Mechatronics and IoT (3-0-0-3)	18MET62 Design of Transmission System (3-0-0-3)	18MET63 Finite Element Analysis (3-0-0-3)	Professional Elective I (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	18MEL61 Mechatronics and IOT Laboratory (0-0-2-1)	18MEL62 CAM Lab (0-0-2-1)	18MEL63 Simulation and Analysis Laboratory (0-0-2-1)	18GEL61/ 18GEI61 Professional Skills Training II / Industrial Training II (0-0-0-2)	18MEP61 Project Work I Phase I (0-0-4-2)	**23**
VII	18MBT71 Engineering Economics and Management (3-0-0-3)	Open Elective III (3-0-0-3)	Professional Elective II (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	18GEP71 Comprehen-sive Test / Viva (0-0-0-2)	18MEP71 Project Work I Phase II (0-0-8-4)				**21**
VIII	Open Elective IV (3-0-0-3)	Professional Elective V (3-0-0-3)	18MEP81 Project Work II (0-0-12-6)								**12**

MAPPING OF COURSES WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	18EGT11	English for Communication I						✓			✓	✓	✓	✓		
1	18MAC11	Mathematics I	✓	✓	✓	✓	✓									
1	18PHC11	Applied Physics	✓	✓	✓	✓										
1	18CYC11	Applied Chemistry	✓	✓	✓	✓										
1	18GET11	Introduction to Engineering	✓	✓	✓	✓		✓	✓					✓		
1	18MEC11	Engineering Drawing	✓	✓	✓	✓						✓	✓	✓	✓	✓
1	18MEL11	Engineering Practices Laboratory	✓	✓	✓	✓	✓				✓	✓	✓	✓		
2	18EGT21	English for Communication II						✓			✓	✓	✓	✓		
2	18MAC21	Mathematics II	✓	✓	✓		✓									
2	18PHC22	Materials Science	✓	✓	✓	✓										
2	18CYC22	Environmental Chemistry in Mechanical Systems	✓	✓	✓	✓			✓							
2	18CSC11	Problem Solving and Programming	✓	✓	✓	✓	✓					✓				
2	18MET21	Manufacturing Technology	✓	✓	✓	✓					✓		✓	✓	✓	✓
2	18VEC11	Value Education						✓		✓				✓		
3	18MAC31	Mathematics III	✓	✓	✓	✓	✓									
3	18MET31	Engineering Mechanics	✓	✓	✓	✓								✓		✓
3	18MET32	Engineering Thermodynamics	✓	✓	✓				✓			✓		✓		✓
3	18MET33	Fluid Mechanics and Hydraulic Machines	✓	✓	✓			✓	✓			✓		✓	✓	✓
3	18MET34	Engineering Materials and Metallurgy	✓	✓		✓	✓		✓					✓	✓	✓
3	18EET35	Electrical Drives and Industrial Electronics	✓	✓	✓	✓									✓	
3	18MEL31	Fluid Mechanics and Hydraulic Machines Laboratory	✓	✓		✓					✓	✓		✓		✓
3	18MEL32	Manufacturing Technology Laboratory	✓		✓	✓	✓	✓			✓	✓			✓	✓
3	18EEL34	Electrical Engineering Laboratory	✓	✓	✓	✓	✓									
4	18MAC41	Statistics and Numerical Methods	✓	✓	✓	✓	✓									
4	18MET41	Strength of Materials	✓	✓	✓	✓	✓							✓		✓
4	18MET42	Thermal Engineering	✓	✓	✓			✓				✓		✓		✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
4	18MET43	Kinematics of Machinery	✓	✓	✓	✓	✓							✓	✓	✓
4	18MET44	Material Removal Processes	✓	✓	✓	✓								✓		✓
4	18MET45	Instrumentation and Control	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
4	18MEL41	Material Removal Processes Laboratory	✓	✓		✓					✓	✓			✓	✓
4	18MEL42	Advanced Materials Testing Laboratory	✓	✓	✓	✓					✓	✓			✓	✓
4	18MEL43	Thermal Engineering Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
4	18EGL31	English for Work Place Communication									✓	✓		✓		
5	18MET51	Heat and Mass Transfer	✓	✓			✓		✓			✓		✓		✓
5	18MET52	Dynamics of Machinery	✓	✓	✓	✓								✓		✓
5	18MET53	Machine Drawing	✓	✓	✓	✓								✓	✓	✓
5	18MET54	Design of Machine Elements	✓	✓	✓	✓								✓		✓
5	18MEL51	Heat Transfer Laboratory	✓	✓		✓	✓				✓	✓		✓	✓	✓
5	18MEL52	Metrology and Dynamics Laboratory	✓	✓		✓					✓			✓	✓	✓
5	18MEL53	CAD Laboratory	✓	✓			✓				✓	✓		✓	✓	✓
5	18GEL51/ 18GEI51	Professional Skills Training I / Industrial Training I	✓	✓				✓	✓		✓	✓	✓	✓		
5	18GET51	Universal Human Values						✓		✓						
6	18MET61	Mechatronics and IoT	✓		✓		✓	✓	✓			✓		✓	✓	✓
6	18MET62	Design of Transmission System	✓	✓	✓		✓	✓				✓		✓		✓
6	18MET63	Finite Element Analysis	✓	✓	✓	✓	✓							✓	✓	✓
6	18MEL61	Mechatronics and IoT Laboratory	✓		✓	✓	✓				✓	✓		✓	✓	✓
6	18MEL62	CAM Laboratory	✓		✓	✓	✓				✓	✓		✓	✓	✓
6	18MEL63	Simulation and Analysis Laboratory	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓
6	18GEL61/ 18GEI61	Professional Skills Training II / Industrial Training II	✓	✓				✓	✓		✓	✓	✓	✓		
6	18MEP61	Project Work I Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18MBT71	Engineering Economics and Management	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18GEP71	Comprehensive Test and Viva	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
8	18MEP71	Project Work I Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	18MEP81	Project Work II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Professional Elective Courses														
6	18MEE01	Fluid Power System	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓
6	18MEE02	CAD/CAM/CIM	✓	✓	✓	✓	✓					✓		✓	✓	✓
6	18MEE03	Gas Dynamics and Jet Propulsion	✓	✓	✓		✓	✓				✓		✓	✓	✓
6	18MEE04	Refrigeration and Air Conditioning	✓	✓				✓	✓			✓		✓		✓
6	18MEE05	Unconventional Machining Processes	✓	✓			✓	✓				✓		✓	✓	✓
6	18MEE06	Design for Manufacture and Assembly	✓		✓	✓	✓					✓		✓		✓
6	18MEE07	Operations Research	✓	✓	✓	✓	✓						✓	✓	✓	✓
6	18MEE08	Production Planning and Control	✓	✓	✓	✓	✓					✓		✓		✓
7	18GEE01	Fundamentals of Research	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18MEE09	Piping Design	✓	✓	✓	✓	✓	✓				✓			✓	✓
7	18MEE10	Design of Jigs, Fixtures and Press Tools	✓	✓	✓	✓								✓		✓
7	18MEE11	Fuels and Combustion Technology	✓	✓	✓				✓						✓	✓
7	18MEE12	Computational Fluid Dynamics	✓	✓	✓	✓	✓							✓	✓	✓
7	18MEE13	CNC Technology	✓	✓	✓	✓	✓					✓		✓	✓	✓
7	18MEE14	Precision Engineering	✓	✓	✓		✓					✓		✓	✓	✓
7	18MEE15	Total Quality Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18MEE16	Project Management	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18MEE17	Mechanics of Composite Materials	✓	✓	✓	✓								✓	✓	✓
7	18MEE18	Advanced Structure of Materials	✓	✓	✓	✓						✓		✓		✓
7	18MEE19	Automobile Engineering	✓		✓			✓	✓					✓	✓	✓
7	18MEE20	Design of Heat Exchangers	✓	✓	✓				✓			✓			✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO1 0	PO11	PO12	PSO1	PSO 2
7	18MEE21	Additive Manufacturing	✓	✓	✓	✓	✓						✓	✓	✓	✓
7	18MEE22	Welding Technology	✓	✓				✓					✓		✓	✓
7	18MEE23	Quality and Reliability Engineering	✓	✓	✓	✓	✓						✓	✓	✓	✓
7	18MEE24	Industrial Engineering and Cost Analysis	✓	✓	✓	✓	✓						✓		✓	✓
7	18MEE25	Introduction to Aircraft Systems	✓		✓				✓			✓		✓		✓
7	18MEE26	Industrial Tribology	✓	✓	✓	✓						✓		✓		✓
7	18MEE27	Instrumentation in Thermal Engineering	✓	✓			✓					✓		✓	✓	✓
7	18MEE28	Energy Auditing and Management	✓	✓	✓		✓	✓	✓			✓	✓		✓	✓
7	18MEE29	Manufacturing Information System	✓	✓	✓							✓		✓		✓
7	18MEE30	Micro Electro Mechanical Systems	✓	✓	✓	✓	✓							✓	✓	✓
7	18MEE31	Maintenance Engineering	✓	✓	✓	✓		✓					✓	✓	✓	✓
7	18MEE32	Industrial Safety Engineering	✓	✓	✓			✓	✓			✓				✓
7	18MEE33	Hybrid Vehicle Technology	✓	✓											✓	✓
7	18MBE49	Entrepreneurship Development		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	18MEE34	Introduction to Aircraft Structures	✓		✓				✓			✓		✓		✓
8	18MEE35	Principles of Farm Machineries	✓	✓	✓							✓		✓	✓	✓
8	18MEE36	Power Plant Engineering	✓	✓	✓			✓	✓				✓	✓		✓
8	18MEE37	Energy Conservation in HVAC System	✓	✓	✓		✓	✓	✓			✓			✓	✓
8	18MEE38	Nanoscience and Technology for Mechanical Engineers	✓	✓	✓	✓	✓							✓	✓	✓
8	18MEE39	Non- Destructive Evaluation Techniques	✓	✓			✓					✓		✓	✓	✓
8	18MEE40	Industrial Marketing	✓	✓				✓	✓			✓			✓	✓

		Open Elective Courses														
5	18MAO01	Mathematical Foundations of Machine Learning	✓	✓	✓	✓	✓									
5	18PHO01	Thin film Technology	✓	✓	✓											
5	18CYO01	Corrosion Science and Engineering	✓	✓	✓	✓										
5	18CEO01	Remote Sensing and its Applications	✓	✓	✓	✓	✓									
5	18MEO01	Renewable Energy Sources	✓	✓	✓	✓			✓			✓		✓		
5	18MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
5	18AUO01	Automotive Engineering	✓	✓	✓		✓									
5	18ECO01	PCB Design and Fabrication	✓	✓	✓	✓	✓				✓					
5	18ECO02	Neural Networks and Fuzzy Logic for Engineering Applications	✓	✓	✓	✓	✓				✓					
5	18EEO01	Electrical Wiring and Lighting	✓	✓	✓	✓	✓	✓								
5	18EEO02	Solar and Wind Energy Systems	✓	✓	✓	✓										
5	18EIO01	Neural Networks and Deep Learning	✓	✓	✓	✓	✓									
5	18CSO01	Data Structures and its Applications	✓	✓	✓	✓	✓									
5	18CSO02	Formal Languages and Automata Theory	✓	✓	✓	✓										
5	18CSO03	Computational Science for Engineers	✓	✓	✓	✓	✓									
5	18ITO01	Python Programming			✓		✓									
5	18ITO02	Advanced Java Programming			✓		✓									
5	18CHO01	Polymer Technology	✓	✓												
5	18CHO02	Introduction to Drugs and Pharmaceuticals Technology	✓	✓	✓	✓	✓									
5	18FTO01	Food Processing Technology	✓	✓	✓	✓										
5	18FTO02	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
6	18MAO02	Graph Theory and its Applications	✓	✓	✓											
6	18MAO03	Number Theory and Cryptography	✓	✓	✓		✓									
6	18CYO02	Instrumental Methods of Analysis	✓	✓	✓	✓										

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	18CEO02	Disaster Management	✓	✓	✓			✓	✓					✓		
6	18MEO02	Design of Experiments	✓	✓	✓	✓	✓						✓	✓		
6	18MTO02	Factory Automation	✓	✓	✓	✓	✓	✓			✓	✓		✓		
6	18MTO03	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓				✓	✓		✓		
6	18AUO02	Autonomous Vehicles	✓	✓	✓											
6	18ECO03	Principles of Quantum Computing	✓	✓	✓	✓	✓									
6	18EEO03	Energy Conservation and Management	✓	✓	✓		✓									
6	18EIO02	Digital Image Processing and Its Applications	✓	✓	✓	✓	✓									
6	18EIO03	Industrial Automation	✓	✓	✓	✓	✓									
6	18CSO04	Web Engineering	✓	✓	✓	✓										
6	18CSO05	Foundations of Data Analytics	✓	✓	✓											
6	18CSO06	Nature Inspired Optimization Techniques	✓	✓	✓	✓										
6	18CSO07	Introducing Data Science	✓	✓	✓											
6	18ITO03	Java Programming	✓	✓	✓	✓	✓	✓						✓		
6	18ITO04	Next Generation Databases	✓	✓	✓	✓										
6	18CHO03	Bio Energy Resources	✓	✓	✓	✓	✓									
6	18CHO04	Fundamentals of Nanoscience and Nanotechnology	✓	✓	✓	✓	✓									
6	18FTO03	Processing of Milk and Milk Products	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	18FTO04	Processing of Fruits and Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓		
7	18MAO04	Advanced Linear Algebra	✓	✓	✓											
7	18MAO05	Optimization Techniques	✓	✓	✓											
7	18PHO02	Structural and Optical Characterization of Materials	✓	✓	✓											
7	18CYO03	Waste and Hazardous Waste Management	✓	✓	✓	✓			✓							
7	18CEO03	Introduction to Smart Cities	✓	✓	✓				✓							
7	18CEO04	Environmental Health and Safety	✓	✓	✓	✓										

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	18MEO03	Fundamentals of Ergonomics	✓	✓	✓	✓		✓	✓			✓		✓		
7	18MEO04	Principles of Management and Industrial Psychology			✓			✓	✓	✓	✓	✓				
7	18MTO04	3D Printing and Design	✓	✓	✓	✓	✓						✓	✓		
7	18MTO05	Drone System Technology	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		
7	18AUO03	Alternate Fuels for Automobile	✓	✓												
7	18ECO04	Electronic Hardware and Troubleshooting	✓	✓	✓	✓	✓	✓								
7	18ECO05	Principles of Communication Techniques	✓	✓	✓	✓	✓									
7	18EEO04	Micro Grid and Smart Grid	✓	✓	✓	✓	✓									
7	18EEO05	Electrical Safety	✓	✓	✓											
7	18EIO04	Biomedical Instrumentation and Applications	✓	✓	✓	✓	✓									
7	18EIO05	PLC Programming and Its Applications	✓	✓	✓	✓	✓									
7	18CSO08	Artificial intelligence and its applications	✓	✓	✓											
7	18ITO05	Business Continuity Planning	✓	✓	✓	✓										
7	18ITO06	Mobile Application Development	✓	✓	✓	✓										
7	18CHO05	Enzyme Engineering	✓	✓	✓	✓	✓									
7	18CHO06	Nuclear Engineering	✓	✓												
7	18FTO05	Principles of Food safety	✓	✓	✓		✓	✓	✓	✓				✓		
7	18FTO06	Food and Nutrition	✓	✓	✓	✓								✓		
7	18CEO05	Infrastructure Planning and Management	✓	✓	✓											
8	18CEO06	Environmental Laws and Policy	✓	✓	✓	✓										
8	18MEO05	Safety Measures for Engineers		✓		✓	✓	✓	✓	✓	✓			✓		
8	18MEO06	Energy Conservation in Thermal Equipments	✓	✓	✓			✓	✓			✓	✓	✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
8	18MTO06	Robotics	✓	✓	✓	✓	✓							✓		
8	18MTO07	Virtual and Augment Reality in Industry 4.0	✓	✓	✓	✓	✓	✓						✓		
8	18AUO04	Automotive Electronics	✓	✓	✓											
8	18AUO05	Vehicle Maintenance	✓		✓			✓								
8	18ECO06	Bioinspired Computing Technologies	✓	✓	✓	✓										
8	18EEO06	Electric Vehicle	✓	✓	✓	✓	✓									
8	18EIO06	Measurements and Instrumentation	✓	✓	✓	✓	✓									
8	18EIO07	Graphical Programming using Virtual Instrumentation	✓	✓	✓	✓	✓									
8	18CSO09	Applied Machine Learning	✓	✓	✓											
8	18CSO10	Fundamentals of block chain	✓	✓	✓	✓										
8	18CSO11	Fundamentals of Internet of Things	✓	✓	✓	✓	✓									
8	18ITO07	Essentials of Information Technology	✓	✓	✓	✓										
8	18ITO08	Virtual and Augmented Reality Frameworks	✓	✓	✓	✓										
8	18CHO07	Fertilizer Technology	✓	✓												
8	18FTO07	Food Ingredients	✓	✓	✓			✓						✓		
8	18FTO08	Fundamentals of Food Packaging and Storage	✓	✓	✓		✓	✓		✓				✓		
		General Open Elective														
5,6,7,8	18GEO01	German Language Level 1								✓	✓	✓		✓		
5,6,7,8	18GEO02	Japanese Language Level 1								✓	✓	✓		✓		
7	18GEO03	Design Thinking for Engineers	✓	✓	✓	✓										
8	18GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5,6,7,8	18GEO05	German Language Level 2								✓	✓	✓		✓		

		General Open Elective														
5,6,7,8	18GEO06	German Language Level 3								✓	✓	✓		✓		
5,6,7,8	18GEO07	German Language Level 4								✓	✓	✓		✓		
5,6,7,8	18GEO08	Japanese Language Level 2								✓	✓	✓		✓		
5,6,7,8	18GEO09	Japanese Language Level 3								✓	✓	✓		✓		
5,6,7,8	18GEO10	Japanese Language Level 4								✓	✓	✓		✓		
5,6	18GEO11	NCC Studies (Army Wing) – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5,6	18GEO12	NCC Studies (Air Wing) – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				

SEMESTER – I									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18EGT11	English for Communication I	3	0	0	3	50	50	100	HS
18MAC11	Mathematics I	3	1*	2*	4	50	50	100	BS
18PHC11	Applied Physics	3	0	2*	3.5	50	50	100	BS
18CYC11	Applied Chemistry	3	0	2*	3.5	50	50	100	BS
18GET11	Introduction to Engineering	3	0	0	3	50	50	100	ES
18MEC11	Engineering Drawing	2	0	2	3	50	50	100	ES
Practical / Employability Enhancement									
18MEL11	Engineering Practices Laboratory	0	0	2	1	100	0	100	ES
Total Credits to be earned					**21**				

*** Alternate Weeks**

SEMESTER – II									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18EGT21	English for Communication II	3	0	0	3	50	50	100	HS
18MAC21	Mathematics II	3	1*	2*	4	50	50	100	BS
18PHC22	Materials Science	3	0	2*	3.5	50	50	100	BS
18CYC22	Environmental Chemistry in Mechanical Systems	3	0	2*	3.5	50	50	100	BS
18CSC11	Problem Solving and Programming	2	0	2	3	50	50	100	ES
18MET21	Manufacturing Technology	3	0	0	3	50	50	100	PC
Practical / Employability Enhancement									
18VEC11	Value Education	2	0	1	1	100	0	100	HS
Total Credits to be earned					**21**				

***Alternate Weeks**

B.E. MECHANICAL ENGINEERING CURRICULUM – R2018

SEMESTER – III									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18MAC31	Mathematics III	3	1*	2*	4	50	50	100	BS
18MET31	Engineering Mechanics	3	1	0	4	50	50	100	PC
18MET32	Engineering Thermodynamics	3	1	0	4	50	50	100	PC
18MET33	Fluid Mechanics and Hydraulic Machines	3	0	0	3	50	50	100	PC
18MET34	Engineering Materials and Metallurgy	3	0	0	3	50	50	100	PC
18EET35	Electrical Drives and Industrial Electronics	3	0	0	3	50	50	100	ES
Practical / Employability Enhancement									
18MEL31	Fluid Mechanics and Hydraulic Machines Laboratory	0	0	2	1	100	0	100	PC
18MEL32	Manufacturing Technology Laboratory	0	0	2	1	100	0	100	PC
18EEL34	Electrical Engineering Laboratory	0	0	2	1	100	0	100	ES
Total Credits to be earned					**24**				

***Alternate Weeks**

SEMESTER – IV									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18MAC41	Statistics and Numerical Methods	3	1*	2*	4	50	50	100	BS
18MET41	Strength of Materials	3	1	0	4	50	50	100	PC
18MET42	Thermal Engineering	3	1	0	4	50	50	100	PC
18MET43	Kinematics of Machinery	3	1	0	4	50	50	100	PC
18MET44	Material Removal Processes	3	0	0	3	50	50	100	PC
18MET45	Instrumentation and Control System	3	0	0	3	50	50	100	PC
Practical / Employability Enhancement									
18MEL41	Material Removal Processes Laboratory	0	0	2	1	100	0	100	PC
18MEL42	Advanced Materials Testing Laboratory	0	0	2	1	100	0	100	PC
18MEL43	Thermal Engineering Laboratory	0	0	2	1	100	0	100	PC
18EGL31	English for Workplace Communication	0	0	2	1	100	0	100	HS
Total Credits to be earned					**26**				

***Alternate Weeks**

B.E. MECHANICAL ENGINEERING CURRICULUM – R2018

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18MET51	Heat and Mass Transfer	3	1	0	4	50	50	100	PC
18MET52	Dynamics of Machinery	3	0	0	3	50	50	100	PC
18MET53	Machine Drawing	3	0	0	3	50	50	100	PC
18MET54	Design of Machine Elements	3	0	0	3	50	50	100	PC
	Open Elective I	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
18MEL51	Heat Transfer Laboratory	0	0	2	1	100	0	100	PC
18MEL52	Metrology and Dynamics Laboratory	0	0	2	1	100	0	100	PC
18MEL53	CAD Laboratory	0	0	2	1	100	0	100	PC
18GEL51/ 18GEI51	Professional Skills Training I / Industrial Training I *	--	--	--	2	100	0	100	EC
18GET51	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					**24**				

***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									
18MET61	Mechatronics and IoT	3	0	0	3	50	50	100	PC
18MET62	Design of Transmission System	3	0	0	3	50	50	100	PC
18MET63	Finite Element Analysis	3	0	0	3	50	50	100	PC
	Professional Elective I	3	0	0	3	50	50	100	PE
	Open Elective I	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
18MEL61	Mechatronics and IoT Laboratory	0	0	2	1	100	0	100	PC
18MEL62	CAM Laboratory	0	0	2	1	100	0	100	PC
18MEL63	Simulation and Analysis Laboratory	0	0	2	1	100	0	100	PC
18GEL61/ 18GEI61	Professional Skills Training II / Industrial Training II*	---	---	---	2	100	0	100	EC
18MEP61	Project Work I Phase I	0	0	4	2	100	0	100	EC
Total Credits to be earned					**23**				

***80 hours of Training**

B.E. MECHANICAL ENGINEERING CURRICULUM – R2018

SEMESTER – VII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18MBT71	Engineering Economics and Management	3	0	0	3	50	50	100	HS
	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
	Open Elective III	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
18GEP71	Comprehensive Test and Viva	---	---	---	2	100	0	100	EC
18MEP71	Project Work I Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					**21**				

SEMESTER – VIII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
	Professional Elective V	3	0	0	3	50	50	100	PE
	Open Elective IV	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
18MEP81	Project Work II	0	0	12	6	50	50	100	EC
Total Credits to be earned					**12**				

Total Credits: 172

LIST OF PROFESSIONAL ELECTIVE (PE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
		Elective – I					
1.	18MEE01	Fluid Power System	3	0	0	3	VI
2.	18MEE02	CAD/CAM/CIM	3	0	0	3	VI
3.	18MEE03	Gas Dynamics and Jet Propulsion	3	0	0	3	VI
4.	18MEE04	Refrigeration and Air Conditioning	3	0	0	3	VI
5.	18MEE05	Unconventional Machining Processes	3	0	0	3	VI
6.	18MEE06	Design for Manufacture and Assembly	3	0	0	3	VI
7.	18MEE07	Operations Research	3	0	0	3	VI
8.	18MEE08	Production Planning and Control	3	0	0	3	VI
		Elective – II					
9.	18GEE01	Fundamentals of Research	3	0	0	3	VII
10.	18MEE09	Piping Design	3	0	0	3	VII
11.	18MEE10	Design of Jigs, Fixtures and Press Tools	3	0	0	3	VII
12.	18MEE11	Fuels and Combustion Technology	3	0	0	3	VII
13.	18MEE12	Computational Fluid Dynamics	3	0	0	3	VII
14.	18MEE13	CNC Technology	3	0	0	3	VII
15.	18MEE14	Precision Engineering	3	0	0	3	VII
16.	18MEE15	Total Quality Management	3	0	0	3	VII
17.	18MEE16	Project Management	3	0	0	3	VII
		Elective – III					
18.	18MEE17	Mechanics of Composite Materials	3	0	0	3	VII
19.	18MEE18	Advanced Structure of Materials	3	0	0	3	VII
20.	18MEE19	Automobile Engineering	3	0	0	3	VII
21.	18MEE20	Design of Heat Exchangers	3	0	0	3	VII
22.	18MEE21	Additive Manufacturing	3	0	0	3	VII
23.	18MEE22	Welding Technology	3	0	0	3	VII
24.	18MEE23	Quality and Reliability Engineering	3	0	0	3	VII
25.	18MEE24	Industrial Engineering and Cost Analysis	3	0	0	3	VII

		Elective – IV					
26.	18MEE25	Introduction to Aircraft Systems	3	0	0	3	VII
27.	18MEE26	Industrial Tribology	3	0	0	3	VII
28.	18MEE27	Instrumentation in Thermal Engineering	3	0	0	3	VII
29.	18MEE28	Energy Auditing and Management	3	0	0	3	VII
30.	18MEE29	Manufacturing Information System	3	0	0	3	VII
31.	18MEE30	Micro Electro Mechanical Systems	3	0	0	3	VII
32.	18MEE31	Maintenance Engineering	3	0	0	3	VII
33.	18MEE32	Industrial Safety Engineering	3	0	0	3	VII
34.	18MEE33	Hybrid Vehicle Technology	3	0	0	3	VII
		Elective – V					
35.	18MBE49	Entrepreneurship Development	3	0	0	3	VIII
36.	18MEE34	Introduction to Aircraft Structures	3	0	0	3	VIII
37.	18MEE35	Principles of Farm Machineries	3	0	0	3	VIII
38.	18MEE36	Power Plant Engineering	3	0	0	3	VIII
39.	18MEE37	Energy Conservation in HVAC System	3	0	0	3	VIII
40.	18MEE38	Nanoscience and Technology for Mechanical Engineers	3	0	0	3	VIII
41.	18MEE39	Non Destructive Evaluation Techniques	3	0	0	3	VIII
42.	18MEE40	Industrial Marketing	3	0	0	3	VIII

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18MEO01	Renewable Energy Sources	3	0	2	4	V
2.	18MEO02	Design of Experiments	3	0	2	4	VI
3.	18MEO03	Fundamentals of Ergonomics	3	0	0	3	VII
4.	18MEO04	Principles of Management and Industrial Psychology	3	0	0	3	VII
5.	18MEO05	Safety Measures for Engineers	3	0	0	3	VIII
6.	18MEO06	Energy Conservation in Thermal Equipments	3	0	0	3	VIII

18EGT11 - ENGLISH FOR COMMUNICATION I

(Common to all Engineering and Technology Branches)

Programme & Branch	B.E. & Mechanical Engineering	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 B1 level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading and Writing. Activity Based Learning – Phase – I:**	**9**
Listening - People talking about their 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.		
Unit - II	**Listening, Speaking, Reading and Writing. 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.		
Unit - III	**Listening, Speaking, Reading and Writing. 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.		
Unit - IV	**Listening, Speaking, Reading and Writing. 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.		
Unit - V	**Listening, Speaking, Reading and Writing. 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.		

Total: 45

TEXT BOOK:

1. Jack C. Richards, "Interchange, Student's Book 2", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1. Jack C. Richards & Theodore Rodgers, "Approaches and Methods in Language Teaching", 3rd Edition, Cambridge University Press, New York, 2014.
2. Penny Ur, "A Course in English Language Teaching", 2nd Edition, Cambridge University Press, New York, 2012.

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		3	47	17		33	100
CAT2			37	23		40	100
CAT3		3	47	33		17	100
ESE		2	42	27		29	100

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

18MAC11 - MATHEMATICS I

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechanical Engineering	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, multivariable functions and differential equations.	
Unit - I	**Matrices:**	**9**
Introduction to Matrices in Engineering – 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 – Applications of Eigen values and Eigen vectors: Electric circuit – Mass string problems.		
Unit - II	**Multivariable Calculus:**	**9**
Functions of two 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 - III	**First Order Ordinary Differential Equations:**	**9**
Solutions of differential equations in variables separable form – Exact differential equations – Linear first order differential equations – Bernoulli's equation – Clairaut's equation.		
Unit - IV	**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^n sinax and x^n cosax – Differential Equations with variable coefficients: Euler-Cauchy's equation – Legendre' s equation.		
Unit - V	**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).		

List of Exercises / Experiments:

1.	Introduction to MATLAB
2.	Matrix operations : Addition, Multiplication, Transpose and Inverse
3.	Computation of eigen values and eigen vectors
4.	Finding ordinary and partial derivatives
5.	Computing extremes of a single variable function
6.	Plotting and visualizing single variable functions
7.	Solving first and second order ordinary differential equations
8.	Solution of Simultaneous first order ODEs

***Alternate Weeks**

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1. Grewal B. S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, New Delhi, 2011.

REFERENCES:

1. Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.
2. Won Y. Yang, Young K. Choi, Jaekwon Kim, Man Cheol Kim, Jin Kim H. and Taeho Im, "Engineering Mathematics with MATLAB", 1st Edition, CRC Press, London, 2018.

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	compute extremal values which arise in function of several	Understanding (K2)
CO3	identify the appropriate method for solving first order ordinary differential equations	Applying (K3)
CO4	solve higher order linear differential equations with constant and variable coefficients	Applying (K3)
CO5	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems	Applying (K3)
CO6	determine eigen values and eigen vectors of a given matrix using MATLAB	Applying (K3), Manipulation (S2)
CO7	compute maxima and minima of a single variable function, plot and visualize single variable function using MATLAB	Applying (K3), Manipulation (S2)
CO8	solve first and second order ordinary differential equations and simultaneous first order ordinary differential equations 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	2	1										
CO2	3	2												
CO3	3	3	1	1										
CO4	3	3	1	1										
CO5	3	3	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	20	10	70				100
CAT2	20	10	70				100
CAT3	20	10	70				100
ESE	20	10	70				100

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

18PHC11 - APPLIED PHYSICS

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	BS	3	0	2*	3.5

Preamble	This course aims to impart the essential concepts of properties of matter, acoustics, ultrasonics, quantum physics, laser and fibre optics, 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	**Properties of Matter:**	**9**
Elasticity: Stress – Strain – Hooke's law – Stress-strain diagram – Poisson's ratio - Modulus of elasticity - Beams – Bending of beams – Expression for bending moment - Cantilever – Depression of the loaded end of a cantilever - Young's modulus by uniform and non-uniform bending methods - I-shaped girders. Viscosity: Viscous force – Viscosity – Co-efficient of viscosity – Importance of viscosity of liquids (qualitative).		
Unit - II	**Acoustics and Ultrasonics:**	**9**
Acoustics: Sound - Reverberation and reverberation time – Growth and decay of sound and Sabine's formula (qualitative) - Absorption coefficient - Factors affecting acoustics of buildings and their remedies. Ultrasonics: Properties of ultrasonic waves - Production of ultrasonic waves - Magnetostrictive generator - Piezoelectric generator - Applications of ultrasonic waves in non destructive testing.		
Unit - III	**Thermal and Quantum Physics:**	**9**
Thermal Physics: Modes of heat transfer - Thermal conductivity - Radial and cylindrical heat flow - Conduction through compound media (series and parallel). Quantum Physics: Matter waves - Schrodinger's time independent and time dependent wave equations – Physical significance of wave function - Particle in a one dimensional box.		
Unit - IV	**Laser, Fibre Optics and Applications:**	**9**
Laser and Applications: Spontaneous emission and stimulated emission - Population inversion - Pumping methods - Einstein's coefficients - Nd:YAG laser - Holography. Fiber Optics and Applications: Principle of propagation of light through optical fibers - Numerical aperture and acceptance angle - Classification of optical fibers based on refractive index, modes and materials - Fiber optical communication links (block diagram).		
Unit - V	**Crystal Physics:**	**9**
Crystal systems - Bravais lattice - Lattice planes - Miller indices - Interplanar spacing in cubic lattice - Atomic radius, Coordination number and Packing factor for SC, BCC and FCC crystal structures - Crystal imperfections: line and surface imperfections.		

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 viscosity of a given liquid using Poiseuilles' method.
3.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using ultrasonic interferometer.
4.	Determination of the wavelength and the angle of divergence of a semiconductor laser.
5.	Determination of the acceptance angle and the numerical aperture of a given optical fiber.

***Alternate Weeks**

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1. Tamilarasan K. and Prabu K., "Engineering Physics - I", 3rd Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2014.

REFERENCES:

1. Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
2. Mehta and Neeraj, "Applied Physics for Engineers", 1st Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, 2011.
3. Tamilarasan K. and Prabu K., "Physics Laboratory Manual", 3rd Edition, SCM Publishers, Erode, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the concepts of elasticity and bending moment of a beam to a simple structure under simple loading to compute the Young\'s modulus of a material, and to explain the concepts of viscosity of liquids.	Applying (K3)
CO2	apply the concepts of growth and decay of sound energy in a hall to recognize the requirements of acoustically good buildings, and to describe the production of ultrasonic waves and non-destructive testing using ultrasonic waves.	Applying (K3)
CO3	use the concepts of heat flow to explain heat conduction through materials, and to describe the behavior of electrons in a metal by means of quantum physics.	Applying (K3)
CO4	apply the concepts of laser 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 fiber optic communication link.	Applying (K3)
CO5	explain seven crystal systems, atomic packing factor of the select crystal systems and the types of crystal defects.	Understanding (K2)
CO6	determine the Young\'s modulus of a material using the concepts of elasticity and bending moment of a beam, and to determine the viscosity of a liquid using the concepts of viscosity.	Applying (K3), Precision (S3)
CO7	compute the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using the concepts of propagation of sound through a medium.	Applying (K3), Precision (S3)
CO8	determine the wavelength and the angle of divergence of a semiconductor laser beam using the concepts of propagation of light through a medium, and to compute the acceptance angle and the numerical aperture of an optical fiber using the concept of total internal reflection.	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	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	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	20	40	40				100
CAT2	20	45	35				100
CAT3	20	50	30				100
ESE	20	40	40				100

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

18CYC11 - 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	2*	3.5

Preamble	Applied Chemistry course imparts the basic principles and concepts of chemistry in the field of Engineering and Technology. It also imparts knowledge on Water Technology, Electrochemistry, Corrosion and its control, Fuels & Combustion and Polymers.	
Unit - I	**Water Technology:**	**9**
Introduction - Sources of water - Impurities in water - Types of water – Water Quality Standards - Hardness of water - Expression of hardness - Units of hardness - Estimation of hardness of water by EDTA method - Determination of alkalinity - Disadvantages of using hard water - Boiler troubles - Scale and sludge - Softening of water - External treatment method - Demineralization process - Internal treatment process - Carbonate and Calgon conditioning - Desalination by reverse osmosis method.		
Unit - II	**Electrochemistry:**	**9**
Introduction - Cells - Representation of a galvanic cell - Reversible and irreversible cells - Electrode potential - Nernst equation - Reference electrode - Standard hydrogen electrode - Glass electrode - Electrochemical series and its applications - Conductometric titrations - Mixture of weak and strong acid vs strong base.		
Unit - III	**Corrosion and its Control:**	**9**
Introduction - Chemical corrosion - Electrochemical corrosion - Galvanic corrosion - Concentration cell corrosion - Galvanic series - Factors influencing rate of corrosion - Corrosion control methods - Sacrificial anodic method - Protective coatings - Pretreatment of metal surface - Metallic coating - Electroplating - Nonmetallic coating - Phosphate coating - Organic coating - Paints - Constituents and their functions - Special paints - water repellant and luminescent paints.		
Unit - IV	**Fuels and Combustion:**	**9**
Introduction - Classification of fuels - Requirements of a good fuel - Combustion - Principle of combustion - Calorific value - Gross and net calorific values - Explosive range - Spontaneous ignition temperature - Calorific intensity - Solid fuels - Coal and its varieties - Proximate analysis - Significance - Metallurgical coke - Otto-Hoffman byproduct method - Liquid fuel - Refining of petroleum - Manufacture of synthetic petrol - Hydrogenation of coal - Bergius method - Knocking - Octane number - Cetane number - Gaseous fuel - LPG.		
Unit - V	**Polymers:**	**9**
Introduction - Classification of polymers - Functionality - Polymerization - Plastics - Types - Thermo and thermosetting plastics - Individual polymers - Polypropylene, PVC, PET and epoxy resin - Preparation, properties and uses - Compounding of plastics - Fabrication of plastics - Compression, injection, extrusion and blow moulding methods - Foamed plastics.		

List of Exercises / Experiments:

1.	Estimation of total, temporary and permanent hardness of water by EDTA method.
2.	Estimation of Ca2+ and Mg2+ hardness separately by EDTA method.
3.	Estimation of alkalinity of the given water sample.
4.	Conductometric titration - Mixture of acids.
5.	Estimation of hydrochloric acid using pH meter.

***Alternate Weeks**

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1. Palanisamy P.N., Manikandan P., Geetha A. & Manjula Rani K., "Applied Chemistry", 5th Edition, Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2018.

REFERENCES:

1. Jain & Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2016.
2. Sharma B.K., "Industrial Chemistry", Krishna Prakasan Media Pvt. Ltd, Meerut, 2014.
3. Palanisamy P.N., Manikandan P., Geetha A & Manjula Rani K., "Chemistry Laboratory Manual", Rajaganapathy Publishers, Erode, 2018.

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 to construct cells and measure the electrode potential	Applying (K3)
CO3	adopt the suitable corrosion control methods for the given practical 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)
CO6	estimate the amount of hardness for the given water sample by EDTA method	Applying (K3), Precision (S3)
CO7	estimate the amount of alkalinity for the given water sample	Applying (K3), Precision (S3)
CO8	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	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2												
CO5	3	2												
CO6	3	2	1	3										
CO7	3	2	1	3										
CO8	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	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)**

18GET11 - INTRODUCTION TO ENGINEERING

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	ES	3	0	0	3

Preamble	The objective of this course is to realize the importance of engineering, measurements and the fundamental concepts of common engineering disciplines like Civil, Mechanical, Electrical and Electronics Engineering.	
Unit - I	**Engineering and Measurements:**	**9**
Engineering and Measurements: Engineering - Engineer and Engineering Graduate - Graduate attributes - Role of engineer - Professional bodies and their role. Physical Quantities - Dimensions - SI Units, Symbols and Conversions - Mechanical Measuring Instruments - Electrical Measuring Instruments - Accuracy and Precision - Data Acquisition System.		
Unit - II	**Mechanical Engineering:**	**9**
Mechanical Engineering: IC Engines - Power Plants - Boilers and Furnaces - Pumps - Refrigeration and Air Conditioner - CAD/CAM - Additive Manufacturing. Hybrid Electric Vehicles, Industry 4.0.		
Unit - III	**Civil Engineering:**	**9**
Civil Engineering: Selection of the site for Building - Building approval process - Contract and tenders - Building Materials - Components of Building - Sequence of works for building construction - Prefabricated Structures - Water Management - Rainwater harvesting - Infrastructure - Bridges, Dams and Roads.		
Unit - IV	**Electrical Engineering:**	**9**
Electrical Engineering: Terminologies - Current, voltage, potential difference, power, energy - Supply: DC, AC - single phase and three phase - Energy conversion - Utility structure - Single line diagram of power system - Apparatus - Tariff - House wiring. Alternator - Induction motor - Solar and wind energy.		
Unit - V	**Electronics Engineering:**	**9**
Electronics Engineering: Resistor, Inductor, capacitor - Diode - LEDs - Rectifier - Power Supply - Transistor - Transistor as an amplifier - MOSFET - Logic Gates - Microprocessor - Micro controller - Radio communication - Internet of Things.		

Total:45

TEXT BOOK:

1. Faculty of Mechanical Engineering, "Introduction to Engineering", McGraw Hill Education India Pvt. Ltd., Chennai.

REFERENCES:

1. Arvid R. Eide, Roland D. Jenison, Steven K. Mickelson and Larry L. Northup. , "Engineering Fundamentals and Problem Solving", 7th Edition, McGraw Hill Education, New York, 2018.
2. Navaneethakrishnan P., Selvakumar P., Rajeshkumar G. and Sangeetha R.K., "Basic Civil and Mechanical Engineering", McGraw Hill Education, New Delhi, 2016.
3. Senthilnathan N., Logeswaran T. and Suresh M., "Basic Electrical and Electronics Engineering", McGraw Hill, New Delhi, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recognize the roles of engineer, measurement quantities and systems in Engineering	Understanding (K2)
CO2	infer the components and principles of mechanical engineering applications	Understanding (K2)
CO3	summarize the process involved in building construction, infrastructure and water conservation	Understanding (K2)
CO4	recognize the fundamental terms involved in electrical engineering	Understanding (K2)
CO5	explain the working of basic electronic components and its applications	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	3	2	1	1		2	1					3		
CO3	3	2	1	1		2	1					3		
CO4	2	1										3		
CO5	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	50	50					100
CAT2	50	50					100
CAT3	50	50					100
ESE	50	50					100

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

18MEC11 - ENGINEERING DRAWING

(Common to all Engineering and Technology Branches)

Programme & Branch	B.E. & Mechanical Engineering	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**
General Principles of Orthographic Projection: 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 Solid: 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: 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 Surfaces: 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**
Isometric Projection and Introduction to AutoCAD: 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.		

Total:45

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	20	40	40				100

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

18MEL11 - ENGINEERING PRACTICES LABORATORY
(Common to all Engineering and Technology Branches)

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

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.	To prepare a leak proof sheet metal tray/box/funnel using modern power tools.
6.	Welding practice using welding simulator.
7.	Project: Preparing innovative articles using wood/sheet metal.
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
8.	Safety Aspects of Electrical Engineering, Electrical Symbols, Components Identification, Fuse selection and installation, Circuit Breakers selection
9.	Wiring circuit for fluorescent lamp and stair case wiring
10.	Measurement of earth resistance
11.	Soldering of simple circuits and trouble shooting
12.	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	3	3	3	3	3				3	3	2	3		
CO2	3	2	1	1					3	2	2	3		
CO3	2	1							3	2	2	3		
CO4	3	2	1	1					3	3	2	3		
CO5	3	2	1	1					3	2	2	3		

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

18EGT21 - ENGLISH FOR COMMUNICATION II

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	HS	3	0	0	3

Preamble	This course is designed to impart required levels of fluency in using the English Language at B1 level in the 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, "Interchange, Student’s Book 3", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1. Jane Willis, "A Framework for Task Based Learning", Longman, Harlow, 1996.
2. Rod Ellis, "Task Based Language Learning and Teaching", Oxford University Press, London, 2003.

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	3	3	30	40		24	100
CAT2	3	3	33	43		18	100
CAT3	3	3	33	43		18	100
ESE	3	3	31	45		18	100

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

18MAC21 - MATHEMATICS II

(Common to All BE/BTech Engineering and Technology Branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	BS	3	1*	2*	4

Preamble	To impart the knowledge of 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	**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 - II	**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 and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.		
Unit - III	**Beta and Gamma Functions:**	**9**
Definition of beta and gamma Functions – Properties – Relation between beta and gamma functions – Transformations of gamma function – Applications of beta and gamma functions: Evaluation of definite integrals in terms of beta and gamma functions.		
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 – 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.	Evaluating indefinite and definite integrals
2.	Evaluating double and triple integrals
3.	Finding the area between two curves
4.	Computing gradient, divergence and curl
5.	Computation of beta and gamma 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 Weeks**

Lecture: 45, Practical:15, Total:60

TEXT BOOK:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, New Delhi, 2014.

REFERENCES:

1. Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - II", 2nd Edition, Pearson India Education, New Delhi, 2018.
2. Won Y. Yang, Young K. Choi, Jaekwon Kim, Man Cheol Kim, Jin Kim H. and Taeho Im, "Engineering Mathematics with MATLAB", 1st Edition, CRC Press, London, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve problems involving double and triple integrals	Understanding (K2)
CO2	apply the concept of vectors in engineering problems	Applying (K3)
CO3	use Beta and Gamma functions to improper evaluate integrals	Applying (K3)
CO4	identify, construct and apply analytic functions in electrostatics and fluid flow problems	Applying (K3)
CO5	evaluate complex integrals which is extensively applied in engineering	Applying (K3)
CO6	evaluate line, double and triple integrals and determine area between two curves using MATLAB	Applying (K3), Manipulation (S2)
CO7	compute gradient, curl and divergence of a vector function 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	2	2											
CO2	3	2												
CO3	3	2	1											
CO4	3	1												
CO5	3	2	2											
CO6					3									
CO7					2									
CO8					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	10	70				100
CAT2	20	10	70				100
CAT3	20	10	70				100
ESE	20	10	70				100

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

18PHC22 - MATERIALS SCIENCE

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	2	BS	3	0	2*	3.5

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 mechanical engineering and provides motivation towards innovations.

UNIT – I	**Conducting Materials:**	**9**

Conductors – Classical free electron theory – Electrical and thermal conductivities – Wiedemann–Franz law – Lorentz number – Draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi function – Density of energy states – Carrier concentration in metals.

UNIT – II	**Semiconducting Materials:**	**9**

Intrinsic semiconductor: Carrier concentration, Electrical conductivity and band gap – Extrinsic semiconductors: Carrier concentration in n-type and p-type semiconductors (qualitative) – Hall effect – Determination of Hall coefficient – Applications: Solar cell.

UNIT –III	**Magnetic, Superconducting and Dielectric Materials:**	**9**

Magnetic Materials: Introduction - Domain theory of ferromagnetism – Hysteresis - Soft and hard magne tic materials - Applications: Transformer core. Superconductors: Properties – Type I and Type II superconductors - Applications of superconductors: Magnetic levitation. Dielectric materials and its applications.

UNIT – IV	**Smart and Nano Materials:**	**9**

Smart Materials: Metallic glasses: Preparation by melt spinning, properties and applications – Shape memory alloys (SMA): Characteristics and applications. Nanomaterials: Low dimensional structures: quantum dot, quantum wire and quantum well – Properties of nanomaterials – Synthesis: Top down and bottom up approaches – Ball milling – Physical vapor deposition method – Carbon nanotubes: Structures – Fabrication by laser ablation – Applications of nano materials.

UNIT – V	**Materials Characterization:**	**9**

Importance of materials characterization - Raman spectroscopy – X-ray diffraction - Scanning electron microscopes: principle, construction and working - Transmission electron microscope: principle, construction and working. Thermal analysis: Thermo gravimetric analysis (TGA).

List of 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 nanocrystalline thin film using Air-wedge arrangement.
5.	Determination of the particle size of given powder using a Laser.

***Alternate Weeks**

Lecture:45, Practical: 15, Total: 60

TEXT BOOK:

1. Tamilarasan K. and Prabu K., "Engineering Physics-II", Tata McGraw Hill Education Private Ltd., New Delhi, 2014.

REFERENCES / MANUAL / SOFTWARES:

1. Raghavan V., "Materials Science and Engineering: A first course", 5th Edition, Prentice-Hall of India, New Delhi, 2009.
2. Li, Lin, Ashok Kumar,"Materials Characterization Techniques", Sam Zhang; CRC Press, 2008.
3. Tamilarasan K. and Prabu K., "Physics Laboratory Manual", SCM Publishers, Erode, 2018.

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 explain the carrier concentration of extrinsic semiconductors and Hall Effect and its applications	Applying (K3)
CO3:	explain the select types, properties and applications of magnetic, superconducting and dielectric materials	Understanding (K2)
CO4:	explain the preparation, properties and applications of the select smart materials (metallic glasses, SMA), nanomaterials and carbon nanotubes	Understanding (K2)
CO5:	apply the concepts of Raman effect, X-ray diffraction, matter waves and thermograph to describe the principle and working of the select materials characterization techniques (Raman spectroscopy, XRD, SEM, TEM and TGA)	Applying (K3)
CO6:	determine the specific resistance of conducting materials and the band gap of semiconducting materials using the concept of electrical conductivity	Applying (K3), Precision (S3)
CO7:	determine the thermal conductivity of dielectrics using the concept of heat flow through materials	Applying (K3), Precision (S3)
CO8:	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	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	1											
CO3	3	2												
CO4	3	2												
CO5	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	20	40	40				100
CAT2	25	40	35				100
CAT3	25	45	30				100
ESE	25	35	40				100

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

18CYC22 - ENVIRONMENTAL CHEMISTRY IN MECHANICAL SYSTEMS

(Common to Mechanical & Mechatronics Engineering branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Chemistry	2	BS	3	0	2*	3.5

Preamble: Environmental Chemistry aims to realize the interdisciplinary and holistic nature of the environment for mechanical and mechatronics engineering students and stimulate them to quest for environment, lubricants, green power technology and environmental impact assessment for sustainable development.

UNIT - I **9**

Chemistry and the Environment: Environment - planet earth - components of environment- atmosphere-hydrosphere-lithosphere-biosphere-interrelationship between components and sub components- environmental pollution – environmental pollutants - toxic effects of pollutants - fluoride, arsenic, chromium, cadmium and lead - recovery and recycling of materials**-** role of an individual in prevention of pollution.

UNIT - II **9**

Environmental Pollution: Definition-causes, effects, control measures and case studies of: a) air pollution - climate change, global warming, acid rain, ozone layer depletion b) water pollution c) soil pollution - solid waste management d) marine pollution e) noise pollution.

UNIT – III **9**

Lubricants, Explosives and their Impact: Lubricants - types of lubricants with examples - liquid lubricants - properties – viscosity index, flash and fire points, cloud and pour points, oiliness, aniline point – solid lubricant – graphite - environmental impacts of lubricants - Explosives - classification - precautions during storage - manufacture of important explosives (TNT, GTN and RDX) - rocket propellants- classification of propellants - environmental impacts of explosives.

UNIT – IV **9**

Green Power Technology: Introduction - types of energy resources- need for green energy - renewable energy resources-solar energy -solar cells- solar cooker, solar dryer and solar ponds -wind energy - wind mill and wind turbine - hydroelectric energy - tidal energy - nano technology for energy sector - role of an individual in conservation of energy resources.

UNIT – V **9**

Environmental Impact Assessment and Auditing: Sustainability - three pillars of sustainability- factors affecting environmental sustainability-approaches for sustainable development - Introduction to EIA - objectives of EIA - steps in EIA - participants of EIA - general approach of environmental auditing - audit programmes in India - ISO 14001 certification - environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act.

List of Experiments:

1. Estimation of chloride ion in the given water sample using Argentometric method.
2. Estimation of chromium (Cr^{6+}) in wastewater sample.
3. Determination of dissolved oxygen in the given wastewater sample.
4. Estimation of molecular weight of the polymer using viscometer.
5. Estimation of copper in the given solution by Iodometric method.

***Alternate Weeks**

Lecture:45, Practical:15, Total: 60

TEXT BOOK:

1. Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., “Environmental Science”, Pearson Education, New Delhi, Revised Edition 2019.

REFERENCES / MANUALS:

1. Jain and Jain, “Engineering Chemistry”, 16th Edition, DhanpatRai Publishing, 2016.
2. Charles H. Eccleston, “Environmental Impact Assessment: A Guide to Best Professional Practices”, CRC Press, 2017.
3. Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., “Chemistry Laboratory Manual”, Rajaganapathy Publishers, Erode, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the knowledge on components of environment to study the impacts of pollutants on it	Applying (K3)
CO2:	manipulate the sources, effects and control methods of various environmental pollution	Applying (K3)
CO3:	determine the types and properties of lubricants, explosives and their impacts on environment	Applying (K3)
CO4:	utilize green power technologies for sustainability	Applying (K3)
CO5:	make use of the knowledge of EIA, EA and environmental legislation laws towards sustainability	Applying (K3)
CO6:	demonstrate the viscometer to estimate the molecular weight of the polymer	Applying (K3), Precision (S3)
CO7:	determine the amount of chloride and copper in the given solution	Applying (K3), Precision (S3)
CO8:	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	2	1	1			3							
CO2	3	2	1	1			3							
CO3	3	2	1	1			3							
CO4	3	2	1	1			3							
CO5	3	2	1	1			3							
CO6	3	2	1	3										
CO7	3	2	1	3										
CO8	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	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)**

18CSC11 - PROBLEM SOLVING AND PROGRAMMING

(Common to All BE/BTech Engineering and Technology Branches)

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

Preamble	This course mainly focuses on the basic concepts of computing, the methodology of problem solving and developing skills in programming using C language.	
Unit - I	**Introduction to Computer and Problem Solving:**	**9**
Overview of computers - Applications of computers - Characteristics of computer - Basic computer Organization - Number System - Problem solving: Planning the computer program – Algorithms - Flowcharts – Pseudocodes - Structuring the logic.		
Unit – II	**Case Study on Problem Solving:**	**9**
Algorithm, Flowchart and Pseudo code for the problems: Exchanging the values of two variables - Finding the biggest number - Counting - Summation of numbers - Factorial computation - Generation of Fibonacci Sequence - Summation of series - Base Conversion - Reversing the digits of an Integer.		
Unit – III	**Introduction to C and Control Statements:**	**9**
Overview of C - Basic structure of a C Program - Executing a C Program - C Character set - Tokens - Keywords and Identifiers - Constants - Variables - Data types - Storage classes - Managing Input and Output operations - Operators and Expressions - Decision making and Branching - Looping - Break and continue statements.		
Unit – IV	**Arrays, Strings and Structures:**	**9**
Arrays – One-dimensional and Two-dimensional arrays - Handling of character strings: Declaring and initializing string variables - Performing simple string operations - Introduction to structures: Structure definition - Structure declaration - Accessing a structure member - Structure initialization - Unions.		
Unit – V	**Functions:**	**9**
User defined functions: Elements of user defined functions - String handling functions - Library functions (strings and characters manipulation) - Passing arguments to functions – Recursion. Introduction to Pointers: Understanding pointers - Accessing address of a variable - Declaring pointer variables - Initialization of pointer variables - Accessing a variable through its pointer - Parameter passing mechanisms.		

List of Exercises / Experiments :

1.	Writing algorithms and drawing flowcharts using Raptor Tool for problems involving sequential, selective and repetitive structures
2.	Programs for demonstration of working of different types of operators like arithmetic, logical, relational and ternary operators involving sequential structures
3.	Demonstration of programs using decision making statements namely ‘if’, ‘else if’, ‘switch’, conditional and unconditional ‘goto’ (selective structures)
4.	Programs for demonstrating repetitive control statements like ‘for’, ‘while’ and ‘do-while’ (iterative structures)
5.	Demonstration of programs for declaration, initialization and performing operations on one-dimensional and two-dimensional numeric arrays
6.	Demonstration of programs for implementing various string operations like ‘copy’, ‘finding length’, ‘compare’, ‘concatenate’ with and without built-in library functions.
7.	Demonstration of programs for making use of user-defined data types namely structures and unions
8.	Demonstration of modular programming concepts using functions – developing programs using built-in and user-defined functions and parameter passing mechanisms

Lecture:30, Practical:30, Total:60

TEXT BOOK:

1. "Problem Solving and Programming", compiled by Department of CSE, Kongu Engineering College, Internal circulation, 2017.

REFERENCES:

1. Dromey R.G., "How to Solve it by Computer", Pearson Education, 2009.
2. Balagurusamy E., "Fundamentals of Computing and Programming", Tata McGrawHill Education Pvt. Ltd., 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the characteristics, organisation, working principles and applications of computers	Understanding (K2)
CO2	express the solution for the given real world problems in terms of algorithm, flowchart and pseudocode	Applying (K3)
CO3	identify the appropriate looping and control statements in C for providing the solution to the given problems	Understanding (K2)
CO4	demonstrate the usage of arrays, strings and structures to solve the given problems	Understanding (K2)
CO5	apply fundamental modular programming knowledge to solve the given problems and recall the basic concepts of pointers	Understanding (K2)
CO6	demonstrate the execution of flowchart for the given problem using Raptor	Applying (K3), Precision (S3)
CO7	demonstrate the application of control statements using simple C programs	Applying (K3), Precision (S3)
CO8	implement solutions to the given problem using user defined functions and data types	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	2													
CO2	2	2	2		2									
CO3		2	1											
CO4		2	1											
CO5		2	1											
CO6	3	2	1	1	1					1				
CO7	3	2	1	1	1					1				
CO8	3	2	1	1	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)**

18MET21 - MANUFACTURING TECHNOLOGY

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

Preamble: A Mechanical Engineer needs to know the concepts in casting, forming, joining and powder metallurgy techniques to get desired shape and size in metals. Manufacturing technology is an introductory course which emphasizes the fundamental principles and overview of manufacturing of metals and polymers in mechanical engineering.

UNIT – I		9

Foundry Technology: Casting processes: Pattern: Types, Material, Allowances – Moulding Sand: Preparation, Properties - Cores: Types and Applications – Heating and Pouring – Solidification and Cooling – Pure metal Alloys – Solidification time – Shrinkage – Directional solidification – Design – Runner – Riser --Gate. **Special Casting Processes:** Expendable mold casting processes – Shell molding - Vacuum molding – Expanded polystyrene process – Investment casting, Plastic mold and Ceramic mold casting, Permanent mold casting process – Die casting – Centrifugal casting – Types, Defects in casting.

UNIT – II		9

Metal Forming Processes: Bulk deformation process – Principles of extrusion, rolling and drawing – Forging processes: open, impression and closed die forging - Types: Upset and Heading – Swaging and Radial, Roll forging – Sheet metal operations: Shearing, Blanking, Punching, Slotting, Perforating, Notching, Trimming, Shaving – Bending operations – Bending allowances – Flanging – Hemming - Seaming and Curling, Ironing, Coining, Embossing.

UNIT – III		9

Plastic Forming Processes: Properties of polymer melts – Extrusion – Production of sheet and film – Fiber and Filament production – Coating processes Injection molding – Compressions and Transfer molding – Blow molding – Rotational molding – Thermoforming.

UNIT – IV		9

Welding Technology: Physics of welding – Features of a fusion welded joint – Working Principles of Arc welding – Resistance welding – Electron beam – Laser beam – Electro slag – Thermit welding – Solid state welding – Weld quality weldability. Soldering and Brazing.

UNIT – V		9

Powder Metallurgy: Characterization of engineering powders – Production of metallic powders – Conventional pressing and sintering – Alternative pressing and Sintering techniques – Design consideration in PM – Product of PM. Additive Manufacturing.

Total: 45

TEXT BOOK:

1. Serope Kalpakjian, Steven R. Schmid, “Manufacturing Process for Engineering Materials”, 5th Edition, Pearson Education, 2009.

REFERENCES:

1. Mikell P. Groover, “Fundamentals of Modern Manufacturing Materials, Processes and Systems”, 5th Edition, Wiley India, 2012.
2. DeGarmo S., “Materials and Processes in Manufacturing”, 11th Edition, John Wiley & Sons, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the principle and processes involved in casting process	Understanding (K2)
CO2:	illustrate the mechanism of different kinds of metal forming processes	Applying (K3)
CO3:	explain the processes related to plastic forming	Understanding (K2)
CO4:	demonstrate the principles involved in various welding techniques	Understanding (K2)
CO5:	describe the concept of powder metallurgy and its applications	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									2	3	1	3
CO2	3	2	1	1					2		2	3	1	3
CO3	2	1									2	1	1	3
CO4	2	1							2		2	2	1	3
CO5	2	1									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	20	50	30				50
CAT2	20	50	30				50
CAT3	30	70					50
ESE	20	40	40				100

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

18VEC11 - VALUE EDUCATION

(Common to All BE/BTech Engineering and Technology Branches)

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

Preamble	The aim of the course is to make the students to understand the purpose and value of life and to exhibit positive human values.	
Unit - I	**Philosophy of Life Science:**	**4**
Life - Purpose of life (four stages of life) - Philosophy of life (who am I') – Law of nature (cause of the life and body) - Content of the Life (five sheaths) - Goal of life. Five duties in life. Methodology: Life and messages of spiritual and national leaders - The forgotten hero, etc. Project report: Complementing with happiness - Every soul is potentially divine.		
Unit - II	**Human Values - Moral Foundation:**	**4**
Truth, forgiveness, compassion, endurance, humility, non violence,moderate diet, non stealing, self purification, self discipline, self study, content, cleanliness, honesty, and totality in faith - Good habits - Attitude forming for Individual peace. Practical Methods: Personal experience with above characters, Puranic Stories - Self resolve diary maintenance.		
Unit - III	**Social Values:**	**4**
Family - Family System - Greatness of women - World brotherhood (vasudeiva kudumbagam) - Glorious Bharath - Bharathian systems - Past-Present-Future - Team spirit - Goal setting - Economics - Education - Politics - Responsibilities of people - Preserving natural resources. Methodology: Preparing an album on glorious Bharath Past, Present and Future Plans. Goal setting - Management Games.Team Spirit - Yogic Games.		
Unit - IV	**Development of Mental Prosperity:**	**4**
Prosperity of mind - Functions of mind - Obstacles of mind - Practical method to perfect mind is yoga - Types - Uses - Precaution - Contradiction - Kriyas - Asanas - Pranayamas - Meditative techniques. Methodology: Asana - Pranayama - Cyclic meditation - Nada anu sandhana - Meditation - Yogic games for memory. Album on asanas, pranayama and mantra.		
Unit - V	**Maintenance of Physical Health:**	**4**
Human body - Structure - Ten Systems of the body as per modern science.Five elements - Harmonious relationship - Life force - Conserving vitality and health through natural life -Pranic food and its importance - Uses of herbs - Right way of cooking to preserve nutrients - Cause of the disease - Acute and chronic - Disease - Life and death. Methodology: Natural food making, traditional millet dishes. Asanas, pranayamas, cleansing procedures, Quiz on healthy living, Uses of herbs or kitchen garden.		

List of Exercises / Experiments:

1.	List of Loosening Exercises: Neck Movements, Shoulder Joint Movements, Elbow Joint Movement, Wrist Joint Movements, Finger Joint Movements, Rip Joint Movement, Hip Joint Movements, Spinal Cord Movement, Knee Joint Movements, Ankle Joint Movements, Toe Joint Movements.
2.	List of Asanas: Surya Namaskara, Shavasana, Makarasanas, Uttanpadasana, Pawanamuktasana, Sedubandasana, Naukasana, Vipareetakarani, Bhujangasana, Sarpasana, Shalabasana, Dhanurasana, Padmasana,Parvatasana, Vakrasana, Janu Sirashasana, Ustrasana, Yoga Mudra, Meru Tandasana, Tadasana, Katichakrasana, Paadahastasana, Parivarta Trikonasana, Ardha Chakrasana, Viruksasana.
3.	List of Pranayamas: Naadi Sodhana Pranayama, Bhastrika Pranayama, Bhramari Pranayama, Sheetali Pranayama.

Lecture:20, Practical:10, Total:30

TEXT BOOK:

1. Value Education, "Compiled by Vethathiri Maharishi Institute for Spiritual and Intuitional Education", Aliyar, Pollachi, 2018.

REFERENCES:

1. Value Education - Yoga Practical Guide, "Compiled by Padmasoorya Naturopathy and Yoga Foundation", Coimbatore, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the purpose and value of life.	Understanding (K2)
CO2	exhibit positive human values.	Understanding (K2)
CO3	understand social values.	Understanding (K2)
CO4	take steps to develop mental and physical health	Applying (K3), Imitation (S1)

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		
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							0
CAT2							0
CAT3							0
ESE	25	75					100

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

18MAC31 - MATHEMATICS III

(Common to Civil Engineering, Mechanical Engineering, Mechatronics Engineering, Automobile Engineering, Electronics And Communication Engineering, Electrical And Electronics Engineering , Electronics And Instrumentation Engineering, Chemical Engineering & Food Technology Branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	BS	3	1*	2*	4

Preamble	To provide the skills for solving the real time engineering problems involving partial differential equations and impart knowledge in Fourier transform and Z-Transform.	
Unit - I	**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 - II	**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 - III	**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).		
Unit - IV	**Fourier Transform:**	**9+3**
Fourier Integral theorem (without proof) – Fourier transform pair – Properties (without proof) – Transforms of simple functions – Fourier Sine and Cosine transforms – Properties (without proof) – Convolution theorem and Parseval's identity (Statement and applications only).		
Unit - V	**Z –Transform:**	**9+3**
Definition – Z-transform of some basic functions – Elementary properties – Inverse Z- transform: Partial fraction method – Residue method – Convolution theorem – Applications of Z-transforms: Solution of difference equations.		

List of Exercises / Experiments :

1.	Expressing given function in terms of Fourier series.
2.	Harmonic Analysis of given data.
3.	Solving second order partial differential equations.
4.	Solution of One dimensional wave equation.
5.	Solution of Two dimensional heat equation.
6.	Determining Fourier and inverse Fourier transform of a given function.
7.	Computing Z- transform of a discrete sequence.
8.	Apply Z- transforms to obtain the solution of difference equations.

***Alternate Weeks**

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1. Veerarajan T., "Transforms and Partial Differential Equations", 3rd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons Ltd., USA, 2019.
2. Duraisamy C., Vengataasalam S., Arun Prakash K. & Suresh M., "Engineering Mathematics – III", 2nd Edition, Pearson India Education, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	express given function or data in terms of Fourier series	Applying (K3)
CO2	solve the given standard partial differential equations	Applying (K3)
CO3	apply Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations	Applying (K3)
CO4	use the mathematical principles of Fourier transforms which will provide the ability to formulate and solve some of the physical problems of engineering	Applying (K3)
CO5	apply Z transform techniques for analyzing linear time invariant systems	Applying (K3)
CO6	express the given data in Fourier series using MATLAB	Applying (K3), Manipulation (S2)
CO7	solve partial differential equations using PDE Modeler	Applying (K3), Manipulation (S2)
CO8	find Fourier and Z-Transforms using MATLAB built in functions	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	1	1										
CO2	3	3	1	1										
CO3	3	3	1	1										
CO4	3	3	1	2										
CO5	3	3	1	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	20	10	70				100
CAT2	20	10	70				100
CAT3	20	10	70				100
ESE	20	10	70				100

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

18MET31 - ENGINEERING MECHANICS

(Common to Mechanical Engineering & Mechatronics Engineering Branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	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**
Statics of Particles: 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**
Statics of Rigid Bodies: 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**
Properties of Surfaces and Solids: 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)**

18MET32 - ENGINEERING THERMODYNAMICS

(Use of Standard Steam table with Mollier diagram and Psychometric chart are permitted)

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

Preamble	To transfer the knowledge of engineering concepts in thermodynamics with relevant practical applications.	
Unit - I	**Basic Concepts and First Law of Thermodynamics:**	**9+3**
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 and Entropy:**	**9+3**
Second Law of Thermodynamics: 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 Substance and Steam:**	**9+3**
Properties of Pure Substance: Properties of Pure Substances -Thermodynamic Properties of Pure Substances in Solid Phase - Liquid Phase - Vapour phase - 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 and Thermodynamic Relations:**	**9+3**
Ideal and Real Gases: 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+3**
Psychrometry: 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.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. Nag P.K. , "Engineering Thermodynamics ", 6th Edition, McGraw Hill Education (India) Pvt. Ltd., Chennai, 2018.

REFERENCES:

1. Claus Borgnakke, Richard E. Sonntag, "Fundamentals of Thermodynamics", 8th Edition, Wiley, US, 2013.
2. Yunus A. Cengel and Michael A. Boles. , "Thermodynamics: An Engineering Approach", 9th Edition, McGraw Hill Education (India) 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 thermodynamic laws	Understanding (K2)
CO2	solve the problems by applying the first and second law of thermodynamics	Applying (K3)
CO3	evaluate the thermodynamic properties of pure substances using steam table	Evaluating (K5)
CO4	analyze the behavior of real and ideal gases and derive the thermodynamic relations	Analyzing (K4)
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	20	30	20	20		100
CAT3	10	20	40	30			100
ESE	5	15	30	30	20		100

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

18MET33 - FLUID MECHANICS AND HYDRAULIC MACHINES

(Common to Mechanical & Mechatronics Engineering Branches)

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

Preamble	To provide an introduction to the properties and behaviour of fluids under static and dynamic conditions. It introduces dimensional analysis and enables to apply the basic performance analysis to hydraulic turbines and pumps.	
Unit - I	**Fluid Properties and Fluid Statics:**	**9**
Fluid Properties: Definition of fluid - Classifications – Properties. Fluid Statics: Pascal's Law – Pressure variation in a fluid at rest – Absolute Pressure – Gauge Pressure - Atmospheric Pressure - Vacuum Pressure –Simple manometer - differential manometer – Hydrostatic forces- Buoyancy – Floatation - Meta centre.		
Unit - II	**Fluid Kinematics and Fluid Dynamics:**	**9**
Fluid Kinematics: 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: Euler's equation of motion along a streamline – Bernoulli's equation and applications - Venturimeter - Orificemeter - Pitot tube.		
Unit - III	**Flow through Pipes and Dimensional Analysis:**	**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 – Power transmission through pipes. Dimensional analysis: Buckingham's π theorem – Introduction to boundary layer flows.		
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 - efficiencies of Pelton Wheel turbine - Francis turbine - Kaplan turbine – Velocity triangles – Specific speed of turbines.		
Unit - V	**Hydraulic Pumps:**	**9**
Hydraulic Pumps: Definition of heads - Efficiencies - 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.		

Total: 45

TEXT BOOK:

1. Sukumar Pati, "Fluid Mechanics and Hydraulic Machines", 9th Edition, McGraw Hill Education, Chennai, 2018.

REFERENCES:

1. Hibbeler R.C, "Fluid Mechanics in SI Units". 1st Edition, Pearson India Education Services Pvt. Ltd., Noida, 2015.
2. Munson B.R., Young D.F., and Okiishi T.H, "Fundamentals of Fluid Mechanics", 7th Edition, John Wiley & Sons, Singapore, 2013.

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	Applying (K3)
CO2	solve the problems related to kinematics and dynamics of fluid flow	Applying (K3)
CO3	analyze the energy losses in flow through pipes	Analyzing (K4)
CO4	evaluate the work done and efficiencies of various hydraulic turbines	Analyzing (K4)
CO5	determine the work done and efficiencies by the various hydraulic pumps	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	2	3
CO2	2	2	1									2	2	3
CO3	3	3	2			1	1					3	2	3
CO4	1	3	2			2	1			2		3	2	3
CO5	2	3	2			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	35	50				100
CAT2	15	20	50	15			100
CAT3	15	20	50	15			100
ESE	10	25	50	15			100

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

18MET34 - ENGINEERING MATERIALS AND METALLURGY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics, Materials Science	3	PC	3	0	0	3

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**
Ferrous Metals: Classification of Engineering Materials – Comparison between Metals and Non-Metals -Alloys – Solid solutions - 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**
Ferrous and Non-Ferrous Alloys: Effect of alloying elements – Manganese – Silicon – Chromium – Molybdenum – Vanadium - Titanium and Tungsten on the technical properties of steel - Stainless and tool steels – HSLA - Maraging steels - Aluminium and its alloys – Precipitation Strengthening Treatment - Copper and its alloys - Magnesium and its alloys.		
Unit - III	**Heat Treatment:**	**9**
Heat Treatment: Definition – 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 and Ceramics: 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**
Stress-Strain Relationship of Materials: Comparative Stress-Strain diagram of cast iron - Steel - Aluminium - Copper - Brass - Al_2O_3 - Glass - Commodity plastics - High performance plastics and rubber. Introduction to New 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.		

Total: 45

TEXT BOOK:

1. Balasubramaniam.R, "Callister's Materials Science and Engineering", 2nd Edition, Wiley India Pvt. Ltd, 2014.

REFERENCES:

1. Sidney H. Avner, "Introduction to Physical Metallurgy", 2nd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 1977.
2. Premamoy Ghosh, "Polymer Science and Technology: Plastics, Rubbers, Blends and Composites", 3rd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010.

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	analyze the effect of alloying elements on the technical properties of ferrous and non-ferrous metals	Analyzing (K4)
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	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											2	3
CO2		3		1									2	3
CO3	1	2		3									1	3
CO4	3			3									2	3
CO5	2				1		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	10	60	20	10			100
CAT2	10	50	30	10			100
CAT3	10	50	30	10			100
ESE	10	40	30	20			100

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

18EET35 - ELECTRICAL DRIVES AND INDUSTRIAL ELECTRONICS
(Common to Mechanical Engineering & Chemical Engineering)

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

Preamble	This course forms the basis for understanding various types of dynamic machines and their starting, braking and speed control methods. It provides the fundamental concepts of power electronic converters and its applications.	
Unit - I	**Electrical Drives and Motor Characteristics:**	**9**
Basic Elements of Drive – Types of Electric Drives – Factors Influence the Choice of Electrical Drives – Classification of Load Torques and Classes of Duty – Selection of Power Rating for Drive Motors – Torque Equation of DC Machine – Speed-Torque Characteristics of DC Motors: Series, Shunt Motor – Torque Equation and Speed-Torque Characteristics of Three Phase Induction Motor – Application: Submersible pump.		
Unit - II	**Motor Starting and Braking Methods:**	**9**
Types of Starters: Two Point Starter, Three Point Starter, Four Point Starter, DOL Starter, Y-Δ Starter. Braking of Electrical Motors: Shunt Motor, Series Motor, Three Phase Induction Motor – Trouble Shooting of Electrical Motors.		
Unit - III	**Power Electronics:**	**9**
Introduction – Construction, Principle of Operation, Static Characteristics of SCR, IGBT-Phase Angle Control – Single Phase Full wave Controlled Rectifiers with R, RL and RLE Load – Three phase Voltage Source Inverters (120° and 180° Mode) – Chopper Operation (Step-Up and Step-Down).		
Unit - IV	**Conventional and Solid State Speed Control of DC Drives:**	**9**
Speed Control of DC Series and Shunt Motors – Armature and Field Control, Ward-Leonard Control System – Controlled Rectifiers Fed DC Drive and Chopper Based DC Drive (Four Quadrant Operation) – Selection of DC Drives for Cranes and Paper Mill.		
Unit - V	**Conventional and Solid State Speed Control of AC Drives:**	**9**
Speed Control of Three Phase Induction Motor – Voltage Control, Voltage / Frequency Control – Slip Power Recovery Scheme (Static Kramer and Scheribus drive) – Inverter and AC Voltage Controller Based Induction Drives – Selection of AC Drives for Textile Mill and Air Compressors.		

Total: 45

TEXT BOOK:

1. Dubey G.K, "Fundamentals of Electrical Drives", 2nd Edition, Narosa Publishing House, New Delhi, 2019.

REFERENCES:

1. Muhammad H. Rashid, "Power Electronics: Devices, Circuits and Applications", 4th Edition, Pearson Education, New Delhi, 2018.
2. Vedam Subrahmaniam, "Electric Drives: Concepts and Applications", 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the fundamentals of electrical drives and the characteristics of electric motors	Understanding (K2)
CO2	classify and interpret the operation of starting and braking methods of AC and DC machines	Understanding (K2)
CO3	sketch the characteristics of various power electronic converters	Applying (K3)
CO4	apply the appropriate speed control techniques for DC drives and their applications	Applying (K3)
CO5	implement the speed control techniques for AC drives and their 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	2	1											1	
CO2	2	1											1	
CO3	3	2	1	1									1	
CO4	3	2	1	1									1	
CO5	3	2	1	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	80					100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

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

18MEL31 - FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY

(Common to Mechanical & Mechatronics Engineering Branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	3	PC	0	0	2	1
Preamble	This laboratory is used in conjunction with fluid mechanics course in reinforcing with the various measurements like flow and losses in pipes. The course also provides the information about performance analysis about hydraulic machines.						

List of Exercises / Experiments:

1.	Determination of co-efficient of discharge using venturimeter.
2.	Calculation of co-efficient of discharge using orifice meter.
3.	Experiment on impact of jet on hemispherical vane.
4.	Identify the co-efficient of friction in flow through pipes.
5.	Determine the head loss occurred due to minor losses in flow through pipes.
6.	Evaluate the percentage of error in Rotometer with the actual flow rate.
7.	Verification of Bernoulli's law using Bernoulli's apparatus.
8.	Performance test on Pelton turbine (constant head method).
9.	Examine the efficiency of Francis turbine (constant speed method).
10.	Evaluate the performance characteristics of the centrifugal pump.
11.	Conduct the performance test on the reciprocating pump.
12.	Determine the efficiency and performance characteristics of submersible pump.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1. Sukumar Pati, "Fluid Mechanics and Hydraulic Machines", 9th Edition, McGraw Hill Education, Chennai, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	perform experiments on flow measuring devices and pipe loss calculation devices	Applying (K3), Manipulation (S2)
CO2	measure and plot the performance characteristics of hydraulic turbines	Applying (K3), Precision (S3)
CO3	determine the performance characteristics of 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	2		1		3
CO2	3	1		3					3	2		1		3
CO3	3	1		3					3	2		1		3

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

18MEL32 - MANUFACTURING TECHNOLOGY LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology	3	PC	0	0	2	1
Preamble	This course provides basic knowledge about manufacturing processes used in industries and offers the hands on training on various manufacturing processes.						

List of Exercises / Experiments:

1.	Prepare a mould by using split patterns.
2.	Prepare a mould by using mould with loose-piece patterns.
3.	Prepare a mould for hollow objects with the help of core.
4.	Produce different weld joints by using horizontal and vertical position of Arc welding operations.
5.	Produce different weld joints by using gas welding operation.
6.	Produce different weld joints by using Tungsten Inert Gas (TIG)/ Metal Inert Gas (MIG) welding operation.
7.	Perform gas cutting and spot welding operations on a given workpiece.
8.	Make a square rod by hand forging operation.
9.	Make a rectangular rod by hand forging operation.
10.	Demonstrate the injection moulding operation by producing different plastic components.
11.	Assembly and disassembly of a bicycle and prepare a bill of materials.
12.	Assembly and disassembly of a tail stock/gear train and prepare a bill of materials.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Hajra Choudhury.S.K, "Elements of Workshop Technology ", Media Promoters & Publishers Private Limited, Mumbai, 2013.
2.	Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	prepare mould for given component	Applying (K3), Precision (S3)
CO2	select the suitable welding process for the given material and perform welding	Applying (K3), Manipulation (S2)
CO3	produce a component using injection moulding machine and dismantle and assemble bicycle, tail stock and gear train	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	1			3	2	1			3	1			1	3
CO2	1		1	3	2	1			3	1			1	3
CO3	1		1	3	2	1			3	2			1	3

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

18EEL34 - ELECTRICAL ENGINEERING LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Practices Laboratory	3	ES	0	0	2	1
Preamble	This laboratory gives the practical exposure to the students to learn about the fundamentals of various rotating machines and power electronic converters. It also enables the students to select the suitable electrical drives based on the performance characteristics for various industrial applications.						

List of Exercises / Experiments:

1.	Load Test on DC Shunt Motor
2.	Speed Control of DC Shunt Motor (Armature control and Field control)
3.	Load Test on Three Phase Squirrel Cage Induction Motor
4.	Speed Control of Three Phase Squirrel Cage Induction Motor
5.	Steady State Characteristics of SCR
6.	Single Phase Fully Controlled Rectifier
7.	Three Phase Inverter (120◦ & 180◦ Mode Operation).
8.	Operational Analysis of Choppers (Step Up and Step Down)
9.	Solid state speed control of DC drive
10.	Solid state speed control of AC drive

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	execute the method of speed control in electrical machines	Applying (K3), Manipulation (S2)
CO2	sketch the characteristics of power electronic devices	Applying (K3), Manipulation (S2)
CO3	analyze the various power electronics converters and execute the speed control methods suitable for electric drives	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	2	1	1										
CO2	3	2	1	1										
CO3	2	3	2	2	1									

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

18MAC41 - STATISTICS AND NUMERICAL METHODS

(Common to Civil Engineering, Mechanical Engineering, Mechatronics Engineering, Automobile Engineering, Electrical And Electronics Engineering , Electronics And Instrumentation Engineering, Chemical Engineering & Food Technology Branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	BS	3	1*	2*	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 mean and difference of means – Small sample tests: Student's t-test for significance of means – F-test for comparison of variances – Chi-square test for goodness of fit and independence of attributes		
Unit - II	**Design of Experiments:**	**9+3**
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 and backward interpolation 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.		

List of Exercises / Experiments:

1.	Testing significance of means by student's t - test
2.	Testing the independence of attributes by Chi-square test
3.	Analyze the difference in means is statistically significant by Completely Randomized Design
4.	Finding positive root by Regula – Falsi method
5.	Solving simultaneous linear equations by Gauss – Seidel Method
6.	Evaluating definite integrals by Trapezoidal and Simpson's rules
7.	Solution of ODE by Euler and Modified Euler methods
8.	Solution of ODE by Runge-Kutta method

***Alternate Weeks**

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

TEXT BOOK:

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

REFERENCES:

1. Jay L. Devore. , "Probability and Statistics for Engineering and the Sciences ", 9th Edition, Cengage Learning , USA, 2016.
2. Steven C. Chapra & Raymond P. Canale. , "Numerical Methods for Engineers ", 7th Edition, McGraw-Hill Education, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify large and small samples and apply suitable tests for solving engineering problems	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 ordinary differential equations numerically	Applying (K3)
CO6	test whether the given data is significant by hypothesis testing and ANOVA using MATLAB	Applying (K3), Manipulation (S2)
CO7	use MATLAB for determining numerical solutions of algebraic equations and integral values	Applying (K3), Manipulation (S2)
CO8	obtain the numerical solution of ordinary differential equations 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	2	1	2										
CO2	3	1	2	2										
CO3	3	2	1	1										
CO4	3	1	1	1										
CO5	3	2	1	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)**

18MET41 - STRENGTH OF MATERIALS

(Common to Mechanical & Mechatronics Engineering Branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics, Mathematics I, Mathematics II	4	PC	3	1	0	4

Preamble	To understand the concepts of types of stress, strain, strain energy, principal stress, principal planes and biaxial state of stress in thin cylinders and spherical shells. Also, estimate and draw the shearing force and bending moment diagram due to external loads and the bending stresses of the beams. Evaluation of Slope and deflection of beams by different methods and buckling load of a columns and struts. Torsion on circular shaft and estimation of stress acting on the helical coil springs.	
Unit - I	**Deformation of Solids and Strain Energy**	**9 + 3**
Deformation of Solids: 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 and Biaxial stresses**	**9 + 3**
Analysis of State of Stress: 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 and Stresses in Beams**	**9 + 3**
Transverse Loading on Beams: 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 and Columns**	**9 + 3**
Deflection of Beams: 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 Torsion on Springs**	**9 + 3**
Torsion on Circular Shafts: 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". 5th 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, 2017.
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	analyze the stress, strain and strain energy of simple bars	Analyzing (K4)
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	2	1	1								3		3
CO2	3	3	2	2	1							3		3
CO3	3	2	1	1								3		3
CO4	3	2	1	1								3		3
CO5	3	3	2	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	15	15	35	35			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)**

18MET42 - THERMAL ENGINEERING

(Use of Standard Steam table with Mollier diagram and Psychrometric chart are permitted)

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

Preamble	To impart knowledge on working and analysis of various thermal systems by applying the concept of thermodynamics.	
Unit - I	**Internal Combustion Engines**	**9+3**
Internal Combustion Engines: Classifications - IC Engine Components and their Functions - Valve Timing and Port Timing Diagrams - 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 Cycles:**	**9+3**
Gas Power Cycles: Otto Cycle - Diesel Cycle - Dual Cycle - Brayton Cycle - Calculation of Mean Effective Pressure and Air Standard Efficiency - Two Stroke - Four Stroke - Petrol and Diesel Engine - Actual p-V Diagrams - Theoretical p-V Diagrams. Vapour Power Cycles: Rankine Cycle Analysis - Reheat - Regeneration.		
Unit - III	**Steam Boilers, Steam Nozzles and Turbines:**	**9+3**
Steam Boilers: Classification - Fire Tube and Water Tube Boilers - Mountings and Accessories - High Pressure Boilers – Types - 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+3**
Air Compressor: 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 – Working Principle (Elementary Treatment Only).		
Unit - V	**Refrigeration and Air Conditioning:**	**9+3**
Refrigeration: Working Principle of Vapour Compression Refrigeration System – Super Heating and Sub Cooling - Performance Calculations - Working Principle of Vapour Absorption System – NH3-H2O and LiBr-H2O 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).		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

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

REFERENCES:

1. Sadhu Singh, "Thermal Engineering", 1st Edition, Pearson, Noida, 2018.
2. Mahesh M. Rathore , "Thermal Engineering", 1st Edition, McGraw Hill Publications, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the working principle of engine and its various subsystems and also estimate the performance of IC engine.	Analyzing (K4)
CO2	apply the concept of thermodynamic processes in gas and vapour power cycles by using p-v, T-s and p-h diagrams.	Applying (K3)
CO3	analyze the performance of boilers, nozzles and turbines.	Analyzing (K4)
CO4	analyze the performance of compressors.	Analyzing (K4)
CO5	apply the concepts of thermodynamics in R&AC systems and perform the cooling load calculations.	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	2			1				1		3		3
CO2	3	3	1							2		3		3
CO3	2	3	1							2		3		3
CO4	3	3	2							1		3		3
CO5	3	3	1							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	30	25	35			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)**

18MET43 - KINEMATICS OF MACHINERY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics, Engineering Drawing	4	PC	3	1	0	4

Preamble	The course provides the analysis of velocity, acceleration and synthesis of various simple mechanisms. Cam profile generation; analyze its velocity and acceleration profiles and understanding of gear theory and terminology, working of gear trains and analysis of various gear trains.	
Unit - I	**Basics of Mechanisms:**	**9 + 3**
Basics of Mechanisms: 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 + 3**
Kinematics of Mechanisms: 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 + 3**
Synthesis of Mechanisms: 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 and High Speed Cams:**	**9 + 3**
Kinematics of Cam: 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 and Gear Trains:**	**9 + 3**
Kinematics of Gears: 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.		

Lecture: 45, Tutorial: 15, Total: 60

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", 4th Edition, Oxford University Press, New Delhi, 2014.
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	understand the basic concepts of kinematics and working principle of simple mechanisms	Understanding (K2)
CO2	analyze the velocity and acceleration of simple mechanisms	Applying (K3)
CO3	synthesize simple mechanisms and understand the basics of computer aided analysis	Analyzing (K4)
CO4	understand the basic concepts of cam follower system and design of plate cam profiles	Applying (K3)
CO5	understand 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	2	1	1	1								3		3
CO2	2	3	3	2								3		3
CO3	2	3	3	3	3							3	3	3
CO4	2	3	3	2								3		3
CO5	2	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	25	25	50				100
CAT2	20	20	30	30			100
CAT3	25	25	50				100
ESE	15	15	50	20			100

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

18MET44 - MATERIAL REMOVAL PROCESSES

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Practices Laboratory, Manufacturing Technology	4	PC	3	0	0	3

Preamble	Material removal processes is a part of manufacturing technology which depicts machine tools, components materials and basics of machining processes.	
Unit - I	**Theory of Metal Cutting and Mechanics of Metal Cutting:**	**9**
Theory of Metal Cutting: 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 – Economics of metal machining – Machinability.		
Unit - II	**Machining with Single Point Tool:**	**9**
Machining with Single Point Tool: 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**
Machining with Multi Edged Tools: 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**
Tool Engineering: Classification of jigs and fixtures - Locating and clamping principles - Locating and clamping devices - Jig bushes - Drilling jigs - Milling fixtures - Turning fixtures - Broaching fixtures - Materials for jigs and fixtures.		
Unit - V	**Unconventional Machining Processes:**	**9**
Unconventional Machining Processes: 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).		

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. & Ronald A. Kohser, "Materials and Processes in Manufacturing", 11th Edition, John Wiley & Sons, New Delhi, 2011.
2. Rao P. N., "Manufacturing Technology", 3rd Edition, Tata McGraw Hill, New Delhi, 2011.

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	Analyzing (K4)
CO2	explain machining with single point cutting tool and determine machining time calculation	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								3		3
CO2	2	1	1									3		3
CO3	2	1	1									3		3
CO4	3	2	1	1								3		3
CO5	2	1	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	50	30	10			100
CAT2	10	50	40				100
CAT3	10	50	40				100
ESE	10	40	30	20			100

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

18MET45 - INSTRUMENTATION AND CONTROL SYSTEM

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics, Mathematics II, Mathematics III, Electrical Drives and Industrial Electronics	4	PC	3	0	0	3

Preamble	This course provides a comprehensive knowledge of sensors and transducers used in varieties of day to day applications like the measurement of length, angle, temperature, pressure, flow, etc. Knowledge of control system helps the modern-day automation requirements/applications. This course offers a platform for the design and implementation of a measurement system and controls system design.	
Unit - I	**Basics of Instrumentation:**	**9**
Basics of Instrumentation: Measurement - Definition and Methods. Generalized Measurement System; Units and Standards; Calibration- Primary - Secondary and Working Standards; National and International Standards; Type 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**
Transducers: Introduction To Transducers; Classification- Primary - Secondary and Tertiary; Mechanical-Bellows - Bourdon's Tube - Springs - Proving Rings - Diaphragm - Monometer - Bimetals - Hydro Pneumatic; Electrical- Resistance - Inductance and Capacitance - Strain Gauges and its Orientation for Measurement; Electromechanical Transducers - Vibration and Acceleration Measurement; Advantages and Limitations; Selection Criteria of Sensors and Transducers.		
Unit - III	**Metrology:**	**9**
Metrology: Length and Angle Standards- Gauge Blocks and Angle Gauges; Dial Gauges; Comparators-Mechanical - Pneumatic - Electrical; Design Aspects in Fixing Least Count of Vernier and Micrometer; Length and Angle Measurement-Analog and Digital; Optical Flats - Interferometers For Small Length and Angular Inspection. Lasers in Length and Angle Measurement - Coordinate Measuring Machine.		
Unit - IV	**Control System Concepts:**	**9**
Control System Concepts: Basic Structure and Terminologies - Open and Closed Loop System - Continuous and Sampled Data. Basic Elements of Feedback Control System: Single and Multivariate System - Block Diagram Representation-Transfer Functions - Mathematical Modeling of Control System - Block Diagram Reduction Techniques - Signal Flow Graphs - Properties - Definition - Masons Gain Formula - Output/Input Ratio.		
Unit - V	**Mechanical and Electrical Control System:**	**9**
Mechanical and Electrical Control System: On-Off Controller - Proportional Controller - PI Controller - PID Controller; Applications of Control System; Automatic On-Off Control System - Temperature Control System -Heating/Cooling System-Room Temperature - Automobiles; Flow Control System- Flow Quantity - Flow Rate - Drip Irrigation; Pressure Control System- Boiler - Pressure Cooker; Airplane Control System - Speed Control In Automobile - Missile Control - Position Control System-Use of Servomotors.		

Total: 45

TEXT BOOK:

1. Sawhaney A. K. & Puneet Sawhaney, "A course in Mechanical Measurements and Control", Dhanpat Rai & Co, New Delhi, 2018.

REFERENCES:

1. Ghosh A. K., "Introduction to Instrumentation and Control", Prentice Hall of India, New Delhi, 2004.
2. Tayal A. K. , "Instrumentation and Mechanical Measurements", 2nd Edition, Galgotia Publications, New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	express the knowledge of measurement system, units, standards, calibration and study instrument characteristics.	Understanding (K2)
CO2	choose right sensor/transducers and design measurement system for different applications.	Analyzing (K4)
CO3	identify instruments for length and angle measurement.	Applying (K3)
CO4	find transfer function for simple control system.	Applying (K3)
CO5	design control system and test it for various 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	1	1							2		3
CO2	3	2	2	1	2							2		3
CO3	3	2	1	1	2			1	1		1	2		3
CO4	3	3	1	2	2							2		3
CO5	3	3	3	1	2	2	1	1	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	40	30				100
CAT2	30	40	20	10			100
CAT3	25	45	30				100
ESE	30	30	30	10			100

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

18MEL41 - MATERIAL REMOVAL PROCESSES LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology, Manufacturing Technology Laboratory	4	PC	0	0	2	1
Preamble	To impart knowledge and skill in the field of machine tools used in the industries. This course also enhances the level of confidence of students by working individually in various machine tools.						

List of Exercises / Experiments:

1.	Perform facing, plain turning and step turning operations in centre lathe.
2.	Carryout knurling and taper turning operations using centre lathe.
3.	Execute external thread cutting operation in centre lathe
4.	Make use of centre lathe to carryout eccentric turning and bush turning operations.
5.	Drill and tap on the flat metal plate using drilling and taping tools.
6.	Perform various milling operations using milling machines.
7.	Grind flat and circular metal work pieces using grinding machines.
8.	Obtain a dovetail and key way shapes using shaping machine.
9.	Prepare a curved surface (convex) in a flat metal work piece using slotting machine.
10.	Make a spur gear using milling/hobbing machines.
11.	Measurement of cutting forces in lathe operations using dynamometer.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Hajra Choudhury S.K. & Nirjhar Roy, "Elements of Workshop Technology-Volume-2", 15th Edition, Media Promoters & Publishers Pvt. Ltd., Mumbai, 2010.
2.	NPTEL Lecture Material for Machining Processes - https://nptel.ac.in/courses/112/105/112105126/

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	produce different profiles on metal parts by machining operations using lathe, milling, shaping and drilling machines	Applying (K3), Manipulation (S2)
CO2	perform grinding operations to improve surface finish	Applying (K3), Manipulation (S2)
CO3	examine the effect of machining parameters on cutting forces	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		2					2	1			2	3
CO2	3	1		2					2	1			2	3
CO3	3	1		2					2	1			2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

18MEL42 - ADVANCED MATERIALS TESTING LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Materials and Metallurgy	4	PC	0	0	2	1
Preamble	Any Design engineer is very essential to have the knowledge of materials and their properties. Material properties are depending on microstructure. So, the structure of the material should be accessed and tested to identify the different properties by various experiments						

List of Exercises / Experiments:

1.	Preparation and determination of compressive strength shear strength of green sand and dry sand.
2.	Sieve analysis –Determination of AFS fineness number.
3.	Microstructure of low carbon, eutectoid steel.
4.	Microstructure of Grey cast-iron and spheroidal cast iron.
5.	Microstructure of copper and aluminum alloys.
6.	Rockwell and Brinell hardness measurement for different materials
7.	Tension test on a mild steel rod.
8.	Double shear test on mild steel and aluminium rods.
9.	Torsion test on mild steel rod.
10.	Impact test on metal specimen (Izod and Charpy Test).
11.	Deflection test on cantilever beam and simply supported beam (Aluminium, Steel and Wood).
12.	Test on Helical springs (open and closed coil).

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Balasubramaniam.R, "Callister's Materials Science and Engineering", 2nd Edition, Wiley India Pvt. Ltd., 2014.
2.	Rajput.R.K. , "Strength of Materials", 5th Edition, S.Chand & Co, NewDelhi, 2018.
3.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	examine and analyse microstructure various metals and alloys	Applying (K3), Manipulation (S2)
CO2	demonstrate the preparation and testing of molding sands	Applying (K3), Manipulation (S2)
CO3	perform mechanical testing of materials and components	Applying (K3), Precision (S3)
CO4	identify and analyse the mechanical behavior of structural components	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	1					2	2			3	3
CO2	3	2	1	1					2	2			3	3
CO3	3	2	1	1					2	2			3	3

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

18MEL43 - THERMAL ENGINEERING 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 focuses the study on fuel properties measurement, performance and heat balance of various IC engines under different loading conditions. Also provide the performance study on reciprocating air compressor and steam boiler.						

List of Exercises / Experiments:

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 and electrical loading.
5.	Performance test on twin-cylinder Diesel engine by electrical loading.
6.	Heat balance test on single-cylinder four-stroke Diesel engines by mechanical, hydraulic, eddy current and electrical loading.
7.	Performance and Morse test on multi-cylinder Petrol engine using hydraulic loading.
8.	Retardation test on single-cylinder four-stroke Diesel engine.
9.	Emission test on single-cylinder Diesel and petrol engines using exhaust gas analyzer.
10.	Performance test on multistage reciprocating air compressor
11.	Performance test on boiler.
12.	Study on steam turbine, condenser and cooling tower.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	analyze the characteristics of the fuels	Analyzing (K4), Manipulation (S2)
CO2	examine the performance and heat balance study of various IC engines under different loading conditions and also analyze its exhaust emission	Analyzing (K4), Manipulation (S2)
CO3	test and plot the performance curves on multistage air compressor and steam boiler	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	2	3					2	3		2	2	3
CO2	3	3	2	3	1				2	3		2	2	3
CO3	3	3	2	3					2	3		2	2	3

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

18EGL31 - ENGLISH FOR WORKPLACE COMMUNICATION
(Common to all Engineering & Technology Branches)

Programme & Branch	B.E. & Civil Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	HS	0	0	2	1

Preamble	This course is designed to impart required levels of fluency in using the English Language at B2 level in the CEFR through activities, hands-on training and application.	
Unit - I	**Listening:**	**6**
Techniques for effective listening - Listening and note taking - Listening activities using listening texts - Listening to discourse samples of native English speakers – Focussed listening for improving pronunciaition - understanding different accents.		
Unit - II	**Reading:**	**6**
Developing reading skills - Reading aloud - Group reading activities - Reading with correct word stress and intonation.		
Unit - III	**Soft Skills:**	**6**
Attitude - Goal setting - Time Management - Team Work - Telephonic conversation skills.		
Unit - IV	**Writing:**	**6**
Making preparatory notes, drafts and PPT"s for laboratory activities - Word editing features - editing and proof reading..		
Unit - V	**Speaking:**	**6**
Verbal and non-verbal communication - Introducing oneself - Introducing others – Mock Interviews - Making presentations on chosen topics - Group Discussion.		

Total:30

REFERENCES/ MANUALS:

1. Kumar, Sanjay and Pushp Lata, "Communication Skills", 2nd Edition, Oxford University Press, New Delhi, 2017.
2. Laboratory Manual.

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		3		
CO2									2	2		2		
CO3									2	2		2		

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

18MET51 - 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	1	0	4

Preamble	To impart knowledge on three modes of heat transfer namely, conduction, convection and radiation.	
Unit - I	**Conduction Heat Transfer, Extended Surface and Transient Heat Conduction:**	**9+3**
Conduction Heat Transfer: 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 Surface: Types - Heat Transfer through Long Fin and Short Fin - Efficiency and Effectiveness Calculation for Circumferential Fin. Transient Heat Conduction: Lumped Heat Analysis and Infinite Solids Approach - Heisler's Chart.		
Unit - II	**Convection Heat Transfer ,Forced Convection and Free Convection:**	**9+3**
Convection Heat Transfer: Newton's Law of Cooling - Convective Heat Transfer Coefficients - Dimensional Analysis using Buckingham π-Theorem - Boundary Layer Profiles of Flow over Flat Plate 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 Plate - Horizontal Plate - Cylinders and Spheres - Heat Transfer in Porous Media.		
Unit - III	**Radiation Heat Transfer:**	**9+3**
Radiation Heat Transfer: Electro Magnetic Spectrum - Thermal Radiation - Concept of Black Body - Basic Laws of Black Body Radiation – Absorptivity - Reflectivity and Transmissivity - Grey Body Radiation – Emissivity - Kirchoff's Law of Radiation - Shape(View) 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+3**
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+3**
Mass Transfer: Diffusion Mass Transfer - Fick 's Law of Diffusion - Equimolar Diffusion - Convective Mass Transfer - Heat and Mass Transfer Analogy. Latest Trends in the field of Heat transfer: 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, Tutorial: 15, Total: 60

TEXT BOOK:

1. Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", 5th Edition, New Age International, New Delhi, 2017.

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", 5th Edition, McGraw-Hill Education, India, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recognize the conduction mode of heat transfer and solve the problems on steady state and transient heat conduction.	Applying (K3)
CO2	identify, analyze and solve the convection based heat transfer problems using appropriate correlations.	Analyzing (K4)
CO3	distinguish between black body and grey body radiation heat transfer and solve the problems using shape factor algebra and electrical analogy.	Analyzing (K4)
CO4	recognize phase change process and type of heat exchanger and analyze and solve the problems using suitable approach.	Analyzing (K4)
CO5	evaluate the diffusion and convective mass transfer problems with appropriate procedures.	Evaluating (K5)

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		1		3
CO2	3	3			2					1		1		3
CO3	3	3			2		2			1		1		3
CO4	3	3			2		2			1		1		3
CO5	3	3			2		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	5	10	60	25			100
CAT2	5	10	50	35			100
CAT3	5	10	30	30	25		100
ESE	5	10	30	30	25		100

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

18MET52 - DYNAMICS OF MACHINERY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics,Strength of Materials, Kinematics of Machinery	5	PC	3	0	0	3

Preamble	To impart 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**
Force Analysis: 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. Fly wheels – 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**
Balancing: 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 Gyroscopes:**	**9**
Governors: 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 and Torsional Systems:**	**9**
Free Vibration: 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**
Forced Vibration: Response to periodic force–Harmonic Force–Force caused by unbalance–Support motion-Logarithmic decrement-magnification factor–Vibration isolation and transmissibility.		

Total:45

TEXT BOOK:

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

REFERENCES:

1. Sadhu Singh, "Theory of Machines", 2nd Edition, Pearson Education, New Delhi, 2006.
2. Khurmi R.S. and Gupta J.K., "Theory of Machines", 14th Edition, S.Chand Publications, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve and analyze the static and dynamic forces acting on different mechanism	Analyzing (K4)
CO2	solve and plot the static and dynamic balancing of various mechanical systems	Analyzing (K4)
CO3	solve and analyze the fluctuation in speed of governors and gyroscopic effect in automobile, aeroplane and ship applications.	Analyzing (K4)
CO4	evaluate, analyze and demonstrate the free vibrations for different systems	Analyzing (K4)
CO5	evaluate, analyze and demonstrate the problems in forced vibrations for different 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	2	1	1								1		3
CO2	3	2	1	1								1		3
CO3	3	3	1	1								1		3
CO4	3	3	3	3								1		3
CO5	3	3	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	15	20	35	30			100
CAT2	15	20	35	30			100
CAT3	15	20	30	35			100
ESE	10	10	40	40			100

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

18MET53 - MACHINE DRAWING

(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 Drawing	5	PC	3	0	0	3

Preamble	This course helps the student to communicate the necessary technical information required for manufacture and assembly of machine components. These drawings follow rules laid down by national and International Organizations.	
Unit - I	**Introduction:**	**9**
Introduction: Need of Graphical Language - Importance of Machine Drawing - Tools (from Instruments to Current Software)- Classification of Machine Drawings - Principles of Machine Drawing - BIS specifications - lines- scales and dimensioning - Conventional representation of Machine Elements-Abbreviations and Symbols.		
Unit - II	**Projections, Sectioning, Limits - Fits and Tolerance:**	**9**
Projections: Designation-Relative position of views. Sectioning: Introduction – Types – Conventions. Limits - Fits and Tolerance: Definitions - Classifications of Fits - System of Fits - Computations - Selection of Fits - Method of Indicating Fits on Drawings - Tolerance Grade - Computations of Tolerance - Positions of Tolerance - Fundamental of Deviations - Shaft and Hole Terminology - Method of Placing Limit Dimensions - Need of Geometrical Tolerance - Geometrical Characteristics of Symbols - Indication of Minimum Material Condition - Interpretation of Indication of Geometrical Tolerance – Examples.		
Unit - III	**Screw Fasteners and Nuts, Joints and Key, and Welded Joints:**	**9**
Screw Fasteners and Nuts: Screw Thread Nomenclature - Threads Form - Conventional representations - Types of Bolts – Designation - Types of Nuts and Screw - Designation of Bolted Joints - Types of Nut Locking Arrangements – Special Types of Bolts and Nuts – Washers. Joints and Key: Types of Joints - Gib and Cotter Joints- Pin Joints and Knuckle Joints- Types of keys. Welded Joints: Types of Welded Joints - Representation of Welds - Symbols and its conventions.		
Unit - IV	**Drawing of Projections and Drawing of Sectional Views:**	**9**
Drawing of Projections: Orthographic view to isometric view and Isometric view to orthographic view of simple machine elements- Importance of Bill of materials. Drawing of Sectional Views: Keys- Bolts and Nuts- Types of coupling- Flanged- Bush Type – Footstep Bearing- Piston-Connecting Rod-Cross head.		
Unit - V	**Assembly Drawing of Mechanical Components:**	**9**
Assembly Drawing of Mechanical Components: Introduction - Types of Assembly - Assembly procedures –Assembly of: Lathe Tail stock - Machine Vice - Pipe Vice - Simple Eccentric - Screw jack - Stuffing Box - Plummer Block - Swivel Bearing and Safety Valve.		

Total: 45

TEXT BOOK:

1. Narayana K.L. & Kannaiah P., "Machine Drawing", 4th Edition, New Age International Publishers Ltd., New Delhi, 2010.

REFERENCES:

1. Bhatt N.D. & Panchal V.M., "Machine Drawing", 49th Edition, Charotar Publishing House Pvt. Ltd., Gujarat, 2013.
2. Sidheswar N., Kannaiah P. & Sastry V.V., "Machine Drawing", 1st Edition, Tata-McGraw Hill Education, Chennai, 2017.

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	Analyzing (K4)
CO2	demonstrate and evaluate the projections, sectioning, limits, fits and tolerance	Analyzing (K4)
CO3	draw fasteners and different joints	Analyzing (K4)
CO4	draw and demonstrate the projections and sectional views of various mechanical elements	Analyzing (K4)
CO5	construct assembly drawings of mechanical components conforming to BIS conventions	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								2	2	3
CO2	3	2	1	1								2	2	3
CO3	3	2	1	1								2	2	3
CO4	3	2	1	1								2	2	3
CO5	3	2	1	1								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	20	50	10			100
CAT2	15	15	20	50			100
CAT3	10	20	20	50			100
ESE	10	20	20	50			100

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

18MET54 - 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	5	PC	3	0	0	3

Preamble	To design the machine components that should satisfy the functional strength and optimized design by using standard practices with data.	
Unit - I	**Steady Stresses and Variable Stresses in Machine Members:**	**9**
Steady Stresses and Variable Stresses in Machine Members: 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, Keys and Couplings:**	**9**
Design of Shafts: Design of solid and hollow shafts based on strength - rigidity and critical speed. Keys: Design of keys and key ways. Couplings: Design of rigid and flexible couplings – design of knuckle joints.		
Unit - III	**Design of Fasteners and Design of Welded Joints:**	**9**
Design of Fasteners: 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.		
Unit - IV	**Design of Springs and Levers:**	**9**
Design of Springs and Levers: Design of helical and leaf Springs - Theory of disc and torsional springs under constant loads and varying loads –Concentric springs – Belleville springs (Theory only) – Design of levers.		
Unit - V	**Design of Bearings and Design of Flywheels:**	**9**
Design of Bearings: 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.		

Total: 45

TEXT BOOK:

1. Bhandari V.B., "Design of Machine Elements", 4th Edition, Tata McGraw-Hill, New Delhi, 2017.

REFERENCES:

1. Shigley J.E. & Mischke C.R., "Mechanical Engineering Design", 10th Edition, McGraw Hill International Education, New York, 2015.
2. Norton R.L., "Design of Machinery", 5th Edition, Tata McGraw Hill, New Delhi, 2012.
3. Juvinall R.C. & Marshek K.M., "Fundamentals of Machine Component Design", 6th Edition, John Wiley & Sons, New Delhi, 2017.

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	Analyzing (K4)
CO2	design and selection of the shafts, couplings, keys and knuckle joint for different applications	Analyzing (K4)
CO3	design and selection of the screw fasteners and welded joints for different applications	Analyzing (K4)
CO4	design and selection of the helical, leaf springs and levers for different applications	Analyzing (K4)
CO5	design and select the bearing, prediction of their life and design of flywheels for different 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	1	1								2		3
CO2	3	3	1	1								2		3
CO3	3	3	1	1								2		3
CO4	3	3	1	1								2		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	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)**

18MEL51 - 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/mechanism behind on the various modes of heat transfer namely Conduction, Convection and Radiation. And also provides the experimental study in 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 evacuated solar tubes.
13.	Performance test on vapour compression refrigeration test rig.
14.	Performance test on air-conditioning test rig.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1. Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", 5th Edition, New Age International, New Delhi, 2017.

	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	Applying (K3), Manipulation (S2)
CO2	perform the test on heat exchangers and estimate the overall heat transfer coefficient and effectiveness.	Applying (K3), Precision (S3)
CO3	execute the performance test on heat pipe, evacuated tube, refrigeration and air-conditioning system.	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	2				1	2		2	2	3
CO2	3	2		3	2				1	2		2	2	3
CO3	3	2		3	2				1	2		2	2	3

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

18MEL52 - METROLOGY AND DYNAMICS LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics, Engineering Mechanics	5	PC	0	0	2	1
Preamble	This course provides the practical knowledge/mechanism behind on the various measurements like linear, angular, etc. And also impart the practical knowledge on dynamics systems like spring mass, bearing, etc.						

List of Exercises / Experiments:

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 Linear Variable Differential Transformer (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 the 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 measuring cylinder and cone dimensions using Coordinate Measuring Machine.
8.	A Study/Demonstration experiment on measuring the surface roughness of materials using surface roughness tester.
9.	Determine the natural frequency of given spring using spring mass system.
10.	Draw the force and couple polygon for static and dynamic balancing of rotating masses.
11.	Determine the characteristics of governor using universal governor apparatus. (Porter, Proell and Watt governor set up).
12.	Determine the loss of couple due to friction using gyroscopic couple apparatus.
13.	Determine the natural and critical frequency of given shaft using whirling of shaft apparatus.
14.	Determine the frequency of transverse forced vibration of cantilever beam.
15.	Determine the damping ratio of single rotor system with viscous damping.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Jain R.K., "Engineering Metrology", 21st Edition, Khanna Publishers, New Delhi, 2004.
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	calibrate the measuring instruments, measure the dimension of the components and determine the characteristics of instruments.	Applying (K3), Manipulation (S2)
CO2	analyze dynamic characters of systems such as frequency, profile and critical speed, 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), 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					1			2	1	3
CO2	3	2		1					1			2	1	3
CO3	3	2		1					1			2	1	3

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

18MEL53 - CAD LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Drawing, Machine Drawing	5	PC	0	0	2	1
Preamble	This course provides modeling and assembly knowledge about various mechanical components. This course provides knowledge on development and execution of part programs using CNC machines.						

List of Exercises / Experiments :

1.	Practice for sketching with different sketching tools (Line, Polyline, Circle and Generalized constraint methods).
2.	Practice for Datum Plane, Axis, Point and Coordinate systems.
3.	3D Part modeling options, protrusion and cut (extrude, revolve). Exercises: Flange Coupling, Screw Jack
4.	3D Part modeling options – protrusion and cut (sweep, blend, helical sweep). Exercises: Machine Vice, Knuckle Joint
5.	Features creation with editing operations – Move , Pattern, Mirror, Round, Chamfer and Rib. Exercise: Simple Eccentric
6.	Model Tree with family table and parametric concepts. Exercises: Types of Bolts and Nuts with different sizes.
7.	Assembly – Creating assembly from individual parts – Imposing assembly constraints.
8.	Assembly mass properties and checking of interferences of components.
9.	Conversion of 3D solid model to 2D drawing – different views – sections – isometric view and dimensioning creation.
10.	Surface modeling with advanced options (Trim, Merge, Projections and Spinal bend).
11.	Performing 3D scanning of mechanical components and acquiring 3D image/design.
12.	Manufacturing prototype of a simple mechanical component using 3D printer.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Sham Tickoo, "PTC Creo Parametric 3.0 for Engineers and Designers", 3rd Edition, Dreamtech Press, New Delhi.
2.	CREO 7.0, SOLID WORKS-2018, CATIA V5-6 R2015.
3.	CAD LAB Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the concept of CAD parametric and applications in engineering fields	Applying (K3), Manipulation (S2)
CO2	identify the features, operations associated with Modeling, Assembly and Drafting	Applying (K3), Manipulation (S2)
CO3	apply the advanced feature creation concept of CAD for Modeling, Assembly and Drafting	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	2		2	3	2
CO2	3	1			3				1	2		2	3	2
CO3	3	1			3				1	2		2	3	2

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

18GEL51 - PROFESSIONAL SKILLS TRAINING I
(Common to all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	B.E. & Mechanical 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)**

18GET51 - UNIVERSAL HUMAN VALUES
(Common to all BE/BTech branches)

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	HS	2	0	0	2

Preamble	To make the student to know what they 'really want to be' in their life and profession, understand the meaning of happiness and prosperity for a human being. Also to facilitate the students to understanding of harmony at all the levels of human living, and live accordingly	
Unit - I	**Introduction:**	**9**
Need and Basic Guidelines of Value Education – Content and Process of Value Education – Self Exploration – purpose of self-Exploration – Content and Process of Self exploration – Natural Acceptance – Realization and Understanding – Basic Human Aspirations – Continuous Happiness and Prosperity – Exploring Happiness and Prosperity – Basic Requirement for Fulfillment of Human Aspirations – Relationships – Physical Facilities – Right Understanding.		
Unit - II	**Harmony in the Self and Body:**	**9**
Human Begin and Body – Understanding Myself as Co–existence of Self ('I') and Body, Needs of the Self and Body, Activities in the Self and Body, Self ('I') as the Conscious Entity, the Body as the Material Entity – Exercise – Body as an Instrument– Harmony in the Self ('I) – Understanding Myself – Harmony with Body.		
Unit - III	**Harmony in the Family and Society:**	**9**
Harmony in the Family – Justice – Feelings (Values) in Human Relationships – Relationship from Family to Society – Identification of Human Goal – Five dimensions of Human Endeavour.		
Unit - IV	**Harmony in Nature and Existence:**	**9**
Order of Nature – Interconnectedness – Understanding the Four order – Innateness – Natural Characteristic – Basic Activity – Conformance – Introduction to Space – Co–existence of units of Space – Limited and unlimited – Active and No–activity – Existence is Co–existence.		
Unit - V	**Implications of the above Holistic Understanding of Harmony on Professional Ethics:**	**9**
Values in different dimensions of Human Living – Definitiveness of Ethical Human Conduct –Implications of Value based Living – Identification of Comprehensive Human Goal – Humanistic Education – Universal Human Order – Competence and Issues in Professional Ethics.		

Total: 45

TEXT BOOK:

1. Gaur R.R., Sangal R., Bagaria G.P., "A Foundation Course in Human Values and Professional Ethics", 1st Edition, Excell Books Pvt. Ltd., New Delhi, 2016.

REFERENCES:

1. Ivan Illich, "Energy & Equity", The Trinity Press, USA, 1974.
2. Schumacher E.F., "Small is Beautiful: a study of economics as if people mattered", Britain, 1973.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society.	Understanding (K2)
CO2	distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co–existence of Self and Body.	Understanding (K2)
CO3	understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human–human relationships and explore their role in ensuring a harmonious society.	Understanding (K2)
CO4	understand the harmony in nature and existence, and work out their mutually fulfilling participation in the nature.	Understanding (K2)
CO5	distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	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						1		3						
CO2								2						
CO3						1		3						
CO4								2						
CO5								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	75					100
CAT2	25	75					100
CAT3	NA						
ESE	NA						

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

18MET61 - MECHATRONICS AND IOT

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	PC	3	0	0	3

Preamble	This course provides the importance of sensors, actuators, control systems, controllers and IoT components involved in industrial automation	
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 - Sound.		
Unit - II	**Control System:**	**9**
Control System: 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**
Microprocessor and Its Interfacing: 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**
Programmable Logic Controller (PLC): 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 – Maintenance and Trouble Shooting of PLC.		
Unit - V	**Introduction to IoT:**	**9**
Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs. Machine to Machine, Difference between IoT and M2M, Software define Network.		

Total: 45

TEXT BOOK:

1. Bolton W., "Mechatronics: A Multidisciplinary Approach", 4th Edition, Pearson Education, UK, 2016.

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 and desired their functions required 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	understand the concepts of internet of things	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	2					2	1	1
CO2	3		2			3	1					2	1	1
CO3	3		2		1	3	1			2		2	1	1
CO4	3		2		1	3	1			2		3	1	1
CO5	3		2		1	3	2			1		3	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	40	40				100
CAT2	20	40	30	10			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)**

18MET62 - 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	6	PC	3	0	0	3

Preamble	This course impart 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 clutches and brakes 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 Clutches and Brakes:**	**9**
Design of Clutches and Brakes: Design of Plate Clutches – Axial Clutches – Cone Clutches – Internal Expanding Rim Clutches – Internal and External Shoe Brakes – Disc Brakes (Description only).		

Total: 45

TEXT BOOK:

1. Prabhu T. J., "Design of Transmission Elements", 5th Edition, 2019.

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 correct analyses 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 of bevel gear, worm gear to suit given loading conditions	Analyzing (K4)
CO4	perform speed calculation	Analyzing (K4)
CO5	design clutches and brakes 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	1	3		2	1				3		2		3
CO2	3	1	3		2	1				3		2		3
CO3	3	1	3		2	1				3		2		3
CO4	3	1	3		2	1				3		2		3
CO5	3	1	3		2	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	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)**

18MET63 - 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**
Fundamental of Finite Element Analysis: 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 – Application of FEA		
Unit - II	**One Dimensional Problems:**	**9**
One Dimensional Problems: 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		
Unit - III	**Two Dimensional Problems:**	**9**
Two Dimensional Problems: 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 and Plane Truss:**	**9**
Axisymmetric Continuum and Plane Truss: Axisymmetric Formulation – Element Stiffness Matrix and Force Vector – Body Forces and Temperature Effects – Stress Calculations – Boundary Conditions – Applications to Cylinders under Internal or External Pressures – Applications of Plane Truss		
Unit - V	**Isoparametric Elements for Two Dimensional Continuum:**	**9**
Isoparametric Elements for Two Dimensional Continuum: 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		

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.

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	describe the finite element theory procedures and applications	Applying (K3)
CO2	analyze 1D structural and thermal problems with the FE techniques	Analyzing (K4)
CO3	apply the 2D FE theory for analysis of 2D problems	Analyzing (K4)
CO4	understand concepts of axisymmetric and apply to real time problems	Analyzing (K4)
CO5	understand and apply the concepts of Isoparametric 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	1	2		1							3	1	3
CO2	3	1	2		2							3	1	3
CO3	3	1	2		2							3	1	3
CO4	3	1	2		2							3	1	3
CO5	3	3	1	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	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)**

18MEL61 - MECHATRONICS AND IOT LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	PC	0	0	2	1
Preamble	This course provides the exposure on typical mechanical measurements, control system simulations and microprocessor interfacing for industrial automation. This course also provides the necessary and practical knowledge of components in Internet of Things and develop the skills required to build real-life IoT based projects.						

List of Exercises / Experiments :

1.	Measurement of displacement using LVDT and capacitive transducer
2.	Measurement of pressure, force and speed
3.	Transfer function model using block diagram reduction techniques using MATLAB
4.	Closed loop analysis of PID controller for position control system
5.	Arithmetic functions, Sum of N numbers using 8085 Microprocessor
6.	Arrange a series of numbers in ascending and descending orders using 8085 microprocessor
7.	To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
8.	To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
9.	To interface DHT11/OLED sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
10.	To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
11.	To interface HC-SR04 Ultrasonic Sensor with Arduino and write a program to print distance between the objects.
12.	To interface gas detection module with Arduino and write a program to turn on the buzzer when the gas leakage is detected.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	Microprocessor kit, MATLAB, IOT Module.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	perform the measurements of different physical parameters using I/O devices, sensors and communication modules	Applying (K3), Manipulation (S2)
CO2	design and develop the mathematical concepts of control systems for real time applications	Applying (K3), Manipulation (S2)
CO3	develop programming for 8085 microprocessor in suitable applications	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				2	1		2	2	2
CO2	3		3	2	3				2	1		2	2	2
CO3	3		3	2	2				2	1		2	2	2

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

18MEL62 - CAM LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Material Removal Processes	6	PC	0	0	2	1
Preamble	This course enhances the skills on development, simulation and execution of part programs using different Computer Numeric Control (CNC) machines.						

List of Exercises / Experiments :

1.	Study of G codes and M codes for machining centre and turning centre.
2.	Part program generation and machining of given component using MTAB XLTURN.
3.	Part program generation and machining of given component using MTAB XLMILL.
4.	Part program generation and machining of given component using CNC Turning Centre (JOBBER XL).
5.	Part program generation and machining of given component using CNC Vertical Milling Centre (L Mill 55).
6.	Simulation and CNC code generation for a given component using MASTERCAM (Lathe) and interfacing it with CNC Turning centre.
7.	Simulation and CNC code generation for a given component using MASTERCAM (Mill) and interfacing it with CNC Machining centre.
8.	Programming and machining of given component using CNC Turning and Machining centres.
9.	Study of various types of robots according to configurations and applications.
10.	Robot programming using Virtual reality software for a given application.
11.	Manufacturing a model of mechanical component using CNC laser cutting process.
12.	Performing engraving operation of a simple art or details over a component using CNC laser engraving machine.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Mikell P. Groover, "Automation, Production System and Computer Integrated Manufacturing", 4th Edition, Pearson Education India, Delhi, 2016.
2.	Radhakrishnan P, "Computer Numerical Control Machines", 1st Edition, New Central Book Agency, Kolkata, 2013.
3.	CAM Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	develop, simulate and execute part program using CNC production and trainer machines.	Applying (K3), Manipulation (S2)
CO2	simulate using CAM package and interface the developed program with the CNC machine.	Applying (K3), Manipulation (S2)
CO3	analyze the robot work cell problems and program an industrial robot.	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		2	1	3				3	3		1	2	2
CO2	2		2	1	3				3	3		1	2	2
CO3	2		2	1	3				3	3		1	2	2

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

18MEL63 - 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 problem in structure, thermal and flow. 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.	Natural frequency extraction using modal analysis.
11.	Harmonic response of a beam for stepped and ramped loads.
12.	Bimetallic layered cantilever plate with structural loading.
13.	Flow through pipes using fluent.
14.	Incompressible fluid flow analysis with and without obstacles.

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 for the given problem.	Analyzing (K4), Manipulation (S2)
CO2	perform structural, thermal, explicit and fluid problems in 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	2	2	3	3	1				3		1	1	3
CO2	3	2	2	3	3	1				3		1	1	3
CO3	3	2	2	3	3	1				3		1	1	3

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

18GEL61 - PROFESSIONAL SKILLS TRAINING II
(Common to all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	B.E. & Mechanical 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 – II**:	**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				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	40	40				100
CAT2		50	50				100
CAT3		50	50				100
ESE	NA						

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

18MEP61 - PROJECT WORK I PHASE I

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	---	6	EC	0	0	4	2

Total: 60

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	identify, conceptualize and define engineering problems that needs to be solved.	Understanding (K2)
CO2:	identify and refer literature.	Understanding (K2)
CO3:	design/develop/assemble/experiment components/systems applying engineering research tools/methods.	Applying (K3)
CO4:	plan, carryout and control project activities like design, development and fabrication.	Creating (K6)
CO5:	present the project work in the form of oral presentation, report and technical/patent papers publications.	Evaluating (K5)

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

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

18MBT71 – ENGINEERING ECONOMICS AND MANAGEMENT

(Common to All BE/BTech Engineering And Technology Branches except Chemical Engineering)

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

Preamble	The aim of the course is to create fundamental knowledge on management by introducing concepts like economics, national income, marketing, operations management, accounting principles etc.	
Unit - I	**Micro Economics:**	**9**
Economics – Basics Concepts and Principles – Demand and Supply – Law of demand and Supply – Determinants – Market Equilibrium – Circular Flow of Economic activities and Income.		
Unit - II	**Macro Economics, Business Ownership and Management Concepts:**	**9**
National Income and its measurement techniques. Inflation - Causes of Inflation – Controlling Inflation – Business Cycle. Forms of business – Ownership types. Management concepts: Taylor and Fayol's Principles – Functions of Management - Managerial Skills - Levels of Management - Roles of manager.		
Unit - III	**Marketing Management:**	**9**
Marketing - Core Concepts of Marketing - Four P's of Marketing - New product development – Intellectual Property rights (IPR), Product Life Cycle - Pricing Strategies and Decisions.		
Unit - IV	**Operations Management:**	**9**
Operations Management - Resources - Types of Production system - Site selection, Plant Layout, Steps in Production Planning and Control - Inventory - EOQ Determination.		
Unit - V	**Financial Management:**	**9**
Accounting Principles – Financial Statements and its uses – Depreciation: Straight Line and Diminishing Balance Method – Break Even Analysis – Capital Budgeting: Significance –Traditional and discounted cash flow methods.		

Total:45

TEXT BOOK:

1. Compiled by Department of Management Studies, Kongu Engineering College, "Economics and Management for Engineers", 1st Edition, McGraw Hill Education, Noida, 2013.

REFERENCES:

1. Geetika, Piyali Ghosh and Purba Roy Choudhury, "Managerial Economics", 3rd Edition, McGraw-Hill, New Delhi, 2018.
2. William J. Stevenson, "Operations Management", 14th Edition, McGraw-Hill Education, 2021.
3. William G. Nickels, James M. McHugh, Susan M. McHugh, "Understanding Business", 12th Edition, McGraw-Hill Education, New York, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify market equilibrium and interpret national income calculations and inflation issues	Applying (K3)
CO2	choose a suitable business ownership for their enterprise and illustrate managerial functions	Applying (K3)
CO3	infer marketing management decisions	Understanding (K2)
CO4	apply appropriate operation management concept in business situations	Applying (K3)
CO5	interpret financial and accounting statements and evaluate new proposals	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			3		2	2	2	3	2	1	2
CO2		1	2			2	2	2	2	2	3	2	1	2
CO3	1	2	1			2		2	2	2	3	2	2	2
CO4	1	2	1			2		2	2	2	3	2	1	2
CO5	2	2				2		2	2	2	3	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	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)**

18GEP71 – COMPREHENSIVE TEST AND VIVA
(Common to all BE/BTech branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	EC	0	0	0	2

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	demonstrate knowledge in their respective programme domain.	Applying (K3)
CO2	defend any type of interviews, viva-voce, and aptitude tests conducted for career progression	Applying (K3)
CO3	exhibit professional etiquette and solve related engineering 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	2	2					1	2	2	3	3	2
CO2	3	3	2	2					1	2	2	3	3	2
CO3	3	3	2	2					1	2	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

18MEP71 - PROJECT WORK I PHASE II

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	----	7	EC	0	0	8	4

Total:120

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	identify, conceptualize and define engineering problems that needs to be solved.	Understanding (K2)
CO2:	identify and refer literature.	Understanding (K2)
CO3:	design/develop/assemble/experiment components/systems applying engineering research tools/methods.	Applying (K3)
CO4:	plan, carryout and control project activities like design, development, fabrication, experimentation, analytical, and simulation work, etc.	Creating (K6)
CO5:	present the project work in the form of oral presentation, report and technical/patent papers publications.	Evaluating (K5)

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	2	3	3	3	3	3	3	3	2	3	3
CO2	3	3	3	2	3	3	3	3	3	3	3	2	3	3
CO3	3	3	3	2	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	2	3	3	3	3	3	3	3	2	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

18MEP81 - PROJECT WORK II

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	----	8	EC	0	0	12	6

Total :180

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	identify, conceptualize and define engineering problems that needs to be solved	Understanding (K2)
CO2:	identify and refer literature	Understanding (K2)
CO3:	design/develop/assemble/experiment components/systems applying engineering research tools/methods	Applying (K3)
CO4:	plan, carryout and control project activities like design, development, fabrication, experimentation, analytical, and simulation work, etc.	Creating (K6)
CO5:	present the project work in the form of oral presentation, report and technical/patent papers publications	Evaluating (K5)

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	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

18MEE01 - FLUID POWER SYSTEM

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fluid Mechanics and Machines	6	PE	3	0	0	3

Preamble	This course provides knowledge and skill to generate, control and transmission of power using pressurized fluids.	
Unit - I	**Fundamentals of Hydraulic System:**	**9**
Fundamentals of Hydraulic System: 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**
Control Components of Hydraulic System: 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 and Actuators: 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**
Fluid Power Circuit Design: 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.		

Total: 45

TEXT BOOK:

1. Esposito Anthony, "Fluid Power with Applications", 7th Edition, Pearson Higher Education, New York, 2015.

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	Analyzing (K4)
CO4	design and construct a fluid power circuits real time applications	Applying (K3)
CO5	design, construct, test, install - maintain and trouble shoot 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	2	2			1	1				1		2	2
CO2	3	2	3	1		1	1						3	3
CO3	3	2	3	1	2	1	1				2		3	3
CO4	3	3	3	1	2	1	1				1		3	3
CO5	3	3	3	1		3	1				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	30	50				100
CAT2	20	30	40	10			100
CAT3	10	30	40	20			100
ESE	10	30	40	20			100

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

18MEE02 - CAD/CAM/CIM

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Drawing, Manufacturing Technology	6	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 FMS with recent advancements.	
Unit - I	**CAD:**	**9**
CAD: 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, and 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	**CAM:**	**9**
Computer-Aided Manufacturing (CAM): 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 - - International Organization for Standardization (ISO) standards for coding - Geometric Codes (G codes) and - Miscellaneous Codes (M-codes) - Cutter Location (CL) data and tool path simulation– Code generation from 3D solid models using Master CAM Software.		
Unit - IV	**CNC Programming:**	**9**
CNC Programming: Manual programming - Canned cycle and subroutines. CIM (CIM): Definition - 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 Flexible Manufacturing System (FMS):**	**9**
Process Planning: 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. Flexible Manufacturing System (FMS): Components of Flexible Manufacturing System (FMS) – Types - FMS workstation - Material handling and storage systems - FMS layout - Application and benefits - Introduction to Rapid prototyping - Communication fundamentals - Local area networks - Topology.		

Total: 45

TEXT BOOK:

1. Zeid Ibrahim & Sivasubramanian, "CAD/CAM Theory and Practice", 2nd Edition, Tata McGraw Hill, New Delhi, 2010 for Units I,II,III,IV.
2. Groover M. P, "Automation, Production System and Computer Integrated Manufacturing", 3rd Edition, Prentice-Hall of India, New Delhi, 2016 for Units 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	analyze various modeling algorithms and 2D & 3D transformations.	Analyzing (K4)
CO2	describe concepts behind visual realism and parametric modeling.	Understanding (K2)
CO3	generate the CNC part programs using G and M codes.	Analyzing (K4)
CO4	identify the part families and demonstrate different classification and coding systems.	Applying (K3)
CO5	demonstrate the concepts of FMS - CAPP and LAN implementations.	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		1		3
CO2	3	2								3		1		3
CO3	3	3	3	2	3					3		1	3	3
CO4	3	3			2					3		1	2	3
CO5	3	2	1	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	20	30	40	10			100
CAT2	15	20	50	15			100
CAT3	20	30	50				100
ESE	10	25	50	15			100

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

18MEE03 - GAS DYNAMICS AND JET PROPULSION
(*Use of Approved Gas Tables is permitted for the End Semester Examination)*

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Thermodynamics, Heat and Mass Transfer	6	PE	3	0	0	3

Preamble	To impart knowledge of compressible fluid flow and propulsion systems.	
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 Through Constant Area Ducts: 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**
Flow Across Shock: 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**
Aircraft Propulsion: 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**
Rocket Propulsion: 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.		

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.

REFERENCES:

1. Rathakrishnan E. , "Gas Dynamics", 6th Edition, Prentice Hall of India, Delhi, 2017.
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	Evaluating (K5)
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	2				1				3		3		3
CO2	3	3			1					1			1	3
CO3	3	3			1					1			1	3
CO4	3	3			1	1				1			1	3
CO5	3	3	2		1	1				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	5	10	50	35			100
CAT2	5	10	40	30	15		100
CAT3	5	10	40	30	15		100
ESE	5	10	30	30	25		100

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

18MEE04 - 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	6	PE	3	0	0	3

Preamble	To impart knowledge on the working cycles of Refrigeration and the processes involved in Air conditioning systems.	
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 and its Limitations-Bell Coleman Cycle-Reverse Brayton or Joule Cycle-Aircraft Refrigeration Cycles-Types.		
Unit - II	**Refrigeration Systems:**	**9**
Refrigeration Systems: 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:**	**9**
Psychrometry: Psychrometric Properties-Psychrometric Processes - Sensible Cooling and Heating-Humidification and Dehumidification-RSHF-GSHF-ADP-ESHF-Evaporative Cooling-Adiabatic Mixing- Psychrometric Calculations for Simple Air Conditioning System -Return Air Systems.		
Unit - V	**Air Conditioning System:**	**9**
Air Conditioning System: 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.		

Total: 45

TEXT BOOK:

1. Arora C.P. , "Refrigeration and Air Conditioning", 3rd Edition, Tata McGraw Hill, New Delhi, 2008.

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, 2001.
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	define the characteristics of refrigerants and describe the functions of refrigeration system components	Analyzing (K4)
CO4	use Psychrometry chart and perform calculations for psychrometric applications	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								2		1		3
CO2	3	2								2		1		3
CO3	3	3				3	3					1		3
CO4	3	2										1		3
CO5	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	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)**

18MEE05 - UNCONVENTIONAL MACHINING PROCESSES

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology, Material Removal Processes	6	PE	3	0	0	3

Preamble	This course addresses the various unconventional machining processes which is an alternate for traditional machining, its principles and their influence on performance of machining in different areas of applications.	
Unit - I	**Introduction and Mechanical Energy Based Processes:**	**9**
Introduction and Mechanical Energy Based Processes: 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**
Electrical Energy Based Processes: 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 and Electro-Chemical Energy Based Processes: 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**
Thermal Energy Based Processes: Laser Beam Machining and Drilling (LBM) - Plasma Arc Machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques – Applications.		
Unit - V	**Hybrid Processes and Advanced Finishing Processes:**	**9**
Hybrid Processes: 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) – Chemo Mechanical Polishing (CMP) – Working principle – Mechanism of material removal – Surface quality – Applications.		

Total: 45

TEXT BOOK:

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

REFERENCES:

1. Pandey P.C. and Shan H.S., “Modern Machining Processes”, 1st Edition, Tata McGraw-Hill, New Delhi, 2017.
2. Kapil Gupta, Jain N.K. and Laubscher R.F., “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:	familiarize with various thermal energy based nontraditional 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	2				2		1	2	3
CO2	3	1			2	2				2		1	2	3
CO3	3	1			2	2				2		1	2	3
CO4	3	1			2	2				2		1	2	3
CO5	3	1			2	2				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)**

18MEE06 - DESIGN FOR MANUFACTURE AND ASSEMBLY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Materials and Metallurgy, Material Removal Processes	6	PE	3	0	0	3

Preamble	This course explores the basis for concurrent engineering studies which is aimed to reduce manufacturing and assembly costs to quantify the improvements. It appears as an assessment tool to study competitors products to quantify manufacturing and assembly difficulties.	
Unit - I	**Tolerance Analysis:**	**9**
Tolerance Analysis: 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**
Materials Selection and Design for Assembly: 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 for Machining: 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**
Design for Injection Molding: 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**
Design for Sand and Die Casting: 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.		

Total: 45

TEXT BOOK:

1. Boothroyd G, Dewhurst P & Knight W. A., "Product Design for Manufacture and Assembly", 3rd Edition, CRC Press, USA, 2013.

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 recommendations for design 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		3	1	1					2		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)**

18MEE07 - OPERATIONS RESEARCH

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mathematics I, Mathematics II, Statistics and Numerical Methods	6	PE	3	0	0	3

Preamble	This course promotes the application of scientific methods in decision-making with respect to the production operations for the effective utilization of scarce resources.	
Unit - I	**Linear Models:**	**9**
Linear Models: 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 - PERT-CPM-problems – Cost analysis and crashing of networks.		
Unit - IV	**Inventory Models:**	**9**
Inventory Models: 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		

Total: 45

TEXT BOOK:

1. Gupta P.K. & Hira D.S., "Operations Research", 7th Edition, S. Chand and Company Ltd., New Delhi, 2014.

REFERENCES:

1. Taha & Hamdy A., "Operation Research: An Introduction", 10th Edition, Pearson Education, Chennai, 2017.
2. Hiller Frederick S. & Lieberman Gerald J., "Introduction to Operations Research", 10th Edition, McGraw-Hill Science, Bengaluru, 2011.
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	Analyzing (K4)
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	Evaluating (K5)

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	2	1	2
CO2	3	2	3		1						1	2	1	2
CO3	3	2	3	2	2						1	2	1	2
CO4	3	2	3	2	2						1	2	1	2
CO5	3	2	3	2	2						1	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	10	30	40	20			100
CAT2	10	30	30	30			100
CAT3	15	20	20	25	20		100
ESE	10	20	30	25	15		100

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

18MEE08 - PRODUCTION PLANNING AND CONTROL

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	PE	3	0	0	3

Preamble	The course offers decision-making abilities about handling of production control and its related areas. It delivers the concepts of scheduling and dispatching with inventory control.	
Unit - I	**Introduction:**	**9**
Introduction: Definition − objectives and functions of production planning and control − Elements of production control − Types of production − Organization of production planning and control department − Internal organization of department – Break Even Analysis – Economics of a new design – asthetic aspect.		
Unit - II	**Product Planning and Process Planning:**	**9**
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 of dispatcher − 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 – Always Better Control (ABC) analysis – Virtual Essential Desirable (VED) analysis – Economic Order Quantity (EOQ) model − Inventory control systems − 'P' Systems and 'Q' Systems. Trends in PPC: Introduction to Material Requirement Planning – I (MRP I) – Manufacturing Resource Planning – II (MRP II) – Enterprises Resource Planning (ERP) - Line of Balance (LOB) – Just in Time (JIT) and KANBAN system.		

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.

REFERENCES:

1. Upendra Kachru, "Production and Operations Management – Text and Cases", 1st Edition, Excel Books, New Delhi, 2007.
2. Norman Gaither G. & Frazier, "Operations Management", 9th Edition, Thomson learning, 2001.

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	manipulate 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	1	1	1									1		2
CO2	1	3	2	2	2					2		1		2
CO3	2	3	2	2	2					2		1		2
CO4	2	3	2	2	2					2		1		2
CO5	2	3	2	2	2					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	30	40	30				100
CAT2	15	15	35	35			100
CAT3	15	15	30	40			100
ESE	15	20	30	35			100

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

18GEE01 - FUNDAMENTALS OF RESEARCH

Programme & Branch	All BE/BTech branches	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**
Introduction to Research: 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 Review: Literature Collection - Methods - Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit - III	**Research Methodology**	**9**
Research Methodology: Appropriate Choice of Algorithms/Methodologies/Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations.		
Unit - IV	**Journals and Papers:**	**9**
Journals and Papers: Journals in Science/Engineering - Indexing and Impact factor of Journals. Plagiarism and Research Ethics. Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study.		
Unit - V	**Reports and Presentations**	**9**
Reports and Presentations: 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.		

Total: 45

TEXT BOOK:

1. Walliman, Nicholas. “Research Methods: The basics”. Routledge, 2017.

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 journals.	Analyzing (K4)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper.	Applying (K3)
CO5	compile a research report and the 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	3	3	2	2	1	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	1	1		3	3	3	2	2	3	3	3	3
CO5	3	3	3	3	3	3	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		40	35	25			100
CAT2		30	40	30			100
CAT3				50	50		100
ESE		25	25	25	25		100

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

18MEE09 - 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 impart 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**
Piping Materials :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**
Pressure Design for Piping: 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.		

Total: 45

TEXT BOOK:

1. Sahu G. K., "Handbook of Piping Design", 2nd Edition, New Age International Publishers, New Delhi, 2008 for Units I,II,III.
2. George A. Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair", Special Indian Edition, Taylor & Francis, USA, 2003 for Units 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	1	1				3			1	3
CO2	3	2	2	1	1	1				3			1	3
CO3	3	2	2	1	1	1				3			1	3
CO4	3	2	2	1	1	1				3			1	3
CO5	3	2	2	1	1	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	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)**

18MEE10 - 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**
Introduction to Jigs and Fixture: 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**
Jigs: 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**
Fixtures: 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 Dies: 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.		

Total: 45

TEXT BOOK:

1. Edward G. Hoffman, “Jigs & Fixture Design”, 5th Edition, Thomson-Delmar Learning, Singapore, 2004 for Units I,II.
2. Elanchezhian C., Sunder Selwyn T., Vijaya Ramnath B., “Design of Jigs, Fixtures and Press Tools” 1st Edition, Eswar Press, Chennai, 2004 for Units 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 related force calculations.	Applying (K4)
CO2	Identify and designing the jigs for various components.	Applying (K4)
CO3	Identify and designing the fixtures for various components.	Applying (K4)
CO4	demonstrate the function of various parts of dies and calculate the strip layout for various press works.	Applying (K4)
CO5	design and select the various types of dies.	Applying (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									2		1
CO2	2	2	3	2								2		1
CO3	2	2	3	2								2		1
CO4	2	2	3	2								2		1
CO5	2	2	3	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	10	10	50	30			100
CAT2	10	10	35	45			100
CAT3	10	10	35	45			100
ESE	10	10	35	45			100

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

18MEE11 - 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 the overview of various fuel properties and their composition. It also describes combustion thermodynamics, pollution control and its measures.	
Unit - I	**Fuel Characteristics:**	**9**
Fuel Characteristics: 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**
Gaseous Fuels: 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**
Air Pollution: 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.		

Total: 45

TEXT BOOK:

1. Samir Sarkar, "Fuels & Combustion", 3rd Edition, CRC Press, New York, 2010.

REFERENCES:

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

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	estimate the composition and their properties of solid & liquid fuels	Analyzing (K4)
CO3	compare the composition of various gaseous fuels & their properties	Evaluating (K5)
CO4	explain 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	2										1	3
CO2	3	2	2				1						1	3
CO3	3	2	1										1	3
CO4	3	2	2				1						1	3
CO5	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	10	25	40	25			100
CAT2	10	30	30	20	10		100
CAT3	20	40	40				100
ESE	20	30	30	20			100

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

18MEE12 - 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 involves on the application of numerical methods to solve fluid flow and heat transfer problems. In addition, the course also provides an introduction into turbulence modeling which enables the application of CFD in vortices and eddies.	
Unit - I	**Governing Equations and Boundary Conditions:**	**9**
Governing Equations and Boundary Conditions: Basics of Computational Fluid Dynamics – Governing Equations – Continuity - Momentum and Energy Equations – General Transport Equation – Physical Boundary Conditions – Discretization – Mathematical Behavior of PDEs on CFD –Elliptic - Parabolic - Hyperbolic Equations.		
Unit - II	**Finite Difference Method:**	**9**
Finite Difference Method: 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 Method: Finite Volume Formulation for Steady-State - One - Two and Three - Dimensional Diffusion Problems – Parabolic Equations – Explicit - Implicit Schemes - Unsteady Heat Conduction on Elliptic and Parabolic Equations - Steady State One-Dimensional Convection and Diffusion – Central - Upwind Differencing Schemes- Hybrid - Power-Law - QUICK Schemes – Properties of Discretization Schemes.		
Unit - IV	**Grid:**	**9**
Grid: Types – 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 Models: Reynolds Stress Equation Model – Algebraic Stress Model - 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.		

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.

REFERENCES:

1. Anderson John D., "Computational Fluid Dynamics: Basic with Applications", 1st Edition, Tata McGraw-Hill, India, 2012.
2. Ghoshdastidar P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill Publishing Company Ltd., India, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recognizing the governing equations and boundary conditions for fluid dynamics.	Understanding (K2)
CO2	applying various finite difference method to solve the complex problems.	Applying (K3)
CO3	analyzing the convection diffusion problems by the finite volume method.	Analyzing (K4)
CO4	identifying the grid generation technique for the flow field variables.	Applying (K3)
CO5	recognizing and summarizing the various turbulence models and its characteristics	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										2	3	2
CO2	3	3	1									2	3	2
CO3	3	2	3									2	3	2
CO4	3	2	2	1	3							2	3	2
CO5	3	2	3	1	3							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	10	40	50				100
CAT2	10	20	35	35			100
CAT3	10	20	35	35			100
ESE	10	20	35	35			100

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

18MEE13 - 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 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**
Basic Concepts of Metal Cutting: Introduction – Mechanics of chip formation-Mechanics of oblique cutting - Cutting forces and power- Tool life – Surface finish-Machinability. CNC Machines: Classification – Construction details- Structure- Configuration of CNC system – Interfacing – Monitoring – Diagnostics – Machine data – Compensations for Machine accuracy – DNC – Adaptive control CNC systems.		
Unit - II	**Drives and Controls:**	**9**
Drives and Controls: 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 Programming of CNC Machines: Part Program Terminology - G and M Codes – Types of interpolation- CNC part programming – Manual part programming (Turning and Milling) - Various programming techniques – APT programming for various machines in ISO and FANUC - CAM packages for CNC machines.		
Unit - IV	**Tooling For CNC Machines:**	**9**
Tooling For CNC Machines: 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 – ATC Mechanisms – Automatic Pallet Changer Tool management- Principles of location- clamping and work holding devices.		
Unit - V	**Economics of CNC Machines and Retrofitting:**	**9**
Economics of CNC Machines and Retrofitting: 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.		

Total: 45

TEXT BOOK:

1. Radhakrishnan P, "Computer Numerical Control Machines", 1st Edition, New Central Book Agency, Kolkata, 2013 for Units I, II,III, IV, V.
2. Kalpakjian S. and Schmid S.R., "Manufacturing Engineering and Technology", 7th Edition, Pearson Education India, New Delhi, 2014 for Unit I.

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	Selecting the 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	2	1	1						1		1	2	3
CO2	3	2	2							1		1	2	3
CO3	3	2	3		3					1		1	3	3
CO4	3	2	3		3					1		1	3	3
CO5	3	2	3		1					1		1	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	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)**

18MEE14 - PRECISION ENGINEERING

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

Preamble	This course deals with precision Manufacturing, micro machining, basic design requirements of precision machine tools. Also able to identify the errors, measure and characterize the machined surfaces.	
Unit - I	**Precision Manufacturing:**	**9**
Precision Manufacturing: 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**
Precision Machining: 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**
Machine Design For Precision Manufacturing: 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**
Mechanical and Thermal Errors: Sources of error - Principles of measurement - Errors due to machine elements – bearings – spindles - Kinematic design - Structural compliance – Vibration. Background - thermal effects - Environmental control of precision machinery. Error mapping and error budgets.		
Unit - V	**Measurement & Characterization and Surface Metrology:**	**9**
Measurement & Characterization: Optical dimensional metrology of precision features – Machine vision - Multi-sensor coordinate metrology - 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.		

Total: 45

TEXT BOOK:

1. Jain V.K., "Introduction to Micromachining", 2nd Edition, Narosa Publishers, New Delhi, 2018.

REFERENCES:

1. Venktesh V.C., SudinIzman, "Precision Engineering", 2nd Edition, Tata McGraw-Hill, New Delhi, 2007.
2. David Dornfeld, Dae-Eun Lee, "Precision Manufacturing", 1st Edition, Springer Boston, 2008.
3. Jain V.K., "Micromanufacturing Processes", 1st Edition, CRC Press, Taylor and Francis Group, 2012.

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	Applying (K3)
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				2					1			2	3
CO2	3									1		1	1	3
CO3	1	2	3		1					1			1	2
CO4	1	3	2		1					1			1	2
CO5	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	25	25	50				100
CAT2	25	25	50				100
CAT3	25	25	50				100
ESE	20	20	60				100

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

18MEE15 - 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 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**
Quality Concepts and Principles: Definition of Quality - Dimensions of Quality - Quality Planning - Quality costs - Basic concepts of Total Quality Management - Historical Review. Principles of TQM - Leadership –Concepts - Quality Council - Quality Statements - Strategic Planning - Deming Philosophy - Barriers to TQM Implementation.		
Unit - II	**Total Quality Management-Principles and Strategies:**	**9**
Total Quality Management-Principles and Strategies: Customer satisfaction –Customer Perception of Quality - Customer Complaints - Customer Retention - Employee Involvement –Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal - Benefits. Continuous Process Improvement –Juran Trilogy - PDSA Cycle - 5S - Kaizen - Supplier Partnership –Partnering - sourcing - Supplier Selection - Supplier Rating - Relationship Development - Performance Measures		
Unit - III	**Control Charts for Process Control:**	**9**
Control Charts for Process Control: The seven tools of quality - Statistical Fundamentals –Measures of central Tendency and Dispersion - Population and Sample - Normal Curve - Control Charts for variables and attributes - Process capability - Concept of six sigma.		
Unit - IV	**TQM-Modern Tools:**	**9**
TQM-Modern Tools: The new seven tools of quality - Benchmarking-Need - Types and process; Quality Function Deployment-HOQ construction - case studies; Taguchi's Robust design-Quality loss function - DOE; Total Productive Maintenance-uptime enhancement; Failure Mode and Effect Analysis-Risk Priority Number - Process - case studies.		
Unit - V	**Quality Systems:**	**9**
Quality Systems: Need for ISO 9000 and Other Quality Systems - ISO 9000 : 2015 Quality System –Elements - Implementation of Quality System - Documentation - Quality Auditing - Introduction to TS 16949 - QS 9000 - ISO 14000 - ISO 18000 - ISO 20000 - ISO 22000. Process of implementing ISO - Barriers in TQM implementation.		

Total: 45

TEXT BOOK:

1. Dale H. Besterfield, "Total Quality Management", 3rd Edition, Pearson Education, New Delhi, 2011.

REFERENCES:

1. Subburaj Ramasamy, "Total Quality Management", Tata McGraw Hill, New Delhi, 2008.
2. Feigenbaum A.V., "Total Quality Management", 4th Edition, Tata McGraw Hill , New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the need, history and principles of quality and TQM	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)**

18MEE16 - PROJECT MANAGEMENT

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Operations Research	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**
Introduction: Project Management: 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 and Demand Analysis: Market Survey-Demand Forecasting Methods-Technical Analysis – Manufacturing Process - Materials-Product Mix-Plant Location-Project Charts and Layouts.		
Unit - III	**Financial Management:**	**9**
Financial Management: Financial Analysis – Cash Flows for Project Appraisal- Investment Evaluation using Capital 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 Management: 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**
Project Implementation: Organization Systems for Project Implementation- Work Breakdown-Coordination and Control- Project Management Softwares.		

Total: 45

TEXT BOOK:

1. Prasanna Chandra, "Projects – Planning, Analysis, Financing, Implementation and Review", 7th Edition, Tata McGraw Hill, New Delhi, 2016.

REFERENCES:

1. Choudry S., "Project Management", 4th Edition, Tata McGraw Hill, New Delhi, 2008.
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	discss 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	analyse mathematical tools for project evaluation	Analyzing (K4)
CO5	assess and understand systems approach for projects	Evaluating (K5)

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	2	2	3	1	3	3	3	2
CO2	2	2					2		3	3	3	3	3	2
CO3	1	1			2				3	2	3	3	3	2
CO4	1	1			2				2	2	3	3	3	2
CO5	1	2			2			1	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	50	50					100
CAT2	20	20	35	25			100
CAT3	20	20	30	15	15		100
ESE	20	20	30	15	15		100

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

18MEE17 - 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, Matrices and Composites: 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**
Composite Manufacturing: 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**
Composite Performance and Analysis: 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**
Composite Mechanics: 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**
Design of Composites: 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.		

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.

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	Analyzing (K4)
CO2	portray the various manufacturing processes involved in the fabrication of composite material.	Analyzing (K4)
CO3	gain knowledge to analyze the performance of composite materials.	Analyzing (K4)
CO4	analyze and solve problems concerning the mechanics of composite materials.	Analyzing (K4)
CO5	perform design calculations for the development of fiber reinforced matrices.	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									2	1	2
CO2	3	1	1									2	1	2
CO3	3	3	1									2	1	2
CO4	3	3	3	2								2	1	1
CO5	3	3	3	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	15	15	40	30			100
CAT2	15	15	40	30			100
CAT3	15	15	30	40			100
ESE	10	10	45	35			100

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

18MEE18 - ADVANCED STRUCTURE 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	Advanced Structure of Materials describes the concept in depth include the three-dimensional theory of elasticity, Stress and strain relations and Compatibility equations. It covers the Shear center estimation, Stresses due to unsymmetrical bending, stress analysis on Curved beams, torsion on non-Circular members and membrane stresses in shells, rotating disks. It also focus the stresses involved in beams on elastic foundation.	
Unit - I	**Theory of Elasticity:**	**9**
Theory of Elasticity: 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**
Shear Centre: 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**
Stresses on Curved Beams: 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: 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**
Beams on Elastic Foundation: 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.		

Total: 45

TEXT BOOK:

1. Sadhu Singh, "Applied Stress Analysis", 19th Edition, Khanna Publishers, New Delhi, 2009.

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	2	2	1						2		1		3
CO2	3	2	2	1						2		1		3
CO3	3	2	2	1						2		1		3
CO4	3	2	2	1						2		1		3
CO5	3	2	2	1						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	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)**

18MEE19 - AUTOMOBILE ENGINEERING

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

Preamble	This course covers the construction and working principle of various systems in automobile.	
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.		

Total: 45

TEXT BOOK:

1. Dr.Kirpal Singh, "Automobile Engineering", 13th Edition, Volume I&II, Standard Publishers Distributor, New Delhi, 2017.

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	demonstrate the various automobile components, engine parts and engine management system	Understanding(K2)
CO2	describe the fuel supply systems and electrical systems in automobiles.	Understanding(K2)
CO3	demonstrate the working of transmission system and its various elements	Understanding(K2)
CO4	illustrate the working of suspension, steering and braking systems.	Understanding(K2)
CO5	apply the pollution standards, safety measures and illustrate the working of electric and hybrid 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		1			2	3					1	2	3
CO2	3		1			2	3					1	2	3
CO3	3		1			2	3					1	2	3
CO4	3		1			2	3					1	2	3
CO5	3		1			2	3					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	40	60					100
CAT2	50	50					100
CAT3	40	50	10				100
ESE	30	50	20				100

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

18MEE20 - 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 of different types of heat exchangers used for various thermal applications.	
Unit – I	**Fundamentals of Heat Exchangers:**	**9**
Fundamentals of Heat Exchangers: 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**
Design of Double Pipe Heat Exchangers: Introduction - Thermal and Hydraulic Design of Inner Tube and Annulus - Hairpin Heat Exchanger with Bare and Multitube Finned Inner Tube - Parallel-Series Arrangements of Hairpins - Total Pressure Drop.		
Unit – III	**Design of Shell and Tube Heat Exchangers:**	**9**
Design of Shell and Tube Heat Exchangers: 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**
Design of Compact Heat Exchangers: 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**
Design of Condensers and Evaporators: 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.		

Total: 45

TEXT BOOK:

1. Sadik Kakac, Hongtan Liu & Anchasa Pramuanjaroenkij. , "Heat Exchangers: Selection, Rating, and Thermal Design", 3rd Edition, CRC Press, USA, 2012.

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, 2013.

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					1			2			1	3
CO2	3	3	2				1			2			1	3
CO3	3	3	2				1			2			1	3
CO4	3	3	2				1			2			1	3
CO5	3	3	2				1			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	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)**

18MEE21 - 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. Variety of applications also be covered ranging from rapid prototyping, rapid manufacturing to mass customization.	
Unit - I	**Introduction to Additive Manufacturing:**	**9**
Introduction to Additive Manufacturing: 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 RP systems – RP Process Chain - 3D Modelling - 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**
Liquid based RP systems: 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**
Solid based RP systems: 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**
Powder based RP Systems: 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**
Rapid Tooling and Applications of RP: 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.		

Total: 45

TEXT BOOK:

1. Chua.C.K., Leong K.F. & Lim C.S., "Rapid Prototyping: Principles and Applications", World Scientific, New Jersy, 2010.

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.

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	select the suitable solid based rapid prototyping system for a specific application.	Applying (K3)
CO4	select 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	40	40	20				100
CAT2	30	40	30				100
CAT3	30	45	25				100
ESE	30	40	30				100

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

18MEE22 - 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 so that the students can apply them in engineering industry applications.	
Unit - I	**Welding Principles, Gas and Arc Welding Processes:**	**9**
Welding Principles, Gas and Arc Welding Processes: 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**
Resistance Welding Processes: 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**
Solid State Welding Processes: Forge Welding – Friction 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**
Special Welding Processes and Design of Weld Joints: Thermit Welding – Atomic Hydrogen Welding –Electron Beam Welding – Laser Beam Welding – Friction Stir 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**
Testing of Weldments, Codes & Standards and Welding Automation: 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.		

Total: 45

TEXT BOOK:

1. David Phillips H., "Welding Engineering: An Introduction", 1st Edition, John Wiley & Sons Ltd., United States, 2016.

REFERENCES:

1. Parmer R.S., "Welding Engineering and Technology", 3rd Edition, Khanna Publishers, New Delhi, 2015.
2. Parmer R.S., "Welding Processes and Technology", 8th Edition, Khanna Publishers, New Delhi, 2004.
3. Nadkarni S.V., "Modern Arc Welding Technology", 1st Edition, Oxford IBH Publishers, New Delhi, 2005.

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	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	30	70					100
CAT2	20	60	20				100
CAT3	20	40	20	20			100
ESE	10	50	20	20			100

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

18MEE23 - QUALITY 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 quality of the product.	
Unit - I	**Introduction:**	**9**
Introduction - 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.		

Total: 45

TEXT BOOK:

1. Douglas C. Montgomery, "Introduction to Statistical Quality Control", 8th Edition, John Wiley, United States, 2019 for Units I,II,III,IV.
2. Srinath L.S, "Reliability Engineering", 4th Edition, Affiliated East West Press, 2005 for Unit V.

REFERENCES:

1. John S. Oakland, "Statistical Process Control", 5th Edition, Elsevier, 2005.
2. Connor P.D.T.O., "Practical Reliability Engineering", John Wiley, 1993.
3. Grant Eugene L., "Statistical Quality Control", McGraw-Hill, 1996.

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 and demonstrate the consumer and producer's risk in sampling	Evaluating (K5)
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						1	2	3	3
CO2	3		3		2						1	2	3	3
CO3	3	1	3	1	2						1	2	3	3
CO4	3	1	3		2						1	2	3	3
CO5	3	1	3	1	2						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	15	25	25	20		100
CAT3	20	20	35	25			100
ESE	15	15	20	20	30		100

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

18MEE24 - INDUSTRIAL ENGINEERING AND COST ANALYSIS

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 involves improving the efficiency of an Organization.	
Unit - I	**Method and 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**
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-Supply Chain Management (SCM)-Objectives-Outsourcing.		
Unit - V	**Value Engineering:**	**9**
Value Engineering – Function - Aims - Procedure-Value Analysis-Function Analysis –System Techniques-Make or Buy Decision-Interest Formulae and Their Applications —Time Value of Money- Single Payment Compound Amount Factor-Present Worth Factor- Equal Payment Series Sinking Fund Factor and Series Method - Capital Recovery Factor-Uniform Gradient Series Annual Equivalent Factor - Effective Interest Rate.		

Total: 45

TEXT BOOK:

1. Telsang Martand, "Industrial Engineering and Production Management", 3rd Edition, S. Chand and Company, New Delhi, 2018 for Units I,II,III,IV.
2. Panneerselvam R, "Engineering Economics", 2nd Edition, Prentice Hall of India, 2013 for Unit V.

REFERENCES:

1. Buffa Elwood S., and Sarin Rakesh K., "Modern Production and Operations Management", 8th Edition, John Wiley and Sons, New York, 2009.
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	analyze the various components of industrial engineering principles & techniques	Analyzing (K4)
CO2	discuss the concept of production, planning and control techniques.	Evaluating (K5)
CO3	test and interpret the estimated forecasting data.	Evaluating (K5)
CO4	measure and analyze various resources in organization	Evaluating (K5)
CO5	examine the value engineering concepts in industries.	Evaluating (K5)

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	2	2								3	3
CO2	3	3	1										3	3
CO3	3	1		3	1								3	3
CO4	1	1	1	1	3						2		3	3
CO5	1	1		1	1						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	20	30	20		100
CAT2	20	20	25	25	10		100
CAT3	15	15	30	30	10		100
ESE	20	15	20	15	30		100

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

18MEE25 - 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 system, basic principles of flight and its control, aircraft performance and various maneuvers	
Unit - I	**Introduction to Aircrafts:**	**9**
Introduction to Aircrafts: 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: 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**
Basic Principles of Flight: 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: 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**
Aircraft Performance and Maneuvers: 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 a Aeroplane during a Turn- Correct and incorrect Angles of Bank- Aerobatics- Inverted Maneuvers- Maneuverability.		

Total: 45

TEXT BOOK:

1. Kermode A.C., "Mechanics of Flight", 11th Edition, Pearson Education, New Delhi, 2006.

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	Applying (K3)
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	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	1		3				1			1		3		2
CO2	1		3				1			1		3		2
CO3	1		3				1			1		3		2
CO4	1		3				1			1		3		2
CO5	1		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	30	35	35				100
CAT2	30	35	35				100
CAT3	20	25	30	25			100
ESE	20	30	30	20			100

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

18MEE26 - 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**
Surfaces and Friction: Topography of Engineering Surfaces–Contact between Solids –Sources of Sliding Friction – Friction Characteristics of Metals –Friction of Non-Metals–Friction of Ceramic Materials and Polymers –Rolling Friction –Source of Rolling Friction – Stick slip motion.		
Unit - II	**Wear and Lubrication:**	**9**
Wear and Lubrication: 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**
Film Lubrication Theory: 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**
Journal Bearings: 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**
Bearing Materials: 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.		

Total: 45

TEXT BOOK:

1. Gwidon W. Stachowiak & Andrew W. Batchelor, "Engineering Tribology", 4th Edition, Butterworth-Heinmann, UK, 2013.

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	2	3	1								1		3
CO2	3	2	3	1								1		3
CO3	3	2	3	3						1		1		3
CO4	3	2	3	3						1		1		3
CO5	3	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	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)**

18MEE27 - INSTRUMENTATION IN THERMAL ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics, Instrumentation and Control System.	7	PE	3	0	0	3

Preamble	This course introduces the characteristics of measuring instruments, techniques and importance of error and uncertainty analysis. This course helps to identify the measuring techniques and gas analysis for various thermal applications.	
Unit - I	**Measurement Characteristics:**	**9**
Measurement Characteristics: 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**
Microprocessors and Computers in Measurement: 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 Physical Quantities: Measurement of Thermo-Physical Properties-Temperature-Pressure-Flow- Use of Sensors for Physical Variables.		
Unit - IV	**Advanced Measurement Techniques:**	**9**
Advanced Measurement Techniques: Shadowgraph-Schlieren-Interferometer-Laser Doppler Anemometer-Hot Wire Anemometer-Heat Flux Sensors-Telemetry in Measurement.		
Unit - V	**Measurement Analyzers:**	**9**
Measurement Analyzers: Chemical-Thermal-Magnetic-Optical Gas Analyzers-Measurement of Smoke-Dust and Moisture-Gas Chromatography-Spectrometry-Measurement of pH.		

Total: 45

TEXT BOOK:

1. Holman J.P., "Experimental Methods for Engineers", 8th Edition, McGraw-Hill, Newyork, 2012.

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, Orient Longman, New Delhi, 1993.
3. Rangan C.S., Sarma G.R.& Mani V.S.V., "Instrumentation Devices and Systems", 2nd Edition, McGraw-Hill, New Delhi, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	recognize the techniques in measurements.	Applying (K3)
CO2	use computers in measurements.	Applying (K3)
CO3	analyze measurements of various physical quantities.	Applying (K3)
CO4	apply the concepts of thermal instruments.	Applying (K3)
CO5	explain the principle of exhaust gas analysis.	Evaluating (K5)

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					3		2	3	3
CO2	3	2			1					3		2	3	3
CO3	3	2			1					3		2	3	3
CO4	3	2			2					3		2	3	3
CO5	3	2			1					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	35	40	25				100
CAT2	25	30	45				100
CAT3	15	20	45		20		100
ESE	20	25	35		20		100

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

18MEE28 - ENERGY AUDITING AND MANAGEMENT

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 provides insights on energy conservation measures and energy audit in thermal and electrical utilities.	
Unit - I	**Energy Audit:**	**9**
Energy Audit: 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 and Water Management: 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**
Energy Audit Applied to Buildings: Building Envelope Analysis-Metal Elements-Strategies for Reducing Heat Loss in Metal Building Walls-Infiltration-Methods for Estimation-Thermal Mass-Insulation- 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**
Electrical System Audit: 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**
Energy Efficiency in Thermal Utilities: Performance Assessment of Thermodynamic Systems – Boilers –Furnaces – Compressors - HVAC Systems - Water Pumps - Fans - Blowers-Heat Exchangers.		

Total: 45

TEXT BOOK:

1. Sonal Desai, "Handbook of Energy Audit", 1st Edition, McGraw Hill Education, India, 2015.

REFERENCES:

1. Albert Thumann, Terry Niehus & William J. Younger, "Handbook of Energy Audits", 9th Edition, Fairmont Press, Lilburn, 2012.
2. Wayne C. Turner & Steve Doty, "Energy Management Handbook - Vol. I and Vol. II", 8th Edition, Fairmont Press, Lilburn, 2012.
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 for energy conservation.	Applying (K3)
CO3	apply the energy audit principles in buildings.	Analyzing (K4)
CO4	explain the procedure of conducting electrical audit.	Analyzing (K4)
CO5	assess the performance of thermal utilities	Evaluating (K5)

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				2		3	3
CO2	3		2			1	1						3	3
CO3	3		2		2	1	1			1			3	3
CO4	3	2			2	1	1			1			3	3
CO5	3	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	36	34	30				100
CAT2	20	30	30	20			100
CAT3	20	20	20	20	20		100
ESE	23	23	22	16	16		100

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

18MEE29 - MANUFACTURING INFORMATION SYSTEM

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology, Material Removal Processes	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 to Evolution of Order Policies: 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**
Database Concepts: 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**
Designing of Database: 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**
Manufacturing Consideration: 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**
Information System for Manufacturing: 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.		

Total: 45

TEXT BOOK:

1. Luca G. Sartori. , “Manufacturing Information Systems”, Addison Wesley Publishing Company, England, 1988 for Units I, IV, V.
2. Date C.J. “An Introduction to Database Systems”. 8th Edition, Addison Wesley, United States, 2003 for Units 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	discuss the concept and parameters involved in computerized production planning 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	2	1								1		2		2
CO2	2	1	1							1		1		2
CO3	3	2	2							1		2		2
CO4	3	2	2							1		2		2
CO5	3	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	15	45	40				100
CAT2	10	40	50				100
CAT3	10	20	35	35			100
ESE	10	30	35	25			100

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

18MEE30 - 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**
Microsystems: 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	**Microsensors and Actuators:**	**9**
Microsensors and Actuators: Micro Sensors - Micro Actuation Techniques - Micropump - Micromotors - Microvalves - Microgrippers - Micro Accelerometers.		
Unit - III	**Micro System Fabrication:**	**9**
Micro System Fabrication: 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 and Design:**	**9**
Micro System Manufacturing and Design: 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**
Micro System Applications: Applications of micro system in - Automotive - Bio medical - Aerospace - Telecommunications field. Basic exposure to software for MEMS design - Micro system Design using CAD tool.		

Total: 45

TEXT BOOK:

1. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture", 2nd Edition, John Wiley and Sons, New York, 2017.

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", Springer, 2017. ISBN -978-3-319-32178-3.

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	identify the micro machining process and packaging.	Applying (K3)
CO5	design and develop the micro system for various 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	2	1									1	3	2
CO2	3	2	1									1	3	2
CO3	3	2	1	2	3							1	3	2
CO4	3	2	1	2	3							1	3	2
CO5	3	2	1	2	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	20	40	40				100
CAT2	20	40	40				100
CAT3	10	40	30	20			100
ESE	20	30	30	20			100

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

18MEE31 - 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 deals with maintenance system and recent trends of maintenance activities adopted in industries.	
Unit - I	**Principles and Maintenance System Planning:**	**9**
Principles and Maintenance System Planning: 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**
Maintenance Techniques: 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 Based Maintenance: Introduction to Condition based monitoring of equipment and systems; 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 and Repair Methods of Basic Elements: 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 for machine beds- 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 and Safety in Maintenance: 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.		

Total: 45

TEXT BOOK:

1. Srivastava S.K., "Maintenance Engineering (Principles - Practices and Management)", 1st Edition, S. Chand & Co., New Delhi, 2014.

REFERENCES:

1. Bhattacharya S.N., "Installation, Servicing and Maintenance", S. Chand & Co., New Delhi, 2011.
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	2	2			2						2	3	2
CO2	3	2	2			1						2	3	2
CO3	3	2	2			1					2	2	3	2
CO4	3	2	2	2		2						2	3	2
CO5	3	2	2			2					1	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	20	20	60				100
CAT2	20	20	60				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)**

18MEE32 - INDUSTRIAL SAFETY ENGINEERING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Technology, Manufacturing Technology Laboratory	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 machines and handling tools.	
Unit - I	**Safety Management:**	**9**
Safety management: Need for safety- Safety and Productivity- Planning for safety – Formulation of safety policy – Safety management techniques- Job safety analysis- Safety sampling technique- Incident recall technique - Plant safety inspection- Safety organization and its functions.		
Unit - II	**Accident Prevention:**	**9**
Accident Prevention: Nature and causes of accidents - Accident proneness - Cost of accident – Accident prevention methods - Accident reporting and investigation – Personal protective equipment – Safety education and training - Damage control and disaster control.		
Unit - III	**Operation Safety:**	**9**
Operation Safety: General safety considerations in material handling - Manual and mechanical safety in machine shop - Safety in use of hand and portable (power) tools - Safety in use of electricity - Safety in welding and cutting - Principles of guarding – Safety in heat treatment - Safety in gas furnace operation.		
Unit - IV	**Safety in Metal Working Machinery:**	**9**
Safety in Metal Working Machinery: General safety rules - Principles - Maintenance - Inspection of turning machines - Boring machines - milling Machines - Planning machines - Grinding machines - CNC machines- Shaping machines - Drilling machines.		
Unit - V	**Safety in Cold Working of Metals and Safety in Hot Working of Metals:**	**9**
Safety in Cold Working of Metals and Safety in Hot Working of Metals: Safety in Cold Working of Metals: Cold working - Power presses- Point of operation safe guarding – Auxiliary mechanisms- Feeding and cutting mechanism- Hand or foot operated presses - Power press setup and die removal - Inspection and maintenance. Safety in Hot Working of Metals: Metal shears - Safety in forging - Hot rolling - Hot bending pipes- Foundry - Health hazards and safety measures.		

Total: 45

TEXT BOOK:

1. Mistry K.U.,"Fundamentals of Industrial Safety and Health, 2nd Edition, Siddharth Prakashan Publisher, Gujarat, 2008.

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. "Occupational Safety Manual BHEL", Trichy, 1988.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the safety management concepts.	Applying (K3)
CO2	interpret the accident prevention methods.	Applying (K3)
CO3	employ the safety techniques in industry.	Applying (K3)
CO4	relate the different kind of safety rules in metal working machinery.	Applying (K3)
CO5	enforce the safety rules in hot and cold working 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	1	2			3	1							2
CO2	3	1	1			3	1							2
CO3	3	1	2			3	1			1				2
CO4	3	1	2			3	1			1				2
CO5	3	1	1			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	20	30	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	10	30	60				100

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

18MEE33 - 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 is gives the brief ideas of Hybrid vehicles propulsion methods-Hybrid architecture-Hybrid power plant specifications-Fuel cell technology and Non electric Hybrid propulsion systems.	
Unit - I	**Introduction and Components of Hybrid Vehicles:**	**9**
Introduction: General Architectures- Vehicle System Components and Analysis- Controls of Hybrid Vehicle Components: 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**
Modeling: 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**
Energy Storages: 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	**Control Problems and Design and Performance Analysis:**	**9**
Control Problems: IC Engine Control- Engine Torque Fluctuation Dumping Control Through Electric Motor- HEV/EV Traction Motor Control- Active Suspension Control of HEV/EV Systems. Design and Performance Analysis: Simulation System- Typical Test Driving Cycles- Preliminary Sizing of Main Components of Hybrid Vehicle- Fuel Economy and Emissions Simulation Calculations.		

Total: 45

TEXT BOOK:

1. Wei Liu, "Introduction To Hybrid Vehicle System Modeling And Control", John Wiley & Sons Inc., Hoboken, New Jersey, 2013.

REFERENCES:

1. Mehrdad Ehsani, Uimin Gao and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles – Fundamentals, Theory and Design", 2nd Edition, CRC Press, New Delhi, 2010.
2. Iqbal Husain, "Electric and Hybrid Vehicles", 2nd Edition, CRC Press, New Delhi, 2010.

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	Understanding (K2)
CO2	explain the architecture of various models of hybrid Vehicles Systems	Understanding (K2)
CO3	classify and explain electronic devices and motor drives	Understanding (K2)
CO4	analyze about the various energy storage Systems	Applying (K3)
CO5	examine the problems in control and analysis based on design and performance	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	1											2	3
CO2	1	2											2	3
CO3	2	1											2	3
CO4	1	1												3
CO5	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	80					100
CAT2	30	70					100
CAT3	20	20	60				100
ESE	10	50	40				100

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

18MBE49 - ENTREPRENEURSHIP DEVELOPMENT

(Common to All BE/BTech Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Economics and Management	8	EC	3	0	0	3

Preamble	The purpose of this course to create entrepreneurial awareness among engineering students.	
Unit - I	**Entrepreneurship Concepts:**	**9**
Entrepreneurship & Entrepreneur- Role in Economic Development - Factors affecting Entrepreneurship- Creativity and Innovation - Entrepreneurship vs Intrapreneurship- Entrepreneurial Motivation factors – Types of Entrepreneurship &Entrepreneurs - Characteristics of Entrepreneurs -Entrepreneurship Development in India		
Unit - II	**Entrepreneurial Ventures and Opportunity Assessment:**	**9**
New venture creation – Bootstrapping,Minipreneurship, Start-ups, Acquiring, Franchising & Social venturing - Venture development stages - Models of market opportunity- Opportunity assessment: Critical Factors In Opportunity Assessment, Idea vs Opportunity, Evaluation process, Global opportunities for entrepreneurs.		
Unit - III	**Business Plan:**	**9**
Designing Business Model- Business Model Canvas- Objectives of a Business Plan - Business Planning Process – Structure of a Business Plan – Technical, Marketing, Financial Feasibility assessment - Competitive analysis - Common errors in Business Plan formulation - Presentation of the Business Plan: The 'Pitch'- case studies		
Unit - IV	**Financing and Accounting:**	**9**
Forms of entrepreneurial capital – Sources of Financial capital: debt financing- Commercial banks and other sources, equity financing: Initial Public offering (IPO), Private placement - Venture capitalists - Angel investors-New forms of financing: Impact investors, Micro-financing, Peer-to-Peer Lending, Crowd funding - Natural capital. Preparing Financial Budget, Break even analysis, Taxation-Direct and indirect taxes, Insolvency and Bankruptcy.		
Unit - V	**Small Business Management:**	**9**
Definition of Small Scale Industries: Strengths and Weaknesses, Sickness in Small Enterprises: Symptoms -Causes and remedies-Indian Startup Ecosystem – Institutions supporting small business enterprises, Business Incubators – Government Policy for Small Scale Enterprises - Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger, FDI and Sub-Contracting		

Total:45

TEXT BOOK:

1. Donald F. Kuratko, "Entrepreneurship: Theory, Process, Practice", 11th Edition, Cengage Learning, Boston, 2020.

REFERENCES:

1. Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, Sabyasachi Sinha, "Entrepreneurship", 11th Edition, McGraw Hill, Noida, 2020.
2. Charantimath Poornima M., "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson Education, Noida, 2018.
3. Gordon E. & Natarajan K., "Entrepreneurship Development", 6th Edition, Himalaya Publishing House, Mumbai, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the importance of entrepreneurship and demonstrate the traits of an entrepreneur	Applying (K3)
CO2	identify suitable entrepreneurial ventures and business opportunity	Applying (K3)
CO3	assess the components of business plan	Analyzing (K4)
CO4	appraise the sources of finance and interpret accounting statements	Applying (K3)
CO5	interpret the causes of sickness of small scale enterprises and its remedies	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	2	1	1		3	2		1
CO2	1	2	2	2		2	2	1	1		3	2		2
CO3	2	2	2	2	2	2	2	2	2	2	3	2		1
CO4	1	1	2	1		2	1	1	1	2	3	2		1
CO5	1	1	2	1		2	1	1	1	2	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	30	30	20			100
CAT3	30	30	40				100
ESE	20	30	40	10			100

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

18MEE34 - 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**
Overview of the Aircraft Design Process, Aircraft Loads, Aircraft Structures Description: 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**
Aircraft Materials and properties: 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**
Static and Fatigue Failures: 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, Buckling of Thin Sheets: 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**
Aircraft Structural Joints, Advanced materials, Vibrations and Flutter: 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.		

Total: 45

TEXT BOOK:

1. Daniel P. Raymer, "Aircraft Design-A Conceptual Approach", 6th Edition, AIAA Education Series, USA, 2012.

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 (K4)
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	15	15	35	35			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)**

18MEE35 – 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 and principles of farm equipments	
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**
Tillage: 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**
Fertilizer Application Equipment: 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**
Principles and Types of Cutting Mechanisms: 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**
Principles of Harvesting Tools and Machines: 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.		

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, 2017.

REFERENCES:

1. Bosoi E.S., "Theory, Construction and Calculation of Agricultural Machines", 1st Edition, Oxonion Press Pvt. Ltd., New Delhi, 1990.
2. Ghosh P.K. and Swain S., "Practical Agricultural Engineering", 1st Edition, NayaProkash, Calcutta, 1993.
3. Donnel Hunt, "Farm Machinery and Management", 10th Edition, Iowa State University Press, Ames, USA, 2016.

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	illustrate 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	2	1							1		1	1	1
CO2	3	2	1							1		1	1	1
CO3	3	2	1							1		1	1	1
CO4	3	2	1							1		1	1	1
CO5	3	2	1							1		1	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	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)**

18MEE36 - 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	To impart knowledge on layout of various power plants and operating construction of subcomponents involved in the power plants.	
Unit - I	**Energy Scenario and Steam Power Plant:**	**9**
Energy Scenario: Indian and Global Energy Scenario - Environmental Issues of Present Day Power Generation. Steam Power Plant: Layout of Steam Power Plant – Selection Criteria - High Pressure Boilers-Types - Super Critical Boilers – Fluidized Bed Boilers – Boiler Trial and Testing - Fuel and Ash Handling Systems -Pulverizer - Stokers – Dust Collectors and Cooling Towers.		
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**
Other Types of Power Generation: 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**
Power Plant Economics: 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 Techniques - Types.		

Total: 45

TEXT BOOK:

1. Rajput R.K, "Power Plant Engineering", 4th Edition, Laxmi Publications, New Delhi, 2012.

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", 3rd Edition, Tata McGraw-Hill, New Delhi, 2011.
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	Analyzing (K4)
CO3	explain the basic theory of nuclear processes and working of Nuclear and Hydel power plants with their layouts	Analyzing (K4)
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	2	2			2	2					2		3
CO2	3	2	2			2	2					2		3
CO3	3	2	2			2	2					2		3
CO4	3	1	2			2	2					2		3
CO5	3	3	3			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	10	30	40	20			100
CAT2	10	30	40	20			100
CAT3	10	30	40	20			100
ESE	10	30	40	20			100

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

18MEE37 - 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	Thermal Engineering	8	PE	3	0	0	3

Preamble	This course provides the importance of energy conservation, energy audit and management practices in HVAC systems.	
Unit - I	**Analysis of Laws of Thermodynamics:**	**9**
Analysis of Laws of Thermodynamics: 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**
Climates and Buildings: Factor that determines 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**
Indoor Environmental Requirements: 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**
Heating and Ventilation Systems: 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 Condition Systems:**	**9**
Air condition Systems: Energy conservation in air handling units – Fans, Air condition apparatus– Window air condition system – Central air condition system – Energy efficient motors – Cooling load estimation – RSH, RLH, TSH, TLH.		

Total: 45

TEXT BOOK:

1. Faye C. McQuiston, Jerald D. Paeker and Jeffrey D. Spitler, "Heating, Ventilating, and Air Conditioning", 5th Edition, John Wiley & Sons Inc., Singapore, 2001.

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, 2012.

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	breakdown the energy variables 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	2	2			1								3
CO2	3	2	2		1	1	2							3
CO3	3	2	3		1		2			1			2	3
CO4	3	2	1		1	2	1			1			2	3
CO5	3	2	3		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	27	48	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)**

18MEE38 - NANOSCIENCE AND TECHNOLOGY FOR MECHANICAL ENGINEERS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	PE	3	0	0	3

Preamble	This course offers the basics of nanoscience and nanotechnology, different types of nano structured materials, their synthesis route, applications in transistors, energy conversion and energy storage.	
Unit - I	**Nanoscience and Technology:**	**9**
Emerging trends in nanoscience and technology, Periodic table, Atomic structure, Molecules and phases, Molecular and atomic size, Surfaces and dimensions, Prospects at the nanoscale, Bulk to nano transition, Scope of nano science and technology.		
Unit - II	**Nanomaterials:**	**9**
Size dependent properties, Optical, electrical, mechanical, magnetic properties, Quantum confinement, 0D, 1D, 2D, 3D nanostructures, quantum dot, quantum wire, quantum well, bulk materials, length and time scale in nanostructures.		
Unit - III	**Nanomaterial Synthesis:**	**9**
Top-Down approach, Bottom-up approach, Chemical precipitation and co-precipitation, Sol-gel synthesis, Self-assembly, Microwave heating synthesis, Electrochemical synthesis, Inert gas condensation, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method and Electro deposition.		
Unit - IV	**Semiconductor Nanoparticles:**	**9**
Size dependant physical properties like Melting point, solid state phase transformations, excitons, band-gap variations. p-n junction, metal-semiconductor, metal-insulator, Field Effect Transistor (FET), Metal Oxide Field Effect Transistor (MOSFETs). Types of Nanocomposite -. metal oxide, ceramic, glass and polymer.		
Unit - V	**Applications of Nanomaterials:**	**9**
Solar cells and Batteries, Fuel Cells, Proton Exchange Membrane (PEM) fuel cell. Acid/ alkaline fuel cells, design of fuel cells, Carbon Nanotubes for energy storage, Energy and Environment, Hydrogen Storage in Carbon Nanotubes.		

Total:45

TEXT BOOK:

1. Charles P., Poole J.R. & Franks J. Qwens, "Introduction to Nanotechnology", Wiley India Pvt. Ltd., Noida, 2012.

REFERENCES:

1. Mick Wilson & Kamali Kannagara, "Nanotechnology - Basics Science and Emerging Technologies", Overseas Press, New Delhi, 2005.
2. Pradeep T., "Nano the Essential Nanoscience and Nanotechnology", 1st Edition, McGraw Hill, New Delhi, 2012.
3. Linden, "Hand book of Batteries and Fuel Cells", 4th Edition, McGraw Hill, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	define the fundamental principles of nanoscience and nanotechnology	Understanding (K2)
CO2	describe the optical, electrical, mechanical and magnetic properties of nanomaterials	Understanding (K2)
CO3	apply engineering concepts for the synthesis of nanomaterials	Applying (K3)
CO4	analyze the properties of semiconducting nanoparticles	Analyzing (K4)
CO5	apply the concepts of nanostructured materials for energy storage	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	1										2	2	2
CO2	2	1										2	2	2
CO3	2	2	1	1								2	2	2
CO4	3	3	2	2	1							2	2	2
CO5	3	3	2	2	1							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	40	60					100
CAT2	20	40	40				100
CAT3	20	20	40	20			100
ESE	20	30	40	10			100

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

18MEE39 – NON-DESTRUCTIVE EVALUATION TECHNIQUES

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Materials and Metallurgy, Instrumentation and Control System	8	PE	3	0	0	3

Preamble	This course provides an introduction to non destructive evaluation testing, in-depth studies on different types of non-destructive testing equipment's along and appropriate selection of testing techniques based on the nature of defect.	
Unit - I	**Introduction and Liquid Penetrant Testing:**	**9**
Introduction and Liquid Penetrant Testing: 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**
Magnetic Particle Testing: 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**
Ultrasonic Testing: 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**
Radiography: 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 and Selection of NDT Methods: 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.		

Total: 45

TEXT BOOK:

1. Baldev Raj, Jayakumar T. & Thavasimuthu M., "Practical Non-Destructive Testing", 3rd Edition, Narosa Publishing House, New Delhi, 2019.

REFERENCES:

1. Hull Barry & John Vernon., "Non-Destructive Testing", 3rd Edition, Macmillan, London, 2015.
2. Hellier C., "Handbook of Non-Destructive Evaluation", 2nd Edition, McGraw-Hill Professional, New Delhi, 2012.
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	explain liquid penetrant and magnetic particle testing methods.	Applying (K3)
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)**

18MEE40 - INDUSTRIAL MARKETING

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Economics and Management	8	PE	3	0	0	3

Preamble	This course provide the behavior of customers and marketing strategies. It improves the skills for solving the real time engineering marketing strategies. This course is also useful to design the channel of market and product development.	
Unit - I	**Introduction:**	**9**
Introduction: Introduction to Industrial Markets - Marketing System - Concepts - Characteristics – Definition Exchange processes – Characteristics of Industrial and Consumer markets –Market demand – Cross elasticity of demand.		
Unit - II	**Industrial Purchasing:**	**9**
Industrial Purchasing: Types of Industrial Customers - Purchasing practices - Industrial Buyer Behaviour – Industrial buying situation – Decision Making Units – Models of Organizational buying behavior- Modern Purchasing terminologies.		
Unit - III	**Marketing Planning and Research:**	**9**
Marketing Planning and Research: Business Marketing – Marketing Planning – Corporate Strategic Planning – Target Marketing - marketing Information Systems – Market Evaluation - Role of IT in Marketing Information Systems - Definition and Process of Marketing Research - Research Instruments.		
Unit - IV	**Product Development and Pricing:**	**9**
Product Development and Pricing: 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**
Channel Design: Channel Design Process - 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.		

Total: 45

TEXT BOOK:

1. Hawaldar K. Krishna, "Industrial Marketing", 4th Edition, Tata McGraw Hill, New Delhi, 2015.

REFERENCES:

1. Philip Kotler and Gary Armstrong, "Principles of Marketing", 5th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2016.
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	analyse industrial markets models of organizational buying behaviour.	Analyzing (K4)
CO3	analyse 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	dissect 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	3
CO2	2	2				3	3			1			2	3
CO3	2	2				3	3			1			2	3
CO4	2	2				3	3			1			2	3
CO5	2	2				3	3			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	25	30	30			100
CAT2	15	30	35	20			100
CAT3	15	25	30	30			100
ESE	15	25	30	30			100

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

18MEO01 - RENEWABLE ENERGY SOURCES
(Offered by Department of Mechanical Engineering)

Programme & Branch	All BE/BTech Branches except Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	0	2	4

Preamble	This course discusses the various technologies behind renewable energy conversion process and the issues involved in the integration of renewable energy to the grid.	
Unit - I	**Grid Integration of Renewable Energy:**	**9**
Grid Integration of Renewable Energy: 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**
Bioenergy: 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.	Determination of the thermal energy gain at the focal point of a concentrating collector.
4.	Determination of the efficiency of solar (Liquid/Air) collector.
5.	To show the effect of variation of tilt angle on the PV module output.
6.	Study on rooftop solar PV plant.
7.	Study on weather monitoring station.
8.	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.

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	express the principle and operation of geothermal energy and Ocean energy sources	Understanding (K2)
CO5	demonstrate an understanding of direct energy conversion systems and new energy source.	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 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	2					3			2		2		3
CO2	3	2	2				3			2		2		3
CO3	3	1	3				3			2		2		3
CO4	3	1	2				3			2		2		3
CO5	3	1	1				3			2		2		3
CO6	2	3	3	3						2				3
CO7	2	3	3	3						2				3
CO8	2	3	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	36	36	28				100
CAT2	36	36	28				100
CAT3	40	60					100
ESE	42	26	32				100

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

18MEO02 - DESIGN OF EXPERIMENTS
(Offered by Department of Mechanical Engineering)

Programme & Branch	All BE/BTech Branches except Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	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**
Experimental Design Fundamentals: 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**
Multifactor Experimental Design: 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**
Analysis and Interpretation Methods: 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**
Special Experimental Designs: 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**
Taguchi Methods: 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/milling operation by the Taguchi method.
4.	Process parameter optimization in turning using the central composite design method.
5.	Mathematical model development for turning/milling/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.

REFERENCES:

1. Phillip J.Rose., "Taguchi Techniques for Quality Engineering", 2nd Edition, McGraw Hill, New Delhi, 1995.
2. NicoloBelavendram., "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.	Analyzing (K4)
CO3	select different analysis and interpretation methods for experimental reslts.	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	2	2	2											2
CO2	3	2	2										2	2
CO3	3	2	3										2	2
CO4	3	2	3										2	2
CO5	3	2	3										2	2
CO6	3	2	3	2	2						2	2	2	2
CO7	3	2	3	2	2						2	2	3	2
CO8	3	2	3	2	2						2	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	15	15	45	25			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)**

18MEO03 - FUNDAMENTALS OF ERGONOMICS
(Offered by Department of Mechanical Engineering)

Programme & Branch	All BE/BTech Branches except Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	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**
Introducing Ergonomics: 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**
Anthropometry: 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 and Movement: 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 Behavior and Perception: 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 and Safety: Contribution of ergonomics to workstation design - Analysis of workplace design - Work envelopes - Workplace evaluation tools - case studies - Occupational / Ergonomic safety and stress at various workplace - health management rules - Scope of Ergonomics in India-case studies.		

Total: 45

TEXT BOOK:

1. Bridger R.S., "Introduction to Ergonomics", 3rd Edition, Taylor & Francis, New York, 2011.

REFERENCES:

1. Pamela McCauley-Bush, "Ergonomics: Foundational Principles, Applications, and Technologies", 1st Edition, Taylor & Francis, CRC Press, New York, 2011.
2. Dul J. and Weerdmeester B., "Ergonomics for beginners, a quick reference guide", 3rd Edition, Taylor & Francis, New York, 2008.

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	assess the common risk factors and areas for ergonomic improvement.	Evaluating (K5)
CO4	apply ergonomic principles in framing work content for 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	3	2	1									2	3	1
CO2	3		2	2								1	3	1
CO3	3			1		2	2					2	3	1
CO4			2			1	1			3		1	3	1
CO5	3											2	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	20	50	30				100
CAT2	20	30	30	10	10		100
CAT3	20	30	20	30			100
ESE	10	40	30	10	10		100

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

18MEO04 - PRINCIPLES OF MANAGEMENT AND INDUSTRIAL PSYCHOLOGY
(Offered by Department of Mechanical Engineering)

Programme & Branch	All BE/BTech Branches except Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	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**
Principles of Management: 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**
Functions of Management: 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 Behaviour:**	**9**
Organizational Behaviour: Definition - Organization - Managerial Role and functions - Organizational approaches - Individual behaviour - causes - Environmental Effect - Behaviour and Performance - Perception - Organizational Implications - Personality - Contributing factors - Dimension - Need Theories - Process Theories - Job Satisfaction - Learning and Behaviour - Learning Curves - Work Design and approaches.		
Unit - IV	**Industrial Psychology and Group Dynamics:**	**9**
Industrial Psychology and Group Dynamics: Introduction - Concept and Meaning - Characteristics and Scope - Historical Development - Individual behaviour - Group behavior - Features of Group - Formation and Development - Types of Groups - Group Structure and Cohesiveness.		
Unit - V	**Interpersonal Relationship:**	**9**
Interpersonal Relationship: Leadership - Concept and Meaning - Principles and Theories - Managing emotions - Emotional Intelligence - Building Interpersonal Relations - Managing the Boss - Dealing with Subordinates.		

Total: 45

TEXT BOOK:

1. Harold Koontz & Heinz Weihrich., "Essentials of Management: An International, Innovation and Leadership Perspective", 10th Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2015 for Units I,II,III.
2. Michael G Aamodt., "Industrial Psychology", 7th Edition, Cengage Learning, India, 2013 for Units 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 behaviour 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			1			3	2	2	2	2				1
CO2			1			3	2	2	2	2				1
CO3			1			3	2	2	2	2				1
CO4			1			3	2	2	2	2				1
CO5			1			3	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	40	60					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)**

18MEO05 - SAFETY MEASURES FOR ENGINEERS
(Offered by Department of Mechanical Engineering)

Programme & Branch	All BE/BTech Branches except 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**
Introduction: Need for Safety - Safety and Productivity - Safety Management Techniques - Job Safety Analysis - Safety Sampling Technique - Incident Recall Technique - Plant Safety Inspection - Accident: Nature and Causes of Accidents - Accident Proneness - Cost of Accident - Accident Prevention Methods - Accident Reporting and Investigation - Safety Education and Training		
Unit - II	**Electrical Safety Equipments and Safety Practices**	**9**
Voltage Measuring Instruments: Safety Voltage Measurement - Contact and Non-Contact Type Testers. Rubber Insulating Equipment: Rubber Mats - Rubber Blankets - Rubber Covers - Line Hoses and Sleeves -Inspection Techniques – Standards. Insulated Tools: Hot Sticks - Cherry Picker - Standards for Tools - Safety Barriers and Signs - Safety Tags - Lock and Locking devices. Fire Extinguishers: Fire Safety Against Electrical fire - Types of Extinguishers. Safety Earthing Practices: Distinction Between System Grounding and Equipment Grounding - Functional Requirement of Earthing Systems - Earth Electrodes - Types. Earth Mats - Procedure for Laying Earth Mat - Earth Resistance Measurements		
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**
Flash and Thermal protection: Glossary of Terminologies - Flame Resistant - Arc Thermal Performance Value (ATPV) - Energy Breakthrough (EBT) - ASTM Standard for Clothing Materials - Choice of Clothing - Flame and Non-Flame Resistant Materials - Guidelines for Selection - Flash Suit Head Protection: Hard Hats – ANSI Z 89.1 Standard - Eye Protection - Requirements of Safety Glasses - Goggles - Selection - Face shield. Hearing Protection – Requirement - Ear plugs and Ear muffs - Noise Reduction Ratio - Thumb Rule. Arm and Hand Protection: Rubber Gloves - ASTM Standards - Leather Protective Glove - Level of Protection. Foot and Leg Protection and Respiratory Protection		
Unit - V	**Risk Assessment and Control Techniques:**	**9**
Risk Assessment: 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		

Total: 45

TEXT BOOK:

1. Mistry K.U., "Fundamentals of Industrial Safety and Health", 2nd Edition, Siddharth Prakashan, Ahmedabad, 2008.

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				2		3	3	3	3			3		
CO2				2		3	3	3	3			3		
CO3		3		3	3	3	3	3	3			3		
CO4				1		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	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)**

18MEO06 - ENERGY CONSERVATION IN THERMAL EQUIPMENTS
(Offered by Department of Mechanical Engineering)

Programme & Branch	All BE/BTech Branches except Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	This course provides the knowledge on the energy audit concepts and provides the professional experience in assessing the energy conservation opportunities of various thermal utilities.	
Unit - I	**Energy Scenario and Energy Conservation Act –2001:**	**9**
Energy Scenario: Global and Indian Energy Consumption – Energy Needs of Growing Economy – Energy Security – Energy Conservation and its Importance – Energy Intensive Industries. Energy Conservation Act –2001: Salient Features - Schemes of BEE (Bureau of Energy Efficiency) under the Act.		
Unit - II	**Energy Audit:**	**9**
Energy Audit: Need and Types of Energy Audit – Energy Audit Questionnaire – Understanding Energy Costs – Energy Performance – Instruments for Energy Audit – Responsibilities and Duties of an Energy Manager.		
Unit – III	**Boiler, Furnace and Waste Heat Recovery:**	**9**
Boiler: Types – Performance Assessment – Energy Saving Opportunities. Furnace: Types – Performance Evaluation – Energy Saving Opportunities. Waste Heat Recovery: Classification and Application – Commercial Waste Heat Recovery Devices.		
Unit – IV	**Cogeneration:**	**9**
Cogeneration : Need – Classification – Commercial Cogeneration Systems – Factors and Technical Parameters Influencing the Selection of Cogeneration Systems – Relative Merits of Cogeneration Systems – Performance Assessment.		
Unit - V	**Financial Management:**	**9**
Financial Management : Need for Investment Appraisal and Criteria – Financial Analysis Techniques – Cash Flow – Sensitivity and Risk Analysis – Financing Options – Energy Performance Contracting and Role of ESCOs.		

Total: 45

TEXT BOOK:

1. Stephan A. Roosa, Steve Doty & Wayne C. Turner, "Energy Management Handbook", 9th Edition, Fairmont Press Inc., U.S.A., 2018.

REFERENCES:

1. Sonal Desai, "Handbook of Energy Audit", 1st Edition, Mc Graw Hill Education, India, 2015.
2. 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	describe the energy scenario and features of energy conservation act 2001.	Understanding (K2)
CO2	explain the principles of energy audit and measuring instruments.	Applying (K3)
CO3	identify the energy conservation opportunities in thermal utilities.	Analyzing (K4)
CO4	illustrate the functions of cogeneration systems and analyze its performance	Analyzing (K4)
CO5	carry out financial calculations related to retrofitting of thermal utilities.	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	2			2		2		3
CO2	3	2	1			1	2			2		2		3
CO3	3	3	1			1	2			2		2		3
CO4	3	3	1			1	2			2		2		3
CO5	3	3	1			1	2			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	20	60	20				100
CAT2	15	50	20	15			100
CAT3	15	50	20	15			100
ESE	15	50	20	15			100

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

18MAO01 - MATHEMATICAL FOUNDATIONS OF MACHINE LEARNING

(Offered by Department of Mathematics)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	To impart the basic knowledge in linear algebra, decomposition of matrices, continuous optimization, linear regression and support vector machines which provide the foundations for machine learning and deep learning.	
Unit - I	**Vector Spaces:**	**9+3**
Definition – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity		
Unit - II	**Linear Transformations:**	**9+3**
Introduction – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - III	**Inner Product Spaces:**	**9+3**
Norms – Inner products – Length and Distance – Angle and Orthogonality – Orthonormal Basis – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection – Rotations.		
Unit - IV	**Matrix Decomposition And Continuous Optimization:**	**9+3**
Cholesky decomposition – Singular Value Decomposition, Continuous Optimization: Introduction – Unconstrained Optimization – Gradient Descent method – Constrained Optimization – Lagrange Multipliers method – Convex Optimization		
Unit - V	**Linear Regression And Support Vector Machines:**	**9+3**
Parameter Estimation – Maximum Likelihood estimation – Bayesian linear regression – Bayesian parameter estimation of Gaussian distribution, Support Vector Machines: Introduction – Margin and support vectors – Kernels – Primal support vector machine – Dual support vector machine.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Howard Anton and Chris Rorres, "Elementary Linear Algebra", 9th Edition, John Wiley and Sons, New Delhi, 2011 for Units I, II, III.
2. Deisenroth M.P., Faisal A.A. and Ong C.S., "Mathematics for Machine Learning", 1st Edition, Cambridge University Press, 2019 for Units IV, V.

REFERENCES:

1. David C. Lay, Steven R. Lay and Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2. Ethem Alpaydin, "Introduction to Machine Learning(Adaptive Computation and Machine Learning series)", 4th Edition, MIT Press, USA, 2020.
3. Duda R.O., Hart E. and Stork D.G., "Pattern Classification", 2nd Edition, John Wiley and Sons, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the concepts of vector spaces.	Understanding (K2)
CO2	apply the concepts of linear mappings in machine learning.	Applying (K3)
CO3	use the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Applying (K3)
CO4	apply the knowledge of factorisation of matrices and optimization techniques in clustering and classification of data.	Applying (K3)
CO5	describe the concepts of parameter estimation and support vector machine.	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	1												
CO3	3	2												
CO4	3	3	1	1	1									
CO5	3	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	10	50	40				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	5	25	70				100

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

18MAO02 - GRAPH THEORY AND ITS APPLICATIONS

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	OE	3	1	0	4

Preamble	To develop rigorous logical thinking and analytical skills by graph theoretic concepts which helps for solving real time engineering problems in networks, computer architecture, compiling techniques, model checking, artificial intelligence, software engineering, expert systems, software/hardware correctness problem.	
Unit - I	**Graphs:**	**9+3**
Introduction – Definition – Types of graphs – Degree of vertex – Walk, path and cycle – Isomorphism – Connected graph – Hamiltonian graph – Euler graph – Digraph – Representations of graphs: Adjacency matrix – Incidence matrix.		
Unit - II	**Trees:**	**9+3**
Introduction – Properties of trees – Pendant vertices in a tree – Distances and centers in a tree – Rooted and binary trees – Spanning tree – Construction of spanning tree: BFS algorithm – DFS algorithm – Tree traversal.		
Unit - III	**Graph Coloring:**	**9+3**
Vertex coloring – Chromatic number – Chromatic partitioning – Independent sets – Chromatic polynomial – Matching – Covering – Four color problem (statement only) – Simple applications.		
Unit - IV	**Basic Algorithms:**	**9+3**
Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm – Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Krushkal's algorithm – Optimal assignment – Kuhn and Munkres algorithm – Travelling salesman problem: Two optimal algorithm – Closest Insertion Algorithm.		
Unit - V	**Network Flows and Applications:**	**9+3**
Flows and cuts in networks - Max-flow Min-cut Theorem – Algorithms: Flow Augmenting Path – Ford-Fulkerson Algorithm for Maximum Flow – Edmonds and Karp algorithm.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall, New Delhi, 2010.

REFERENCES:

1. Douglas B.West, "Graph Theory", 2nd Edition, Prentice Hall, New Delhi, 2017.
2. Jonathan L. Gross & Jay Yellen, "Graph Theory and its Applications", 2nd Edition, CRC Press, New York, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the types of graphs and illustrate isomorphism on graphs.	Understanding (K2)
CO2	use the concepts and properties of different types of trees in data structures.	Applying (K3)
CO3	estimate the chromatic partition, chromatic polynomial and matching of a given graph.	Applying (K3)
CO4	apply various graph theoretic algorithms to communication and network problems.	Applying (K3)
CO5	identify the maximal flow in network by means of algorithms.	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	1												
CO3	3	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	10	50	40				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

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

18MAO03 - NUMBER THEORY AND CRYPTOGRAPHY

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	OE	3	1	0	4

Preamble	To provide the skills for applying various number theoretic algorithms, congruences, primality tests in cryptography and network security and impart knowledge of basic cryptographic techniques.	
Unit - I	**Divisibility Theory and Canonical Decompositions:**	**9+3**
Division algorithm- Base-b representations – number patterns – Prime and composite numbers – Fibonacci and Lucas numbers – Fermat numbers – GCD – Euclidean Algorithm – Fundamental theorem of Arithmetic – LCM.		
Unit - II	**Theory of Congruences:**	**9+3**
Basic concepts – Properties of congruences – Linear congruences – Solution of congruences – Fermat's Little theorem – Euler's theorem – Chinese remainder theorem.		
Unit - III	**Number Theoretic Functions:**	**9+3**
Introduction – Functions τ and σ– Mobius function – Greatest integer function – Euler's Phi function – Euler's theorem – Properties of Euler's function – Applications to Cryptography.		
Unit - IV	**Primality Testing and Factorization:**	**9+3**
Primality testing: Fermat's pseudo primality test – Solvay-Strassen test – Miller-Rabin test – Fibonacci test – Lucas test – Integer factorization: Trial division – Pollard's Rho method – Quadratic sieve method.		
Unit - V	**Classical Cryptographic Techniques:**	**9+3**
Introduction – Substitution techniques – Transposition techniques – Encryption and decryption – Symmetric and asymmetric key cryptography – Steganography.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Thomas Koshy, "Elementary Number Theory with Applications", 2nd Edition, Academic Press, Elsevier, USA, 2007 for Units I, II, III.
2. William Stallings, "Cryptography and Network Security: Principles and Practice", 7th Edition, Pearson Education, New Delhi, 2019 for Units IV, V.

REFERENCES:

1. Ivan Niven, Herbert S. Zukerman & Hugh L. Montgomery, "An Introduction to the Theory of Numbers", Reprint Edition, John Wiley & Sons, New Delhi, 2008.
2. Bernard Menezes, "Cryptography and Network Security", 1st Edition, Cengage Learning India, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand various the concepts of divisibility and canonical decompositions.	Understanding (K2)
CO2	obtain knowledge in theory of congruences and solution of linear congruences.	Applying (K3)
CO3	use different number theoretic function suitably in cryptography.	Applying (K3)
CO4	apply various Primality test and factorisation algorithms to network security problems.	Applying (K3)
CO5	identify the suitable cryptographic techniques to handle real time security issues.	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												
CO2	3	1												
CO3	3	1												
CO4	3	2	1		2									
CO5	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	10	30	60				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)**

18MAO04 - ADVANCED LINEAR ALGEBRA

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

Preamble	To provide the skills for applying linear equations, decomposition of matrices and linear transformations in real time engineering problems and impart knowledge of vector spaces.	
Unit - I	**Linear Equations:**	**9**
System of linear equations – Row reduction and echelon forms – Vector equations – Matrix equations – Solution sets of linear systems – Applications of Linear systems: Matrix operations – inverse of a matrix, Matrix factorization – Applications to computer graphics.		
Unit - II	**Vector Spaces:**	**9**
Definition – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.		
Unit - III	**Inner Product Space:**	**9**
Inner products – Angle and Orthogonality in inner product spaces – Orthonormal Bases – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection – Least square technique.		
Unit - IV	**Linear Transformations:**	**9**
General linear transformation – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - V	**Eigenvalues and Eigenvectors:**	**9**
Definition – Orthogonal Diagonalization – Quadratic forms – Quadratic surfaces – Singular value decomposition – Applications.		

Total: 45

TEXT BOOK:

1. Howard Anton & Chris Rorres, "Elementary Linear Algebra", 11th Edition, John Wiley & Sons, USA, 2014.

REFERENCES:

1. David C. Lay, Steven R. Lay & Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2. Gareth Williams, "Linear Algebra with Applications", 8th Edition, Jones & Barlett Learning, USA, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use the concepts of matrices and vectors in the solution of a system of linear equations.	Applying (K3)
CO2	understand the concepts of vector spaces.	Understanding (K2)
CO3	understand the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Understanding (K2)
CO4	transform the system from one dimension to another and represent the pertinent linear transformation in matrix form.	Applying (K3)
CO5	apply the knowledge of quadratic forms and techniques of singular value decomposition for problems arising in power/control system analysis, signals and 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	1											
CO2	3	1												
CO3	3	1	1											
CO4	3	2	1											
CO5	3	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	10	20	70				100
CAT2	10	30	60				100
CAT3	10	20	70				100
ESE	10	20	70				100

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

18MAO05 - OPTIMIZATION TECHNIQUES

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

Preamble	To provide the skills for solving the real time engineering problems involving linear, non-linear, transportation and assignment problems and also impart knowledge in project management and game theoretic concepts.	
Unit - I	**Linear Programming:**	**9**
Introduction – Formulation of Linear Programming Problem – Advantages of Linear Programming methods – Limitations of Linear Programming models – Standard form of LPP – Graphical Method – Simplex Method – Artificial variable techniques – Big M Method.		
Unit - II	**Transportation Problem:**	**9**
Mathematical Formulation of Transportation Problem – Initial basic feasible solution – North West Corner Method – Least Cost Method – Vogel's approximation method – Optimal solution – MODI Method – Degeneracy – Unbalanced transportation problem – Maximization transportation problem.		
Unit - III	**Assignment Problem and Theory of Games:**	**9**
Assignment Problem: Mathematical model of Assignment problem – Hungarian Method – Unbalanced assignment problem. Theory of Games: Two-person zero-sum game – Pure strategies - Game with mixed strategies – Rules of Dominance – Solution methods: Algebraic method – Matrix method – Graphical method.		
Unit - IV	**Project Management:**	**9**
Basic Concept of network Scheduling – Construction of network diagram – Critical path method – Programme evaluation and review technique – Project crashing – Time-cost trade-off procedure.		
Unit - V	**Non-Linear Programming:**	**9**
Formulation of non–linear programming problem – Constrained optimization with equality constraints – Kuhn-Tucker conditions – Constrained optimization with inequality constraints.		

Total: 45

TEXT BOOK:

1. Kanti Swarup, Gupta P.K. & Man Mohan, "Operation Research", 14th Edition, Sultan Chand & Sons, New Delhi, 2014.

REFERENCES:

1. Sharma J.K., "Operations Research – Theory and Applications", 4th Edition, Macmillan Publishers India Ltd., New Delhi, 2009.
2. Gupta P.K. & Hira D.S., "Operations Research: An Introduction", 6th Edition, S.Chand and Co. Ltd, New Delhi, 2008.

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	apply transportation algorithms in engineering problems.	Applying (K3)
CO3	use assignment and game theory concepts in practical situations.	Applying (K3)
CO4	handle the problems of Project Management using CPM and PERT.	Applying (K3)
CO5	solve various types of Non-linear Programming 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	1											
CO2	3	1	1											
CO3	3	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	5	10	85				100
CAT2	5	10	85				100
CAT3	5	10	85				100
ESE	5	10	85				100

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

18PHO01 - THIN FILM TECHNOLOGY
(Offered by Department of Physics)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	This course aims to impart the essential knowledge on deposition, characterization and application of thin films in various engineering fields, and also provides motivation towards innovations.	
Unit - I	**Theories and models of thin film growth:**	**9+3**
Introduction - Theories of thin film nucleation: Impingement, Adsorption and Thermal accommodation - The capillarity model - The atomistic models - Structural consequences of thin film nucleation - The four stages of film Growth - The incorporation of defects during growth.		
Unit - II	**Vacuum technology:**	**9+3**
Principle and working of vacuum pumps: Roots pump, Rotary pump, Diffusion pump, Turbo molecular pump, Cryogenic-pump, Ion pump, Ti-sublimation pump - Measurement of Pressure: Bayet-Albert gauge, Pirani and Penning gauge - Cold cathode and hot cathode ionization gauges - Pressure controlling system (qualitative).		
Unit - III	**Deposition of thin films - Physical methods:**	**9+3**
Thermal evaporation – Electron beam evaporation – Pulsed laser deposition – Ion plating – DC sputtering – RF sputtering – Magnetron sputtering – Reactive sputtering - Molecular beam epitaxy - Demonstration of deposition of thin films by RF sputtering.		
Unit - IV	**Deposition of thin films – Chemical methods:**	**9+3**
Chemical vapor deposition – Sol-gel method - Chemical bath deposition - Hydro thermal methods – Electroplating deposition - Electroless deposition - Spray Pyrolysis - Spin coating.		
Unit - V	**Characterization and Applications of thin films:**	**9+3**
Characterization: X-ray diffraction, Energy dispersive X-ray analysis, Atomic probe microscopy, UV-vis spectroscopy, Four probe resistivity – Applications (qualitative): Thin film resistors, Thin film capacitors, Thin film diodes, Thin film transistors, Thin film solar cells, Thin film gas sensors, Thin films for information storage and Optical coatings.		

Lecture:45, Tutorial:15,Total:60

TEXT BOOK:

1. Maissel L.I. and Glang R., "Hand book of Thin Film Technology", McGraw Hill Inc., 1970 for Units I,II,III, IV.
2. Zhang S., Li L. and Kumar A., "Materials Characterization Techniques", CRC Press, 2009 for Unit V.

REFERENCES:

1. Ohring M., "Material Science of Thin Films", Academic Press, 1992.
2. Goswami A., "Thin Film Fundamentals", New Age International Pvt. Ltd., 2003.
3. Chopra K.L., "Thin Film Phenomena", McGraw Hill Inc., 1969.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	utilize the appropriate theory and models to comprehend the thin film growth process.	Applying (K3)
CO2	apply the principle of vacuum pump to explain select methods to create vacuum and to make use of the principle of vacuum gauge to explain the measurement of vacuum by select methods.	Applying (K3)
CO3	describe the deposition of thin films by select physical methods using the principle of working of respective methods.	Applying (K3)
CO4	explain the deposition of thin films by select chemical methods using the principle of working of respective methods.	Applying (K3)
CO5	make use of select characterization techniques to comprehend the properties of thin films and also to illustrate the various device applications of thin films.	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	25	35	40				100
CAT2	20	40	40				100
CAT3	20	35	45				100
ESE	20	40	40				100

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

18PHO02 - STRUCTURAL AND OPTICAL CHARACTERIZATION OF MATERIALS

(Offered by Department of Physics)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

Preamble	This course aims to impart the essential knowledge on the characterization of materials using X-ray diffraction, Raman spectroscopy, UV-visible spectroscopy, Electron microscopy and Scanning tunneling microscopy and their application in various engineering fields, and also provides motivation towards innovations.	
Unit - I	**Introduction to Characterization Techniques and X-Ray Diffraction:**	**9**
Importance of materials characterization - Classification of characterization techniques - Destructive and non-destructive techniques - Crystalline materials - Reciprocal lattice - Theory of X-ray diffraction - Powder and Single crystal X-ray diffraction: Instrumentation, XRD pattern, Systematic procedure for structure determination, Particle size determination, Strain calculation - Applications of X ray diffraction measurements.		
Unit - II	**Raman Spectroscopy:**	**9**
Introduction – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of light and Raman effect – Structure determination – Instrumentation – Near-Infra-Red FT Raman Spectroscopy.		
Unit - III	**Electron Microscopy:**	**9**
Need of Electron Microscopy - Electron Specimen interaction: Emission of secondary electrons, Backscattered electrons, Characteristic X-rays, Transmitted electrons, Specimen interaction volume - Resolution - Scanning electron microscope and Transmission electron microscope: Schematic diagram, Short details of each component and working - Field Emission Gun - Field Emission Scanning electron microscope - Merits of Transmission electron microscope.		
Unit - IV	**Scanning Tunneling Microscopy:**	**9**
Introduction to quantum mechanical tunneling - Basic principles of scanning tunneling microscopy - Two modes of scanning - Interpreting scanning tunneling microscopic images -Applications of scanning tunneling microscopy.		
Unit - V	**Ultra Violet and Visible Spectroscopy:**	**9**
Regions of UV-Visible radiation - Colour and light absorption - The chromophore concept - Beer's and Lambert's laws – Theory of electronic transition - Frank Condon principle – Instrumentation and Working of UV vis spectrometer - Applications of UV visible spectroscopy.		

Total:45

TEXT BOOK:

1. Cullity B.D. and Stock S.R., "Elements of X-ray diffraction ", 3rd Edition, Pearson Education, India, 2003 for Units I,II,III,IV.
2. Banwell C.N., "Fundamentals of Molecular Spectroscopy", Tata McGraw-Hill Publications, New Delhi, 2007 for Unit V.

REFERENCES:

1. Holt D.B. and Joy D.C., "SEM micro characterization of semiconductors", Academic Press, New Delhi, 1989.
2. Willard H.H., Merritt L.L., John A. Dean and Settle F.A., "Instrumental Methods of Analysis", 7th Edition, CBS Publishers and Distributors, New Delhi.
3. Elton N. Kaufman, "Characterization of Materials (Volume1&2)", Wiley-Interscience, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the concept of X-ray diffraction to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO2	make use of the concept of Raman effect and Raman spectroscopy to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO3	determine the micro-structural parameters of materials and to perform surface analysis of materials using the concept of matter waves and electron microscopy.	Applying (K3)
CO4	utilize the concept and phenomenon of quantum mechanical tunneling to interpret the surface image at the atomic level recorded using scanning tunneling microscopy.	Applying (K3)
CO5	apply the theory of UV-Vis spectroscopy to comprehend the working of UV-Vis spectrophotometer.	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	40	40				100
CAT3	20	35	45				100
ESE	20	40	40				100

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

18CYO01 - CORROSION SCIENCE AND ENGINEERING

(Offered by Department of Chemistry)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	Corrosion science and engineering aims to equip the students to have wide range knowledge of corrosion and prevention methods in order to meet the industrial needs.	
Unit - I	**Corrosion and its units:**	**9+3**
Importance of corrosion prevention in various industries: direct and indirect effects of corrosion –free energy and oxidation potential criterion of uniform corrosion –Pilling Bedworth ratio and it consequences –units corrosion rate – mdd (milligrams per square decimeter per day) and mpy (Mils per year) –importance of pitting factor – Pourbaix diagrams of Mg, Al and Fe – and their limitations.		
Unit - II	**Mechanism of Corrosion:**	**9+3**
Localized corrosion: electro chemical mechanism Vs. chemical mechanism – Galvanic corrosion – Area effect in anodic and cathodic metal coatings, Organic coatings of bimetallic systems – prediction using emf Series and Galvanic series – Crevice corrosion – Mechanism of differential oxygenation corrosion – Auto catalytic mechanism of pitting due to crevice or differential oxygenation corrosion – Principles and procedures of cathodic protection: Sacrificial anodes and external cathodic current impression – stray current corrosion.		
Unit - III	**Types of Corrosion:**	**9+3**
Inter-granular corrosion: Stainless steels – cause and mechanism (Cr- Depletion theory) – Weld decay and knife line attack – Stress corrosion and fatigue corrosion – Theory of critical corrosion rate in corrosion fatigue. Cavitation damage – Fretting damage – Atmospheric corrosion – Bacterial corrosion – Marine corrosion –High temperature oxidation of metals – Ionic diffusion through protective oxides.		
Unit - IV	**Kinetics of Corrosion:**	**9+3**
Kinetic aspects of corrosion: Over potential activation and concentration over potentials – Exchange current density – Mixed potential theory – corrosion rates of Fe and Zn in air – free acid – effect of oxidizing agents – Phenomenon of passivation – Theories – effect of oxidizing agents and velocity of flow on passivating metals – effect of galvanic coupling of Fe and Ti respectively with Platinum – Noble metal alloying – anodic protection.		
Unit - V	**Prevention of Corrosion:**	**9+3**
Corrosion in inhibition: Inhibitors of corrosion – passivators, adsorbing inhibitors, V.P. inhibitors. Prevention of galvanic crevice, inter granular, Stress and fatigue corrosion at the design stage and in service conditions – control of catastrophic oxidation and Hydrogen disease -control of Bacterial corrosion – Langelier saturation Index and its uses. Corrosion prevention by Coatings – Surface pre- treatment – Hot dip, diffusion and cladded coatings – Phosphating and its uses.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Winston R. & Uhlig H.H., "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, A John Wiley & Sons Inc. Publication, New Jersey, 2008.

REFERENCES:

1. McCafferty E., "Introduction to Corrosion Science", Springer, New York, 2010.
2. Fontanna, "Corrosion Engineering (Materials Science and Metallurgy Series)", McGraw Hill International Education, Singapore, 2005.
3. Pietro Pedeferri, "Corrosion Science and Engineering", Springer Nature Switzerland AG, Switzerland, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the importance of direct and indirect corrosion to familiarize for industrial needs.	Understanding (K2)
CO2	demonstrate the mechanism of different types of corrosion with respect to the environment.	Applying (K3)
CO3	organize the various types and theory of corrosion to understand the corrosion problems.	Applying (K3)
CO4	utilize the theories and kinetics of corrosion to interpret with the real time applications.	Applying (K3)
CO5	summarize the corrosion prevention methods to avoid corrosion related issues.	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												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	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)**

18CYO02 - INSTRUMENTAL METHODS OF ANALYSIS

(Offered by Department of Chemistry)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	BS	3	1	0	4

Preamble	Instrumental methods of analysis aim to prepare the students to have all-encompassing knowledge of spectral methods in order to identify the molecules and reaction mechanism for the process to enhance application towards the industries.	
Unit - I	**Absorption and Emission Spectroscopy:**	**9+3**
Basic concepts of Absorption and emission spectroscopy – representation of spectra – basic elements of practical spectroscopy – signal to noise ratio - techniques for signal to noise enhancement – resolving power – Fourier transform spectroscopy – evaluation of results – basic principles, instrumentation and applications of atomic absorption, atomic fluorescence and atomic emission spectroscopy.		
Unit - II	**IR, Raman and NMR Spectroscopy:**	**9+3**
Infrared spectroscopy – correlation of IR Spectra with molecular structure, instrumentation, samplings technique and quantitative analysis. Raman Spectroscopy – Classical and Quantum theory instrumentation, Structural analysis and quantitative analysis. Nuclear magnetic resonance spectroscopy – basic principles – pulsed Fourier transform NMR spectrometer – elucidation of NMR spectra and quantitative analysis.		
Unit - III	**Surface Studies:**	**9+3**
Surface study – x-ray emission spectroscopy (XES), electron spectroscopy for chemical analysis (ESCA) - UV photo electron spectroscopy (UPS)- X- ray photo electron spectroscopy (XPS) - Auger emission Spectroscopy (AES) - Transmission Electron microscopy (TEM) - Scanning Electron microscopy (SEM) - Surface tunneling microscopy (STEM) - Atomic force microscopy (AFM).		
Unit - IV	**Mass Spectroscopy:**	**9+3**
Mass spectroscopy – Ionization methods in mass spectroscopy – mass analyzer – ion collection systems - correlation of molecular spectra with molecular structure. Instrumentation design and application of Fourier transform mass spectroscopy (FT-MS)- Inductively coupled plasma mass spectroscopy (ICP-MS) - Secondary Ion Mass Spectroscopy (SIMS) and Ion microprobe mass analyzer (IMMA).		
Unit - V	**Thermal Analysis:**	**9+3**
Thermal analysis: principles and instrumentations and applications of thermogravimetry (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), evolved gas detection, thermo mechanical analysis and Thermometric titrimetry.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Willard H.H., Merritt L.L., Dean J.A & Settle F.A., "Instrumental Methods of Analysis", 7th Edition, CBS Publishers & Distributors, New Delhi, 2012.

REFERENCES:

1. Chatwal G.R. & Anand Sham K., "Instrumental Methods of Chemical Analysis", 5th Edition, Himalaya Publishing House, Girgaon, Mumbai, 2019.
2. Srivastava A.K. & Jain P.C., "Instrumental Approach to Chemical Analysis", 4th Edition, S Chand and Company Ltd, New Delhi, 2012.
3. Sharma B.K., "Instrumental Method of Chemical Analysis", Krishna Prakashan Media Pvt. Ltd., Meerut, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the basics of spectroscopy to understand the instrumentation of various spectral techniques.	Understanding (K2)
CO2	apply the IR, Raman and NMR for quantitative analysis of the sample.	Applying (K3)
CO3	apply the various techniques for the better understanding of surface morphology.	Applying (K3)
CO4	explain the principle, instrumentation of mass spectroscopy for the analysis of organic sample.	Understanding (K2)
CO5	illustrate the thermal analysis for the identification of thermal stability of the compounds.	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												
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)**

18CYO03 - WASTE AND HAZARDOUS WASTE MANAGEMENT

(Offered by Department of Chemistry)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	BS	3	0	0	3

Preamble	Waste and Hazardous waste management aims to equip the students to have a wide-range knowledge on waste management	
Unit – I	**Solid Waste Management:**	**9**
Solid wastes: Definition, types, sources, classification and composition of solid waste- Solid waste management system – Factors affecting solid waste management system – Solid waste processing technologies – incineration, combustion, stabilization, solidification, chemical fixation, encapsulation, composting, vermicomposting – Energy from waste –Biogasification –Anaerobic digestion, pyrolysis, refuse derived fuels; Landfill leachate and gas management, Landfill bioreactors – Recycling of household and commercial waste, recycling of paper, recycling of tire, recycling of plastics – Health and Environmental effects of Solid Waste – SWM: Indian scenario –Characteristics and quantity of various wastes.		
Unit – II	**Hazardous Waste Management:**	**9**
Hazardous waste Management: Identification and sources – characteristics and categorization – collection, segregation, packaging, labelling, transportation, processing (3R) – risk assessment and waste management treatment and disposal – storage and leak detection – site selection criteria, manifest system and records – Indian scenario – Responsibilities of various authorities. Radioactive Waste Management: Definition, sources, classification, collection, segregation, treatment and disposal.		
Unit – III	**E-Waste and Biomedical Waste Management:**	**9**
E-Waste Management: Definition, sources, classification, collection, segregation, treatment and disposal. Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste – categories and classification of biomedical waste – hazard of biomedical waste – need for disposal of biomedical waste – waste minimization – waste segregation and labelling – waste handling and collection- Treatment – autoclaving, Incineration, Chemical Disinfection – Disposal – Infection control Practices-status in India.		
Unit – IV	**Pollution from Major Industries and Management:**	**9**
Introduction- sources and characteristics – waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants – Wastewater reclamation concepts.		
Unit – V	**Solid Waste Management Legislation:**	**9**
Solid waste management plan – Solid Waste (Management and Handling) Rules, 2000, 2016 and amendments if any – Biomedical Waste (Management and Handling) Rules, 2016; Notification of Ash utilization 1999, 2003, 2009, 2015 and amendments if any – Plastic Waste Management Rules, 2016 – E-Waste Management Rules, 2016 – Bio-Medical Waste Management Rules, 2016 – Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 – Construction and Demolition Waste Management Rules, 2016.		

Total:45

TEXT BOOK:

1. John Pichtel, "Waste Management Practices: Municipal, Hazardous, and Industrial", 2nd Edition, CRC Press, Boca Raton, Florida, 2014 for Unit II, III.
2. Sharma U.C. & Neetu Singh, "Environmental Science and Engineering, Volume 5: Solid Waste Management", 2nd Edition, Studium Press, United State of America, 2017 for Unit I,IV,V.

REFERENCES:

1. VanGuilder & Cliff, "Hazardous Waste Management: An Introduction", Har Cdr Edition, Mercury Learning & Information, Herndon, VA, 2011.
2. Karen Hardt, "Solid Waste Management", 1st Edition, Callisto Reference, Germany, 2018.
3. Majeti Narasimha Vara Prasad, Meththika Vithanage & Anwesha Borthakur, "Handbook of Electronic Waste Management: International Best Practices and Case Studies", 1st Edition, Butterworth-Heinemann, United Kingdom, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the technical points that are required to set up a solid waste management system.	Applying (K3)
CO2	select the various disposal methods of hazardous wastes like radioactive wastes.	Understanding (K2)
CO3	organize the appropriate method for managing e-waste and biomedical wastes.	Applying (K3)
CO4	identify to plan minimization of industrial wastes.	Applying (K3)
CO5	relate the legal legislation to solid waste management.	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			3							
CO2	2	1					3							
CO3	3	2	1	1			3							
CO4	3	2	1	1			3							
CO5	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	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)**

18GEO01 – GERMAN LANGUAGE LEVEL 1

(Offered by Department of Electronics and Communication Engineering)

Programme& Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Basics of Language	5,6,7,8	HS	4	0	0	4

Preamble	To acquire the vocabulary as per the Common European framework of German language A1 level competence. This course will help to assimilate the basic grammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the German grammar and confidently articulate in day today situations.	
Unit - I	**Contacts (Kontakte):**	**12**
Understanding Letters, simple instructions, speaking about language learning, finding specific information in text, Acknowledging the theme and understanding conversations, Making appointments. Grammar – Preposition with Dative, Articles in Dative and Accusative possessive articles.		
Unit - II	**Accommodation (Die Wohnung):**	**12**
Understanding Accommodation advertisements, describing accommodation and directions, responding to an invitation, Expressing feelings, Colours. Grammar – Adjective with to be verb, Adjective with *sehr/zu*, Adjective with Accusative, prepositions with Dative		
Unit - III	**Working Environment Communication (ArbeitenSie):**	**12**
Daily Schedule, speaking about past, understanding Job openings advertisements, Opinions, Telephonic conversations, Speaking about Jobs. Grammar – Perfect tense, Participle II – regular and irregular verbs, Conjunctions – *und, oder, aber*.		
Unit - IV	**Clothes and Style (Kleidung und mode) :**	**12**
Clothes, Chats on shopping clothes, reporting on past, Orienting oneself in Supermarkets, Information and research about Berlin. Grammar – Interrogative articles and Demonstrative articles, Partizip II – separable and non-separable verbs, Personal pronouns in Dative, Verbs with Dative.		
Unit - V	**Health and Vacation (Gesundheit und Urlaub):**	**12**
Personal information, Human Body parts, Sports, Understanding instructions and prompts, health tips. Grammar – Imperative with *du/Ihr*, Modal verbs – sollen, müssen, nichtdürfen, dürfen. Suggestions for travel, Path, Postcards, weather, Travel reports, Problems in hotel, Tourist destinations. Grammar – Pronoun: *man*, Question words – *Wer, Wen, Was, Wem*, Adverbs – *Zuerst, dann, Später, ZumSchl*		

Total:60

TEXT BOOK:

1. "Stefanie Dengler, Paul Rusch, Helen Schmitz, TanjaSieber, "Netzwerk Deutsch alsFremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs", Goyal Publishers, Delhi, 2015.

REFERENCES:

1. https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware
   Refer: German 1 for undergraduate students
2. https://www.dw.com/en/learn-german - Deutsche Welle , Geramany's International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understanding letters and simple texts	Remembering (K1)
CO2	assimilating vocabulary on accommodation and invitation	Understanding (K2)
CO3	comprehend concept of time, telephonic conversation and job-related information	Understanding (K2)
CO4	understanding how to do shopping in a German store	Understanding (K2)
CO5	understanding body parts and how to plan personal travel	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								1	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	25	75					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO02 – JAPANESE LANGUAGE LEVEL 1

(Offered by Department of Electronics and Communication Engineering)

Programme& Branch	All BE/BTech Engineering & Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Basics of Language	5,6,7,8	HS	4	0	0	4

Preamble	To understand the basics of Japanese language which provides understanding of Hiragana, Katakana and 110 Kanjis and provides the ability to understand basic conversations and also enables one to request other person and also understand Casual form	
Unit - I	**Introduction to groups of verbs:**	**12**
tai form-Verb groups-te form-Give and ask permission to do an action-Present continuous form-Restrict other person from doing an action-nouns-Basic Questions		
Unit - II	**Introduction to Casual Form:**	**12**
nai form-Dictionary form-ta form-Polite style and Casual style differences-Conversation in plain style-Place of usage of Polite style and Casual style		
Unit - III	**Express opinions and thoughts:**	**12**
Introduction to new particle-Express someone one's thought-Convey the message of one person to another-Ask someone if something is right -Noun modifications		
Unit - IV	**Introduction to If clause and Kanjis:**	**12**
If clause tara form-Express gratitude for an action done by other person-Hypothetical situation-Particles to use in case of Motion verbs-110 Kanjis		
Unit - V	**Introduction to Counters:**	**12**
How to use numbers-How to use quantifiers-Past form of adjectives and Nouns-Way to say preference-Way of expression degrees of an action-Other necessary particles-How to use numbers-How to use quantifiers-Past form of adjectives		

Total:60

TEXT BOOK:

1. "MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1. MargheritaPezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2. Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	read and understand typical expression in Hiragana and Katakana	Remembering (K1)
CO2	understand Polite form and Casual form of Japanese	Understanding (K2)
CO3	comprehend personal communication and express greetings	Understanding (K2)
CO4	understand the Kanjis in Japanese Script	Understanding (K2)
CO5	comprehend concept of time, counters and job-related information	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								1	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	25	75					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO03 - DESIGN THINKING FOR ENGINEERS

(Offered by Department of Computer Science and Engineering)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming	7	OE	3	0	0	3

Preamble	In this course, systematic process of thinking which empowers even the most traditional thinker to develop new, innovative solutions to the problem at handare studied with an emphasis on bringing ideas to life based on how real users think, feel and behave.	
Unit - I	**Introduction::**	**9**
Introduction – Need for design thinking – Design and Business – The Design Process – Design Brief –Visualization – Four Questions, Ten Tools – Explore – STEEP Analysis – Strategic Priorities – Activity System – Stakeholder Mapping – Opportunity Framing.		
Unit - II	**Visualization:**	**9**
Introduction – Visualization – Journey Mapping – Value Chain Analysis – Mind Mapping – Empathize –Observations – Need Finding – User Personas.		
Unit - III	**Brainstorming:**	**9**
Introduction – Brainstorming – Concept Development – Experiment – Ideation – Prototyping – Idea Refinement.		
Unit - IV	**Assumption Testing:**	**9**
Introduction – Assumption Testing – Rapid Prototyping – Engage – Storyboarding.		
Unit - V	**Customer Co-Creation Learning Launch:**	**9**
Introduction – Customer Co-Creation Learning Launch – Leading Growth and Innovation – Evolve– Concept Synthesis – Strategic Requirements – Evolved Activity Systems – Quick Wins.		

Total:45

TEXT BOOK:

1. Jeanne Liedtka and Tim Ogilvie, "Designing for Growth: A Design Thinking Tool Kit for Managers", Columbia University Press, 2011.

REFERENCES:

1. Lee Chong Hwa, "Design Thinking The Guidebook", Design Thinking Master Trainers of Bhutan, 2017.
2. Jeanne Liedtka, Tim Ogilvie, and Rachel Brozenske, "The Designing for Growth FieldBook: A Step-by-Step Project Guide", Columbia University Press, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the basic concepts of design thinking	Understanding (K2)
CO2	make use of the mind mapping process for designing any system	Applying (K3)
CO3	develop many creative ideas through structured brainstorming sessions.	Applying (K3)
CO4	develop rapid prototypes to bring the ideas into reality	Applying (K3)
CO5	plan the implementation of the any system considering the real time feedback	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	1	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	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	10	70	20				100
CAT2	10	30	60				100
CAT3	10	20	70				100
ESE	10	20	70				100

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

18GEO04 - INNOVATION AND BUSINESS MODEL DEVELOPMENT

(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	OE	3	0	0	3

Preamble	This course will inspire the students to think innovation concepts and ideas for business model developments.	
Unit - I	**Innovation and Design Thinking:**	**9**
Innovation and Creativity– Types of innovation – challenges in innovation- steps in innovation management- 7 concerns of design. Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping		
Unit - II	**User Study and Contextual Enquiry:**	**9**
Explanatory research – primary and secondary data – classification of secondary data – sources of secondary data – qualitative research – focus groups – depth interviews – analysis of qualitative data – survey methods – observations- Process of identifying customer needs –organize needs into a hierarchy –establish relative importance of the needs- Establish target specifications		
Unit - III	**Product Design:**	**9**
Techniques and tools for concept generation, concept evaluation – Product architecture –Minimum Viable Product (MVP)- Product prototyping – tools and techniques– overview of processes and materials – evaluation tools and techniques for user-product interaction		
Unit - IV	**Business Model Canvas (BMC):**	**9**
Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies		
Unit - V	**IPR and Commercialization:**	**9**
Need for Intellectual Property- Basic concepts - Different Types of IPs: Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design– Patent Licensing - Technology Commercialization – Innovation Marketing		

Total:45

TEXT BOOK:

1. Rishikesha T.Krishnan, “8 Steps To Innovation: Going From Jugaad To Excellence”, Collins India, 2013.

REFERENCES:

1. Peter Drucker, “Innovation and Entrepreneurship”, Routledge CRC Press, London, 2014.
2. Eppinger, S.D. and Ulrich, K.T. “Product design and development”, 7th Edition, McGraw-Hill Higher Education, 2020.
3. Alexander Osterwalder, “Business model generation: A handbook for visionaries, game changers, and challengers”, 1st Edition, John Wiley and Sons; 2010.
4. Indian Innovators Association, “Patent IPR Licensing – Technology Commercialization – Innovation Marketing: Guide Book for Researchers, Innovators”, Notion Press, Chennai, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand innovation need and design thinking phases	Understanding (K2)
CO2	identify, screen and analyse ideas for new products based on customer needs	Analysing (K4)
CO3	develop and analyse the product concepts based on the customer needs and presents the overall architecture of the product.	Analysing (K4)
CO4	predict a structured business model for MVP	Applying (K3)
CO5	practice the procedures for protection of their ideas' IPR	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			2						3	2	2
CO2	3	3	3	3	2	2	2	2	3	3	3	3	2	2
CO3	2	2	3	3	3	3	3	3	3	3	3	3	2	2
CO4				3	2	2	2	3	3	3	3	3	2	2
CO5				3	2	2		3	2	3	3	3	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	30	40	10			100
CAT2	20	30	40	20			100
CAT3	30	30	40				100
ESE	20	30	30	20			100

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

18GEO05 - GERMAN LANGUAGE LEVEL 2

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	German Language Level 1	**5/6/7/8**	**HS**	**4**	**0**	**0**	**4**

Preamble	This course aims to help the learner to acquire the vocabulary as per the Common European framework of German language A1 level competence. This course will help to assimilate the basic grammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the German grammar and confidently articulate in day today situations.	
Unit - I	**Contacts(Kontakte):**	**12**
Understanding Letters, simple instructions, speaking about language learning, finding specific information in text, Acknowledging the theme and understanding conversations, Making appointments. Grammar – Preposition with Dative, Articles in Dative and Accusative possessive articles.		
Unit - II	**Accomodation(Die Wohnung):**	**12**
Understanding Accommodation advertisements, describing accommodation and directions, responding to an invitation, Expressing feelings, Colours. Grammar – Adjective with to be verb, Adjective with *sehr/zu*, Adjective with Accusative, prepositions with Dative		
Unit - III	**Are you Working?(Arbeiten Sie):**	**12**
Daily Schedule, speaking about past, understanding Job openings advertisements, Opinions, Telephonic conversations, Speakin about Jobs. Grammar – Perfect tense, Participle II – regular and irregular verbs, Conjunctions – *und, oder, aber*.		
Unit - IV	**Clothes and Style(Kleidung und mode):**	**12**
Clothes, Chats on shopping clothes, reporting on past, Orienting oneself in Supermarkets, Information and research about Berlin. Grammar – Interrogative articles and Demonstrative articles, Partizip II – separable and non-separable verbs, Personal pronouns in Dative, Verbs with Dative		
Unit - V	**Health and Vacation(Gesundheit und Urlaub):**	**12**
Personal information, Human Body parts, Sports, Understanding instructions and prompts, health tips. Grammar – Imperative with *du/Ihr*, Modal verbs – sollen, müssen, nicht dürfen, dürfen. Suggestions for travel, Path, Postcards, weather, Travel reports, Problems in hotel, Tourist destinations. Grammar – Pronoun: *man*, Question words – *Wer, Wen, Was, Wem*, Adverbs – *Zuerst, dann, Später, Zum Schl*		

Total: 60

TEXT BOOK:

1	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, “Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015.

REFERENCES:

1	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware
2	https://www.dw.com/en/learn-german - Deutsche Welle , Geramany’s International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand letters and simple texts	Remembering (K1)
CO2	assimilate vocabulary on Accommodation and invitation	Understanding (K2)
CO3	comprehend concept of time, telephonic conversation and job-related information	Understanding (K2)
CO4	understand how to do shopping in a German store	Understanding (K2)
CO5	understand body parts and how to plan personal travel	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								1	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO06 - GERMAN LANGUAGE LEVEL 3

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	German Language Level 2	5/6/7/8	HS	3	0	0	3

Preamble	This course provides enriching information about various everyday situations in personal and professional life and enhances the vocabulary and speaking ability to respond to and also seek information in those situations. It also equips one to express opinions and negotiate appointments. With diligent learning one can capture all basic grammatical structure to answer confidently in everyday situations.	
Unit - I	**All about food (Rund Ums Essen):**	**9**
Understand information about person, Speak about food, Introduce self and others, Understand and explain a picture base story, To justify something, To speak about feelings, To express opinions, To answer questions on a text, To describe a restaurant. Grammar: Possessive Articles in Dative, Yes/No questions, Reflexive verbs, Sentence with 'weil'		
Unit - II	**School days (Nach der Schulzeit):**	**9**
Understand School reports, Speak and write comments about schooldays, To speak about habits, Understand and provide City-Tipps, To Understand School types in Germany and speak about it. Grammar: Modal verbs in Past tense, Positional Verbs, Two-way prepositions in Dativ and Akkusativ.		
Unit - III	**Media in everyday life (Medien in Alltag):**	**9**
To speak about advantages and disadvantages of Media, formulate comparisons, Express your own opinion, Talk about Movies, Understand and Write Movie reviews. Grammar: Comparative degree, Comparative Sentences with 'Als' and 'Wie', Subordinate clause with 'dass', Superlative degree.		
Unit - IV	**Feelings and expressions (Gefühle):**	**9**
Express thanks and congratulations, Talk about feelings, To understand information about festivals and speak about it, To describe a city, Express joy and regrets, Understand and write Blog entries, Write appropriate heading. Grammar: Subordinate Clause with 'Wenn', Adjectives to be used along with definite articles.		
Unit - V	**Profession and Travel (Beruf und Reisen):**	**9**
To have a conversation at ticket counter, To talk about leisure activities, To gather information from Texts, Introduce people, Express career preferences, Ideate the dream job, To prepare and make telephone calls, To understand text about Workplace. Ask for information, Express uncertainty, Understand and give directions, Understand a newspaper article, Say your own opinion, Talk about the way to work, Describe a statistic, Understand information about a trip, Talk about travel. Grammar: Adjective to be used along with indefinite articles, Prepositions, verb – 'werden', Subordinate clause – indirect questions, All units will include elements for reading, writing, speaking and listening.		

Total: 45

TEXT BOOK:

1. Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, "Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs", Goyal Publishers, Delhi, 2015.

REFERENCES:

1. Rosa-Maria Dallapiazza , Eduard von Jan, Till Schonherr, "Tangram 2 (German)" , Goyal Publishers, Delhi, 2011.
2. https://www.dw.com/en/learn-german - Deutsche Welle , Geramany's International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand German food style, restaurant and be able express oneself.	Remembering (K1)
CO2	understand German school system and discuss about habits and provide City-Tipps.	Understanding (K2)
CO3	analyze and compare media in everyday life.	Understanding (K2)
CO4	express feelings, describe a city and write blog entries.	Understanding (K2)
CO5	seek and provide information in a professional setup, give directions to others and talk about travel.	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								1	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO07 - GERMAN LANGUAGE LEVEL 4

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	German Language Level 3	5/6/7/8	HS	3	0	0	3

Preamble	This course imparts knowledge about interacting with external world, understanding various cultural aspects, behaviour and addressing relationships in personal and professional front. It helps one to understand reports from various media and at work. Enhance learner's grammatical exposure and cover the core basic grammatical concepts which would lay the foundation to have a better hold of the language. With focused learning one should be able to read and respond to reports, write simple formal and informal letters and text messages and be able to engage in simple conversations in known situations.	
Unit - I	**Learning (Lernen):**	**9**
Understanding and describing learning problems, Understanding and giving advice, Giving reasons, Understanding reports about everyday work life, Talking about everyday working life, Understanding a radio report, Understanding and making a mini-presentation. Grammar: Conjunctions- denn,weil, Konjuntiv II: Sollte(suggestions), Genitive, Temporal prepositions – bis, über + Akkusativ,ab+dativ		
Unit - II	**Athletic (Sportlich):**	**9**
Expressing enthusiasm, hope, disappointment, Understanding and writing fan comments, Formulating follow-ups, Making suggestions and reacting, Making an appointment, Understanding a report about an excursion, Understanding difficult texts, Introducing a tourist attraction. Grammar: Conjunctions – deshalb, trotzdem, Verbs with Dativ and Akkusativ		
Unit - III	**Living Together (Zusammen Leben):**	**9**
To complain, apologize & give in, As for something, Understand experience reports, Report on the past, Talk about pets, Respond to information, Write and correct a story. Grammatik: Konjunctiv II- könnte, Subordinate clauses – als and Wenn.		
Unit – IV	**Good Entertainment (Gute Unterhaltung):**	**9**
Talk about music style, Buy concert tickets, Introduce a musician / band, Understand newspaper reports, Give more detailed information about a person, Understand information about painting, Understand description of a picture, Describe a picture. Grammatik: Interrogative Articles: Was fuer eine? , Pronouns – man/jemand/niemand and alles/etwas/nichts , Relative sentences in Nominativ.		
Unit - V	**Passage of time and Culture (Zeitablauf & Kultur):**	**9**
Talk about wishes, Express wishes, Give Suggestions, Understand a conversation, Plan something together, To ask others something, Understand a text, Exchange information, Talk about proverbs, write a story. Understand information about other cultures, Discuss about behavior, Express intentions, Use the appropriate salutation, Understand tips in a text, Talk about forms of addressing others, Give more information, Discuss about clichés and write about them. All units will include elements for reading, writing, speaking and listening. Grammatik: Konjunctiv II (Wishes, Suggestions), Verbs with prepositions, W- questions with prepositions, Relative sentences in Akkusativ, Subordinate clauses with damit and Um…Zu.		

Total: 45

TEXT BOOK:

1. Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, "Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch", Goyal Publishers, Delhi, 2015.

REFERENCES:

1. Rosa-Maria Dallapiazza, Eduard von Jan, Till Schonherr, "Tangram 2 (German)", Goyal Publishers, Delhi, 2011.
2. https://www.dw.com/en/learn-german - Deutsche Welle, Geramany's International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	leverage learning in Workplace, understanding reports and make presentation.	Remembering (K1)
CO2	reciprocate to different situations, make appointment and understand texts.	Understanding (K2)
CO3	handle relationships and respond appropriately to exchange information	Understanding (K2)
CO4	familiarize to various channels of entertainment	Understanding (K2)
CO5	know about various cultural aspects, usage of proverbs and cliches.	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								1	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO08 - JAPANESE LANGUAGE LEVEL 2

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Japanese Language Level 1	5/6/7/8	HS	4	0	0	4

Preamble	The basic level of Japanese which provides understanding of Hiragana, Katakana and 110 Kanjis and provides the ability to understand basic conversations and also enables one to request other person and also understand Casual form	
Unit - I	**Introduction to groups of verbs:**	**12**
tai form-Verb groups-te form-Give and ask permission to do an action-Present continuous form-Restrict other person from doing an action-nouns-Basic Questions		
Unit - II	**Introduction to Casual Form:**	**12**
nai form-Dictionary form-ta form-Polite style and Casual style differences-Conversation in plain style-Place of usage of Polite style and Casual style		
Unit - III	**Express opinions and thoughts:**	**12**
Introduction to new particle-Express someone one's thought-Convey the message of one person to another-Ask someone if something is right -Noun modifications		
Unit - IV	**Introduction to If clause and remaining Kanjis:**	**12**
If clause tara form-Express gratitude for an action done by other person-Hypothetical situation-Particles to use in case of Motion verbs-50 Kanjis		
Unit - V	**Introduction to giving and receiving with te form and "when, even if" usages:**	**12**
Providing to and getting from differences - Understanding of situations and framing sentences using when and even if..etc.		

Total: 60

TEXT BOOK:

1. "MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1. Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2. Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	differentiate groups of verbs and its forms	Remembering (K1)
CO2	understand Polite form and Casual form of Japanese	Understanding (K2)
CO3	comprehend personal communication and express greetings	Understanding (K2)
CO4	understand the Kanjis in Japanese Script and If clause	Understanding (K2)
CO5	comprehend concept of “even if”, “when” and job-related information	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								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								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	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO09 - JAPANESE LANGUAGE LEVEL 3

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Japanese Language Level 2	5/6/7/8	HS	3	0	0	3

Preamble	The intermediate level of Japanese which provides understanding of all forms ofverbs, adverbs, conjunctions, etc. which includes 150 Kanji's and provides the ability to comprehend conversations encountered in daily life	
Unit - I	**Introduction to Potential verbs:**	**9**
Causes and Reasons-Favouring Expressions-Expressing a State-Potential Verb Sentences-Simultaneous actions-Verb Groups-te Form-Customary Actions-Nouns-Basic Questions and Kanji's.		
Unit - II	**Introduction to Transitive and Intransitive verbs:**	**9**
Consequence of verbs- Embarrassment about Facts- Consequence of Verbs with an Intentions-Affirmative Sentences-Conjunctions-Basic Questions and kanji's.		
Unit - III	**Introduction to Volitional forms:**	**9**
Expressions of Speakers Intention-Expressing Suggestion or Advice-Usage of Adverbs and Quantifiers-Basic Questions and kanji's.		
Unit - IV	**Introduction to Imperative and Prohibitive verbs:**	**9**
Commanding person- Interrogatives-Expressions of Third Person-Actions and its Occurrence - Possibilities of an Action-Changing of States Basic Questions and Kanji's.		
Unit - V	**Introduction to Conditional form and Passive verbs:**	**9**
Description of Requirement and Speaker's Judgement, HabitualActions, Directions and suggestions-Passive forms of Verbs-Basic Questions and Kanji's.		

Total: 45

TEXT BOOK:

1. "MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1. Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2. Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	read and understand BasicVocabularies.	Remembering (K1)
CO2	understand Conversations used in daily life.	Understanding (K2)
CO3	comprehend personal communication and express greetings.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script.	Understanding (K2)
CO5	comprehend Coherent conversations in everyday situations.	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								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								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	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO10 - JAPANESE LANGUAGE LEVEL 4

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Japanese Language Level 3	5/6/7/8	HS	3	0	0	3

Preamble	The intermediate level of Japanese provides understanding of expressions of verbs, its pattern, Relationships which also includes 150 Kanji's and also provides the ability to understand relationship among the people.	
Unit - I	**Introduction to Reasoning:**	**9**
Causes and Sequences-Causes and Effects-Interrogative Patterns-Adjective as a Noun -Basic Questions and Kanji's.		
Unit - II	**Introduction to Exchanging of things:**	**9**
Expressions for Giving and Receiving of Things-Polite Expression of Request-Indicating a Purpose of Actions-Basic Quantifiers-Basic Questions and kanji's.		
Unit - III	**Introduction to States of an Action:**	**9**
Sentence Pattern to Indicate Appearance-Degree of Action and State-Adjectives as Adverbs- Convey information -Basic Questions and kanji's.		
Unit - IV	**Introduction to Causative Verbs:**	**9**
Causative Forms of Verbs-Asking Opportunity to do something-Hypothetical Questions-Judgement and Course of an actions-Basic Questions and Kanji's.		
Unit - V	**Introduction to Relationship in Social Status:**	**9**
Honorific expressions- Respectful expressions- Humble expressions-Polite expressions-Basic Questions and Kanji's.		

Total: 45

TEXT BOOK:

1. "MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1. Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2. Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	read and Understand Relationship of a Person.	Remembering (K1)
CO2	understand Conversations Used in Everyday Activities.	Understanding (K2)
CO3	comprehend Contents at Near Natural Speed.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script.	Understanding (K2)
CO5	comprehend Orally Presented Materials.	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								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								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	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO11 - NCC Studies(Army Wing) – I

(Offered by Department of Electrical and Electronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5 / 6	OE	3	0	2	4

Preamble	This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, learning military subjects including weapon training.	
Unit - I	**NCC Organisation and National Integration:**	**9**
NCC Organisation – History of NCC- NCC Organisation- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honours and Awards – Incentives for NCC cadets by central and state govt. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Images and Slogans on National Integration.		
Unit - II	**Basic physical Training and Drill:**	**9**
Basic physical Training – various exercises for fitness(with Demonstration)-Food – Hygiene and Cleanliness. Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting.(WITH DEMONSTRATION)		
Unit - III	**Weapon Training:**	**9**
Main Parts of a Rifle- Characteristics of 5.56mm INSAS rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing(WITH PRACTICE SESSION) - Characteristics of 7.62mm SLR- LMG- carbine machine gun.		
Unit - IV	**Social Awareness and Community Development:**	**9**
Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY-JGSY-NSAP-PMGSY-Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility		
Unit - V	**Specialized Subject (ARMY):**	**9**
Basic structure of Armed Forces- Military History – War heroes- battles of Indo-Pak war- Param Vir Chakra- Career in the Defence forces- Service tests and interviews-Fieldcraft and Battlecraft-Basics of Map reading including practical.		

Lecture :45, Practical:30, Total:75

TEXT BOOK:

1. "National Cadet Corps- A Concise handbook of NCC Cadets", Ramesh Publishing House, New Delhi, 2014.

REFERENCES:

1. "Cadets Handbook – Common Subjects SD/SW", published by DG NCC, New Delhi.
2. "Cadets Handbook- Specialized Subjects SD/SW", published by DG NCC, New Delhi.
3. "NCC OTA Precise", published by DG NCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate Health Exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders..	Applying (K3)
CO3	basic knowledge of weapons and their use and handling.	Applying (K3)
CO4	understanding about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils	Applying (K3)
CO5	acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles.	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									
CO3	3	2	1	1										
CO4	3	2	1	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	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						

18GEO12 - NCC STUDIES (AIR WING) – I

(Offered by Department of Information Technology)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5 / 6	OE	3	0	2	4

Preamble	This course is designed especially for NCC Cadets. This course will help develop character , camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, honing qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets.	
Unit – I	**NCC Organization and National Integration:**	**9**
NCC Organization – History of NCC- NCC Organization- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honors' and Awards – Incentives for NCC cadets by central and state govt. History and Organization of IAF-Indo-Pak War-1971-Operation Safed Sagar. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Images and Slogans on National Integration.		
Unit – II	**Drill and Weapon Training:**	**9**
Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting.(WITH DEMONSTRATION). Main Parts of a Rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing (WITH PRACTICE SESSION).		
Unit – III	**Principles of Flight:**	**9**
Laws of motion-Forces acting on aircraft–Bernoulli's theorem-Stalling-Primary control surfaces – secondary control surfaces-Aircraft recognition.		
Unit - IV	**Aero Engines:**	**9**
Introduction of Aero engine-Types of engine-piston engine-jet engines-Turboprop engines-Basic Flight Instruments-Modern trends.		
Unit – V	**Aero Modeling:**	**9**
History of aero modeling-Materials used in Aero-modeling-Types of Aero-models – Static Models-Gliders-Control line models-Radio Control Models-Building and Flying of Aero-models.		

Lecture :45, Practical30, Total:75

TEXT BOOK:

1	"National Cadet Corps- A Concise handbook of NCC Cadets" by Ramesh Publishing House, New Delhi,2014.

REFERENCES:

1	"Cadets Handbook – Common Subjects SD/SW" by DG NCC, New Delhi.
2	"Cadets Handbook – Specialised Subjects SD/SW" by DG NCC, New Delhi.
3	"NCC OTA Precise" by DGNCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	display sense of patriotism, secular values and shall be transformed into motivated youth who will carry out nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate the sense of discipline with smartness and have basic knowledge of weapons and their use and handling	Applying (K3)
CO3	illustrate various forces and moments acting on aircraft	Applying (K3)
CO4	outline the concepts of aircraft engine and rocket propulsion	Applying (K3)
CO5	design, build and fly chuck gliders/model airplanes and display static models.	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									
CO3	3	2	1	1										
CO4	3	2	1	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	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						