KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

REGULATIONS, CURRICULUM & SYLLABI – 2022

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

BACHELOR OF ENGINEERING DEGREE IN

MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

INDEX

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

DEPARTMENT VISION

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

DEPARTMENT 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 be able to:

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 be able to**:**	
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 be able to**:**	
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	3	3
PEO4	2	1	2	1	2	3	1	2	3	3	3	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(Autonomous)

REGULATIONS 2022

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 2022 – 2023 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 (COE)" means authorized person who is responsible for all examination related activities of the College.

xi. "Head of the Department (HOD)" means Head of the Department concerned.

2. PROGRAMMES AND BRANCHES OF STUDY

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

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

3. ADMISSION REQUIREMENTS

3.1 First Semester Admission

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

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

(OR)

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

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

3.2 Lateral Entry Admission

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

(OR)

The candidates who hold a BSc degree in Science(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 also 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, English Communication Skills, Universal Human Values and Yoga & Values for Holistic Development.

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-plant Training in Industry or elsewhere

viii. Audit Courses (AC)

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

x. Honours Degree Courses (HC)

4.2 Credit Assignment and Honours Degree

4.2.1. Credit Assignment

Each course is assigned certain number of credits as follows:

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

The minimum number of credits to complete the BE/BTech programme is 168.

4.2.2 Honours Degree

If a candidate earns 18 to 20 additional credits in an emerging area, then he/she can be awarded with Honours degree mentioning that emerging area as his/her specialization. The respective board of studies shall recommend the specializations for honours degree and appropriate additional courses to be studied by the candidate which shall get approval from Academic Council of the institution. A candidate shall have not less than 7.5 CGPA and no history of arrears to opt for the honours degree and has to maintain the same during the entire programme.
Various specializations for various branches recommended by the respective boards of studies are given below:

SNo	Specializations for Honours degree in emerging areas	To be offered as Honours, Only for the following branches mentioned against the specialization
1.	Construction Technology	BE – Civil Engineering
2.	Smart Cities	BE – Civil Engineering
3.	Smart Manufacturing *	BE – Mechanical Engineering
4.	Computational Product Design *	BE – Mechanical Engineering
5.	Intelligent Autonomous Systems *	BE – Mechatronics Engineering
6.	E-Mobility *	BE – Automobile Engineering
7.	Artificial Intelligence and Machine Learning	BE – Electronics and Communication Engineering
8.	System on Chip Design *	BE – Electronics and Communication Engineering
9.	Electric Vehicles	BE – Electrical and Electronics Engineering
10.	Microgrid Technologies	BE – Electrical and Electronics Engineering
11.	Intelligent Sensors Technology *	BE – Electronics and Instrumentation Engineering
12.	Smart Industrial Automation *	BE – Electronics and Instrumentation Engineering
13.	Data Science	BE – Computer Science and Engineering
14.	Cyber Security	BE – Computer Science and Engineering
15.	Data Science	BTech – Information Technology
16.	Cyber Security	BTech – Information Technology
17.	Petroleum and Petrochemical Engineering *	BTech – Chemical Engineering
18.	Waste Technology *	BTech – Chemical Engineering
19.	Food Processing and Management *	BTech – Food Technology
20.	Virtual and Augumented Reality	BE- Computer Science and Design
21.	Data Science	BE- Computer Science and Design
22.	Internet of Things (IoT)	BTech – Artificial Intelligence and Data Science
23.	Blockchain	BTech – Artificial Intelligence and Data Science
24.	Internet of Things (IoT)	BTech – Artificial Intelligence and Machine Learning
25.	Blockchain	BTech – Artificial Intelligence and Machine Learning

*Title by KEC

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

4.3 Employability Enhancement Courses

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

4.3.1 Professional Skills Training/ Indsutrial Training/Entrepreneurships/Start Ups/ Inplant Training

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 fourth semester and phase II in fifth 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 fifth semester vacation period. Such candidate can earn two credits for this training course in place of Professional Skills Training course II in fifth semester. He/She shall attend Professional Skills Training Phase I in fourth 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 2 credits in place of 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 Full Time Project through Internships

The curriculum enables a candidate to go for full time project 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-II Phase-I 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 One/Two Credit 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 One / Two Credit 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.

4.3.4 A student shall go for in-plant training for duration of two weeks during the entire programme. It is mandatory for all the students.

4.4 One / Two Credit Courses / Online Courses / Self Study Courses

The candidates may optionally undergo One / Two Credit Courses / Online Courses / Self Study Courses as elective courses.

4.4.1 **One / Two Credit Courses:** One / Two credit courses shall be offered by the college with the prior approval from respective Board of Studies. A candidate can earn a maximum of six credits through one / two credit 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 one / two credit 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 seventh semesters the candidates have the option of registering for additional elective/Honours courses or dropping of already registered additional elective/Honours courses within two weeks from the start of the semester. Add / Drop is only an option given to the candidates.

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.

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

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Comprehensive Test and Viva, Project Work, Industrial Training /Professional Skills Training, Internship/In-plant Training 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	40	60
2.	Theory cum Practical (The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components.)	50	50
3.	Practical	60	40
4.	Professional Skills Training / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work I / Mandatory Course/Industrial Training/ Universal Human Values / Yoga and Values for Holistic Development	100	---
5.	Project Work II Phase I / Project Work II Phase II / Internships	50	50
6.	One / Two credit Course	The distribution of marks shall be decided based on the credit weightage assigned	---
7.	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 40 marks and the end semester examination shall be for 60 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 60. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. 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	20	Average of best 2 tests (20 marks)
	Test - II	20	
	Test - III	20	
2.	Tutorial: (Tutorial/Problem Solving (or) Simulation (or) Simulation & Mini Project (or) Mini Project (or) Case Studies (or) Any other relevant to the course)	15	Type of assessment is to be chosen based on the nature of the course and to be approved by Principal
3.	Others: 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	40	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 of every year.

7.4 Theory cum Practical Courses

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

7.5 Practical Courses

For all practical courses out of 100 marks, the continuous assessment shall be for 60 marks and the end semester examination shall be for 40 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidates' records shall be maintained.

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

7.5.2 The end semester examination shall be conducted for a maximum of 100 marks for duration of 3 hours and reduced to 40 marks. The appointment of examiners and the schedule shall be decided by chairman of Board of Study of the relevant board.

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

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

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

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

<table>
<tr><td colspan="6">Continuous Assessment
(Max. 50 Marks)</td><td colspan="4">End Semester Examination
(Max. 50 Marks)</td></tr>
<tr><td colspan="2">Zeroth Review</td><td colspan="2">Review I
(Max.. 20 Marks)</td><td colspan="2">Review II
(Max. 30 Marks)</td><td>Report Evaluation
(Max. 20 Marks)</td><td colspan="3">Viva - Voce
(Max. 30 Marks)</td></tr>
<tr><td>Rv. Com</td><td>Super visor</td><td>Review Committee (excluding supervisor)</td><td>Super visor</td><td>Review Committee (excluding supervisor)</td><td>Super visor</td><td>Ext. Exr.</td><td>Super visor</td><td>Exr.1</td><td>Exr.2</td></tr>
<tr><td>0</td><td>0</td><td>10</td><td>10</td><td>15</td><td>15</td><td>20</td><td>10</td><td>10</td><td>10</td></tr>
</table>

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 / 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 3rd semester vacation and during 4th semester. Phase II training shall be conducted for minimum of 80 hours in 4th semester vacation and during 5th semester. The evaluation procedure shall be approved by the board of the offering department and 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 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 In-Plant Training

Each candidate shall go for In-Plant training for a duration of minimum of two weeks during the entire programme of study and submit a brief report about the training undergone and a certificate issued from the organization concerned.

7.12 One / Two Credit Courses

For all one/ two credit courses out of 100 marks, the continuous assessment shall be 50 marks and the model examination shall be for 50 marks. Minimum of two continuous assessments tests shall be conducted during the one / two credit course duration by the offering department concerned. Model examination shall be conducted at the end of the course.

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 SC (Successfully Completed). Performance grade will not be shown for the audit course.

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

7.16 Mandatory Courses

A candidate joined in first semester shall attend and complete a mandatory course namely Student Induction Program of duration three weeks at the beginning of first semester. The candidates studying in second year shall attend and complete another one mandatory course namely Environmental Science. No credits shall be given for mandatory courses and shall be evaluated through continuous assessment tests only vide clause 7.1 for a maximum of 100 marks each. Upon the successful completion, these courses will be listed in the semester grade sheet and in the consolidated grade sheet with the grade “SC” (Successfully Completed). Since no grade points are assigned, these courses will not be counted for the purpose of GPA and CGPA calculations.

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

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

8. REQUIREMENTS FOR COMPLETION OF A SEMESTER

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

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

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

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

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

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

8.1.5 Candidate’s progress is satisfactory.

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

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

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

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

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

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

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

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

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

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

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

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

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

11. PROVISION FOR BREAK OF STUDY

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

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

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

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

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

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

12. PASSING REQUIREMENTS

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

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

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

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:

For all the passed candidates, the relative grading principle is applied to assign the letter grades.

Marks / Examination Status	Letter Grade	Grade Point
Based on the relative grading	O (Outstanding)	10
	A+ (Excellent)	9
	A (Very Good)	8
	B+ (Good)	7
	B (Average)	6
	C (Satisfactory)	5
Less than 50	U (Reappearance)	0
Successfully Completed	SC	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-2022 (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 or a candidate who gets readmitted and has to move from one regulations to another regulations and who qualifies for the award of the degree (vide clause 16) and satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.

- Submission of equivalent course list approved by the respective Board of studies.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 9.00

17.2 First Class:

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

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry candidates) within ten consecutive semesters (eight consecutive semesters for lateral entry candidates) excluding authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 6.50

17.3 Second Class:

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

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

17.5 Honors Degree:

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

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 7.50

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 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 – R2022										
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	**4/5**	**4**	**2/1**			**2**	**3**		**15**	**9.09**
BS	**8**	**8**		**4**					**20**	**11.9**
ES	**8/10**	**8/7**	**8**						**24/25**	**14.2/14.8**
PC	**3/0**	**3**	**12**	**15**	**17**	**8**	**0/3**		**58**	**34.5**
PE					**3**	**3**	**9/6**	**3**	**18/15**	**8.9**
OE					**4**	**4**	**3**	**3**	**14**	**8.3**
EC				**2**	**2**	**6/7**	**5/6**	**4**	**21**	**12.5**
MC	**0**		**0**						**0**	**0.0**
Semester wise Total	**23**	**23/22**	**22/21**	**21**	**26**	**23/24**	**20/21**	**10**	**168**	**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.	22EGT11	Communication Skills – I	3	0	0	3	I
2.	22TAM01	Heritage of Tamils	1	0	0	1	I
3.	22VEC11	Yoga and Values for Holistic Development	1	0	1	1	I
4.	22EGT21	Communication Skills – II	3	0	0	3	II
5.	22TAM02	Tamils and Technology	1	0	0	1	II
6.	22EGL31	Communication Skills Development Laboratory	0	0	2	1	III
7.	22GET31	Universal Human Values	2	0	0	2	VI
8.	22GCT71	Engineering Economics and Management	3	0	0	3	VII
Total Credits to be earned						**15**	

BASIC SCIENCE (BS)

S. No.	Course Code	Course Name	L	T	P	C	Sem
1.	22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	I
2.	22PHT12	Physics for Mechanical Engineering	3	0	0	3	I
3.	22PHL12	Physics Laboratory for Mechanical Engineering	0	0	2	1	I
4.	22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	II
5.	22CYT22	Chemistry for Mechanical Engineering	3	0	0	3	II
6.	22CYL22	Chemistry Laboratory for Mechanical Systems	0	0	2	1	II
7.	22MAT41	Numerical Methods for Engineers	3	1	0	4	IV
Total Credits to be earned						**20**	

ENGINEERING SCIENCE (ES)							
S. No.	Course Code	Course Name	L	T	P	C	Sem
1.	22MET11	Engineering Drawing	2	1	0	3	I
2.	22CSC11	Problem Solving and Programming in C	3	0	2	4	I
3.	22MEL11	Engineering Practices Laboratory	0	0	2	1	I
4.	22CSC21	Fundamentals of Data Structures	3	0	2	4	II
5.	22EET14	Electrical and Electronics Engineering	3	0	0	3	II
6.	22EEL14	Electrical and Electronics Engineering Laboratory	0	0	2	1	II
7.	22ITC31	Introduction to Python	3	0	2	4	III
8.	22MEC31	Fluid Mechanics and Hydraulic Machines	3	0	2	4	III
Total Credits to be earned						**24**	

PROFESSIONAL CORE (PC)								
S. No.	Course Code	Course Name	L	T	P	C	Sem	Domain/ Stream
1.	22MET12	Engineering Mechanics	3	0	0	3	I	Design
2.	22MET21	Engineering Materials and Metallurgy	3	0	0	3	II	Material Science
3.	22MET31	Manufacturing Technology	3	0	0	3	III	Mfg.
4.	22MET32	Engineering Thermodynamics	3	1	0	4	III	Thermal
5.	22MET33	Strength of Materials	3	0	0	3	III	Design
6.	22MEL31	Manufacturing Technology and Material Property Testing Laboratory	0	0	2	1	III	Mfg.
7.	22MEL32	Machine Drawing and AutoCAD Laboratory	0	0	2	1	III	Design
8.	22MET41	Thermal Engineering	3	0	0	3	IV	Thermal
9.	22MET42	Machining and Measurements	3	0	0	3	IV	Mfg.
10.	22MET43	CAD/CAM/CIM for Automation	3	0	0	3	IV	Mfg.
11.	22MET44	Kinematics of Machinery	3	0	0	3	IV	Design
12.	22MEL41	Thermal Engineering and Renewable Energy Laboratory	0	0	2	1	IV	Thermal
13.	22MEL42	Machining and Measurements Laboratory	0	0	2	1	IV	Mfg.
14.	22MEL43	Solid Modeling Laboratory	0	0	2	1	IV	Design
15.	22MEC51	Heat and Mass Transfer	3	0	2	4	V	Thermal
16.	22MEC52	Dynamics of Machinery	3	0	2	4	V	Design

17.	22MET51	Operations Research	3	1	0	4	V	Mfg.
18.	22MET52	Artificial Intelligence in Mechanical Systems	3	0	0	3	V	Mfg.
19.	22MEL51	CAM and Robotics Laboratory	0	0	2	1	V	Mfg.
20.	22MEL52	Surface and Sheet Metal Design Laboratory	0	0	2	1	V	Design
21.	22MET61	Design of Machine Elements	3	1	0	4	VI	Design
22.	22MET62	Finite Element Analysis	3	0	0	3	VI	Design
23.	22MEL61	Simulation Laboratory	0	0	2	1	VI	Design
Total Credits to be earned						**58**		

LIST OF PROFESSIONAL ELECTIVES (PEs)							
S. No.	Course Code	Course Name	L	T	P	C	Domain/ Stream
Semester – V							
Professional Elective – I							
1.	22MEE01	Fluid Power System	3	0	0	3	Design
2.	22MEE02	Piping Design	3	0	0	3	Design
3.	22MEE03	Unconventional Machining Processes	3	0	0	3	Mfg.
4.	22MEE04	Design for Manufacture and Assembly	3	0	0	3	Mfg.
5.	22MEE05	Automobile Engineering	3	0	0	3	Thermal
6.	22MEE06	Fuels and Combustion Technology	3	0	0	3	Thermal
7.	22MEE07	Industrial Engineering	3	0	0	3	Ind. Engg.
8.	22MEE08	Production Planning and Control	3	0	0	3	Ind. Engg.
Semester – VI							
Professional Elective – II							
9.	22MEE09	Design of Transmission Systems	3	0	0	3	Design
10.	22MEE10	Vibration and Noise Control	3	0	0	3	Design
11.	22MEE11	Intelligent Manufacturing Systems	3	0	0	3	Mfg.
12.	22MEE12	Manufacturing Information System	3	0	0	3	Mfg.
13.	22MEE13	Alternative Energy Systems and Applications	3	0	0	3	Thermal
14.	22MEE14	Instrumentation in Thermal Engineering	3	0	0	3	Thermal
15.	22MEE15	Digitalization in Supply Chain Management	3	0	0	3	Ind. Engg.
16.	22MEE16	Lean Six Sigma	3	0	0	3	Ind. Engg.
Semester – VII							
Professional Elective – III							
17.	22GEE01	Fundamentals of Research	3	0	0	3	General
18.	22MEE17	Mechanics of Composite Materials	3	0	0	3	Design
19.	22MEE18	Design of Jigs, Fixtures and Press Tools	3	0	0	3	Design
20.	22MEE19	CNC Technology	3	0	0	3	Mfg.
21.	22MEE20	Precision Engineering	3	0	0	3	Mfg.
22.	22MEE21	Computational Fluid Dynamics	3	0	0	3	Thermal
23.	22MEE22	Gas Dynamics and Jet Propulsion	3	0	0	3	Thermal
24.	22MEE23	Project Management	3	0	0	3	Ind. Engg.

25.	22GEE02	Total Quality Management	3	0	0	3	Ind. Engg.
Professional Elective – IV							
26.	22MEE24	Industrial Tribology	3	0	0	3	Design
27.	22MEE25	Advanced Mechanics of Materials	3	0	0	3	Design
28.	22MEE26	Additive Manufacturing	3	0	0	3	Mfg.
29.	22MEE27	Welding Technology	3	0	0	3	Mfg.
30.	22MEE28	Power Plant Engineering	3	0	0	3	Thermal
31.	22MEE29	Design of Heat Exchangers	3	0	0	3	Thermal
32.	22MEE30	Quality Control and Reliability Engineering	3	0	0	3	Ind. Engg.
33.	22MEE31	Multi - Variate Artificial Intelligence Data Analysis	3	0	0	3	Ind. Engg.
34.	22MEE32	Hybrid Vehicle Technology	3	0	0	3	Thermal
Professional Elective – V							
35.	22MEE33	Introduction to Aircraft Systems	3	0	0	3	Design
36.	22MEE34	Mechatronics and IoT	3	0	0	3	Design
37.	22MEE35	Modeling and Analysis of Manufacturing Systems	3	0	0	3	Mfg.
38.	22MEE36	Micro Electro Mechanical Systems	3	0	0	3	Mfg.
39.	22MEE37	Refrigeration and Air Conditioning	3	0	0	3	Thermal
40.	22MEE38	Energy Auditing and Management	3	0	0	3	Thermal
41.	22MEE39	Maintenance Engineering	3	0	0	3	Ind. Engg.
42.	22MEE40	Industrial Safety Engineering	3	0	0	3	Ind. Engg.
Semester – VIII							
Elective – VI							
43.	22MEE41	Introduction to Aircraft Structures	3	0	0	3	Design
44.	22MEE42	Product Design and Optimization	3	0	0	3	Design
45.	22MEE43	Nanotechnology for Mechanical Engineers	3	0	0	3	Mfg.
46.	22MEE44	Non Destructive Evaluation Techniques	3	0	0	3	Mfg.
47.	22MEE45	Turbomachines	3	0	0	3	Thermal
48.	22MEE46	Energy Conservation in HVAC System	3	0	0	3	Thermal
49.	22MEE47	Industrial Marketing	3	0	0	3	Ind. Engg.
50.	22MEE48	Decision Support Systems	3	0	0	3	Ind. Engg.
Total Credits to be earned						**18**	

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

EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22GCL41/ 22GCI41	Professional Skills Training I / Industrial Training I	--	--	--	2	IV
2.	22GCL51/ 22GCI51	Professional Skills Training II / Industrial Training II	--	--	--	2	V
3.	22MEP61	Project Work I	0	0	8	4	VI
4.	22GEP61	Comprehensive Test and Viva	--	--	--	2	VI
5.	22MEP71	Project Work II Phase I	0	0	10	5	VII
6.	22MEP81	Project Work II Phase II	0	0	8	4	VIII
Total Credits to be earned						**19**	

MANDATORY COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MNT11	Student Induction Program	--	--	--	0	I
2.	22MNT31	Environmental Science	2	0	0	0	III
Total Credits to be earned						**00**	

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MEX01	Renewable Energy Sources	3	0	2	4	V
2.	22MEX02	Design of Experiments	3	0	2	4	VI
3.	22MEO01	Fundamentals of Ergonomics	3	0	0	3	VII
4.	22MEO02	Principles of Management and Industrial Psychology	3	0	0	3	VII
5.	22MEO03	Waste Heat Recovery System and Storage	3	0	0	3	VII
6.	22MEO04	Safety Measures for Engineers	3	0	0	3	VIII
7.	22MEO05	Energy Conservation in Thermal Equipments	3	0	0	3	VIII
8.	22MEO06	Climate Change and New Energy Technology	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					
1.	22CEX01	Remote Sensing and its Applications	3	0	2	4	CIVIL
2.	22MEX01	Renewable Energy Sources	3	0	2	4	MECH
3.	22MTO01	Design of Mechatronics Systems	3	1	0	4	MTS
4.	22MTX01	Data Acquisition and Virtual Instrumentation	3	0	2	4	MTS
5.	22MTX02	Factory Automation	3	0	2	4	MTS
6.	22AUX01	Automotive Engineering	3	0	2	4	AUTO
7.	22ECX01	Basics of Electronics in Automation Appliances	3	0	2	4	ECE
8.	22ECX02	Image Processing	3	0	2	4	ECE
9.	22EEO01	Solar and Wind Energy Systems	3	1	0	4	EEE
10.	22EEO02	Electrical Wiring and Lighting	3	1	0	4	EEE
11.	22EEO03	Programmable Logic Controller and SCADA	3	1	0	4	EEE
12.	22EEO04	Analog and Digital Electronics	3	1	0	4	EEE
13.	22EEO05	Power Electronics and Drives	3	1	0	4	EEE
14.	22EEO06	Sensors and Actuators	3	1	0	4	EEE
15.	22EIO01	Measurements and Instrumentation	3	1	0	4	EIE
16.	22EIO02	Biomedical Instrumentation and Applications	3	1	0	4	EIE
17.	22EIO03	Industrial Automation	3	1	0	4	EIE
18.	22CSX01	Fundamentals of Databases	3	0	2	4	CSE
19.	22CSX02	Data science for Engineers	3	0	2	4	CSE
20.	22CSX03	Enterprise Application Development Using Java	3	0	2	4	CSE
21.	22CSO01	Computational science for Engineers	3	1	0	4	CSE
22.	22CSO02	Formal Languages and Automata Theory	3	1	0	4	CSE
23.	22ITO01	Artificial Intelligence	3	1	0	4	IT
24.	22ITX01	Next Generation Databases	3	0	2	4	IT
25.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT
26.	22CDO01	Fundamentals of User Experience Design	3	1	0	4	CSD
27.	22ADO01	Data Warehousing and Data Mining	3	1	0	4	AIDS

28.	22ALO01	Business Intelligence	3	1	0	4	AIML
29.	22CHO01	Industrial Enzymology	3	1	0	4	CHEM
30.	22CHO02	Waste to Energy Conversion	3	1	0	4	CHEM
31.	22CHO03	Applied Nanotechnology	3	1	0	4	CHEM
32.	22FTX01	Baking Technology	3	0	2	4	FT
33.	22FTO01	Food Processing Technology	3	1	0	4	FT
34.	22MAO01	Mathematical Foundations for Machine Learning	3	1	0	4	MATHS
35.	22MAO02	Numerical Computing	3	1	0	4	MATHS
36.	22MAO03	Stochastic Processes and Queuing Theory	3	1	0	4	MATHS
37.	22MAO04	Statistics for Engineers	3	1	0	4	MATHS
38.	22PHO01	Thin Film Technology	3	1	0	4	PHYSICS
39.	22PHO02	High Energy Storage Devices	3	1	0	4	PHYSICS
40.	22PHO03	Structural and Optical Characterization of Materials	3	1	0	4	PHYSICS
41.	22CYO01	Instrumental Methods of Analysis	3	1	0	4	CHEMISTRY
42.	22CYO02	Chemistry Concepts for Competitive Examinations	3	1	0	4	CHEMISTRY
43.	22CYO03	Organic Chemistry for Industry	3	1	0	4	CHEMISTRY
		SEMESTER VI					
44.	22CEO01	Disaster Management	3	1	0	4	CIVIL
45.	22MEX02	Design of Experiments	3	0	2	4	MECH
46.	22MTO02	Robotics	3	1	0	4	MTS
47.	22MTO03	3D Printing and Design	3	1	0	4	MTS
48.	22AUO01	Automotive Electronics	3	1	0	4	ECE
49.	22ECX03	PCB Design and Fabrication	3	0	2	4	ECE
50.	22EEO07	Energy Conservation and Management	3	1	0	4	EEE
51.	22EEO08	Microprocessors and Microcontrollers Interfacing	3	1	0	4	EEE
52.	22EEO09	Electrical Safety	3	1	0	4	EEE
53.	22EEO10	VLSI System Design	3	1	0	4	EEE
54.	22EEO11	Automation for Industrial Applications	3	1	0	4	EEE
55.	22EIO04	PLC Programming with High Level Languages	3	1	0	4	EIE
56.	22EIO05	Virtual Instrumentation	3	1	0	4	EIE
57.	22CSX04	Foundations of Machine Learning	3	0	2	4	CSE
58.	22CSX05	Web Engineering	3	0	2	4	CSE

59.	22ITX02	Advanced Java Programming	3	0	2	4	IT
60.	22ITO02	Internet of Things	3	1	0	4	IT
61.	22ITO03	Fundamentals of Software Development	3	1	0	4	IT
62.	22ITO04	Mobile Application Development	3	1	0	4	IT
63.	22CDX01	Fundamentals of User Interactive Design	3	0	2	4	CSD
64.	22ADX01	Data Visualization	3	0	2	4	AIDS
65.	22ALX01	Data Exploration and Visualization Techniques	3	0	2	4	AIML
66.	22CHO04	Air Pollution Monitoring and Control	3	1	0	4	CHEM
67.	22CHO05	Paints and Coatings	3	1	0	4	CHEM
68.	22CHO06	Powder Technology	3	1	0	4	CHEM
	22FTX02	Processing of milk and milk products	3	0	2	4	FT
	22FTX03	Processing of Fruits and Vegetables	3	0	2	4	FT
69.	22MAO05	Graph Theory and its Applications	3	1	0	4	MATHS
70.	22MAX01	Data Analytics using R Programming	3	0	2	4	MATHS
71.	22MAO06	Operations Research	3	1	0	4	MATHS
72.	22MAO07	Number Theory and Cryptography	3	1	0	4	MATHS
73.	22PHO04	Synthesis, Characterization and Biological Applications of Nanomaterials	3	1	0	4	PHYSICS
74.	22PHO05	Techniques of Crystal Growth	3	1	0	4	PHYSICS
75.	22CYO04	Corrosion Science and Engineering	3	1	0	4	CHEMISTRY
76.	22CYO05	Chemistry of Cosmetics in Daily Life	3	1	0	4	CHEMISTRY
77.	22CYO06	Nanocomposite Materials	3	1	0	4	CHEMISTRY
		SEMESTER VII					
78.	22CEO02	Introduction to Smart Cities	3	0	0	3	CIVIL
79.	22CEO03	Environmental Health and Safety	3	0	0	3	CIVIL
80.	22MEO01	Fundamentals of Ergonomics	3	0	0	3	MECH
81.	22MEO02	Principles of Management and Industrial Psychology	3	0	0	3	MECH
82.	22MEO03	Waste Heat Recovery System and Storage	3	0	0	3	MECH
83.	22MTO04	Drone System Technology	3	0	0	3	MTS
84.	22AUO02	Vehicle Maintenance	3	0	0	3	AUTO
85.	22ECO01	Wearable Devices	3	0	0	3	ECE
86.	22ECX04	Electronic Hardware and Troubleshooting	2	0	2	3	ECE

87.	22EEO12	Electric Vehicle	3	0	0	3	EEE
88.	22EEO13	E-Waste Management	3	0	0	3	EEE
89.	22EEO14	Embedded System Design	3	0	0	3	EEE
90.	22EEO15	Energy Storage Systems and Controllers	3	0	0	3	EEE
91.	22EEO16	AI Techniques for Engineering Applications	3	0	0	3	EEE
92.	22EIO06	Introduction to Distributed Control Systems	3	0	0	3	EIE
93.	22EIO07	Instrumentation in Aircraft Navigation and Control	3	0	0	3	EIE
94.	22EIO08	Industry 4.0 with Industrial IoT	3	0	0	3	EIE
95.	22EIO09	Industrial Data Communication	3	0	0	3	EIE
96.	22EIO10	Wireless Instrumentation	3	0	0	3	EIE
97.	22EIO11	Instrumentation Techniques in Agriculture	3	0	0	3	EIE
98.	22CSO03	Nature Inspired optimization techniques	3	0	0	3	CSE
99.	22ITO05	Fundamentals of Cloud Computing	3	0	0	3	IT
100.	22CDO02	Introduction to Mobile Game Design	3	0	0	3	CSD
101.	22CDO03	Introduction to Graphics Design	3	0	0	3	CSD
102.	22ADO02	Neural Networks and Deep Learning	3	0	0	3	AIDS
103.	22ALO02	Industrial Machine Learning	3	0	0	3	AIML
104.	22CHO07	Hydrogen Energy	3	0	0	3	CHEM
105.	22CHO08	Rubber Technology	3	0	0	3	CHEM
106.	22FTO02	Principles of Food safety	3	0	0	3	FT
107.	22FTO03	Fundamentals of Food Packaging and Storage	3	0	0	3	FT
108.	22MAO08	Non-Linear Optimization	3	0	0	3	MATHS
109.	22MAO09	Optimization for Engineers	3	0	0	3	MATHS
110.	22CYO07	Waste and Hazardous Waste Management	3	0	0	3	CHEMISTRY
111.	22CYO08	Chemistry in Every day Life	3	0	0	3	CHEMISTRY
		SEMESTER VIII					
112.	22CEO04	Infrastructure Planning and Management	3	0	0	3	CIVIL
113.	22CEO05	Environmental Laws and Policy	3	0	0	3	CIVIL
114.	22MEO04	Safety Measures for Engineers	3	0	0	3	MECH
115.	22MEO05	Energy Conservation in Thermal Equipments	3	0	0	3	MECH
116.	22MEO06	Climate Change and New Energy Technology	3	0	0	3	MECH

117.	22MTO05	Micro and Nano Electromechanical Systems	3	0	0	3	MTS
118.	22AUO03	Public Transport Management	3	0	0	3	ECE
119.	22AUO04	Autonomous Vehicles	3	0	0	3	ECE
120.	22ECO02	Optical Engineering	3	0	0	3	EEE
121.	22EEO17	Smart Grid Technologies	3	0	0	3	EEE
122.	22EEO18	Biomass Energy Systems	3	0	0	3	EEE
123.	22EIO12	Environmental Sensors	3	0	0	3	EIE
124.	22EIO13	Pollution Control and Management	3	0	0	3	EIE
125.	22CSO04	Machine Translation	3	0	0	3	CSE
126.	22CSO05	Fundamentals of Blockchain	3	0	0	3	CSE
127.	22ITO06	Introduction to Ethical Hacking	3	0	0	3	IT
128.	22ITO07	Business Continuity Planning	3	0	0	3	IT
129.	22CDX02	Virtual Reality and Augmented Reality	3	0	0	3	CSD
130.	22ADO03	Business Analytics	3	0	0	3	AIDS
131.	22ALO03	Machine Learning for Smart Cities	3	0	0	3	AIML
132.	22CHO09	Industrial Accident Prevention and Management	3	0	0	3	CHEM
133.	22CHO10	Electrochemical Engineering	3	0	0	3	CHEM
134.	22CHO11	Smart and Functional Materials	3	0	0	3	CHEM
135.	22FTO04	Food Ingredients	3	0	0	3	FT
136.	22FTO05	Food and Nutrition	3	0	0	3	FT
137.	22CYO09	Chemistry of Nutrition for Women Health	3	0	0	3	CHEMISTRY

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

SNo	Course Code	**Course Title**	L	T	P	C	Offering Department	Semester
1.	22GEO01	German Language Level 1	4	0	0	4	ECE	ALL
2.	22GEO02	Japanese Language Level 1	4	0	0	4	ECE	ALL
3.	22GEO03	Design Thinking for Engineers	3	1	0	4	CSE	5
4.	22GEO04	Innovation and Business Model Development	3	1	0	4	MTS	6
5.	22GEO05	German Language Level 2	4	0	0	4	ECE	ALL
6.	22GEO06	German Language Level 3	3	0	0	3	ECE	ALL
7.	22GEO07	German Language Level 4	3	0	0	3	ECE	ALL
8.	22GEO08	Japanese Language Level 2	4	0	0	4	ECE	ALL
9.	22GEO09	Japanese Language Level 3	3	0	0	3	ECE	ALL

10.	22GEO10	Japanese Language Level 4	3	0	0	3	ECE	ALL
11.	22GEO11	French Language Level 1	4	0	0	4	ECE	ALL
12.	22GEO12	French Language Level 2	4	0	0	4	ECE	ALL
13.	22GEO13	French Language Level 3	3	0	0	3	ECE	ALL
14.	22GEO14	Spanish Language Level 1	4	0	0	4	ECE	ALL
15.	22GEO15	Spanish Language Level 2	4	0	0	4	ECE	ALL
16.	22GEO16	Spanish Language Level 3	3	0	0	3	ECE	ALL
17.	22GEO17	Entrepreneurship Development	3	0	0	3	MTS	7
18.	22GEX01	NCC Studies (Army Wing) - I	3	0	2	4	EEE	5 / 6
19.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT	5 / 6
20.	22MBO01	Cost Accounting for Engineers	3	1	0	4	MBA	5
21.	22MBO02	Economic Analysis for Decision Making	3	1	0	4	MBA	6
22.	22MBO03	Marketing Analytics	3	1	0	4	MBA	7

KEC R2022: SCHEDULING OF COURSES – BE (Mechanical Engineering) Total Credits: 168

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Credits
I	22EGT11 Communication Skills - I (3-0-0-3)	22MAC11 Matrices and Ordinary Differential Equations (3-1*-2*-4)	22PHT12 Physics for Mechanical Engineering (3-0-0-3)	22MET11 Engineering Drawing (2-1-0-3)	22MET12 Engineering Mechanics (3-0-0-3)	22CSC11 Problem Solving and Programming in C (3-0-2-4)	22MEL11 Engineering Practices Laboratory (0-0-2-1)	22PHL12 Physics Laboratory for Mechanical Engineering (0-0-2-1)	22VEC11 Yoga and Values for Holistic Development (1-0-1-1)	22MNT11 Student Induction Program (0-0-0-0)	23
II	22EGT21 Communication Skills - II (3-0-0-3)	22MAC21 Multivariable Calculus and Complex Analysis (3-1*-2*-4)	22CYT22 Chemistry for Mechanical Engineering (3-0-0-3)	22MET21 Engineering Materials and Metallurgy (3-0-0-3)	22CSC21 Fundamentals of Data Structures (3-0-2-4)	22EET22 Electrical and Electronics Engineering (3-0-0-3)	22TAM01 Heritage of Tamils (1-0-0-1)	22CYL22 Chemistry Laboratory for Mechanical Systems (0-0-2-1)	22EEL14 Electrical and Electronics Engineering Laboratory (0-0-2-1)		23
III	22ITC31 Introduction to Python (3-0-2-4)	22MEC31 Fluid Mechanics and Hydraulic Machines (3-0-2-4)	22MET31 Manufacturing Technology (3-0-0-3)	22MET32 Engineering Thermodynamics (3-1-0-4)	22MET33 Strength of Materials (3-0-0-3)	22MNT31 Environmental Science (2-0-0-0)	22TAM02 Tamils and Technology (1-0-0-1)	22MEL31 Manufacturing Technology and Material Property Testing Laboratory (0-0-2-1)	22MEL32 Machine Drawing using AutoCAD Laboratory (0-0-2-1)	22EGL31 Communication Skills Development Laboratory (0-0-2-1)	22
IV	22MAT41 Numerical Methods for Engineers (3-1-0-4)	22MET41 Thermal Engineering (3-0-0-3)	22MET42 Machining and Measurements (3-0-0-3)	22MET43 CAD/CAM/CIM for Automation (3-0-0-3)	22MET44 Kinematics of Machinery (3-0-0-3)	22MEL41 Thermal Engineering and Renewable Energy Laboratory (0-0-2-1)	22MEL42 Machining and Measurements Laboratory (0-0-2-1)	22MEl43 Solid Modeling Laboratory (0-0-2-1)	22GCL41/ 22GCI41 Professional Skills Training I / Industrial Training I (0-0-0-2)		21
V	22MEC51 Heat and Mass Transfer (3-0-2-4)	22MEC52 Dynamics of Machinery (3-0-2-4)	22MET51 Operations Research (3-1-0-4)	22MET52 Artificial Intelligence in Mechanical Systems (3-0-0-3)	Professional Elective I (3-0-0-3)	Open Elective I (3-1/0-0/2-4)	22MEL51 CAM and Robotics Laboratory (0-0-2-1)	22MEL52 Surface and Sheet Metal Design Laboratory (0-0-2-1)	22GCL51/22GCI51 Professional Skills Training II / Industrial Training II (0-0-0-2)		26
VI	22MET61 Design of Machine Elements (3-1-0-4)	22MET62 Finite Element Analysis (3-0-0-3)	Professional Elective II (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	22MEL61 Simulation Laboratory (0-0-2-1)	22MEP61 Project Work I (0-0-8-4)	22GEP61 Comprehensive Test and Viva (0-0-0-2)	22GET31 Universal Human Values (2-0-0-2)			23
VII	22GCT71 Engineering Economics and Management (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	Professional Elective V (3-0-0-3)	Open Elective III (3-0-0-3)	22MEP71 Project Work II Phase I (0-0-10-5)					20
VIII	Professional Elective VI (3-0-0-3)	Open Elective IV (3-0-0-3)	22MEP81 Project Work II Phase II (0-0-8-4)								10

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	22EGT11	Communication Skills – I						✓			✓	✓	✓	✓		
1	22MAC11	Matrices and Ordinary Differential Equations	✓	✓	✓		✓									
1	22PHT12	Physics for Mechanical Engineering	✓	✓	✓						✓	✓		✓	✓	✓
1	22MET11	Engineering Drawing	✓	✓	✓		✓					✓		✓		
1	22MET12	Engineering Mechanics	✓	✓	✓	✓								✓		✓
1	22CSC11	Problem Solving and Programming in C	✓	✓	✓	✓	✓				✓	✓		✓		
1	22MEL11	Engineering Practices Laboratory	✓		✓	✓	✓	✓			✓	✓		✓		
1	22GCL12	Foundation Laboratory - Electrical, IoT, Web	✓	✓	✓	✓					✓					
1	22PHL12	Physics Laboratory for Mechanical Engineering	✓	✓	✓	✓					✓	✓		✓	✓	
1	22VEC11	Yoga and Values for Holistic Development						✓		✓	✓					
1	22MNT11	Student Induction Program														
2	22EGT21	Communication Skills – II						✓			✓	✓	✓	✓		
2	22MAC21	Multivariable Calculus and Complex Analysis	✓	✓	✓		✓									
2	22CYT22	Chemistry for Mechanical Engineering	✓	✓	✓	✓										
2	22MET21	Engineering Materials and Metallurgy	✓	✓		✓			✓							✓
2	22CSC21	Fundamentals of Data Structures	✓	✓	✓	✓										
2	22EET14	Electrical and Electronics Engineering	✓	✓	✓	✓									✓	✓
2	22TAM01	Heritage of Tamils						✓		✓	✓	✓		✓		
2	22CYL22	Chemistry Laboratory for Mechanical Systems	✓	✓	✓	✓			✓							
2	22GCL11	Foundation Laboratory - Manufacturing, Design and Robotics	✓	✓	✓		✓				✓	✓		✓		
2	22EEL14	Electrical and Electronics Engineering Laboratory	✓	✓	✓	✓	✓		✓						✓	✓
3	22ITC32	Introduction to Python	✓	✓	✓	✓										
3	22MEC31	Fluid Mechanics and Hydraulic Machines	✓	✓	✓	✓						✓		✓		
3	22MET31	Manufacturing Technology	✓	✓			✓								✓	✓
3	22MET32	Engineering Thermodynamics	✓	✓	✓									✓		✓
3	22MET33	Strength of Materials	✓	✓	✓									✓		✓
3	22MNT31	Environmental Science	✓	✓	✓				✓							
3	22TAM02	Tamils and Technology						✓		✓	✓	✓		✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
3	22MEL31	Manufacturing Technology and Material Property Testing Laboratory	✓	✓		✓					✓	✓				✓
3	22MEL32	Machine Drawing using AutoCAD Laboratory	✓				✓				✓				✓	✓
3	22EGL31	Communication Skills Development Laboratory									✓	✓		✓		
4	22MAT41	Numerical Methods for Engineers	✓	✓	✓											
4	22MET41	Thermal Engineering	✓	✓	✓									✓		✓
4	22MET42	Machining and Measurements	✓	✓			✓								✓	✓
4	22MET43	CAD/CAM/CIM for Automation	✓	✓			✓								✓	✓
4	22MET44	Kinematics of Machinery	✓	✓	✓											✓
4	22MEL41	Thermal Engineering and Renewable Energy Laboratory	✓	✓		✓	✓				✓	✓			✓	✓
4	22MEL42	Machining and Measurements Laboratory	✓	✓			✓				✓				✓	✓
4	22MEL43	Solid Modeling Laboratory	✓	✓			✓				✓				✓	✓
4	22GCL41/ 22GCI41	Professional Skills Training I / Industrial Training I	✓	✓				✓	✓		✓	✓	✓	✓		
5	22MEC51	Heat and Mass Transfer	✓		✓	✓	✓		✓		✓	✓		✓	✓	✓
5	22MEC52	Dynamics of Machinery	✓	✓		✓					✓					✓
5	22MET51	Operations Research	✓	✓	✓								✓		✓	✓
5	22MET52	Artificial Intelligence in Mechanical Systems	✓	✓	✓		✓	✓			✓				✓	✓
6	22MEL51	CAM and Robotics Laboratory	✓	✓			✓				✓				✓	✓
6	22MEL52	Surface and Sheet Metal Design Laboratory	✓		✓		✓				✓			✓	✓	✓
6	22GCL51/ 22GCI51	Professional Skills Training II / Industrial Training II	✓	✓				✓	✓		✓	✓	✓	✓		
6	22MET61	Design of Machine Elements	✓	✓												✓
6	22MET62	Finite Element Analysis	✓	✓	✓											✓
6	22MEL61	Simulation Laboratory	✓		✓		✓				✓				✓	✓
6	22MEP61	Project Work I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	22GEP61	Comprehensive Test and Viva														
6	22GET31	Universal Human Values	✓	✓	✓	✓										

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22GCT71	Engineering Economics and Management	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓		
7	22MEP71	Project Work II Phase I	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	22MEP81	Project Work II Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	22MEE01	Fluid Power System	✓	✓	✓											✓
5	22MEE02	Piping Design	✓	✓	✓											✓
5	22MEE03	Unconventional Machining Processes	✓				✓								✓	✓
5	22MEE04	Design for Manufacture and Assembly	✓	✓	✓											✓
5	22MEE05	Automobile Engineering	✓		✓		✓		✓						✓	✓
5	22MEE06	Fuels and Combustion Technology	✓		✓				✓	✓						✓
5	22MEE07	Industrial Engineering	✓	✓		✓							✓		✓	✓
5	22MEE08	Production Planning and Control	✓	✓	✓								✓		✓	✓
6	22MEE09	Design of Transmission Systems	✓	✓	✓											✓
6	22MEE10	Vibration and Noise Control	✓	✓	✓											✓
6	22MEE11	Intelligent Manufacturing Systems	✓	✓	✓		✓								✓	✓
6	22MEE12	Manufacturing Information System	✓	✓			✓							✓	✓	✓
6	22MEE13	Alternative Energy Systems and Applications	✓		✓			✓	✓							✓
6	22MEE14	Instrumentation in Thermal Engineering	✓				✓							✓	✓	✓
6	22MEE15	Digitalization in Supply Chain Management	✓	✓	✓	✓	✓									✓
6	22MEE16	Lean Six Sigma	✓	✓			✓				✓				✓	✓
7	22GEE01	Fundamentals of Research	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	22MEE17	Mechanics of Composite Materials	✓	✓	✓	✓										✓
7	22MEE18	Design of Jigs, Fixtures and Press Tools	✓	✓	✓											✓
7	22MEE19	CNC Technology	✓		✓		✓									✓
7	22MEE20	Precision Engineering	✓	✓	✓				✓						✓	✓
7	22MEE21	Computational Fluid Dynamics	✓				✓							✓	✓	✓
7	22MEE22	Gas Dynamics and Jet Propulsion	✓		✓									✓		✓
7	22MEE23	Project Management	✓	✓			✓						✓		✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22GEE02	Total Quality Management	✓	✓				✓						✓		✓
7	22MEE24	Industrial Tribology	✓	✓										✓		✓
7	22MEE25	Advanced Mechanics of Materials	✓	✓	✓											✓
7	22MEE26	Additive Manufacturing	✓	✓	✓											✓
7	22MEE27	Welding Technology	✓	✓	✓											✓
7	22MEE28	Power Plant Engineering	✓		✓			✓	✓				✓			✓
7	22MEE29	Design of Heat Exchangers	✓		✓				✓							✓
7	22MEE30	Quality Control and Reliability Engineering	✓	✓	✓		✓						✓	✓	✓	✓
7	22MEE31	Multi - Variate Artificial Intelligence Data Analysis	✓	✓		✓	✓								✓	✓
7	22MEE32	Hybrid Vehicle Technology	✓	✓	✓											✓
7	22MEE33	Introduction to Aircraft Systems	✓	✓	✓											✓
7	22MEE34	Mechatronics and IoT	✓		✓		✓								✓	
7	22MEE35	Modeling and Analysis of Manufacturing Systems	✓	✓	✓											✓
7	22MEE36	Micro Electro Mechanical Systems	✓		✓		✓								✓	✓
7	22MEE37	Refrigeration and Air Conditioning	✓	✓	✓			✓								✓
7	22MEE38	Energy Auditing and Management	✓	✓	✓		✓	✓	✓					✓	✓	✓
7	22MEE39	Maintenance Engineering	✓	✓	✓		✓								✓	✓
7	22MEE40	Industrial Safety Engineering	✓	✓	✓			✓	✓						✓	✓
8	22MEE41	Introduction to Aircraft Structures	✓	✓	✓											✓
8	22MEE42	Product Design and Optimization	✓	✓	✓		✓	✓	✓						✓	✓
8	22MEE43	Nanotechnology for Mechanical Engineers	✓	✓	✓	✓	✓	✓							✓	✓
8	22MEE44	Non Destructive Evaluation Techniques	✓		✓		✓								✓	✓
8	22MEE45	Turbomachines	✓	✓	✓										✓	✓
8	22MEE46	Energy Conservation in HVAC System	✓		✓			✓	✓					✓		✓
8	22MEE47	Industrial Marketing	✓	✓			✓					✓		✓	✓	✓
8	22MEE48	Decision Support Systems	✓	✓	✓		✓				✓				✓	✓
5	22MEX01	Renewable Energy Sources	✓		✓	✓	✓	✓	✓		✓					

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	22MEX02	Design of Experiments	✓	✓	✓	✓	✓				✓					
7	22MEO01	Fundamentals of Ergonomics	✓	✓	✓	✓	✓	✓	✓					✓		
7	22MEO02	Principles of Management and Industrial Psychology	✓					✓				✓	✓			
7	22MEO03	Waste Heat Recovery System and Storage	✓	✓	✓	✓			✓							
8	22MEO04	Safety Measures for Engineers	✓					✓	✓	✓						
8	22MEO05	Energy Conservation in Thermal Equipments	✓		✓		✓	✓	✓					✓		
8	22MEO06	Climate Change and New Energy Technology	✓		✓			✓	✓	✓						

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
5	22CEX01	Remote Sensing and its Applications	✓	✓	✓	✓		✓			✓			✓		
5	22MEX01	Renewable Energy Sources	✓		✓	✓	✓	✓	✓	✓	✓					
5	22MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
5	22MTX01	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓							✓		
5	22MTX02	Factory Automation	✓	✓	✓	✓	✓				✓	✓		✓		
5	22AUX01	Automotive Engineering	✓	✓	✓			✓	✓		✓	✓		✓		
5	22ECX01	Basics of Electronics in Automation Appliances	✓	✓	✓	✓		✓	✓	✓			✓	✓		
5	22ECX02	Image Processing	✓	✓	✓	✓	✓				✓	✓		✓		
5	22EEO01	Solar and Wind Energy Systems	✓	✓	✓			✓	✓					✓		
5	22EEO02	Electrical Wiring and Lighting	✓	✓	✓	✓	✓							✓		
5	22EEO03	Programmable Logic Controller and SCADA	✓	✓	✓	✓		✓			✓			✓		
5	22EEO04	Analog and Digital Electronics	✓	✓	✓	✓	✓							✓		
5	22EEO05	Power Electronics and Drives	✓	✓	✓	✓	✓	✓			✓					
5	22EEO06	Sensors and Actuators	✓	✓	✓			✓						✓		
5	22EIO01	Measurements and Instrumentation	✓	✓	✓	✓	✓									

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22EIO02	Biomedical Instrumentation and Applications	✓	✓	✓	✓	✓	✓		✓						
5	22EIO03	Industrial Automation	✓	✓	✓	✓	✓									
5	22CSX01	Fundamentals of Databases	✓	✓	✓											
5	22CSX02	Data science for Engineers	✓	✓	✓	✓	✓									
5	22CSX03	Enterprise Application Development Using Java	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5	22CSO01	Computational science for Engineers	✓	✓	✓											
5	22CSO02	Formal Languages and Automata Theory	✓	✓	✓											
5	22ITO01	Artificial Intelligence	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
5	22ITX01	Next Generation Databases	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
5	22CDO01	Fundamentals of User Experience Design	✓	✓	✓	✓	✓				✓	✓	✓			
5	22ADO01	Data Warehousing and Data Mining	✓	✓	✓											
5	22ALO01	Business Intelligence	✓	✓	✓											
5	22CHO01	Industrial Enzymology	✓	✓	✓							✓	✓	✓		
5	22CHO02	Waste to Energy Conversion	✓	✓												
5	22CHO03	Applied Nanotechnology	✓	✓	✓	✓	✓	✓	✓	✓				✓		
5	22FTX01	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
5	22FTO01	Food Processing Technology	✓	✓	✓	✓		✓				✓		✓		
5	22MAO01	Mathematical Foundations for Machine Learning	✓	✓	✓	✓	✓									
5	22MAO02	Numerical Computing	✓	✓	✓											
5	22MAO03	Stochastic Processes and Queuing Theory	✓	✓	✓											
5	22MAO04	Statistics for Engineers	✓	✓	✓											
5	22PHO01	Thin Film Technology	✓	✓	✓						✓	✓		✓		
5	22PHO02	High Energy Storage Devices	✓	✓	✓						✓	✓		✓		
5	22PHO03	Structural and Optical Characterization of Materials	✓	✓	✓						✓	✓		✓		
5	22CYO01	Instrumental Methods of Analysis	✓	✓	✓	✓										

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22CYO02	Chemistry Concepts for Competitive Examinations	✓	✓	✓											
5	22CYO03	Organic Chemistry for Industry	✓	✓	✓	✓										
5	22MBO01	Cost Accounting for Engineers										✓	✓	✓		
6	22CEO01	Disaster Management	✓	✓	✓			✓	✓					✓		
6	22MEX02	Design of Experiments	✓	✓	✓	✓	✓				✓					
6	22GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
6	22MTO02	Robotics	✓	✓	✓	✓	✓							✓		
6	22MTO03	3D Printing and Design	✓	✓			✓							✓		
6	22AUO01	Automotive Electronics	✓	✓	✓	✓								✓		
6	22ECX03	PCB Design and Fabrication	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		
6	22EEO07	Energy Conservation and Management	✓	✓	✓		✓		✓	✓	✓			✓		
6	22EEO08	Microprocessors and Microcontrollers Interfacing	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
6	22EEO09	Electrical Safety	✓	✓	✓				✓	✓			✓	✓		
6	22EEO10	VLSI System Design	✓	✓	✓	✓	✓				✓		✓	✓		
6	22EEO11	Automation for Industrial Applications	✓	✓	✓	✓			✓		✓			✓		
6	22EIO04	PLC Programming with High Level Languages	✓	✓	✓	✓	✓									
6	22EIO05	Virtual Instrumentation	✓	✓	✓	✓	✓									
6	22CSX04	Foundations of Machine Learning	✓	✓	✓											
6	22CSX05	Web Engineering	✓	✓	✓											
6	22ITX02	Advanced Java Programming	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
6	22ITO02	Internet of Things	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
6	22ITO03	Fundamentals of Software Development	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
6	22ITO04	Mobile Application Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
6	22CDX01	Fundamentals of User Interactive Design	✓	✓	✓	✓										
6	22ADX01	Data Visualization	✓	✓	✓											

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	22ALX01	Data Exploration and Visualization Techniques	✓	✓	✓											
6	22CHO04	Air Pollution Monitoring and Control	✓	✓	✓			✓	✓							
6	22CHO05	Paints and Coatings	✓	✓	✓				✓							
6	22CHO06	Powder Technology	✓	✓	✓			✓	✓					✓		
6	22FTX02	Processing of milk and milk products	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	22FTX03	Processing of Fruits and Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	22MAO05	Graph Theory and its Applications	✓	✓	✓											
6	22MAX01	Data Analytics using R Programming	✓	✓	✓	✓	✓									
6	22MAO06	Operations Research	✓	✓	✓											
6	22MAO07	Number Theory and Cryptography	✓	✓	✓		✓									
6	22PHO04	Synthesis, Characterization and Biological Applications of Nanomaterials	✓	✓	✓						✓	✓		✓		
6	22PHO05	Techniques of Crystal Growth	✓	✓	✓						✓	✓		✓		
6	22CYO04	Corrosion Science and Engineering	✓	✓	✓	✓										
6	22CYO05	Chemistry of Cosmetics in Daily Life	✓	✓	✓											
6	22CYO06	Nanocomposite Materials	✓	✓	✓	✓										
6	22MBO02	Economic Analysis for Decision Making					✓					✓	✓			
7	22CEO02	Introduction to Smart Cities	✓	✓	✓	✓	✓									
7	22CEO03	Environmental Health and Safety	✓	✓	✓			✓	✓							
7	22MEO01	Fundamentals of Ergonomics	✓	✓	✓	✓	✓	✓	✓					✓		
7	22MEO02	Principles of Management and Industrial Psychology	✓					✓				✓	✓			
7	22MEO03	Waste Heat Recovery System and Storage	✓	✓	✓	✓			✓							
7	22GEO05	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
7	22MTO04	Drone System Technology	✓	✓	✓	✓	✓							✓		
7	22AUO02	Vehicle Maintenance	✓	✓			✓		✓					✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22ECO01	Wearable Devices	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		
7	22ECX04	Electronic Hardware and Troubleshooting	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		
7	22EEO12	Electric Vehicle	✓	✓	✓	✓		✓	✓		✓			✓		
7	22EEO13	E-Waste Management	✓	✓	✓	✓		✓	✓					✓		
7	22EEO14	Embedded System Design	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
7	22EEO15	Energy Storage Systems and Controllers	✓	✓	✓			✓			✓		✓	✓		
7	22EEO16	AI Techniques for Engineering Applications	✓	✓	✓	✓										
7	22EIO06	Introduction to Distributed Control Systems	✓	✓	✓	✓	✓			✓		✓				
7	22EIO07	Instrumentation in Aircraft Navigation and Control	✓	✓	✓	✓	✓									
7	22EIO08	Industry 4.0 with Industrial IoT	✓	✓	✓	✓	✓			✓						
7	22EIO09	Industrial Data Communication	✓	✓	✓	✓	✓	✓								
7	22EIO10	Wireless Instrumentation	✓	✓	✓	✓	✓		✓							
7	22EIO11	Instrumentation Techniques in Agriculture	✓	✓	✓	✓	✓									
7	22CSO03	Nature Inspired optimization techniques	✓	✓	✓											
7	22ITO05	Fundamentals of Cloud Computing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
7	22ITO06	Introduction to Ethical Hacking	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
7	22CDO02	Introduction to Mobile Game Design	✓	✓	✓	✓										
7	22CDO03	Introduction to Graphics Design	✓	✓	✓	✓										
7	22ADO02	Neural Networks and Deep Learning	✓	✓	✓	✓										
7	22ALO02	Industrial Machine Learning	✓	✓	✓											
7	22CHO07	Hydrogen Energy	✓	✓										✓		
7	22CHO08	Rubber Technology	✓	✓				✓	✓					✓		
7	22FTO02	Principles of Food safety	✓	✓	✓			✓	✓	✓		✓		✓		
7	22FTO03	Fundamentals of Food Packaging and Storage	✓	✓	✓	✓	✓	✓		✓		✓		✓		
7	22MAO08	Non-Linear Optimization	✓	✓	✓											

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22MAO09	Optimization for Engineers	✓	✓	✓											
7	22CYO07	Waste and Hazardous Waste Management	✓	✓	✓	✓			✓							
7	22CYO08	Chemistry in Every day Life	✓	✓	✓	✓										
7	22MBO03	Marketing Analytics										✓	✓	✓		
8	22CEO04	Infrastructure Planning and Management	✓	✓	✓		✓									
8	22CEO05	Environmental Laws and Policy	✓	✓			✓									
8	22MEO04	Safety Measures for Engineers	✓					✓	✓	✓						
8	22MEO05	Energy Conservation in Thermal Equipments	✓		✓		✓	✓	✓					✓		
8	22MEO06	Climate Change and New Energy Technology	✓		✓			✓	✓	✓						
8	22MTO05	Micro and Nano Electromechanical Systems	✓	✓	✓	✓								✓		
8	22AUO03	Public Transport Management	✓	✓				✓	✓	✓				✓		
8	22AUO04	Autonomous Vehicles	✓	✓	✓	✓	✓	✓	✓					✓		
8	22ECO02	Optical Engineering	✓	✓	✓	✓		✓	✓	✓	✓			✓		
8	22EEO17	Smart Grid Technologies	✓	✓	✓	✓	✓			✓				✓		
8	22EEO18	Biomass Energy Systems	✓	✓	✓			✓	✓				✓	✓		
8	22EIO12	Environmental Sensors	✓	✓	✓	✓	✓		✓							
8	22EIO13	Pollution Control and Management	✓	✓	✓	✓	✓	✓		✓						
8	22CSO04	Machine Translation	✓	✓	✓											
8	22CSO05	Fundamentals of Blockchain	✓	✓	✓											
8	22ITO07	Business Continuity Planning	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
8	22CDX02	Virtual Reality and Augmented Reality	✓	✓	✓	✓										
8	22ADO03	Business Analytics	✓	✓	✓	✓										
8	22ALO03	Machine Learning for Smart Cities	✓	✓	✓	✓										
8	22CHO09	Industrial Accident Prevention and Management	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		
8	22CHO10	Electrochemical Engineering	✓	✓	✓											
8	22CHO11	Smart and Functional Materials	✓	✓					✓	✓	✓			✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
8	22FTO04	Food Ingredients	✓	✓	✓			✓		✓		✓		✓		
8	22FTO05	Food and Nutrition	✓	✓	✓			✓				✓		✓		
8	22CYO09	Chemistry of Nutrition for Women Health	✓	✓	✓											
		General Open Elective Courses														
ALL	22GEO01	German Language Level 1								✓	✓	✓		✓		
ALL	22GEO02	Japanese Language Level 1								✓	✓	✓		✓		
5	22GEO03	Design Thinking for Engineers	✓	✓	✓	✓										
6	22GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
ALL	22GEO05	German Language Level 2								✓	✓	✓		✓		
ALL	22GEO06	German Language Level 3								✓	✓	✓		✓		
ALL	22GEO07	German Language Level 4								✓	✓	✓		✓		
ALL	22GEO08	Japanese Language Level 2								✓	✓	✓		✓		
ALL	22GEO09	Japanese Language Level 3								✓	✓	✓		✓		
ALL	22GEO10	Japanese Language Level 4								✓	✓	✓		✓		
ALL	22GEO11	French Language Level 1								✓	✓	✓		✓		
ALL	22GEO12	French Language Level 2								✓	✓	✓		✓		
ALL	22GEO13	French Language Level 3								✓	✓	✓		✓		
ALL	22GEO14	Spanish Language Level 1								✓	✓	✓		✓		
ALL	22GEO15	Spanish Language Level 2								✓	✓	✓		✓		
ALL	22GEO16	Spanish Language Level 3								✓	✓	✓		✓		
7	22GEO17	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5 / 6	22GEX01	NCC Studies (Army Wing) - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5 / 6	22GEX02	NCC Studies (Air Wing) - 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5	22MBO01	Cost Accounting for Engineers										✓	✓	✓		
6	22MBO02	Economic Analysis for Decision Making					✓					✓	✓			
7	22MBO03	Marketing Analytics										✓	✓	✓		

B.E. MECHANICAL ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23 onwards)

SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT11	Communication Skills – I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	50	50	100	BS
22PHT12	Physics for Mechanical Engineering	3	0	0	3	40	60	100	BS
22MET11	Engineering Drawing	2	1	0	3	40	60	100	ES
22MET12	Engineering Mechanics	3	0	0	3	40	60	100	PC
22CSC11	Problem Solving and Programming in C	3	0	2	4	50	50	100	ES
Practical / Employability Enhancement									
22MEL11	Engineering Practices Laboratory	0	0	2	1	60	40	100	ES
22PHL12	Physics Laboratory for Mechanical Engineering	0	0	2	1	60	40	100	BS
22VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
22MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					23				

* Alternate Weeks

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT21	Communication Skills – II	3	0	0	3	40	60	100	HS
22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
22CYT22	Chemistry for Mechanical Engineering	3	0	0	3	40	60	100	BS
22MET21	Engineering Materials and Metallurgy	3	0	0	3	40	60	100	PC
22CSC21	Fundamentals of Data Structures	3	0	2	4	50	50	100	ES
22EET14	Electrical and Electronics Engineering	3	0	0	3	40	60	100	ES
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22CYL22	Chemistry Laboratory for Mechanical Systems	0	0	2	1	60	40	100	BS
22EEL14	Electrical and Electronics Engineering Laboratory	0	0	2	1	60	40	100	ES
Total Credits to be earned					23				

* Alternate Weeks

B.E. - MECHANICAL ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23 onwards)

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22ITC32	Introduction to Python	3	0	2	4	100	0	100	ES
22MEC31	Fluid Mechanics and Hydraulic Machines	3	0	2	4	50	50	100	ES
22MET31	Manufacturing Technology	3	0	0	3	40	60	100	PC
22MET32	Engineering Thermodynamics	3	1	0	4	40	60	100	PC
22MET33	Strength of Materials	3	0	0	3	40	60	100	PC
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22MEL31	Manufacturing Technology and Material Property Testing Laboratory	0	0	2	1	60	40	100	PC
22MEL32	Machine Drawing using AutoCAD Laboratory	0	0	2	1	60	40	100	PC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
Total Credits to be earned					22				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22MAT41	Numerical Methods for Engineers	3	1	0	4	40	60	100	BS
22MET41	Thermal Engineering	3	0	0	3	40	60	100	PC
22MET42	Machining and Measurements	3	0	0	3	40	60	100	PC
22MET43	CAD/CAM/CIM for Automation	3	0	0	3	40	60	100	PC
22MET44	Kinematics of Machinery	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22MEL41	Thermal Engineering and Renewable Energy Laboratory	0	0	2	1	60	40	100	PC
22MEL42	Machining and Measurements Laboratory	0	0	2	1	60	40	100	PC
22MEL43	Solid Modeling Laboratory	0	0	2	1	60	40	100	PC
22GCL41/ 22GCI41	Professional Skills Training I / Industrial Training I	--	--	--	2	100	0	100	EC
Total Credits to be earned					21				

B.E. MECHANICAL ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23 onwards)

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22MEC51	Heat and Mass Transfer	3	0	2	4	50	50	100	PC
22MEC52	Dynamics of Machinery	3	0	2	4	50	50	100	PC
22MET51	Operations Research	3	1	0	4	40	60	100	PC
22MET52	Artificial Intelligence in Mechanical Systems	3	0	0	3	40	60	100	PC
	Professional Elective – I	3	0	0	3	40	60	100	PE
	Open Elective – I	3	1/0	0/2	4	40	60	100	OE
Practical / Employability Enhancement									
22MEL51	CAM and Robotics Laboratory	0	0	2	1	60	40	100	PC
22MEL52	Surface and Sheet Metal Design Laboratory	0	0	2	1	60	40	100	PC
22GCL51/ 22GCI51	Professional Skills Training II / Industrial Training II	--	--	--	2	100	0	100	EC
Total Credits to be earned					26				

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22MET61	Design of Machine Elements	3	1	0	4	40	60	100	PC
22MET62	Finite Element Analysis	3	0	0	3	40	60	100	PC
	Professional Elective – II	3	0	0	3	40	60	100	PE
	Open Elective – II	3	1/0	0/2	4	40	60	100	OE
Practical / Employability Enhancement									
22MEL61	Simulation Laboratory	0	0	2	1	60	40	100	PC
22MEP61	Project Work I	0	0	8	4	100	0	100	EC
22GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					23				

B.E. MECHANICAL ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23 onwards)

SEMESTER – VII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22GCT71	Engineering Economics and Management	3	0	0	3	40	60	100	HS
	Professional Elective – III	3	0	0	3	40	60	100	PE
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Professional Elective – V	3	0	0	3	40	60	100	PE
	Open Elective – III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22MEP71	Project Work II Phase I	0	0	10	5	50	50	100	EC
Total Credits to be earned					20				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Professional Elective – VI	3	0	0	3	40	60	100	PE
	Open Elective – IV	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22MEP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits: 168

LIST OF PROFESSIONAL ELECTIVES (PEs) (For the students admitted in the year 2022-23)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester – V							
Elective – I							
1.	22MEE01	Fluid Power System	3	0	0	3	Design
2.	22MEE02	Piping Design	3	0	0	3	Design
3.	22MEE03	Unconventional Machining Processes	3	0	0	3	Mfg.
4.	22MEE04	Design for Manufacture and Assembly	3	0	0	3	Mfg.
5.	22MEE05	Automobile Engineering	3	0	0	3	Thermal
6.	22MEE06	Fuels and Combustion Technology	3	0	0	3	Thermal
7.	22MEE07	Industrial Engineering	3	0	0	3	Ind. Engg.
8.	22MEE08	Production Planning and Control	3	0	0	3	Ind. Engg.
Semester – VI							
Elective – II							
9.	22MEE09	Design of Transmission Systems	3	0	0	3	Design
10.	22MEE10	Vibration and Noise Control	3	0	0	3	Design
11.	22MEE11	Intelligent Manufacturing Systems	3	0	0	3	Mfg.
12.	22MEE12	Manufacturing Information System	3	0	0	3	Mfg.
13.	22MEE13	Alternative Energy Systems and Applications	3	0	0	3	Thermal
14.	22MEE14	Instrumentation in Thermal Engineering	3	0	0	3	Thermal
15.	22MEE15	Digitalization in Supply Chain Management	3	0	0	3	Ind. Engg.
16.	22MEE16	Lean Six Sigma	3	0	0	3	Ind. Engg.
Semester – VII							
Elective – III							
17.	22GEE01	Fundamentals of Research	3	0	0	3	General
18.	22MEE17	Mechanics of Composite Materials	3	0	0	3	Design
19.	22MEE18	Design of Jigs, Fixtures and Press Tools	3	0	0	3	Design
20.	22MEE19	CNC Technology	3	0	0	3	Mfg.
21.	22MEE20	Precision Engineering	3	0	0	3	Mfg.
22.	22MEE21	Computational Fluid Dynamics	3	0	0	3	Thermal
23.	22MEE22	Gas Dynamics and Jet Propulsion	3	0	0	3	Thermal
24.	22MEE23	Project Management	3	0	0	3	Ind. Engg.
25.	22GEE02	Total Quality Management	3	0	0	3	Ind. Engg.

Elective – IV							
26.	22MEE24	Industrial Tribology	3	0	0	3	Design
27.	22MEE25	Advanced Mechanics of Materials	3	0	0	3	Design
28.	22MEE26	Additive Manufacturing	3	0	0	3	Mfg.
29.	22MEE27	Welding Technology	3	0	0	3	Mfg.
30.	22MEE28	Power Plant Engineering	3	0	0	3	Thermal
31.	22MEE29	Design of Heat Exchangers	3	0	0	3	Thermal
32.	22MEE30	Quality Control and Reliability Engineering	3	0	0	3	Ind. Engg.
33.	22MEE31	Multi - Variate Artificial Intelligence Data Analysis	3	0	0	3	Ind.Engg.
34.	22MEE32	Hybrid Vehicle Technology	3	0	0	3	Thermal
Elective – V							
35.	22MEE33	Introduction to Aircraft Systems	3	0	0	3	Design
36.	22MEE34	Mechatronics and IoT	3	0	0	3	Design
37.	22MEE35	Modeling and Analysis of Manufacturing Systems	3	0	0	3	Mfg.
38.	22MEE36	Micro Electro Mechanical Systems	3	0	0	3	Mfg.
39.	22MEE37	Refrigeration and Air Conditioning	3	0	0	3	Thermal
40.	22MEE38	Energy Auditing and Management	3	0	0	3	Thermal
41.	22MEE39	Maintenance Engineering	3	0	0	3	Ind.Engg.
42.	22MEE40	Industrial Safety Engineering	3	0	0	3	Ind.Engg.
Semester – VIII							
Elective – VI							
43.	22MEE41	Introduction to Aircraft Structures	3	0	0	3	Design
44.	22MEE42	Product Design and Optimization	3	0	0	3	Design
45.	22MEE43	Nanotechnology for Mechanical Engineers	3	0	0	3	Mfg.
46.	22MEE44	Non Destructive Evaluation Techniques	3	0	0	3	Mfg.
47.	22MEE45	Turbomachines	3	0	0	3	Thermal
48.	22MEE46	Energy Conservation in HVAC System	3	0	0	3	Thermal
49.	22MEE47	Industrial Marketing	3	0	0	3	Ind.Engg.
50.	22MEE48	Decision Support Systems	3	0	0	3	Ind.Engg.

B.E. MECHANICAL ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2023-24 onwards)

SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Cate gory**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT11	Communication Skills – I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	50	50	100	BS
22PHT12	Physics for Mechanical Engineering	3	0	0	3	40	60	100	BS
22MET11	Engineering Drawing	2	1	0	3	40	60	100	ES
22CSC11	Problem Solving and Programming in C	3	0	2	4	50	50	100	ES
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22GCL12	Foundation Laboratory - Electrical, IoT, Web	0	0	6	3	60	40	100	ES
22PHL12	Physics Laboratory for Mechanical Engineering	0	0	2	1	60	40	100	BS
22VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
22MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					23				

* Alternate Weeks

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Cate gory**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT21	Communication Skills – II	3	0	0	3	40	60	100	HS
22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
22CYT22	Chemistry for Mechanical Engineering	3	0	0	3	40	60	100	BS
22MET12	Engineering Mechanics	3	0	0	3	40	60	100	PC
22CSC21	Fundamentals of Data Structures	3	0	2	4	50	50	100	ES
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22GCL11	Foundation Laboratory - Manufacturing, Design and Robotics	0	0	6	3	60	40	100	ES
22CYL22	Chemistry Laboratory for Mechanical Systems	0	0	2	1	60	40	100	BS
Total Credits to be earned					22				

B.E. - MECHANICAL ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2023-24 onwards)

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22ITC32	Introduction to Python	3	0	2	4	50	50	100	ES
22MEC31	Fluid Mechanics and Hydraulic Machines	3	0	2	4	50	50	100	ES
22MET31	Manufacturing Technology	3	0	0	3	40	60	100	PC
22MET32	Engineering Thermodynamics	3	1	0	4	40	60	100	PC
22MET33	Strength of Materials	3	0	0	3	40	60	100	PC
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Practical / Employability Enhancement									
22MEL31	Manufacturing Technology and Materials Testing Laboratory	0	0	2	1	60	40	100	PC
22MEL32	Machine Drawing using AutoCAD Laboratory	0	0	2	1	60	40	100	PC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
Total Credits to be earned					21				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22MAT41	Numerical Methods for Engineers	3	1	0	4	40	60	100	BS
22MET41	Thermal Engineering	3	0	0	3	40	60	100	PC
22MET42	Machining and Measurements	3	0	0	3	40	60	100	PC
22MET21	Engineering Materials and Metallurgy	3	0	0	3	40	60	100	PC
22MET44	Kinematics of Machinery	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22MEL41	Thermal Engineering and Renewable Energy Laboratory	0	0	2	1	60	40	100	PC
22MEL42	Machining and Measurements Laboratory	0	0	2	1	60	40	100	PC
22MEL43	Solid Modeling Laboratory	0	0	2	1	60	40	100	PC
22GCL41/ 22GCI41	Professional Skills Training I / Industrial Training I	--	--	--	2	100	0	100	EC
Total Credits to be earned					21				

B.E. MECHANICAL ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2023-24 onwards)

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22MEC51	Heat and Mass Transfer	3	0	2	4	50	50	100	PC
22MEC52	Dynamics of Machinery	3	0	2	4	50	50	100	PC
22MET51	Operations Research	3	1	0	4	40	60	100	PC
22MET43	CAD/CAM/CIM for Automation	3	0	0	3	40	60	100	PC
	Professional Elective – I	3	0	0	3	40	60	100	PE
	Open Elective – I	3	1/0	0/2	4	40	60	100	OE
Practical / Employability Enhancement									
22MEL51	CAM and Robotics Laboratory	0	0	2	1	60	40	100	PC
22MEL52	Surface and Sheet Metal Design Laboratory	0	0	2	1	60	40	100	PC
22GCL51/ 22GCI51	Professional Skills Training II / Industrial Training II	--	--	--	2	100	0	100	EC
Total Credits to be earned					26				

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22MET61	Design of Machine Elements	3	1	0	4	40	60	100	PC
22MET62	Finite Element Analysis	3	0	0	3	40	60	100	PC
	Professional Elective – II	3	0	0	3	40	60	100	PE
	Open Elective – II	3	1/0	0/2	4	40	60	100	OE
Practical / Employability Enhancement									
22MEL61	Simulation Laboratory	0	0	2	1	60	40	100	PC
22MEP62	Project Work I	0	0	10	5	100	0	100	EC
22GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					24				

B.E. MECHANICAL ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2023-24 onwards)

SEMESTER – VII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22GCT71	Engineering Economics and Management	3	0	0	3	40	60	100	HS
22MET52	Artificial Intelligence in Mechanical Systems	3	0	0	3	40	60	100	PC
	Professional Elective – III	3	0	0	3	40	60	100	PE
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Open Elective – III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22MEP72	Project Work II Phase I	0	0	12	6	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	40	60	100	PE
	Open Elective – IV	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22MEP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits: 168

LIST OF PROFESSIONAL ELECTIVES (PEs) (For the students admitted in the year 2023-24)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester – V							
Elective – I							
1.	22MEE01	Fluid Power System	3	0	0	3	Design
2.	22MEE02	Piping Design	3	0	0	3	Design
3.	22MEE03	Unconventional Machining Processes	3	0	0	3	Mfg.
4.	22MEE04	Design for Manufacture and Assembly	3	0	0	3	Mfg.
5.	22MEE05	Automobile Engineering	3	0	0	3	Thermal
6.	22MEE06	Fuels and Combustion Technology	3	0	0	3	Thermal
7.	22MEE07	Industrial Engineering	3	0	0	3	Ind. Engg.
8.	22MEE08	Production Planning and Control	3	0	0	3	Ind. Engg.
Semester – VI							
Elective – II							
9.	22MEE09	Design of Transmission Systems	3	0	0	3	Design
10.	22MEE10	Vibration and Noise Control	3	0	0	3	Design
11.	22MEE11	Intelligent Manufacturing Systems	3	0	0	3	Mfg.
12.	22MEE12	Manufacturing Information System	3	0	0	3	Mfg.
13.	22MEE13	Alternative Energy Systems and Applications	3	0	0	3	Thermal
14.	22MEE14	Instrumentation in Thermal Engineering	3	0	0	3	Thermal
15.	22MEE15	Digitalization in Supply Chain Management	3	0	0	3	Ind. Engg.
16.	22MEE16	Lean Six Sigma	3	0	0	3	Ind. Engg.
Semester – VII							
Elective – III							
17.	22GEE01	Fundamentals of Research	3	0	0	3	General
18.	22MEE17	Mechanics of Composite Materials	3	0	0	3	Design
19.	22MEE18	Design of Jigs, Fixtures and Press Tools	3	0	0	3	Design
20.	22MEE19	CNC Technology	3	0	0	3	Mfg.
21.	22MEE20	Precision Engineering	3	0	0	3	Mfg.
22.	22MEE21	Computational Fluid Dynamics	3	0	0	3	Thermal
23.	22MEE22	Gas Dynamics and Jet Propulsion	3	0	0	3	Thermal
24.	22MEE23	Project Management	3	0	0	3	Ind. Engg.
25.	22GEE02	Total Quality Management	3	0	0	3	Ind. Engg.

Elective – IV							
26.	22MEE24	Industrial Tribology	3	0	0	3	Design
27.	22MEE25	Advanced Mechanics of Materials	3	0	0	3	Design
28.	22MEE26	Additive Manufacturing	3	0	0	3	Mfg.
29.	22MEE27	Welding Technology	3	0	0	3	Mfg.
30.	22MEE28	Power Plant Engineering	3	0	0	3	Thermal
31.	22MEE29	Design of Heat Exchangers	3	0	0	3	Thermal
32.	22MEE30	Quality Control and Reliability Engineering	3	0	0	3	Ind. Engg.
33.	22MEE31	Multi - Variate Artificial Intelligence Data Analysis	3	0	0	3	Ind.Engg.
34.	22MEE32	Hybrid Vehicle Technology	3	0	0	3	Thermal
35.	22MEE33	Introduction to Aircraft Systems	3	0	0	3	Design
36.	22MEE34	Mechatronics and IoT	3	0	0	3	Design
37.	22MEE35	Modeling and Analysis of Manufacturing Systems	3	0	0	3	Mfg.
38.	22MEE36	Micro Electro Mechanical Systems	3	0	0	3	Mfg.
39.	22MEE37	Refrigeration and Air Conditioning	3	0	0	3	Thermal
40.	22MEE38	Energy Auditing and Management	3	0	0	3	Thermal
41.	22MEE39	Maintenance Engineering	3	0	0	3	Ind.Engg.
42.	22MEE40	Industrial Safety Engineering	3	0	0	3	Ind.Engg.
		Semester – VIII					
		Elective – V					
43.	22MEE41	Introduction to Aircraft Structures	3	0	0	3	Design
44.	22MEE42	Product Design and Optimization	3	0	0	3	Design
45.	22MEE43	Nanotechnology for Mechanical Engineers	3	0	0	3	Mfg.
46.	22MEE44	Non Destructive Evaluation Techniques	3	0	0	3	Mfg.
47.	22MEE45	Turbomachines	3	0	0	3	Thermal
48.	22MEE46	Energy Conservation in HVAC System	3	0	0	3	Thermal
49.	22MEE47	Industrial Marketing	3	0	0	3	Ind.Engg.
50.	22MEE48	Decision Support Systems	3	0	0	3	Ind.Engg.

LIST OFOPEN ELECTIVECOURSESOFFEREDTOOTHERDEPARTMENTS(OEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Semester**
1.	22MEX01	Renewable Energy Sources	3	0	2	4	V
2.	22MEX02	Design of Experiments	3	0	2	4	VI
3.	22MEO01	Fundamentals of Ergonomics	3	0	0	3	VII
4.	22MEO02	Principles of Management and Industrial Psychology	3	0	0	3	VII
5.	22MEO03	Waste Heat Recovery System and Storage	3	0	0	3	VII
6.	22MEO04	Safety Measures for Engineers	3	0	0	3	VIII
7.	22MEO05	Energy Conservation in Thermal Equipments	3	0	0	3	VIII
8.	22MEO06	Climate Change and New Energy Technology	3	0	0	3	VIII

22EGT11 - COMMUNICATION SKILLS I								
(Common to All Engineering and Technology Branches)								
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**	
Prerequisites	**Nil**	**I**	**HS**	**3**	**0**	**0**	**3**	

Preamble	This course is designed to impart required levels of Communication Skills and Proficiency in English language necessary for different professional contexts.	
Unit – I	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Parts of speech **-** Tenses **-** Types of sentences**:** Assertive, Imperative, Interrogative & Exclamatory **–** Affirmative & Negative **-** Gerunds & Infinitives **- Vocabulary:** Affixes **-** Synonyms & Antonyms **- Listening:** Types of listening **-** Barriers to listening **-** Listening to short talks **-** TV shows **- Speaking:** Verbal & Non-verbal communication **-** Pair conversation **-** Role play **- Reading:** Types of Reading **–** Intensive: scanning, word by word, survey **- Writing:** Dialogue writing, Informal Letters **-** Paragraph writing		
Unit – II	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Voices **-** Impersonal passives **- Vocabulary:** Homonyms, Homophones & Homographs **- Listening:** Importance of listening **-** Listening to announcements & radio broadcasts **- Speaking:** Persuasive & Impromptu talks **-** Narrating a story **- Reading:** Reading comprehension **-** Articles from Newspapers/Magazines **-** Cloze exercises **- Writing:** Essay writing, Jumbled sentences		
Unit – III	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Prepositions **- Vocabulary:** Compound Nouns **- Listening:** Listening to TED Talks, Commentaries **- Speaking:** Self Introduction **- Reading:** Extensive: speed, skimming **-** Identifying lexical & contextual meanings **- Writing:** Instructions & Warnings **-** Formal letters: Seeking permission for Industrial visits & Inviting guests		
Unit – IV	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Articles & Determiners **- Vocabulary:** Technical Vocabulary **-** Analogy **-** Unscrambling words **-** Logical reasoning **- Listening:** Listening to conversations - **Speaking:** Tongue twisters **-** Skill Sharing **-** Note-taking **- Reading:** Note making **-** Paraphrasing & Summarizing **- Writing:** Recommendations & Suggestions **-** Business letters: Enquiry, Calling for quotations & placing orders		
Unit – V	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Cause and effect expressions **- Vocabulary:** Abbreviations & acronyms, Definitions **Listening:** Listening to eminent personalities **- Speaking:** Commonly mispronounced words **-** Welcome address, Chief guest address & Vote of thanks **- Reading -** IELTS type passages **- Writing:** Preparing transcript for a speech **-** Interpreting news articles & advertisements		
		Total:45

TEXT BOOK:	
1.	Sanjay Kumar & Pushp Lata, “Communication Skills”, 2nd Edition, Oxford University Press, New Delhi, 2018.
REFERENCES:	
1.	Ashraf Rizvi, "Effective Technical Communication", 2nd Edition, McGraw-Hill India, 2017.
2.	S. P. Dhanavel, "English and Communication Skills for Students of Science and Engineering", Orient BlackSwan Publishers, Hyderabad, 2009.
3.	Jack C. Richards and Chuck Sandy, “Passages” Student’s Book 1, 3rd Edition, Cambridge University Press, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	use language effectively by acquiring vocabulary and syntax in context	Applying (K3)
CO2	listen and comprehend different spoken discourses from a variety of situations	Applying (K3)
CO3	speak confidently in different professional contexts and with peers	Creating (K6)
CO4	comprehend different genres of texts by adopting various reading strategies	Understanding (K2)
CO5	write legibly and flawlessly at varied professional contexts proficiently with appropriate choice of words and structures	Creating (K6)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2			1	3	1	1
CO2									2	3		1
CO3									2	3		2
CO4						1				3	1	1
CO5										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		37	30			33	100
CAT2		30	30			40	100
CAT3		33	34			33	
ESE		17	63			20	100

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

22MAC11 - MATRICES AND ORDINARY DIFFERENTIAL EQUATIONS							
(Common to all Engineering and Technology branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**1***	**2***	**4**

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

LIST OF EXPERIMENTS / EXERCISES:

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

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

TEXT BOOK:

1.	Ramana B V, "Higher Engineering Mathematics", 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCES/ MANUAL / SOFTWARE:

1.	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.
2.	Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.

4.	Grewal B.S., “Higher Engineering Mathematics" 44thEdition, Khanna Publishers, New Delhi, 2018.
5.	MATLAB – Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	solve engineering problems which needs matrix computations.	Applying (K3)
CO2	identify the appropriate method for solving first order ordinary differential equations.	Applying (K3)
CO3	solve higher order linear differential equations with constant and variable coefficients.	Applying (K3)
CO4	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems.	Applying (K3)
CO5	apply Laplace Transform to find solutions of Linear Ordinary Differential Equations	Applying (K3)
CO6	understand the basics of MATLAB, solve ordinary differential equations and compute Laplace transforms 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											
CO2	3	3	2											
CO3	3	3	2											
CO4	3	3	2											
CO5	3	3	3											
CO6					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)

***Alternate week**

22PHT12 - PHYSICS FOR MECHANICAL ENGINEERING							
Programme & Branch	**BE- Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to impart the knowledge on conductors, semiconductors, dielectrics, sound absorbing materials and select materials characterization techniques. It also describes the applications of aforementioned topics in mechanical engineering.	
Unit – I	**Conducting materials:**	**9**
Conductors – Classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann-Franz law – Lorentz number – Draw backs of classical theory – Quantum free electron theory – Fermi distribution function – Effect of temperature onFermi function – Density of energy states – Carrier concentration in metals.		
Unit – II	**Semiconducting materials and Devices:**	**9**
Intrinsic semiconductor – Carrier concentration – Electrical conductivity and band gap – Extrinsic semiconductors – Carrier concentration in n-type and p-type semiconductors – Hall effect – Determination of Hall coefficient – Applications – Uni JunctionTransistor (UJT) — Junction Field Effect Transistor (JFET).		
Unit – III	**Dielectric materials:**	**9**
Dielectrics – Dielectric constant – Polarization – Displacement vector – Electric susceptibility – Types of polarization mechanisms:Electronic, ionic, orientational and space-charge – Frequency and temperature dependence – Internal field – Clausius-Mosotti relation – Dielectric loss – Dielectric breakdown – Uses of dielectric materials in capacitors.		
Unit – IV	**Acoustics and Sound absorbing materials:**	**9**
Classification of sound – Characteristics of sound – Sound Intensity level – Reverberation – Reverberation time – Growth and decay of sound – Sabine's formula for reverberation time – Determination of sound absorption coefficient of materials – Sound absorbing materials – Types of sound absorbing materials: Porous, membrane and resonance absorbers – Natural sound absorbing materials – Synthetic sound absorbing materials – Sound proofing and its types (qualitative).		
Unit – V	**Materials characterization:**	**9**
Importance of materials characterization – X-ray diffraction (powder method) – Scanning electron microscope – Transmissionelectron microscope (qualitative) – Raman spectroscopy – Thermo gravimetric analysis.		
		Total:45

TEXT BOOK:

1.	Hitendra K. Malik and A.K. Singh, "Engineering Physics", 2nd Edition McGraw-Hill Education , New Delhi, 2018. (Units I,II,III)
2.	Kosten, Cornelis Willem, and Zwikker, Cornelis. Sound Absorbing Materials. Elsevier Publishing Company, Netherlands, 1949. (Unit IV)
3.	Sam Zhang, Lin Li and Ashok Kumar, "Materials Characterization Techniques", 1st Edition, CRC Press, Boca Raton, 2008. (Unit V)

REFERENCES:

1.	Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
2.	Zine El Abiddine Fellah and Erick Ogam (Ed.), "Acoustics of Materials", Intech open, 2019.
3.	Avadhanulu M.N., Kshirsagar P.G. and Arun Murthy T.V.S., "A Textbook of Engineering Physics", 11th Edition, S. Chand & Company Pvt. Ltd., New Delhi, 2019.

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 and thermal conductivity of metals and to comprehend the effect of temperature on Fermi function and to compute the expressions for density of states and carrier concentration in metals	Applying (K3)
CO2	use the concept of density of states to compute the carrier concentration, electrical conductivity and band gap of intrinsic semiconductors, and to compute the carrier concentration of extrinsic semiconductors, and also to explain the phenomenon related to Hall Effect and the working of UJT and JFET.	Applying (K3)
CO3	apply the concept of electric dipole moment and electric polarization to comprehend the different polarization mechanisms in dielectrics, Clausius-Mosotti relation, dielectric loss, dielectric breakdown and to describe its uses in capacitors.	Applying (K3)
CO4	utilize the concepts of sound propagation and sound absorption in a medium to compute reverberation time and sound absorption coefficient, and to realize the applications of sound absorbing and sound proofing materials in industries.	Applying (K3)
CO5	apply the concepts of X-ray diffraction, matter waves, Raman effect and thermogram to describe the principle and working of select material characterization techniques.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MET11 - ENGINEERING DRAWING

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1 / 2	ES	2	1	0	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:** **6+3**

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:** **6+3**

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:** **6+3**

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:** **6+3**

Development of Lateral Surfaces of Simple Solids Like Prisms, Pyramids, Cylinders and Cones -Development of Simple Truncated SolidsInvolving Prisms, Pyramids, Cylinders and Cones.

Unit – V **Isometric Projection and Introduction to AutoCAD:** **6+3**

Principles of Isometric Projection - Isometric Scale - Isometric Projections of Simple and Truncated Solids Like Prisms, Pyramids, Cylinders and Cones - Conversion of Isometric Projection into Orthographic Projection - Introduction to AutoCAD.

Lecture: 30, Tutorial:15, Total:45

TEXT BOOK:

1. Natarajan.K.V. “A Textbook of Engineering Graphics”,35th Edition, Dhanalakshmi Publishers, Chennai, 2022,

REFERENCES:

1. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, 16th Edition, New Age International Publishers, Chennai, 2022.
2. Basant Agrawal, Agrawal C.M., “Engineering Drawing”, 3rd Edition, McGraw Hill Education, 2019.
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	Applying (K3)
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 into 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			2					3		2		
CO2	3	2	1		2					3		2		
CO3	3	2	1		2					3		2		
CO4	3	2	1		2					3		2		
CO5	3	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	6	9	85				100
CAT2	6	9	85				100
CAT3	6	9	85				100
ESE	10	10	80				100

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

22MET12 - ENGINEERING MECHANICS							
(Common to Mechanical & Mechatronics Engineering branches)							
Programme & Branch	**B.E. - Mechanical Engineering, B.E. - Mechatronics Engineering branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1/2**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides introduction to the basic concepts of forces, inertia, centroid and moment of area along with their effects. It introduces the phenomenon of friction and its effects. It familiarizes students to cognitive learning in applied mechanics and develops problem-solving skills.

Unit - I	**Statics of Particles**	**9**
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**
Moments: Moment of a Force about a Point and about an Axis – Vectorial Representation of Moments and Couples – 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 – Trusses: Method of Joints - Method of Sections- Equilibrium of Rigid Bodies in Three Dimensions.		
Unit - III	**Properties of Surfaces and Solids**	**9**
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**
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**
Dynamics of Particles: Newton's Law, Work - Energy and Impulse - Momentum Principles — Impact of Elastic Bodies. Kinematics of Rigid Body: Translation - Rotation about a Fixed Axis – General Plane Motion. Kinetics of Rigid Body.		
		Total:45

TEXT BOOK:

1.	Rajasekaran S and Sankarasubramanian G, "Fundamentals of Engineering Mechanics", 3rd Edition, Vikas Publishing, Chennai, 2017.

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.
3.	Meriam J L, Kraige L G , Bolton J.N., " Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 9th edition, Wiley student edition, 2021

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	2	1								1		3
CO2	3	2	2	1								1		3
CO3	3	2	2	1								1		3
CO4	3	2	2	1								1		3
CO5	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	5	70	20			100
CAT2	5	5	70	20			100
CAT3	5	5	70	20			100
ESE	5	5	70	20			100

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

22CSC11 - PROBLEM SOLVING AND PROGRAMMING IN C							
(Common to All Engineering and Technology branches except CSE, IT, CSD, AIDS & AIML)							
Programme & Branch	**All BE/BTech Engineering & Technology branches , except CSE, IT, CSD, AIDS & AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**2**	**4**

Preamble	The course aims to provide exposure to problem-solving through programming. It introduces all the fundamental concepts of C Programming. This course provides adequate knowledge to solve problems using C	
Unit – I	**Introduction to C and Operators:**	**9**
The structure of a C program – Compiling and executing C program – C Tokens – Character set in C – Keywords – identifiers-Basic data Types – Variables – constants – Input / Output statements – Operators		
Unit – II	**Control Statements and Arrays:**	**9**
Decision-making and looping statements, Arrays: Declaring, initializing and accessing arrays – operations on arrays – Two-dimensional arrays and their operations.		
Unit – III	**Functions:**	**9**
Functions: Introduction- Using functions, function declaration and definition – function call – return statement – passing parameters to functions: basic data types and arrays – storage classes – recursive functions		
Unit – IV	**Strings and Pointers:**	**9**
Strings: Introduction – operations on strings: finding length, concatenation, comparing and copying – string and character manipulation functions, Arrays of strings. Pointers : declaring pointer variables – pointer expression and arithmetic, pointers and 1D arrays, pointers and strings		
Unit – V	**User-defined Data Types and File Handling:**	**9**
User-defined data types: Structure: Introduction – nested structures– arrays of structure – structure and functions -unions – enumerated data type. File Handling : Introduction - opening and closing files – reading and writing data to files -Manipulating file position indicator : fseek(), ftell() and rewind()		

LIST OF EXPERIMENTS / EXERCISES:

1.	Programs for demonstrating the use of different types of format Specifiers
2.	Programs for demonstrating the use of different types of operators like arithmetic, logical, relational, and ternary operators
3.	Programs for demonstrating the use of using decision making statements
4.	Programs for demonstrating the use of repetitive structures
5.	Programs for demonstrating one-dimensional arrays
6.	Programs for demonstrating two-dimensional arrays
7.	Programs to demonstrate modular programming concepts using functions
8.	Programs to demonstrate recursive functions.
9.	Programs to demonstrate strings (Using built-in and user-definedfunctions)
10.	Programs to illustrate the use of pointers
11.	Programs to illustrate the use of structures and unions
12.	Programs to implement file Handling

Lecture:45, Practical:30, Total:75

TEXT BOOK:

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

REFERENCES/ MANUAL / SOFTWARE:	
1.	Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2018.
2.	Sumitabha Das, “Computer Fundamentals and C Programming”, 1st Edition, McGraw Hill, 2018.
3.	Balagurusamy E., "Programming in ANSI C", 7th Edition, McGraw Hill Education, 2017.
4.	Behrouz A. Forouzan & Richard F.Gilberg, “Computer Science A Structured Programming Approach Using C”, 3rd Edition, Cengage,2017.
5.	https://www.cprogramming.com/tutorial/c-tutorial.html

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	develop simple programs using input/output statements and operators	Applying (K3), Precision (S3)
CO2	identify the appropriate looping and control statements in C and develop applications using these statements	Applying (K3), Precision (S3)
CO3	develop simple C programs using the concepts of arrays and modular programming	Applying (K3), Precision (S3)
CO4	apply the concepts of pointers and develop C programs using strings and pointers	Applying (K3), Precision (S3)
CO5	make use of user-defined data types and file concepts to solve given problems	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	2	2	1				1	1		1		
CO2	3	2	2	2	1				1	1		1		
CO3	3	2	2	2	1				1	1		1		
CO4	3	2	2	2	1				1	1		1		
CO5	3	2	2	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	10	30	60				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)

22MEL11 - ENGINEERING PRACTICES LABORATORY

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**1/ 2**	**ES**	**0**	**0**	**2**	**1**

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

LIST OF EXPERIMENTS / EXERCISES:

	PART A – MECHANICAL ENGINEERING
1.	Prepare a Square / Rectangular / V-Shape Projection with its Counterpart for Mating and Perform the Drilling, Tapping, and Assembling Tasks from the given Square / Rectangular MS Plates using Modern Power Tools.
2.	Prepare T / L / Lap Joint from given Wooden Work Piece and Make a Box / Tray out of Plywood using Modern Power Tools.
3.	Perform the Thread Formation on a GI/PVC Pipe and Prepare a Water Line from the Overhead Tank that is Leak-Proof.
4.	Make a Butt / Lap / Tee Joint of MS Plate using Arc Welding Process and Welding Simulator.
5.	**Activity:** Prepare an Innovative Model with the Knowledge from Fitting / Carpentry / Plumbing / Welding Involving Modern Power Tools.
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
6.	Wiring circuit for fluorescent lamp and Stair case wiring
7.	Wiring Circuit of Incandescent lamp using Impulse Relay
8.	Measurement of Earth Resistance
9.	Soldering of Simple Circuits and trouble shooting
10.	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) Manipulation (S2)
CO2	identify and use appropriate modern power tools and complete the exercises/models accurately	Applying (K3) Manipulation (S2)
CO3	perform house wiring and realize the importance of earthing	Applying (K3), Manipulation (S2)
CO4	soldering with simple electronics circuits	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	1	3	1			3	3		3		
CO2	3		3	1	3				3	3		3		
CO3	3		3	2	1				2	2		3		
CO4	3		2	1	1				2	3		3		
CO5	3		3	2	1				2	2		3		

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

22GCL12 – Foundation Laboratory - Electrical, IoT, Web								
(Common to all BE/BTech branches)								
Programme& Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 /2**	**ES**	**0**	**0**	**6**	**3**

Preamble	This course is designed to provide a foundational knowledge on engineering with hands-on experience on the house wiring, Internet of Things and Web Technologies.

LIST OF EXPERIMENTS / EXERCISES:

PART A – Electrical Installation (30 Hours)	
1.	Develop wiring diagrams using software tools.
2.	Identify and select suitable components for Energy Measurement and Circuit Protection
3.	Design a wiring circuit integrating Energy Meter, MCB and RCCB
4.	Develop a wiring circuit for incandescent lamp and fluorescent lamp
5.	Develop and Investigate Simple and Staircase Wiring for Residential Applications
6.	Design the Wiring Circuits for Calling Bell System and Dimmable Light
7.	Create wiring circuits for power loads
8.	Measurement of Earth Resistance and its connections.
PART B – Internet of Things (30 Hours)	
1.	Design a Single layer PCB layout designing
2.	Fabricate Single layer PCB printing
3.	Assembling, soldering and desoldering practice on single layer PCB
4.	GPIO programming in ESP8266
5.	Sensor and actuator interfacing with internet enabled microcontroller device
6.	Sensor and actuator calibration
7.	Integration of microcontroller based system with Cloud platform
PART C – Web Technologies (30 Hours)	
1.	Design a website for an application using HTML and CSS.
2.	Convert the designed website into responsive website using Bootstrap.
3.	Add dynamism to the website by using JavaScript and embed the Social Media components to the website.
4.	Incorporate database interaction to the website.
5.	Deploy the developed website in the server.
	Total:90

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Eric T.Freeman,Elisabeth Robson, ”Head First JavaScript Programming A Brain-Friendly Guide”, 1st Edition, O’Reilly , 2014.

3.	Eric T.Freeman,Elisabeth Robson, ”Head First HTML and CSS”,2nd Edition, O’Reilly , 2012
4.	Lynn Beighley,”Head First SQL”,1st Editin, O’Reilly,2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	design electrical wiring circuits for buildings based on their requirement	Applying(K3), Precision (S3)
CO2	develop IoT based solutions and PCB for real world use cases.	Applying (K3), Precision (S3)
CO3	design and host an interactive dynamic website.	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	2	1					1					
CO2	3	2	2	1					1					
CO3	3	2	2	1					1					

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

22PHL12 - PHYSICS LABORATORY FOR MECHANICAL ENGINEERING

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

Preamble	This course aims to impart hands on training in the determination of parameters such as specific resistance, thermal conductivity, Fermi energy level, band gap, Hall coefficient, dielectric constant, velocity of ultrasound, compressibility of a liquid, AC frequency, thickness of thin film and knowledge on the working of p-n diode and UJT, and also to impart skills on writing coding / developing project / product related to societal requirement.

LIST OF EXPERIMENTS / EXERCISES:

1.	Determination of the specific resistance of the given metallic wire using Carey-Foster's bridge.
2.	Determination of the thermal conductivity of a bad conductor using Lee's disc.
3.	Determination of the Fermi energy level of copper using Wheatstone's bridge.
4.	Determination of the band gap of a given semiconducting material using post-office box / Determination of the Hall coefficient of a material using Hall effect arrangement.
5.	Observation of the I-V characteristics of a p-n junction diode.
6.	Observation of the I-V characteristics of a uni junction transistor / Determination of the dielectric constant of a material bycharging and discharging.
7.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of the liquid using ultrasonic interferometer.
8.	Determination of the frequency of alternating current using electrically vibrating tuning fork (Melde's apparatus).
9.	Determination of the thickness of a thin film by air-wedge arrangement.
10.	Writing coding for any one of the above experiments / developing a project / a product.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Physics Laboratory Manual / Record, Department of Physics, 1st Edition, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	determine the specific resistance of a given wire using the principle of Wheatstone bridge and the thermal conductivity of a bad conductor using the concept of heat conduction through materials.	Applying (K3), Precision (S3)
CO2	determine the Fermi energy level of copper and band gap of a semiconductor using the concept of variation of resistance with temperature or to determine the Hall coefficient of a material using the concept of Hall effect. To obtain the I-V characteristics of a p-n junction diode. To plot the I-V characteristics of a uni-junction transistor using the concept of creation of negative resistance region or to determine the dielectric constant of a dielectric material using the concepts of charging and discharging of a capacitor	Applying (K3), Precision (S3)
CO3	determine the velocity of ultrasound in a liquid and the frequency of alternating current using the concept of formation of stationary waves and also to compute the thickness of a thin film by using the concept of interference and also to write coding/ do project/ develop product.	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	2	3					2	2		2	3	
CO2	3	2	2	3					2	2		2	3	
CO3	3	2	2	3					2	2		2	3	

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

22VEC11 - YOGA AND VALUES FOR HOLISTIC DEVELOPMENT							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**HS**	**1**	**0**	**1**	**1**

Preamble	Yoga or yogasanas are considered as art and science of healthy living by our ancient gurus. It is method to bring harmony of body and mind for general wellbeing. Yoga is considered as one of the greatest gifts to the world by Indians for healthy living. Students in particular are benefitted by learning yoga.	
Unit – I	**Introduction:**	**2**
The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga – Yoga is a Science and Art – Rules and Regulations of Asanas – Classifications of Yogasanas – Patanjali's Ashtanga Yoga – Pranayama – Mudras & Bandhas - Shatkarma (Cleansing Practice) - Streams of Yoga – Modern Trends in yoga.		
Unit – II	**Yoga and Mind:**	**2**
The Nature of Mind - Five Elements and the Mind - Meditation and the Mind - Functions of the Mind - Role of Yoga in Psychological problems: Mood Disorders, Major Depressive Disorder, Cyclothymic Disorder.		
Unit – III	**Yoga and Values, Diet:**	**2**
Human Values – Social Values – Role of Yoga in Personality Integration - Concepts of Natural Diet - Naturopathy Diet – Eliminative Diet – Soothing Diet – Constructive Diet.		
Unit – IV	**Asanas:**	**2**
Prayer - Starting & Closing - Preparatory practices – Loosening Practices – Meaning, Definitions and Objectives of Asanas - Principles of Practicing Asanas. Asanas: Standing – Sitting – Prone – Supine – Suryanamaskar.		
Unit – V	**Pranayama and Meditation:**	**2**
Breathing Practices for awareness - Definitions and Objectives of Pranayama - Principles of Practicing Pranayama. Pranayama: Nadi Shuddhi - Kapalabathi – Sitali – Sitkari – Bhranari – Ujjayi – Relaxation Techniques – Meditation.		
		Lecture: 10, Practical: 10, Total:20

TEXT BOOK:

1.	Swami satyananda saraswathi, "Asana pranayama mudra bandha", Bihar school of yoga, 4th Edition, 1969.
2.	Swami mukthi Bodhanandha, "Hatha yoga pradipika", Bihar school of yoga, 4th Edition, 1985.

REFERENCES:

1.	B.K.S. Iyenkar, "Yoga the path of holistic health", DK Limited, 2nd Edition, 1969.
2.	Selvarasu, "Kriya cleansing in yoga", Aruvi yoga, 3rd Edition, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	realize the importance of yoga in physical health.	Applying (K3)
CO2	realize the importance of yoga in mental health.	Applying (K3)
CO3	realize the role of yoga in personality development and diet.	Applying (K3)
CO4	do the loosening practices, Asanas and realize its benefits.	Applying (K3)
CO5	do the practice of Pranayama, meditation and realize its benefits	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

* ±3% may be varied (CAT3 – 100 marks)

22EGT21 - COMMUNICATION SKILLS II							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Communication Skills I**	**2**	**HS**	**3**	**0**	**0**	**3**

Preamble	This course is designed to equip students with the necessary skills to listen, read, write and speak so as to develop their linguistic and communicative competencies.

Unit – I	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**

Grammar: Sentence Patterns **-** Simple, Compound & Complex sentences **- Vocabulary:** Portmanteau words **-** One word substitution **- Listening:** Speeches from company CEOs **-** TV debates **Speaking:** Just-a-minute talk **-** Group discussion **- Reading:** Reading for Gist **- Writing:** Job application letter with resume **–** Transcoding

Unit – II	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**

Grammar: Concord **- Vocabulary:** Phrasal verbs **-** Idioms & Phrases - **Listening:** Listening to celebrity talks - **Speaking:** Talking about celebrities - Practicing Pronunciation through web tools - **Reading:** Company correspondence, technical texts/working principles of a machine - **Writing:** Description: Person, Place**,** Process, Product and Picture

Unit – III	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**

Grammar: Discourse markers **-** Transitional words and phrases **- Vocabulary:** Commonly confused words **- Listening:** Listening to guest lectures **- Speaking:** Technical & Non-technical presentations **-** Workshop presentations **- Reading:** Reputed company profiles, Business Plans **- Writing:** a dream job/company **-** Letter to the Editor **–** Biography & Autobiography **-** Checklist

Unit – IV	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**

Grammar: Degrees of Comparison **-** Punctuations **–** Fragments & run-ons **- Vocabulary:** British & American **-** Spelling & words **- Listening:** Listening to global accents **-** listening to motivational speeches **-** S**peaking:** Narrating personal milestones **-** Sports commentaries **-** Movie Enactment **- Reading:** Narrative passages **- Writing:** E mail **-** Agenda & Minutes of Meeting **-** Special & Technical reports

Unit – V	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**

Grammar: Purpose and Function **-** If clause **-** Error detection **- Vocabulary:** Coding & Decoding **-** Alphabet test **- Listening:** Listening to sample HR Interviews **- Speaking:** Introduction to phonetics - Stress, rhythm & Intonation **–** Guided & unguided speeches/conversations **-** Giving feedback **–** Debate **- Reading:** Key Note speeches **-** Newspaper reports **-** short technical texts from journals **Writing:** Circulars **-** Critical Appreciation of a non-detailed text **-** Technical proposals

Total:45

TEXT BOOK:

1.	Sanjay Kumar & Pushp Lata, “Communication Skills”, 2nd Edition, Oxford University Press, New Delhi, 2018.

REFERENCES:

1.	Meenakshi Raman and Sangeeta Sharma. “Technical Communication- Principles and Practice”. 4th Edition, Oxford University Press, New Delhi, 2022.
2.	Murphy Raymond, "English Grammar in Use", 5th Edition, Cambridge University Press, New York, 2019.
3.	Jack C. Richards and Chuck Sandy, “Passages” Student’s Book 2, 3rd Edition, Cambridge University Press, New York, 2014.

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 accents and infer implied meanings	Applying (K3)
CO3	speak clearly, initiate and sustain a discussion and negotiate using appropriate communicative strategies	Creating (K6)
CO4	read different genres of texts, infer implied meanings and critically analyze and evaluate them	Understanding (K2)
CO5	produce different types of narrative, descriptive expository texts and understand creative, critical, analytical and evaluative writing	Creating (K6)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2			1	3	1	1
CO2									2	3		1
CO3									2	3		2
CO4						1				3	1	1
CO5										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		37	30			33	100
CAT2		7	50			43	100
CAT3		17	50			33	100
ESE		15	45			40	100

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

22MAC21 - MULTIVARIABLE CALCULUS AND COMPLEX ANALYSIS							
(Common to CIVIL, MECH, MTS, ECE, EEE, EIE & FT branches)							
Programme & Branch	**B.E &Civil, Mech, MTS, ECE, EEE, EIE & FT branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**3**	**1***	**2***	**4**

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

LIST OF EXPERIMENTS / EXERCISES:

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

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

TEXT BOOK:

1.	Ramana B V, "Higher Engineering Mathematics", 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCES/ MANUAL / SOFTWARE:

1.	Kreyszig E, "Advanced Engineering Mathematics ", 10thEdition, John Wiley, New Delhi, India, 2016.
2.	Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi
3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M.,"Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.
4.	Grewal B.S,"Higher Engineering Mathematics" 44thEdition, Khanna Publishers,New Delhi, 2018.
5.	MATLAB – Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	compute the total derivatives and extreme values of multivariable functions.	Applying (K3)
CO2	evaluate multiple integrals and apply them to compute the area and volume of the regions.	Applying (K3)
CO3	apply the concepts of derivatives and line integrals of vector functions in engineering problems.	Applying (K3)
CO4	construct analytic functions and bilinear transformations and determine the image of given region under the given conformal mapping.	Applying (K3)
CO5	apply the techniques of complex integration to evaluate real and complex integrals over suitable closed curves.	Applying (K3)
CO6	demonstrate MATLAB programming to understand the concepts of functions of two variables, vector operators, multiple integrals and complex variables.	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											
CO2	3	3	2											
CO3	3	3												
CO4	3	3												
CO5	3	3	3											
CO6					3									

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

ASSESSMENT PATTERN - THEORY

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

* ±3% may be varied (CAT 1 & 2 – 60 marks & ESE – 100 marks)

***Alternate week**

22CYT22 – CHEMISTRY FOR MECHANICAL ENGINEERING								
Programme & Branch	**B.E & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to emphasize the engineering students to realize the importance of electrochemistry, electrochemical storage devices, fuels & combustion, engineering materials and the need for corrosion & its control methods.

Unit – I	**ELECTROCHEMISTRY**	**9**
Introduction – cells – types – representation of galvanic cell – electrode potential – Nernst equation (derivation of cell EMF) –calculation of cell EMF from single electrode potential – reference electrodes: construction, working and applications of standard hydrogen electrode, standard calomel electrode, glass electrode – EMF series and its applications – potentiometric titrations (redox) – conductometric titrations – mixture of weak and strong acid vs strong base.		
Unit – II	**ELECTROCHEMICAL STORAGE DEVICES**	**9**
Batteries: Introduction- types of batteries – discharging and charging of battery – characteristics of battery – battery rating –various tests on battery – primary battery: silver button cell – secondary battery: Ni-Cd battery –modern battery: lithium-ion battery – maintenance of batteries – choice of batteries for electric vehicle applications. **Fuel Cells:** Introduction-Importance and classification of fuel cells – description, principle, components and applications of fuel cells: H_2-O_2 fuel cell, alkaline fuel cell, molten carbonate fuel cell and direct methanol fuel cell.		
Unit – III	**CORROSION AND ITS CONTROL METHODS**	**9**
Corrosion: Introduction – chemical corrosion – Pilling-Bedworth rule – electrochemical corrosion and it's types – galvanic corrosion – differential aeration corrosion with examples – galvanic series – factors influencing rate of corrosion – measurement ofcorrosion (wt. loss method only). **Control methods** – sacrificial anodic protection method – corrosion inhibitors – protective coatings – pretreatment of metal surface – metallic coating: electroplating, electroless plating and hot dipping (tinning and galvanizing) methods – non-metallic coating: anodizing – organic coating: paints, constituents and functions – ceramic coatings.		
Unit – IV	**FUELS AND COMBUSTION**	**9**
Introduction – classification of fuels – characteristics of a good fuel – combustion – calorific values – gross and net calorific values – theoretical calculation of calorific value by Dulong's formula – flue gas analysis by Orsat's method – 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 process – knocking: spark ignition engine – octane number, compression ignition engine – cetane number – power alcohol and biodiesel – gaseous fuel – water gas – introduction of Bharat Stage Emission Standard (BSES) system.		
Unit – V	**CHEMISTRY OF ENGINEERING MATERIALS**	**9**
Lubricants: Introduction – classification – properties : viscosity, viscosity index, flash and fire point, cloud and pour point, oiliness, aniline point and carbon residue. **Explosives:** Introduction - classification – manufacture of important explosives (TNT, GTN and RDX). **Rocket propellants:** Introduction – properties and classification. **Abrasives**: Introduction-properties of abrasives – types of abrasives: i) natural abrasives – diamond, corundum and quartz ii) synthetic abrasives – silicon carbide, boron carbide – industrial applications of abrasives. **Adhesives**: Introduction-requisites of a good adhesive-advantages and disadvantages of adhesive bonding- adhesive action-classification of adhesives-industrial applications of adhesives.		
		Total:45

TEXT BOOK:

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

REFERENCES:

1.	Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., "Environmental Science", Pearson Education, New Delhi, Revised Edition 2019.
2.	Dara .S.S, "A Text book of Engineering Chemistry", S. Chand and company Ltd., 2021.
3.	Sunita Rattan, " A Text book of Engineering Chemistry", S.K. Kataria& Sons Publishers, First edition, 2018, Reprint-2022.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the principles of electrochemistry for various applications	Applying (K3)
CO2	use the concepts of batteries, fuel cells and their applications in various fields.	Applying (K3)
CO3	make use of corrosion control methods to solve corrosion related issues.	Applying (K3)
CO4	apply the concepts of fuels and combustion for engineering applications	Applying (K3)
CO5	utilize the concepts of lubricants, explosives and adhesives 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	PSO 2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

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)

22MET21 - ENGINEERING MATERIALS AND METALLURGY

Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Physics for Mechanical Engineering**	**2/4**	**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 processes and their influence on the physico-mechanical properties of metals.	
Unit - I	**Ferrous Metals**	**9**
Classification of Engineering Materials - Comparison between Metals and Non-Metals - Alloys - Solid Solutions - Principles of Alloy Formation - Substitutional and Interstitial - Phase Diagrams - Lever Rule - Isomorphous - Eutectic - Eutectoid - Peritectic and Peritectoid Reactions - Iron - Iron Carbide Equilibrium Diagram - Classification of Steel and Cast Iron - Microstructure - Properties and Applications - Ferrite and Austenite Stabilizers.		
Unit - II	**Ferrous and Non-Ferrous Alloys**	**9**
Effect of Alloying Elements - Manganese - Silicon - Chromium - Molybdenum - Vanadium - Titanium and Tungsten on the Technical Properties of Steel - Stainless and Tool Steels - High Strength Low Alloy Steels - Maraging Steels - Aluminium and its Alloys - Precipitation Strengthening Treatment - Copper and its Alloys - Magnesium and its Alloys - High Entropy Alloys.		
Unit - III	**Heat Treatment**	**9**
Definition - Purpose of Heat Treatments - Nucleation, Grain Growth and Kinetics - Full Annealing - Stress Relief - Recrystallization and Spheroidizing - Normalizing - Quenching - Hardening and Tempering of Steel - Isothermal Transformation Diagrams - Cooling Curves Superimposed on Time Temperature Transformation Diagram - Critical Cooling Rate - Austempering - Martempering - Hardenability - Jominy End Quench Test. Case Hardening - Carburizing - Nitriding - Cyaniding - Carbonitriding - Flame and Induction Hardening.		
Unit – IV	**Polymers and Ceramics**	**9**
Polymers – Types - Thermoset and Thermoplastics - Glass Transition and Melting Temperature of Polymers - Structures - Properties and Applications of Polyethylene - Polypropylene - Polystyrene - Polyvinyl chloride - Poly methyl methaacrylate - Polyethylene terephthalate - Polycarbonate - Polyamide - Polyimide - Polyamide-imide - Polyphenylene oxide - Polyphenylene sulfide - Polyether ether ketone - Polytetrafluroethylene - Urea - Phenolformaldehydes. Processing - Extrusion - Injection molding - Compression molding - Transfer molding - Extrusion blow molding - Rotational molding - Thermoforming. Engineering Ceramics - Properties and Applications of Alumina - Silicon Carbide - Silicon Nitride - Partially Stabilized Zirconia and Sialon.		
Unit - V	**Powder Metallurgy and Introduction to New Materials**	**9**
Introduction - Production of Metallic Powders - Processing Methods - Compaction Methods - Design Consideration in Powder Metallurgy - Products. Anisotropic materials - Composites - Fiber and Particulate Reinforced Materials - Biomaterials - 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., 2017 for Units I, II, III, IV.
2.	Sina Ebnesajjad. “Handbook of Biopolymers and Biodegradable Plastics: Properties, Processing and Applications”, 1st Edition, Elsevier, Amsterdam, Netherlands, 2013 for Unit V.

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the microstructure, composition and properties of ferrous metals	Understanding(K2)
CO2	interpret the effect of alloying elements on the technical properties of ferrous and non-ferrous metals	Applying (K3)
CO3	apply the principles of heat-treatment processes	Understanding(K2)
CO4	demonstrate the structure-property relationship and allied applications of polymers and ceramics	Understanding(K2)
CO5	reveal the principles of metal-forming process and infer the development of new materials	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												3
CO2	3	2		1										3
CO3	3	2		1										3
CO4	3													3
CO5	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	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

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

22CSC21 – FUNDAMENTALS OF DATA STRUCTURES

(Common to Civil, Mechanical, Automobile, Chemical Branches)

Programme & Branch	**BE - Civil, Mechanical, Automobile & BTech – Chemical Engineering Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Programming in C**	**2**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course is indented to introduce the concept of elementary data structures and notion of algorithms to novice learner from cross disciplines in Engineering and Technology.	
Unit – I	**List**	**9**
Data Structures - Abstract Data Types (ADT) - List ADT and Array Implementation - Linked List- Singly Linked List- Insertion - Deletion - Copying Singly Linked List - Doubly Linked List- Insertion -Deletion.		
Unit – II	**Stack and Queues**	**9**
Stack ADT – Array and Linked List implementation of Stacks - Application: Balancing Parenthesis – Infix to Postfix - Postfix Expression Evaluation - Queue ADT – Array and Linked List implementation of Queues – Applications		
Unit – III	**Trees**	**9**
Trees- Preliminaries – Binary Trees –Binary Tree Traversals - The Search Tree ADT – Binary Search Trees– Operations : Find – FindMin – FindMax – Insertion – Deletion- Expression Tree		
Unit – IV	**Graphs**	**9**
Graphs – Definitions – Graph Traversals: Breadth First Search – Depth First Search - Shortest-Path Algorithms: Unweighted Shortest Paths – Dijkstra's Algorithm – Minimum Spanning Tree – Prim's Algorithm- Kruskal's Algorithm		
Unit – V	**Sorting and Hashing**	**9**
Sorting - Preliminaries – Insertion Sort – Quicksort – Merge sort – Hashing – General Idea – Hash Function – Separate Chaining – Open Addressing		

LIST OF EXPERIMENTS / EXERCISES:

1.	Implementation of C programs using pointers
2.	Implementation of singly linked list and its operations
3.	Implementation of doubly linked list and its operations
4.	Implementation of Stack and its operations
5.	Implementation of Queue and its operations
6.	Implementation of Stack and Queue using Singly Linked List
7.	Evaluate the Post-fix Expression using Stack ADT
8.	Implementation of Binary Search Tree traversals
9.	Implementation of Insertion sort and Quick sort
10.	Implementation of hash function

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Weiss M. A., "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education Asia, New Delhi, 2016.

REFERENCES/ MANUAL / SOFTWARE:

1.	Horowitz Sahni, Andreson Freed, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, Hyderabad, 2011.
2.	Langsam Y.M., Augenstein J. and Tenenbaum A. M., "Data Structures using C and C++", 2nd Edition, Pearson Education, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply List ADT for solving the given problems	Applying (K3)
CO2	make use of arrays and linked lists to create Stack and Queue ADTs.	Applying (K3)
CO3	utilize Tree ADT to develop simple application	Applying (K3)
CO4	make use of Graph ADT for standard problems	Applying (K3)
CO5	illustrate the use of standard sorting and Hashing Techniques	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

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	30				100
CAT2	5	35	60				100
CAT3	5	35	60				100
ESE	5	35	60				100

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

22EET14 - ELECTRICAL AND ELECTRONICS ENGINEERING

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

Preamble	This course is aimed to introduce the fundamental concepts and principles in Electrical and Electronics	
Unit – I	**Introduction**	**9**

Introduction: Electric Potential, Current, Power and Energy -Renewable and Non Renewable sources of Energy-Structure of Electric Power System -Electrical Safety Aspects as per IE rules
Electric Circuits : Solving simple DC Circuits using KVL and KCL- Single phase AC circuit fundamentals – Power, Power factor – solving simple AC circuits – 3 phase AC circuits (qualitative analysis)

UNIT – II	**DC Machines and Transformers**	**9**

DC MOTORS: Principle of Operation- types – back emf – torque equation - speed torque characteristics – losses and efficiency – speed control of DC motor –Applications.
Transformers: Single phase Transformers – Construction and working principle – Types, Emf equation

UNIT – III	**AC Machines and Drives**	**9**

AC MOTORS: 3 phase Induction Motor -construction– Principle of operation – types – torque equation - speed torque characteristics – 1 phase Induction Motor – Principle of operation- types. Synchronous Motors – construction - Principle of Operation.
INDUSTRIAL APPLICATIONS: Motor Selection – factors to be considered – power rating – types of Duty cycle – selection of motors for machine tools applications, centrifugal pumps.

UNIT – IV	**Electronic Devices and Circuits**	**9**

ELECTRONIC DEVICES: Construction, principle of operation, types and Characteristics: PN junction diodes, -zener diode - BJT- – Light emitting diode - Principles and Applications.
ELECTRONIC CIRCUITS: (Qualitative analysis only) Half wave and full wave rectifier, capacitive filters, zener voltage regulator, UPS and SMPS (Block Diagram approach).

UNIT – V	**DIGITAL ELECTRONICS and INTEGRATED CIRCUITS**	**9**

DIGITAL ELECTRONICS: Logic gates, Half adder, full adder, Full subtractor, Flip flops and Asynchronous Binary Ripple Counter
LINEAR INTEGRATED CIRCUITS: Operational amplifiers, Ideal op-amp characteristics, Inverting and Non-inverting amplifier (Qualitative analysis), op-amp applications.

Total:45

TEXT BOOK:

1.	Muthusubramanian.R, Salivahanan.S and Muraleedharan.K.A, “Basic Electrical, Electronics and Computer Engineering”, Tata McGraw Hill Publishers, 2010.

REFERENCES/ MANUAL / SOFTWARE:

1.	Dubey G.K., “Fundamentals of Electrical Drives”, 2nd Edition, Narosa Publishing House, New Delhi, 2010..
2.	Jegathesan V., Vinoth Kumar K. and Saravanakumar R., “Basic Electrical and Electronics Engineering”, 1st Edition, Wiley India, 2011.
3.	Mehta.V.K and Rohit Mehta, “Principles of Electrical Engineering and Electronics”, S.Chand & Co. Limited.,New Delhi, 2006

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

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1									2	3
CO2	3	2											1	2
CO3	3	2	1	1									1	2
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	20	60	20				100
CAT2	30	70					100
CAT3	30	70					
ESE	20	60	20				100

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

22TAM01 - தமிழர் மரபு							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2 / 1**	**HS**	**1**	**0**	**0**	**1**

Preamble	தமிழர்களின் மொழி, இலக்கியம், ஓவியங்கள், சிற்பக்கலைகள், நாட்டுப்புறக் கலைகள், வீர விளையாட்டுக்கள், திணைக் கோட்பாடுகள், இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பைப் பற்றிய அறிவை வழங்குவதே இந்த பாடத்தின் நோக்கமாகும்.	
அலகு – I	**மொழி மற்றும் இலக்கியம்**	**3**
இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.		
அலகு – II	**மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**	**3**
நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.		
அலகு – III	**நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுக்கள்**	**3**
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.		
அலகு – IV	**தமிழர்களின் திணைக் கோட்பாடுகள்**	**3**
தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு- சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும் கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.		
அலகு – V	**இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**	**3**
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறபகுதிகளில் தமிழ் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.		
		Total: 15

TEXT BOOK:

1.	ஆ. பூபாலன், தமிழர் மரபு, VRB Publishers Pvt Ltd, 2022.

REFERENCES:

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

COURSE OUTCOMES: படிப்பை முடித்தவுடன், மாணவர்கள்		BT Mapped (Highest Level)
CO1	தமிழ் மொழி மற்றும் இலக்கியத்தில் மதிப்புமிக்க கருத்துக்களை விளக்க முடியும்.	Understanding (K2)
CO2	தமிழர்களின் சிற்பம் மற்றும் அவர்களின் ஓவியங்கள் பற்றி விளக்க முடியும்.	Understanding (K2)
CO3	தமிழர்களின் நாட்டுப்புற மற்றும் தற்காப்புக் கலைகளைப் பற்றி சுருக்கமாகக் கூற முடியும்.	Understanding (K2)
CO4	தமிழர்களின் திணைக் கோட்பாடுகளைப் பற்றி விளக்க முடியும்.	Understanding (K2)
CO5	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு பற்றி விளக்க முடியும்.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22TAM01 - HERITAGE OF TAMILS								
(Common to All Engineering and Technology Branches)								
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2 / 1**	**HS**	**1**	**0**	**0**	**1**

Preamble	The objective of this course is to impart knowledge about Tamil language, literature, paintings, sculptures, folk arts, heroic games, doctrines, contribution of Tamils to Indian culture.

UNIT I	**Language and Literature**	**3**
Language families in india - dravidian languages – tamil as a classical language - classical literature in tamil – secular nature of sangam literature – distributive justice in sangam literature - management principles in thirukural - tamil epics and impact of buddhism & jainism in tamil land - bakthi literature azhwars and nayanmars - forms of minor poetry - development of modern literature in tamil - contribution of bharathiyar and bharathidhasan.		
UNIT II	**Heritage - Rock Art Paintings to Modern Art – Sculpture**	**3**
Hero stone to modern sculpture - bronze icons - tribes and their handicrafts - art of temple car making - - massive terracotta sculptures, village deities, thiruvalluvar statue at kanyakumari, making of musical instruments - mridhangam, parai, veenai, yazh and nadhaswaram - role of temples in social and economic life of tamils.		
UNIT III	**Folk and Martial Arts**	**3**
Therukoothu – karagattam - villu pattu - kaniyan koothu – oyillattam - leather puppetry – silambattam – valari - tiger dance - sports and games of tamils.		
UNIT IV	**Thinai Concept of Tamils**	**3**
Flora and fauna of tamils & aham and puram concept from tholkappiyam and sangam literature - aram concept of tamils - education and literacy during sangam age - ancient cities and ports of sangam age - export and import during sangam age - overseas conquest of cholas.		
UNIT V	**Contribution of Tamils to Indian National Movement and Indian Culture**	**3**
Contribution of tamils to indian freedom struggle - the cultural influence of tamils over the other parts of india – self-respect movement - role of siddha medicine in indigenous systems of medicine – inscriptions & manuscripts – print history of tamil books.		
		Total: 15

TEXT BOOK:

1.	S.Muthuramalingam, M.Saravanakumar, Heritage of Tamils, Yes Dee Publishing Pvt Ltd, 2023.

REFERENCES:

1.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies).
2.	The Contribution of Tamil of the Tamils to Indian Culture(Dr.M.Valarmathi)(Puplished by International Institute of Tamil Studies).
3.	Keeladi – ‘Sangam City C ivilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu).

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain valuable concepts in language and literature of tamils.	Understanding (K2)
CO2	illustrate about the tamils sculpture and their paintings.	Understanding (K2)
CO3	summarize about the tamils folk and martial arts.	Understanding (K2)
CO4	explain the thinai concept of tamils.	Understanding (K2)
CO5	explain the contribution of Tamils to the Indian National Movement and Indian culture.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22TAM02 - தமிழரும் தொழில்நுட்பமும்

(Common to All Engineering and Technology Branches)

Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2 / 3**	**HS**	**1**	**0**	**0**	**1**

முன்னுரை	தமிழ் கலாச்சாரத்தோடு ஒன்றிய தொழில் நுட்பங்களை பற்றிப் எடுத்துரைத்தல்

அலகு – I	**நெசவு மற்றும் பானை தொழில்நுட்பம்**	**3**

சங்க காலத்தில் நெசவு தொழில் – பானைத் தொழில்நுட்பம் கருப்பு சிவப்பு பாண்டங்கள் – பாண்டகளில் கீறல் குறியீடுகள்

அலகு – II	**வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**	**3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப்பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச்சிற்பங்களும், கோவில்களும் – சோழர் காலத்து பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் –மாதிரிகட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னை இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு – III	**உற்பத்தித் தொழில்நுட்பம்**	**3**

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

அலகு – IV	**வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம்**	**3**

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

அலகு – V	**அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்**	**3**

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

Total:15

TEXT BOOK:

1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியில் பணிகள் கழகம்), உலகத் தமிழாராய்ச்சி நிறுவனம், சென்னை, 2002
2.	கணினித்தமிழ் முனைவர் இல. சுந்தரம், விகடன் பிரசுரம், 2016

REFERENCES:

1.	கீழடி-வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
2.	பொருநை-ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
3.	Social Life of Tamils (Dr.K.K.Pillay) A joint Publication of TNTB & ESC and RMRL – (in print)
4.	Social Life of the Tamils – The Classical Period (Dr.S.Sigaravelu) (Published by: International Institute of Tamil Studies).
5.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies)
6.	The Contribution of the Tamil to Indian Culture (Dr.M.Valarmathi) (Puplished by International Institute of Tamil Studies).
7.	Keeladi – 'Sangam City Civilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu)
8.	Studies in the History of India with Special Reference to Tamilnadu (Dr.K.K.Pillay) (Published by: The Author)
9.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamilnadu Textbook and Educational Services Corporation, Tamilnadu)

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

COURSE OUTCOMES: படிப்பை முடித்தவுடன், மாணவர்கள்		BT Mapped (Highest Level)
CO1	தமிழ் கலாச்சாரம் மற்றும் தமிழ் சமூகத்தினுடைய நெசவு மற்றும் பானை தொழில்நுட்பம் பற்றி விளக்க முடியும்.	Understanding (K2)
CO2	தமிழர்களின் வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்ப ஆற்றல் பற்றி விளக்க முடியும்.	Understanding (K2)
CO3	தமிழர்களின் உற்பத்தித் தொழில்நுட்பம் பற்றி சுருக்கமாகக் கூற முடியும்.	Understanding (K2)
CO4	தமிழர்களின் வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் பற்றி விளக்க முடியும்.	Understanding (K2)
CO5	தமிழர்களின் அறிவியல் தமிழ் மற்றும் கணினித்தமிழ் பற்றி விளக்க முடியும்.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22TAM02 - TAMILS AND TECHNOLOGY

(Common to All Engineering and Technology Branches)

Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2 / 3**	**HS**	**1**	**0**	**0**	**1**

Preamble	This course aims to impart the essential knowledge on the tamil culture and related technology	
UNIT – I	**WEAVING AND CERAMIC TECHNOLOGY**	**3**
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.		
UNIT – II	**DESIGN AND CONSTRUCTION TECHNOLOGY**	**3**
Designing and Structural construction House & Designs in household materials during Sangam Age – Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram – Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places – Temples of Nayaka Period – Type study (Madurai Meenakshi Temple) – Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo – Saracenic architecture at Madras during British Period.		
UNIT – III	**MANUFACTURING TECHNOLOGY**	**3**
Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting, steel – Copper and gold – Coins as source of history – Minting of Coins – Beads making – industries Stone beads – Glass beads –Terracotta beads –Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram.		
UNIT – IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	**3**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry – Wells designed for cattle use – Agriculture and Agro Processing – Knowledge of Sea – Fisheries – Pearl – Conche diving – Ancient Knowledge of Ocean – Knowledge Specific Society.		
UNIT – V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	**3**
Development of Scientific Tamil – Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.		
		Total:15

TEXT BOOK:

1.	Social Life of Tamils (Dr.K.K.Pillay) A joint Publication of TNTB & ESC and RMRL – (in print)
2.	Social Life of the Tamils – The Classical Period (Dr.S.Sigaravelu) (Published by: International Institute of Tamil Studies).

REFERENCES:

1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியில் பணிகள் கழகம்), உலகத் தமிழாராய்ச்சி நிறுவனம், சென்னை, 2002
2.	கணினித்தமிழ் முனைவர் இல. சுந்தரம், விகடன் பிரசுரம், 2016
3.	கீழடி வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
4.	பொருநை ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு
5.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies)
6.	The Contribution of the Tamils to Indian Culture (Dr.M.Valarmathi)(Puplished by International Institute of Tamil Studies).
7.	Keeladi – 'Sangam City Civilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu)
8.	Studies in the History of India with Special Reference to Tamilnadu (dr.K.K.Pillay) (Published by : The Author)
9.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamilnadu Textbook and Educational Services Corporation, Tamilnadu)
10.	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain weaving and ceramic technology in tamil culture and tamil society.	Understanding (K2)
CO2	Illustrate about the design and construction technology.	Understanding (K2)
CO3	summarize about the manufacturing technology.	Understanding (K2)
CO4	explain the agriculture and irrigation technology.	Understanding (K2)
CO5	explain the significance of tamil in scientific and computing.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22CYL22 –CHEMISTRY LABORATORY FOR MECHANICAL SYSTEMS							
(Common to Mechanical, Mechatronics and Automobile branches)							
Programme & Branch	**B.E - Mechanical, Mechatronics and Automobile branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**0**	**0**	**2**	**1**

Preamble	This course aims to impart the basic concepts of volumetric, conductometric, complexometric, calorimetric, pH meteric, potentiometric, spectrophotometric experiments and thereby to improve the analytical capability to engineering students. It also aims to impart the knowledge on the estimation of Fe, Ni, S, Ca & Mg, DO, COD in mechanical applications.

LIST OF EXPERIMENTS / EXERCISES:

1.	Determination of strength of an unknown solution using pH meter.
2.	Analysis and comparison of the strength of acids in the given mixture using conductivity meter.
3.	Potentiometric approach using a Pt electrode for the estimation of iron in the given sample.
4.	Spectrophotometric method for the determination of Iron in steel.
5.	Determination of molecular weight of a polymer / liquid by Ostwald viscometer.
6.	Volumetric analysis of nickel by complexometric method.
7.	Estimation of sulphur present in fuel using electro-analytical techniques.
8.	Assessment of the given water sample for the suitability of drinking / industrial purpose by estimating the calcium,magnesium and total hardness by EDTA method.
9.	Determination of dissolved oxygen in the given wastewater sample.
10.	Determination of COD of the given wastewater sample.
11.	Electroplating process (Demonstration).
12.	Proximate analysis of Coal - determine moisture, volatile matter and ash content of a given sample of coal (Demonstration).
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., “Chemistry Laboratory Manual”, 1st Edition, Rajaganapathy Publishers, Erode, 2022.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	estimate the hardness, DO and COD present in the given water sample.	Applying (K3), Precision (S3)
CO2	analyze the amount of Fe, Ni, conductivity and pH of the given solution.	Applying (K3), Precision (S3)
CO3	demonstrate the viscometer for the determination of molecular weight of polymer and sulphur content in coal.	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	3			3							
CO2	3	2	1	3			3							
CO3	3	2	1	3			2							

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

22EEL14 - ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

Programme & Branch	**B.E – Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**ES**	**0**	**0**	**2**	**1**

Preamble	To provide knowledge about basic concepts in electrical and electronics engineering

LIST OF EXPERIMENTS / EXERCISES:

1.	Resistor color coding and verification of Ohm's Law and Kirchhoff's Laws
2.	Computation of Current in a Loop using Mesh analysis
3.	Speed control of DC shunt motor
4.	Load test on single phase transformer
5.	Load test on three phase induction motor
6.	Speed control of Three phase induction motor using PWM inverter
7.	Characteristics of BJT
8.	Implementation of Half wave and Full wave Rectifier with simple Capacitor Filter
9.	Verification of logic gates
10.	Op-amp based Inverting and Non-Inverting amplifiers
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

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

Mapping of Cos with POs and PSOs

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

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

22GCL11 – Foundation Laboratory - Manufacturing, Design and Robotics

(Common to All BE/BTech branches)

Programme& Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**1 / 2**	**ES**	**0**	**0**	**6**	**3**

Preamble	This course is designed to provide foundational knowledge on engineering with hands-on experience on developing a prototype model with the basic knowledge of Computer-aided Design, Manufacturing Processes, 3D Printing Technology, Robotics and Embedded Control.

LIST OF EXPERIMENTS / EXERCISES:

PART A – Manufacturing (30 Hours)

1.	Selection of product, free hand sketching and detailing
2.	Construction of model using Arc/TIG/MIG/Gas/Spot welding operations
3.	Enhancing the model with sheet metal
4.	Creating the parts of the model using lathe
5.	Creating the parts of the model using milling and drilling machines

PART B – Product Design and Development (30 Hours)

1.	Free hand sketching and detailing of the component
2.	3D part modelling of the component using CAD software
3.	Engineering Analysis of the component model
4.	Generate the component using 3D printer
5.	Value addition to the produced component using CNC milling machine, CNC laser cutting machine and CNC router

PART C – Robotics (30 Hours)

1.	Design of electronic circuit and its debugging
2.	Interfacing of sensors, actuators and wireless communion modules with microcontroller
3.	Assembly of Tracker Robot with accessories
4.	Development of control strategies for motion control, path planning and obstacle avoidance
5.	Demonstration and testing of Robot in static environment

Total:90

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	AutoCAD 2020 and SOLID WORKS 2018 Software

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	develop the prototype model using mechanical operations like welding, forming and machining processes	Applying (K3), Precision (S3)
CO2	sketch 3D model and enhance the prototype using modern machines like 3D printer, CNC milling machine, CNC Laser cutter and CNC Router	Applying (K3), Precision (S3)
CO3	design and develop the autonomous robot for real-time applications	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	3	3		2				3	2		2		
CO2	3	3	3		3				3	2		2		
CO3	3	3	3		2				3	2		2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy														

22ITC32 - INTRODUCTION TO PYTHON							
(Common to Civil, Mechanical, Chemical& Automobile Engineering branches)							
Programme & Branch	**BE- Civil, Mechanical, Automobile & BTech – Chemical Engineering branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**ProblemSolvingandProgramming in C**	**3/4**	**ES**	**3**	**0**	**2**	**4**

Preamble	This course deals with core python programming. It gives a comprehensive introduction to problem solving using python constructs and libraries.

Unit – I	**Introduction:**	**9**

Problem solving strategies – program design tools – Types of errors – Testing and Debugging- Basics: Literals – variables and identifiers – data types – input operation – comments – reserved words – indentation – Operators and Expressions – Decision Control Statements: Introduction – conditional statement – iterative statements – Nested Loops – break, continue and pass statements – else inloops.

Unit – II	**Lists, Tuples and Dictionary:**	**9**

Lists: Access, update, nested, cloning, operations, methods , comprehensions, looping – Tuple: Create, utility, access, update, delete, operations, assignments, returning multiple values, nested tuples, index and count method – Dictionary: Create, access, add and modify, delete, sort, looping, nested, built-in methods – list vs tuple vs dictionary.

Unit – III	**Strings and Regular Expressions:**	**9**

Strings: Concatenation , append, multiply on strings – Immutable – formatting operator – Built-in string methods and functions – slice operation – functions – operators – comparing – iterating – string module – Regular Expressions – match, search, sub, findall and finditer functions – flag options.

Unit – IV	**Functions and Modules:**	**9**

Functions: Introduction – definition – call – variable scope and lifetime – return statement – function arguments – lambda function – documentation strings – programming practices recursive function- Modules: Modules – packages – standard library methods – functionredefinition.

Unit – V	**Object Orientation:**	**9**

Class and Objects: Class and objects – class methods and self – constructor – class and object variables – destructor – public and private data member. NumPy : NumPy Arrays – Computation on NumPy Arrays. Matplotlib : Line plots – Scatter Plots

LIST OF EXPERIMENTS / EXERCISES:

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

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Reema Thareja., “Python Programming using problem solving approach”, 3rd impression, Oxford University Press., New Delhi, 2017.

REFERENCES/ MANUAL / SOFTWARE:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	use basic Python constructs to build simple programs	Applying(K3), Precision(S3)
CO2	apply list, tuple, and dictionary to handle a variety of data.	Applying(K3), Precision(S3)
CO3	apply strings and regular expressions for searching and retrieval	Applying(K3), Precision(S3)
CO4	solve the problems using functions and modules.	Applying(K3), Precision(S3)
CO5	apply object-oriented concepts and perform basic data science operations using Python	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	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	15	75				100
CAT2	10	15	75				100
CAT3	10	15	75				100
ESE	10	15	75				100

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

22MEC31 - FLUID MECHANICS AND HYDRAULIC MACHINES

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

Preamble	This course provides an introduction to the properties and behavior of fluids under static and dynamic conditions. It introduces dimensional analysis and performance analysis of hydraulic machines.

Unit - I	**Fluid Properties and Statics**	**9**

Fluid Properties: Definition of Fluid - Classifications - Properties - Mass Density - Specific Weight - Specific Gravity - Viscosity - Compressibility - Vapour Pressure - Surface Tension - Capillarity. Fluid Statics: Pascal's Law - Pressure Variation in a Fluid at Rest - Absolute Pressure - Gauge Pressure - Atmospheric Pressure - Vacuum Pressures - Simple Manometer - Differential Manometer - Hydrostatic Forces.

Unit - II	**Fluid Kinematics and Dynamics**	**9**

Fluid Kinematics: Control Volume -Types of Fluid Flows – Continuity Equation in Two and Three Dimensions (Cartesian Co-ordinates) – Velocity Potential Function and Stream Function. Fluid Dynamics: Momentum – Energy - Euler's Equation of Motion along a Streamline – Bernoulli's Equation and Applications – Venturimeter – Orificemeter - Pitot Tube.

Unit - III	**Flow through Pipes and Dimensionless Number**	**9**

Flow through Pipes: Flow of Viscous Fluid through Circular Pipe - Loss of Energy in Pipes Loss of Energy due to Friction (Darcy-Weisbach and Chezy's formula) - Minor Energy losses - Pipes in Series - Pipes in Parallel - Boundary Layer Concepts. DimensionlessNumber: Dimensional Analysis - Dimensionless Number.

Unit - IV	**Impact of Jet and Hydraulic Turbines**	**9**

Impact of Jet: Impact of Jets - Work Done and Force Exerted by a Liquid on Moving Flat Vanes - Efficiency - Work Done and Force Exerted by a Liquid on Unsymmetrical Moving Curved Vane - Efficiency - Velocity Triangles. Hydraulic Turbines: Classifications - Design - Work Done and Efficiencies of Pelton Wheel Turbine - Francis Turbine - Kaplan Turbine - Velocity Triangles - Specific Speed of Turbines.

Unit – V	**Hydraulic Pumps**	**9**

Definitions of Heads - Efficiencies and Work Done of a Centrifugal Pump - Velocity Triangles - Cavitation - Specific Speed of Pumps - Working Principles of Single Acting and Double Acting Reciprocating Pump - Basic Principles of Indicator Diagram.

LIST OF EXPERIMENTS / EXERCISES:

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

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Sukumar Pati. "Fluid Mechanics and Hydraulic Machines". 1st Edition, Mc Graw Hill Education, Chennai, Reprint, 2018.

REFERENCES:

1.	Subramanya K., "Fluid Mechanics and Hydraulic Machines", 2nd Edition, Mc Graw Hill Education, Chennai, 2021.
2.	Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 11th Edition, Laxmi Publications, New Delhi, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the fluid properties and study the pressure measurements	Applying (K3) Precision (S3)
CO2	solve the problems related to kinematics and dynamics of fluid flow.	Applying (K3) Manipulation (S2)
CO3	calculate the energy losses in flow through pipes.	Applying (K3) Manipulation (S2)
CO4	interpret the work done and efficiencies of various hydraulic turbines.	Applying (K3) Manipulation (S2)
CO5	determine the work done and efficiencies by the various hydraulic pumps.	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	3	3								2		
CO3	3	2	3	3								2		
CO4	3	2	3	3						1		2		
CO5	3	2	3	3						1		2		

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

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	25	60				100
CAT2	15	25	60				100
CAT3	15	25	60				100
ESE	10	30	60				100

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

22MET31 - MANUFACTURING TECHNOLOGY							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Physics for Mechanical Engineering**	**3**	**PC**	**3**	**0**	**0**	**3**

Preamble	To provide the basic concepts and techniques of metal casting processes, deformation processes, special welding processes and fundamentals of additive manufacturing processes.

Unit - I	**Metal Casting Processes**	**9**
Introduction - Classification - Types of Casting Processes - Pattern: Types - Material - Allowances - Molding Sand - Preparation for Sand Casting - Properties - Cores: Types - Applications - Heating - Pouring - Cooling - Solidification of Pure Metals and Alloys - Directional Solidification - Design: Runner - Riser - Gate.		
Unit - II	**Special Casting Processes**	**9**
Expendable Mold Casting Processes – Shell Molding – Vacuum Molding – Expanded Polystyrene Process – Investment Casting – Plastic Mold Casting – Ceramic Mold Casting – Permanent Mold Casting – Die Casting – Centrifugal Casting – Continuous Casting – Squeeze Casting – Slush Casting – Defects in Casting.		
Unit - III	**Welding Processes**	**9**
Introduction – Fusion Welding Processes: Arc Welding – Gas Welding – Resistance Spot Welding – Electron Beam Welding – Laser Beam Welding – Electro Slag Welding – Thermit Welding – Solid State Welding Processes: Friction Stir Welding – Forge Welding – Diffusion Welding – Explosive Welding – Friction Welding – Ultrasonic Welding – Soldering and Brazing.		
Unit - IV	**Metal Forming Processes**	**9**
Bulk Deformation Processes – Hot Working and Cold Working Processes – Rolling Process – Types: Transverse Rolling – Thread Rolling – Shape Rolling – Ring Rolling – Tube Piercing – Skew Rolling. Forging Process – Types: Open Die Forging – Closed Die Forging – Upsetting - Swaging – Radial forging – Roll Forging. Extrusion Process – Types: Direct Extrusion – Indirect Extrusion – Hydrostatic Extrusion. Drawing Process – Types: Wire Drawing – Deep Drawing – Rod Drawing – Tube Drawing. Sheet Metal Operations: Shearing – Blanking - Punching – Slotting – Perforating – Notching –Trimming – Shaving – Bending Operations: Flanging – Hemming – Seaming – Curling – Ironing – Coining - Embossing.		
Unit - V	**Fundamentals of Additive Manufacturing (AM)**	**9**
Introduction to AM – Classification of AM Processes – Types of Materials Used in AM Processes – Principles, Parameters, Applications and Limitations of: Stereolithography – Fused Deposition Modeling – Laminated Object Manufacturing – Selective Laser Sintering – Selective Laser Melting, Directed Energy Deposition based AM Processes: Laser Engineered Net Shaping – Direct Metal Deposition – Electron Beam Based Metal Deposition, Wire Arc Additive Manufacturing.		
		Total:45

TEXT BOOK:

1.	Rao P.N. “Manufacturing Technology - Foundry, Forming and Welding”, Volume - 1, 4th Edition, McGraw Hill Education Pvt Ltd., New Delhi, 2017.

REFERENCES:

1.	Serope Kalpakjian, Steven R. Schmid. “Manufacturing Engineering and Technology”, 7th Edition, Pearson Education Limited, New Delhi, 2019.
2.	Kaushish J. P.“Manufacturing Processes”, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2014.
3.	Sharma P.C. “Manufacturing Technology - I”, 5th Edition, S. Chand and Company Private Limited, New Delhi, 2010.
4.	HajraChoudhury S.K., Hajrachoudhury A.K., Nirjharroy “Elements of Workshop Technology - Vol.I”, 15th Edition, Media Promoters & Publishers Private Limited, Mumbai, 2019.
5.	Ian Gibson, David W Rosen, Brent Stucker, “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, 2nd Edition, Springer, New York, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the principles involved in metal casting processes	Understanding (K2)
CO2	describe the principles and processes involved in special casting process	Understanding (K2)
CO3	demonstrate the principles involved in various welding techniques	Understanding (K2)
CO4	illustrate the mechanisms involved in different kinds of metal forming processes	Applying (K3)
CO5	describe the principles of different additive manufacturing processes	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	75					100
CAT2	25	75					100
CAT3	10	65	25				100
ESE	10	70	20				100

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

22MET32 - ENGINEERING THERMODYNAMICS							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course aims to transfer the fundamental knowledge on thermodynamic laws and their relevant practical applications.In addition, this course covers the properties of steam, gases and atmospheric air.

Unit - I	**Basic Concepts and First Law of Thermodynamics**	**9+3**
Basic Concepts: Microscopic and Macroscopic Thermodynamics - Thermodynamic System - Closed System - Open System - Isolated System - Concept of Continuum - Property - State - Path - Process - Cycle - Quasi-Static Process - Concept of Temperature and Heat - Specific Heat Capacities - Internal Energy - Enthalpy - Work - Modes of Work - Zeroth Law of Thermodynamics. First Law of Thermodynamics: Law - Application to Closed and Open Systems - Steady Flow Energy Equation (SFEE) with reference to Thermal Equipments.		
Unit - II	**Second Law of Thermodynamics**	**9+3**
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 - Principle of Increase of Entropy - Absolute Entropy - Basic Concepts of Exergy.		
Unit - III	**Properties of Pure Substances**	**9+3**
Properties of Pure Substances -Thermodynamic Properties of Pure Substances in Solid Phase - Liquid Phase - Vapour phase — Gibbs Phase Rule - p-v Diagram - p-T Diagram - T-s Diagram - h-s Diagram - pvT Surfaces. Steam - Formation of Steam **-** Thermodynamic Properties of Steam - Use of Steam Tables and Mollier Chart - Calculations of Work Done and Heat Transfer in Non-Flow and Flow Processes.		
Unit – IV	**Ideal, Real Gases and Thermodynamic Relations**	**9+3**
Avogadro's Law - Concept of Ideal and Real Gases and its Properties - Equation of State - 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**
Definition - Properties of Atmospheric Air - Calculations of Properties of Air-Vapour Mixtures - Psychrometric Chart -Psychrometric Processes - Sensible Heating - Sensible Cooling - Cooling and Dehumidification - Heating and Humidification - Adiabatic Mixing - Evaporative Cooling - Basic Problems.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

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

REFERENCES:

1.	Claus Borgnakke, Richard E. Sonntag. "Fundamentals of Thermodynamics". 10th Edition, Wiley, U.S., 2019.
2.	Yunus A. Cengel, Michael A. Boles and Mehmet Kanoglu. "Thermodynamics: An Engineering Approach". 9th Edition, McGraw Hill Education Pvt. Ltd.,New Delhi, 2019.

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

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											2		3
CO2	3		3									2		3
CO3	3		3									2		3
CO4	3	2	1									2		3
CO5	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	15	25	60				100
CAT2	15	25	60				100
CAT3	15	25	60				100
ESE	5	25	70				100

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

22MET33 - STRENGTH OF MATERIALS							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Mechanics**	**3**	**PC**	**3**	**0**	**0**	**3**

Preamble	The course provides the various properties of materials, deformable bodies, biaxial state of stress, thin cylinders, spherical shells, types of beams, bending stresses and deflection of beams. It also imparts design of columns, torsion on circular shaft and springs.

Unit – I	**Deformation of Solids**	**9**

Stability – Strength – Stiffness – Tensile – Compressive and Shear stresses – Strain – Comparative Stress – Strain Diagram of Cast iron – Steel – Aluminium – Copper – Brass – Al_2O_3 – Glass – Commodity Plastics – High Performance Plastics and Rubber – Poisson's ratio – Lateral Strain – Simple and Compound bars – Relation between Elastic Constants – Thermal Stresses. Strain Energy: Uniaxial Loads – Gradually Applied Load – Suddenly Applied Load and Impact Load.

Unit – II	**Analysis of State of Stress**	**9**

Biaxial State of Stress – Thin Cylinders and Shells – Deformation in Thin Cylinders and Spherical Shells. Biaxial Stresses: Stresses at a Point on Inclined Planes – Principal Planes and Stresses – Mohr's Circle for Biaxial Stress- Maximum Shear Stress.

Unit – III	**Transverse Loading on Beams**	**9**

Types – Transverse Loading in Beams – Shear Force and Bending Moment in Beams – Cantilevers – Simply Supported and Overhanging Beams – Point of Contraflexure. Stresses in Beams: Theory of Simple Bending – Analysis of Stress- Load Carrying Capacity.

Unit – IV	**Deflection of Beams**	**9**

Elastic Curve of Neutral Axis of the Beam Under Normal Loads – Evaluation of Beam Deflection and Slope – Double Integration Method and Macaulay's Method. Columns: End Condition – Equivalent Length of Column – Euler's Equation – Slenderness Ratio – Rankine's Formula for Columns.

Unit – V	**Torsion on Circular Shafts and Springs**	**9**

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.

Total:45

TEXT BOOK:

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

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	calculate the stress, strain and strain energy of simple bars	Applying (K3)
CO2	analyze the biaxial state of stresses at a point in a body, thin cylinders and spherical shells	Analyzing (K4)
CO3	construct the shear force and bending moment diagrams and analyze the bending stresses of beams	Analyzing (K4)
CO4	estimate the slope and the deflection of beams and strengths of the columns	Analyzing (K4)
CO5	analyze the torsional 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
CO2	3	2	3									1		3
CO3	3	2	3									1		3
CO4	3	2	3									1		3
CO5	3	2	3									1		3

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

ASSESSMENT PATTERN – THEORY

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

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

22MNT31 - ENVIRONMENTAL SCIENCE							
(Common to All BE/BTech branches)							
Programme & Branch	**All B.E/B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3 / 6**	**MC**	**2**	**0**	**0**	**0**

Preamble	This course provides an approach to understand the various natural resources, ecosystem, bio-diversity, pollution control & monitoring methods for sustainable life and also to provide knowledge and to create awareness for engineering students on biological sciences.	
Unit – I	**Environmental Studies and Natural Resources**	**5**
Introduction to Environmental Science – uses, over-exploitation and conservation of forest, water, mineral, food, energy and land resources–case studies		
Unit – II	**Ecosystem and Biodiversity**	**5**
Ecosystems: concept and components of an ecosystem -structural and functional features – Functional attributes (Food chain and Food web only). Biodiversity: Introduction – Classification – Bio geographical classification of India- Values of biodiversity – Threats and Conservation of biodiversity - case studies.		
Unit – III	**Environmental Pollution**	**5**
Environmental Pollution: Definition – causes, effects and control measures of: (a) Air pollution - Climate change, global warming, acid rain, ozone layer depletion (b)Water pollution (c) Soil pollution - Role of an individual in prevention of pollution - case studies.		
Unit – IV	**Environmental Monitoring**	**5**
Sustainability -three pillars of sustainability- factors affecting environmental sustainability-approaches for sustainable development - Introduction to EIA - objectives of EIA - environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act.		
Unit – V	**Introduction to Biological Science**	**5**
Functions of Carbohydrates, lipids, proteins and nucleic acids - Cells and its organelles - plasma membrane, mitochondria and nucleus- Heredity and DNA - organization of DNA in cells - Genes and chromosomes- Cell division -Types of cell division- mitosis & meiosis - Cell cycle and molecules that control cell cycle.		
		Total:25

TEXT BOOK:

1.	Anubha Kaushik, and Kaushik C.P., “Environmental Science and Engineering”, 6th Multicolour Edition, New Age International Pvt. Ltd., New Delhi, 2018, for Unit-I, II, III, IV.
2.	Rastogi.SC, “Cells and Molecular Biology”, 2nd Edition, reprint, New Age International (P) Limited Publishers, New Delhi, 2008, for Unit-V.

REFERENCES:

1.	Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., “Environmental Science”, Pearson Education, New Delhi, Revised Edition 2019.
2.	Mukhtar Ahmad, “Text book of modern biochemistry", Volume I & II, Oxford & IBH Publishing Co. Pvt. LTD, Delhi, 1995.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22MEL31 - MANUFACTURING TECHNOLOGY AND MATERIAL PROPERTY TESTING LABORATORY							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course imparts hands-on training to various metal addition, forming processes and determination of essential mechanical properties of various materials

MANUFACTURING TECHNOLOGY LABORATORY

LIST OF EXPERIMENTS / EXERCISES:

1.	Prepare a Mold by using Solid /Split/Loose-piece Patterns and Mold for Hollow Objects with the help of Core.
2.	Produce Different Weld by Gas Tungsten Arc Welding (GTAW)/ Gas Metal Arc Welding (GMAW) Operations.
3.	Perform Gas Cutting and Produce Different Weld by Gas Welding and Spot Welding Operations.
4.	Make a Square/Rectangular Rod by Hand Forging Operation.
5.	Demonstrate The Injection Molding Operation by Producing Different Plastic Components.

MATERIAL PROPERTY TESTING LABORATORY

1.	Tension Test of Mild Steel and Aluminium Specimens.
2.	Double Shear Test of Mild Steel and Aluminium Specimens.
3.	Torsion Test of Mild Steel Specimen.
4.	Deflection Test of Cantilever Beam and Simply Supported Beam (Aluminium, Steel and Wood).
5.	Test on Helical Springs (Open and Closed Coil).

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	HajraChoudhury S.K. ,Hajrachoudhury A.K., Nirjharroy "Elements of Workshop Technology - Vol.I", 14^{th} Edition, Media Promoters & Publishers Private Limited, Mumbai, 2008.
2.	Rajput R.K. "Strength of Materials". 7^{th} Edition, S.Chand & Co., New Delhi, 2018
3.	Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	select suitable parameters and prepare mould and weld joints.	Applying (K3) Manipulation (S2)
CO2	perform metal forming processes, produce metal parts and plastic components.	Applying (K3) Manipulation (S2)
CO3	determine the tensile and double shear test of various materials.	Applying (K3) Manipulation (S2)
CO4	estimate the torsion and deflection test of various materials.	Applying (K3) Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

22MEL32 - MACHINE DRAWING USING AUTOCAD LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	0	0	2	1

Preamble	This course imparts the knowledge on National and International Standard of drawing and to communicate the necessary technical information required for manufacture and assembly of machine components.

LIST OF EXPERIMENTS / EXERCISES:

1.	Study of GD&T Systems with BIS Standards and Types of Keys, Pins used in Machines.
2.	Draw the Conversion of Isometric View to Orthographic View of Simple Machine Components.
3.	Draw Orthographic views of Square and Hexagonal Bolt and Nut.
4.	Draw the Assembled Sectional views of Gib and Cotter Joint.
5.	Draw the Assembled Sectional views of Knuckle Joints.
6.	Draw the Assembled Sectional views of Flange coupling.
7.	Draw the Assembled Sectional views of Simple Eccentric.
8.	Draw the Assembled Sectional views of Machine Vice.
9.	Draw the Flange Coupling front view, side view and top view using AutoCAD.
10.	Draw the Knuckle Joint front view, side view and top view using AutoCAD.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Bhatt N. D., Panchal V.M., “Machine Drawing”, 40th Edition, Charotar Publishing House Pvt. Ltd., Gujarat, 2016.
2.	Sidheswar N., Kannaiah P., Sastry V.V., “Machine Drawing”,27th Reprint, Tata-McGraw Hill Education, Chennai, 2004.
3.	Narayana K. L., Kannaiah P., and Reddy K.Venkata “Machine Drawing”, 6th Edition, New Age International Publishers Limited, NewDelhi, 2019.

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

Mapping of Cos with POs and PSOs

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

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

22EGL31 - COMMUNICATION SKILLS DEVELOPMENT LABORATORY							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3 / 4**	**HS**	**0**	**0**	**2**	**1**

Preamble	This course is designed to impart necessary skills to listen, speak, read and write in order to obtain better professional communication skills.

LIST OF EXPERIMENTS / EXERCISES:

1.	Self Introduction & Mock Interview
2.	Job Application letter with Resume
3.	Presentation: A Technical topic / Project report & a Case study
4.	Situational Dialogues / Telephonic Conversations
5.	Group Discussion
6.	Reading Aloud
7.	Listening Comprehension
8.	Writing Company Profiles
9.	Preparing reviews of a book/product/movie
10.	Pronunciation Test
	Total: 30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Orell Digital Language Lab Software

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	enhance effective listening and reading skills	Understanding (K2), Imitation (S1)
CO2	acquire professional skills required for workplace/higher education	Applying (K3), Naturalization (S5)
CO3	use English language skills effectively in various situations	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**
CO1									2	3		3
CO2									2	2		2
CO3									2	2		2

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

22MAT41 - NUMERICAL METHODS FOR ENGINEERS							
(Common to Civil,Mechanical,Mechatronics,Automobileand Food Technology Branches)							
Programme & Branch	**BE - Civil,Mechanical,Mechatronics, Automobile and BTech - Food Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**BS**	**3**	**1**	**0**	**4**

Preamble	To impart knowledge in interpolation, numerical differentiation and integration. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations and solve linear system of equations, ordinary and partial differential equations.	
Unit – I	**Solution to Algebraic and Transcendental Equations:**	**9+3**
Iteration method – 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 – II	**Interpolation:**	**9+3**
Interpolation with equal intervals: Newton‘s forward and backward difference formulae – Central difference interpolation formulae: Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange‘s interpolation formula – Newton‘s divided difference formula.		
Unit – III	**Numerical Differentiation and Integration:**	**9+3**
Differentiation using Newton‘s forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule – Simpsons 3/8thrule – Double integrals using Trapezoidal and Simpson‘s rules.		
Unit – IV	**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.		
Unit – V	**Solutions of Boundary Value Problems in PDE:**	**9+3**
Solution of one dimensional heat equation – Bender –Schmidt recurrence relation – Crank – Nicolson method – One dimensional wave equation – Solution of two dimensional Laplace equations – Solution of Poisson equation.		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:

1.	Veerarajan T, Ramachandran T., “Numerical Methods”, 1st Edition, McGraw Hill Education,Chennai, 2019.

REFERENCES:

1.	Sankara Rao. K., “Numerical Methods for Scientists and Engineers”, 3rdEdition, Prentice Hall of India Pvt. Ltd, New Delhi, 2007.
2.	Steven C. Chapra, Raymond P. Canale., “Numerical Methods for Engineers”, 7thEdition, McGraw-Hill Education, 2014.
3.	Sastry, S.S, “Introductory Methods of Numerical Analysis”, 5thEdition, PHI Learning Pvt. Ltd, 2015.
4.	Ramana B V, “Higher Engineering Mathematics”, 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply various numerical techniques to solve algebraic and transcendental equations.	Applying (K3)
CO2	perform interpolation on given data using standard numerical techniques.	Applying (K3)
CO3	understand the concepts of numerical differentiation and integration	Applying (K3)
CO4	compute the solution of first order ordinary differential equations by numerical techniques..	Applying (K3)
CO5	apply various numerical techniques for solving partial differential equations.	Applying (K3)

Mapping of Cos with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22MET41 - THERMAL ENGINEERING							
(Use of Steam Table and Refrigeration Table are 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**	**4**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides an extensive knowledge on the working of different thermal utilities such as internal combustion engines, boilers, nozzles, turbines, air compressors and refrigeration & air-conditioning systems along with the performance calculations. And also it provides the knowledge on gas and vapour power cycles.	
Unit – I	**Internal Combustion Engines**	**9**
Classifications - Internal Combustion Engine Components and their Functions - Two Stroke - Four Stroke - Petrol and Diesel Engine - Valve Timing and Port Timing Diagrams - Injection - Ignition - Lubrication and Cooling Systems - Knocking and Detonation - Performance Calculations - Exhaust Gas Analysis - Pollution Control Norms and Methods - Catalytic Converters - EGR - SCR – DPF - DOC.		
Unit – II	**Gas Power Cycles and Vapour Power Cycle**	**9**
Gas Power Cycles: Otto Cycle - Diesel Cycle - Dual Cycle - Brayton Cycle - Calculation of Mean Effective Pressure and Air Standard Efficiency - Actual and Theoretical p-v Diagrams. Vapour Power Cycle: Rankine Cycle - Reheat - Regeneration.		
Unit – III	**Steam Boilers, Nozzles and Turbines:**	**9**
Steam Boilers: Classification - Fire Tube and Water Tube Boilers - Mountings and Accessories - High Pressure Boilers - Types - Supercritical Boilers. Steam Nozzles: Flow of Steam through Nozzles - Shapes of Nozzle - Effect of Friction - Critical Pressure Ratio and Supersaturated Flow. Turbines: Impulse and Reaction Principles - Compounding and its Types - Velocity Diagrams for Single Stage Turbines - Governing of Turbines and its Types.		
Unit – IV	**Air Compressor**	**9**
Classifications and Working Principle of Reciprocating Air Compressor – Work Done with and without Clearance - Various Efficiencies of Reciprocating Air Compressors - Multistage Air Compressor with Inter Cooling - Work Done on Multistage Air Compressor - Rotary Compressors - Types - Working Principle (Elementary Treatment Only) - Applications.		
Unit – V	**Refrigeration and Air-Conditioning**	**9**
Refrigeration: Working Principle of Vapour Compression Refrigeration System - Superheating and Subcooling - Performance Calculations - Working Principle of Vapour Absorption Refrigeration System - NH_3-H_2O and LiBr-H_2O Systems (Elementary treatment only). Air-Conditioning: Types - Working Principle of air-conditioning Systems - Air Handling Unit (AHU) - Concept of RSHF - GSHF - ESHF - Cooling Load Calculations (Basic Problems in Summer and Winter Air-Conditioning).		
		Total:45

TEXT BOOK:

1.	Rajput R.K. “Thermal Engineering”. 11th Edition, Laxmi Publications, New Delhi, 2020.

REFERENCES:

1.	Ballaney P.L., “Thermal Engineering”. 25th Edition, Khanna Publisher, New Delhi, 2018.
2.	Mahesh M. Rathore. “Thermal Engineering”. 1st Edition, McGraw Hill Publications, New Delhi, 2010.
3.	Yunus A. Cengel, Michael A. Boles, and Mehmet Kanoglu. “Thermodynamics: An Engineering Approach”. 9th Edition, McGraw Hill Education Pvt. Ltd.,New Delhi, 2019.

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

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3									1		3
CO2	3	2	3									1		3
CO3	3	1	2									1		3
CO4	3		3									1		3
CO5	3	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	40	45				100
CAT2	15	40	45				100
CAT3	15	40	45				100
ESE	5	40	55				100

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

22MET42 - MACHINING AND MEASUREMENTS							
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	This course depicts the metal cutting principles, machine tools and its parts, components materials and the working principles of various unconventional machining processes. It also provides the fundamentals of measurements and measurement devices.	
Unit – I	**Theory of Metal Cutting:**	**9**
Elements of Cutting Process – Classification of Cutting Tools – Tool Materials – Nomenclature of Single Point Cutting Tool – Milling Tool – Drilling Tool. Mechanics of Metal Cutting: Chip Formation and its Types – Chip Breakers – Merchant Circle Diagram – Cutting Force Calculation – Cutting Fluids – Tool Wear – Tool Life – Taylor's Tool Life Equation – Economics of Metal Machining – Machinability.		
Unit – II	**Machining with Single Point Tool:**	**9**
Lathe Construction – Specification – Types of Lathe – Centre Lathe – Turret – Capstan Lathe – Lathe Accessories & Attachments – Tool Holders – Work Holders – Special Attachments. Lathe Operations: Thread Cutting – Methods of Taper Turning – Machining Time – Power Estimation – Tooling Layout – Automatic Lathe.		
Unit – III	**Machining with Multi Edged Tools:**	**9**
Drilling Machines: Types — Operations – Work Holders – Tool Holders. Milling Machines: Types – Fundamentals of Milling Processes – Operations – Types of Milling Cutters. Broaching Machines: Types – Broach Construction – Types of Operations – Broaching Methods. Grinding Machines: Specification of Grinding Wheel – Working Principle – Cylindrical Grinding – Dressing – Truing – Loading – Selection of Grinding Wheel — Finishing Operations.		
Unit – IV	**Unconventional Machining Processes:**	**9**
Need for Unconventional Machining Processes – Classification Based on Nature of Energy – Introduction – Equipment – Materials – Applications – Advantages & Limitations – Effect of Process Parameters of Abrasive Jet Machining – Abrasive Water Jet Machining – Ultrasonic Machining – Electro Chemical Machining – Chemical Milling – Electric Discharge Machining – Plasma Arc Machining – Laser Beam Machining.		
Unit – V	**Fundamentals of Metrology:**	**9**
Measurement – Definition and Methods – Generalized Measurement System – Units and Standards – Calibration Characteristics of instruments – Introduction to Transducers – Gauge Types – Length measurements – Vernier Caliper – Micrometer – Inside Micrometer – Bore Gauge – Comparator types – Angle measurement – Bevel Protractor – Sine bar – Angle Dekkor – Optical Flat – Form measurement – External Thread – Straightness – Flatness.		
		Total:45

TEXT BOOKS:

1.	Kaushish J.P., "Manufacturing Processes", 2nd Edition, PHI Learning Pvt. Ltd., Delhi, 2014 for Units I, II, III, IV.
2.	Rajput R.K., "Mechanical Measurements and Instrumentation", 2nd Edition, S.K.Kataria & Sons Publishers, New Delhi, 2013 for Unit V,.

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the basic concepts of metal cutting and perform cutting force and tool life calculations.	Applying (K3)
CO2	demonstrate the single point cutting tool operations using various lathe machines and calculate machining time.	Applying (K3)
CO3	depict the fundamental concepts of machining with multi point tools.	Applying (K3)
CO4	demonstrate the fundamental principles of material removal in unconventional machining processes.	Applying (K3)
CO5	interpret the basic concept of measurement system, calibration and characteristics of instruments.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												3
CO2	3	2												3
CO3	3	2												3
CO4	3	2			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	25	65	10				100
CAT2	25	65	10				100
CAT3	20	60	20				100
ESE	20	60	20				100

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

22MET43 - CAD/CAM/CIM FOR AUTOMATION							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Drawing, Machining and Measurements**	**4/5**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge of CAD with 2D and 3D transformations, CNC technology with G codes and M codes, various CIM technologies and robotics technology with vision systems.

Unit – I	**Computer Aided Design (CAD)**	**9**

The Design Process and Role of CAD - Introduction to Computer Graphics - Output Primitives - Bresenham's Line and Circle Drawing Algorithms - Parametric Equations for Line and Circle - 2D & 3D Transformations - Translation - Scaling - Rotation – Homogeneous Coordinate.

Unit – II	**Computer Aided Manufacturing (CAM)**	**9**

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 - Geometric Codes (G Codes) and - Miscellaneous Codes (M-Codes) - Cutter Location (CL) Data and Tool Path. Code Generation from 3D Solid Models Using Master CAM Software.

Unit – III	**Computer Integrated Manufacturing (CIM)**	**9**

CIM : Definition - CIM Wheel - Role of Group Technology in CAD/CAM integration - Computer Aided Process Planning (CAPP) – Variant and Generative Approaches – FMS - Components of FMS – Types - FMS Workstation - Material Handling And Storage Systems - FMS Layout – Application and Benefits.

Unit – IV	**Robot Technology**	**9**

Robot Anatomy – Joints and Links – Common Robot Configurations – Robot Control Systems – Accuracy and Repeatability – End Effectors – Sensors in Robotics. Robot Programming Methods: On-Line and off-Line Methods. Introduction of Robotic Drive Systems and Actuators: Hydraulic – Pneumatic and Electric Drives.

Unit – V	**Robotic Vision Systems**	**9**

Imaging – Sensing and Digitization, Image Processing Techniques – Robot Industrial Applications: Material Handling, Processing – Assembly and Inspection. Introduction to Kinematics: Position and Orientation of Objects – Rotation – Euler Angles – Rigid Motion Representation using Homogeneous Transformation Matrix.

Total:45

TEXT BOOKS:

1.	Zeid Ibrahim & Siva Subramanian., "CAD/CAM Theory and Practice", 2nd Edition, McGraw Hill Education, New Delhi, 2009 for Units I,II,III.
2.	Groover M. P., "Automation, Production System and Computer Integrated Manufacturing", 4th Edition, Prentice-Hall of India, New Delhi, 2022 for Units IV,V.

REFERENCES:

1.	Hearn Donald & Baker M. Pauline., "Computer Graphic", 2nd Edition, Uttar Pradesh Pearson, New Delhi, 2022.
2.	Rajput. R. K, "Robotics and industrial automation" 1st Edition, S. Chand publisher, New Delhi, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the modeling algorithms and 2D & 3D transformations	Applying (K3)
CO2	demonstrate components of CNC and code generation using software	Applying (K3)
CO3	demonstrate the concepts of FMS - CAPP implementations	Understanding (K2)
CO4	demonstrate the different robot anatomy and programming methods	Understanding (K2)
CO5	applying the different robotic vision system	Applying(K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			3								3	2
CO2	1	3			3								3	2
CO3	1	3			3								3	2
CO4	3				3								3	2
CO5	1	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	20	60	20				100
CAT3	20	40	40				100
ESE	20	40	40				100

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

22MET44 - KINEMATICS OF MACHINERY

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

Preamble	The course provides the analysis of velocity, acceleration and synthesis of various simple mechanisms. It also deals withvarious cam profile generations and studies on gears and gear trains.

Unit – I **Basics of Mechanisms** **9**

Classification of Mechanisms - Basic Kinematic Concepts and Definitions - Degree of Freedom - Mobility - Kutzbach Criterion - Grubler‘s Criterion - Grashof‘s Law - Kinematic Inversions of Four - Bar Chain and Slider Crank Chains - Limit Positions - Mechanical Advantage - Transmission Angle - Description of Common Mechanisms - Quick Return Mechanisms - Indexing Mechanisms - Ratcheting.

Unit – II **Kinematics of Mechanisms** **9**

Velocity and Acceleration of Simple Mechanisms by Relative Velocity Method - Velocity Analysis using Instantaneous Centre Method - Klien‘s Construction for Slider Crank Mechanism - Coriolis Acceleration Component.

Unit – III **Synthesis of Mechanisms** **9**

Synthesis of Mechanism - Classification of Synthesis - Function Generation by Relative Pole Method - Graphical Synthesis of Slider Crank and Four bar Mechanisms for Two and Three Positions - Computer Aided synthesis of four bar mechanism using Freudenstein’s Equation - Analytical Solution for Velocity and Acceleration of Slider Crank Mechanism - Introduction to Commercial Software Packages for the Development of Kinematic Models.

Unit – IV **Kinematics of CAM** **9**

Cams - Types of Cams and Followers - Displacement - Velocity and Acceleration Curves for Uniform Velocity - Uniform Acceleration and Retardation - SHM and Cycloidal Curves - Layout of Plate Cam Profile - Reciprocating and Oscillating Followers - Knife - Edge Follower - Roller and Flat Faced Followers. High Speed Cams: Circular Arc and Tangent Cams - Pressure Angle and Undercutting.

Unit – V **Kinematics of Gears** **9**

Theory of Gearing - Gear Nomenclature - Law of Gearing - Tooth Forms - Minimum Number Teeth - Length of Arc of Contact - Velocity and Torque Calculation - Contact Ratio and Interference. Gear Trains: Types - Parallel Axis and Epicyclic Gear Trains.

Total:45

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2											3
CO2	2	3	2											3
CO3	2	3	2											3
CO4	2	3	2											3
CO5	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	25	65				100
CAT2	10	25	50	15			100
CAT3	10	25	65				100
ESE	10	25	50	15			100

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

22MEL41 - THERMAL ENGINEERING AND RENEWABLE ENERGY LABORATORY

Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics**	**4**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides practical exposure on fuel properties measurement, performance analysis of internal combustion engines, reciprocating air compressor and solar / wind energy systems.

LIST OF EXPERIMENTS / EXERCISES:

THERMAL ENGINEERING LABORATORY

1.	Draw a Valve Timing and Port Timing Diagram for Four Stroke and Two Stroke Engines.
2.	Determination of Flash and Fire Point of given Fuels using Open and Closed Cup Apparatus.
3.	Determination of Viscosity of given Oils using Redwood and Saybolt Viscometers.
4.	Performance Test on Single Cylinder Four Stroke Diesel Engine by Mechanical / Hydraulic / Eddy Current / Electrical Loading.
5.	Heat Balance Test on Single Cylinder Four Stroke Diesel Engine by Mechanical / Hydraulic / Eddy Current / Electrical Loading.
6.	Performance Test on Multistage Reciprocating Air Compressor.

RENEWABLE ENERGY LABORATORY

1.	Analyze the Effect of the Variation of Speed, Tip Speed Ratio on the Coefficient of Power of Wind Turbine.
2.	Determination of the Thermal Energy Gain at the Focal Point of a Concentrating Collector.
3.	Determination of the Efficiency of Solar (Liquid / Air) Collector.
4.	Plot the Effect of Variation of Tilt Angle on the Photovoltaic Module Output.
5.	Study on Rooftop Solar Photovoltaic Plant and Weather Monitoring Station.
6.	Performance Test on Solar Evacuated Tube

Total:30

REFERENCES/ MANUAL /SOFTWARE:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the characteristics of the fuels and test and plot the performance curves on multistage aircompressor.	Analyzing (K4), Manipulation (S2)
CO2	examine the performance and heat balance study of various IC engines under different loadingconditions	Analyzing (K4), Manipulation (S2)
CO3	determine the performance of Solar energy systems and analyze the data from rooftop solar PV plant..	Analyzing (K4), Manipulation (S2)
CO4	analyze the effect of various parameters in wind turbine	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	1	2		3					3	3				3
CO2	1	2		3					3	3				3
CO3	1	2		3	2				3	3			2	3
CO4	1	2		3	2				3	3			2	3

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

22MEL42 - MACHINING AND MEASUREMENTS LABORATORY

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Physics for Mechanical Engineering	4	PC	0	0	2	1

Preamble	This course imparts the basic knowledge and provides hands-on training to various metal removal operations. This course provides the practical knowledge/mechanism behind the various measurements like linear, angular, etc.

LIST OF EXPERIMENTS / EXERCISES:

MACHINING AND MEASUREMENTS LABORATORY

1.	Carryout Knurling and Taper Turning Operations using Centre Lathe.
2.	Execute External Thread Cutting Operation in Centre Lathe.
3.	Obtain a Dovetail/Keyway Shape using Shaping Machine.
4.	Perform Grinding Operation on the Flat and Cylindrical Work Pieces using Surface and Cylindrical Grinding Machines.
5.	Make a Hole and thread on Flat Surface using Drilling and Tapping Tools.
6.	Make a Spur Gear/Keyway/Contour Shape using Milling Machines.
7.	Prepare a Convex Shape in a Flat Metal Work Piece using Slotting Machine.

MEASUREMENTS LABORATORY

1.	Calibration of Linear Instrument with Sliding Principle and Measurement of the given Component by using Vernier Caliper and Vernier Height Gauge
2.	Calibration of Mechanical and Electrical Comparator and Check the Dimensional Tolerance using Dial Gauge and LVDT.
3.	Calibration of Linear Instrument with Bolt and Nut Principle and Measurement of given Component by using Outside Micrometer and Depth Micrometer.
4.	Measurement of Angle of given Component by using Sine Bar and Bevel Protractor.
5.	Calibration of Optical Instrument and Measurement of given Component by using Profile Projector.
6.	A Study/Demonstration Experiment on Flatness and Straightness Checking by using Autocollimator.
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.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	HajraChoudhury S.K. ,HajraChoudhury A.K., Nirjharroy "Elements of Workshop Technology - Vol.II", 15th Edition, Media Promoters & Publishers Private Limited, Mumbai, 2010.
2.	Rajput R.K., "Mechanical Measurements and Instrumentation", 2nd Edition, S.K.Kataria & Sons Publishers, New Delhi, 2013
3.	Laboratory Manuals

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 lathe, milling, drilling, shaping and slotting machining operations	Applying (K3), Manipulation (S2)
CO2	perform grinding operations on circular and flat metal piece to enhance surface finish	Applying (K3), Manipulation (S2)
CO3	calibrate the measuring instruments and measure the dimension of the components	Applying (K3), Manipulation (S2)
CO4	determine the characteristics of instruments	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					3
CO2	3	1							2					3
CO3	3	1			1				2				3	3
CO4	3	1			1				2				3	3

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

22MEL43 - SOLID MODELING LABORATORY							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Drawing, Machine Drawing and AutoCAD Laboratory, Engineering Materials and Metallurgy, Strength of Materials**	**4**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides the practical knowledge on how to use the computer aided tools in drafting a component design and performing basic modeling of components and also provides the hands on experience and determination of essential mechanical properties of various materials.

SOLID MODELLING LABORATORY

LIST OF EXPERIMENTS / EXERCISES:

1.	Performing 2D Sketching using Different Generalized Constraints.
2.	Practice for datum plan, axis, point and coordinate systems.
3.	3D Part Modeling Options, Protrusion and Cut (Extrude). Exercises: Flange Coupling.
4.	3D Part Modeling Options, Protrusion and Cut (Revolve). Exercises: Screw jack
5.	3D Part Modeling Options – Protrusion and Cut (Sweep, Blend, Helical Sweep). Exercises: Machine Vice, Knuckle Joint.
6.	Features Creation with Editing Operations – Move, Pattern, Mirror, Round, Chamfer and Rib. Exercise: Simple Eccentric.
7.	Assembly – Creating Assembly from Individual Parts – Imposing Assembly Constraints – Mass Property Calculation.
8.	Conversion of 3D Solid Model to 2D Drawing – Different Views – Sections – Isometric View and Annotation Creation.
9.	Manufacturing Prototype of a Simple Mechanical Component using 3D Printer.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Sham Tickoo, "PTC Creo Parametric 2.0 for Designers", 6th Edition, CAD / CIM Technologies, New Delhi.
2.	Online Documentation for CREO 8.0, SOLID WORKS-2020 and CATIA V5-6 R2015.
3.	Laboratory Manual for Solid Modeling.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	model the mechanical components using parametric modeling, assembly and drafting	Applying (K3), Manipulation (S2)
CO2	Apply basic feature and editing operations associated with modeling and assembly	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				2				3	2
CO2	3	1			3				2				3	2
CO3	3	1			3				2				3	2

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

22GEL41 - PROFESSIONAL SKILLS TRAINING - I								
(Common to All BE/ BTech Engineering and Technology branches)								
Programme & Branch	**All BE/ BTech Engineering and Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**	
Prerequisites	**Nil**	**4**	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 and 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 -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:45

TEXT BOOK:

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

REFERENCES:

1.	Stephen Bailey, “Academic Writing: A practical guide for students”, Routledge, New York, 2011.
2.	Meenakshi Raman and Sangeeta Sharma. “Technical Communication- Principles and Practice”. 4th Edition, Oxford University Press, New Delhi, 2022.

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 individualand 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						100

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

22MEC51 - HEAT AND MASS TRANSFER

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

Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics, Thermal Engineering**	**5**	**PC**	**3**	**0**	**2**	**4**

Preamble	Heat and Mass Transfer course is designed to impart knowledge on three modes of heat transfer namely conduction, convection and radiation. This course also helps to understand the experimental heat transfer methods used for calculating the heat transfer characteristics.	
Unit – I	**Conduction Heat Transfer**	**9**
Fourier‘s Law of Conduction-Thermal Conductivity – Three Dimensional Heat Conduction Equation in Cartesian Coordinate System – One Dimensional Steady State Heat Conduction through Plane Wall, Cylinder and Sphere – Critical Radius of Insulation – Composite Wall and Cylinder – Conduction with Internal Heat Generation through Plane Wall, Cylinder and Sphere.		
Unit – II	**Convection Heat Transfer**	**9**
Newton's Law of Cooling – Boundary Layer Profiles of Flow over Flat Plate and Flow through Pipes - Forced Convection –External Flow: Flow over Flat Plate and Sphere, Flow across Bank of Tubes – Internal Flow – Free Convection: Flow over Vertical Plate, Horizontal Plate and Sphere.		
Unit – III	**Radiation Heat Transfer**	**9**
Electro Magnetic Spectrum – Thermal Radiation - Concept of Black Body - Basic Laws of Black Body Radiation – Absorptivity, Reflectivity and Transmissivity – Kirchoff's Law of Radiation – Shape Factor and its Algebra – Radiosity and Irradiation – Electrical Analogy – Two and Three Surfaces Interaction – Radiation Shields – Introduction to Gas Radiation.		
Unit – IV	**Phase Change Heat Transfer and Heat Exchangers**	**9**
Phase Change Heat Transfer: Boiling – Pool boiling: Nucleate Boiling and Film boiling – Flow Boiling – Condensation – Drop-wise and Film-wise Condensation – Correlations in Boiling and Condensation. Heat Exchangers: Types of Heat Exchangers – Logarithmic Mean Temperature Difference (LMTD) Method – Effectiveness – Number of Transfer Units (NTU) Method –Fouling Factors.		
Unit – V	**Mass Transfer and Latest Trends in the field of Heat transfer**	**9**
Mass Transfer: Mass Transfer: Diffusion Mass Transfer – Fick‘s Law of Diffusion – Equimolar Counter Diffusion – Convective Mass Transfer – Heat and Mass Transfer Analogy. Latest Trends: Nano Fluids for Heat Transfer – Cooling of Electronic Components Thermal Management in Electric Vehicles using IoT.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Determination of Thermal Conductivity of the given Insulating Material.
2.	Experimental Study on Transient Heat Conduction.
3.	Determination of Convective Heat Transfer Co-efficient in Natural and Forced Convection modes.
4.	Determination of the Fin Effectiveness and Efficiency in Free and Forced Convection Heat Transfer modes.
5.	Determination of Stefan-Boltzmann Constant using Stefan-Boltzmann Apparatus.
6.	Determination of Emissivity of the given Test Specimen at various Temperatures using the Emissivity Measurement Apparatus.
7.	Determination of Heat Transfer rate and Effectiveness of the given Double Pipe Heat Exchanger and Shell & Tube Heat Exchanger.
8.	Performance Test on Vapour Compression Refrigeration Test Rig.
9.	Performance Test on Air-Conditioning Test Rig.
10.	Data study from Infra-Red Thermography Images.

Lecture:45, Practical:30, Total:75

TEXT BOOK:

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

REFERENCES/ MANUAL / SOFTWARE:

1.	Holman.J.P., Souvik Bhattacharyya,"HeatTransfer",10th Edition, McGraw-Hill Education, India,2017.
2.	Yunus A. Cengel, AfshinJ.Ghajar,"Heat and Mass Transfer: Fundamentals and Applications", 6th Edition, McGraw Hill Education, India, 2020.
3.	D.K. Dixit, "Heat and Mass Transfer", 1st Edition, McGraw Hill Education, India, 2015.
4.	Heat Transfer Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	recognize the basic concepts and evaluate the rate of conductive heat transfer under steady state and transient	Analyzing (K4), Precision (S3)
CO2	apply free and forced convective heat transfer correlation to internal and external flows	Applying (K3) Precision (S3)
CO3	apply laws of radiation in calculating heat transfer between two surfaces	Applying (K3) Precision (S3)
CO4	design and conduct the test on heat exchanger and estimate the heat transfer co efficient and effectiveness of the heat exchanger.	Analyzing (K4), Precision (S3)
CO5	apply diffusive and convective mass transfer correlations to solve mass transfer problems	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		3	3	2				1	3		2	2	3
CO2	2		3							1		2	2	3
CO3	2		3				2		1	1		2	2	3
CO4	2		3	3	2		2		1	3		2	2	3
CO5	2		3		2		2			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	10	20	40	30			100
CAT2	20	30	50				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)

22MEC52 - DYNAMICS OF MACHINERY							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Mechanics, Kinematics of Machinery, Strength of Materials**	**5**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course provides the theoretical as well as practical knowledge on force analysis of various static & dynamic members, balancing of rotating & reciprocating masses in various types of engines. It also emphasis on analyzing the fluctuation in speed of governors, gyroscopic effect on various modes of transport systems, impact of free and forced vibration in various systems.

Unit – I	**Force Analysis**	**9**
Static Force Analysis – Free Body Diagrams, Conditions of Two, Three and Four Force Members. Inertia Forces and D'Alembert's Principle – Inertia Force Analysis in Reciprocating Engines – Crank Shaft Torque. Flywheels – Turning Moment Diagrams and Fluctuation of Energy of Reciprocating Engine Mechanisms – Coefficient of Fluctuation of Energy and Speed – Weight of Flywheel Required.		
Unit – II	**Balancing**	**9**
Static and Dynamic Balancing – Balancing of Rotating Masses – Balancing a Single Cylinder Engine – Balancing Multi Cylinder Engines – Balancing of Radial Engine – Direct and Reverse Crank Method.		
Unit – III	**Governors and Gyroscope**	**9**
Types – Centrifugal Governors – Gravity Controlled and Spring Controlled Centrifugal Governors – Characteristics – Effect of Friction – Controlling Force. Gyroscopes – Gyroscopic Couples – Gyroscopic Effects in Automobiles, Ships and Aeroplanes.		
Unit – IV	**Free Vibration**	**9**
Basic Features of Vibratory Systems – Types – Single Degree of Freedom System – Transverse Vibration of Beams – Natural Frequency by Energy Method – Dunkerley's Method - Critical Speed - Damped Free Vibration of Single Degree Freedom System - Types of Damping – Free Vibration with Viscous Damping – Critically Damped System, Under Damped System. Torsional Systems: Natural Frequency of Two and Three Rotor Systems.		
Unit – V	**Forced Vibration**	**9**
Response to Periodic Force – Harmonic Force – Force caused by Unbalance – Support Motion - Logarithmic Decrement Magnification Factor – Vibration Isolation and Transmissibility.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Draw the Force and Couple Polygon for Static and Dynamic Balancing of Rotating Masses.
2.	Determine the Characteristics of Porter governor using Universal Governor Apparatus.
3.	Determine the Loss of Couple due to Friction using Gyroscopic Couple Apparatus.
4.	Determine the Natural and Critical Frequency of given Shaft using Whirling of Shaft Apparatus.
5.	Determine the Natural Frequency of given Spring using Spring Mass System.
6.	Determine the Transmissibility Ratio of given Eccentric Mass in Vibration Table.
7.	Determine the Damping Ratio of Single Rotor System with Viscous Damping.
8.	Determine the Natural Frequency of Free - Free Beam.
9.	Determine the Forced Frequency of Cantilever Beam.
10.	Determine the Natural frequency of Double Rotor System.
11.	Simulation Models using MATLAB.

ecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Rattan S.S., "Theory of Machines", 5th Edition, McGraw Hill Education Publishing Company Ltd., New Delhi, 2022.

REFERENCES/ MANUAL / SOFTWARE:

1.	Laboratory Manual.
2.	Khurmi R.S. and Gupta J.K., "Theory of Machines", 14th Edition, S. Chand & Co. Ltd., New Delhi, 2020.
3.	Sadhu Singh, "Theory of Machines", 3rd Edition, Pearson Education India, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve and apply the effect of static and dynamic forces acting on different mechanisms, evaluate the characteristics of static systems for balancing	Applying (K3), Manipulation (S2)
CO2	solve and plot the static and dynamic balancing of various mechanical systems	Applying (K3), Manipulation (S2)
CO3	apply and solve the fluctuation effects in governors and the effects of gyroscopic couple in automobile, aeroplane and ship applications	Applying (K3), Manipulation (S2)
CO4	apply and solve the impact of free vibrations and analyze its characteristics in the design of mechanical systems	Applying (K3), Manipulation (S2)
CO5	apply and solve the impact of the forced vibrations and analyze its characteristics in the design of mechanical systems	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					2					3
CO2	3	3		3					2					3
CO3	3	3		3					2					3
CO4	3	3		3					2					3
CO5	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	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	80				100
ESE	10	10	80				100

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

22MET51 - OPERATIONS RESEARCH

Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Numerical Methods for Engineers**	**5**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course provides an in-depth insight into the concepts, theories and techniques of Operations Research. It also emphasis the role of operation research in planning, controlling and enhancing performance which could be successfully used for optimizing the managerial decisions.	
Unit – I	**Linear Models**	**9+3**
Introduction - Phases of Operations Research Study – Formation of Linear Programming Problem (LPP) - Canonical form of LPP – Solutions to LPP - Graphical Method - Simplex Algorithm - Artificial Variables Technique - Big M Method - Two Phase Method.		
Unit – II	**Transportation Problems, Assignment Problems and Sequencing Problems**	**9+3**
Transportation Problems: Mathematical Formulation-Basic Feasible Solutions – North-West Corner (NWC) method – Least Cost Method (LCM)–Vogels Approximation Method (VAM). Optimality Test – Modified Distribution (MODI) Technique. Assignment Problems: Mathematical Formulation –Hungarian Algorithm. Sequencing Problems:1 Job' M' Machine, 'N' Jobs 1 Machine, 'N' Jobs 2 Machines, N' Jobs 3 Machines, 'N' Jobs M Machine and 2 Jobs 'M' Machine Problems.		
Unit – III	**Network Models and Project Management**	**9+3**
Network Models: Shortest Route - Minimal Spanning Tree - Maximum Flow Models. Project Management: Construction of Networks - Activity and Event Based Diagrams – Program Evaluation and Review Technique (PERT) & Critical Path Method (CPM) Problems – Cost Analysis and Crashing of Networks.		
Unit – IV	**Inventory Models**	**9+3**
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+3**
Queuing Models: Queuing Systems and Structures - Notations - Parameter - Single Server and Multi server Models - Poisson Input -Exponential Service - Constant Rate Service - Infinite Population. Replacement Models: Replacement of Items Due to Deterioration with and without Time Value of Money - Individual and Group Replacement Policy.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

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

REFERENCES:

1.	Taha & Hamdy A., "Operations Research: An Introduction", 10th Edition, Pearson Education, Chennai, 2017
2.	Hiller Frederick S. , Lieberman Gerald J., Bodhibrata Nag & Preetam Basu, "Introduction to Operations Research", 10th Edition, McGraw-Hill Education, Bengaluru, 2017.

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 advanced solutions in transportation, assignment and sequencing problems	Applying (K3)
CO3	construct networks and analyze optimality for Industrial application	Analyzing (K4)
CO4	compare various inventory module including EOQ and select appropriate inventory control Techniques.	Analyzing (K4)
CO5	measure queuing characteristics and compute the optimum replacement period for capital equipment's and items that fail unexpectedly	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	1										3	1
CO2	2	3	1										3	1
CO3	1	3									2		3	1
CO4	2	3	1										3	1
CO5	2	3	1										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	30	50				100
CAT2	20	20	30	30			100
CAT3	20	20	30	30			100
ESE	10	20	35	35			100

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

22MET52 - ARTIFICIAL INTELLIGENCE IN MECHANICAL SYSTEMS

Programme & Branch	B.E. & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5/7	PC	3	0	0	3

Preamble	This course gives a brief introduction about Artificial Intelligence (AI) and the types of data used in mechanical systems. This course also provides detailed description about the usage of AI in mechanical systems. In addition, provides the role of AI in global business.

Unit - I	**Artificial Intelligence (AI) in Manufacturing:**	**9**
Overview, Need and Application of AI in Manufacturing – Advantages – AI as a Catalyst to Smart Manufacturing – Advantages and Shortcomings - Risk Associates with AI. AI in Process Capabilities: Improvement at Process Level – Benefits at Organizational Level – AI as a Key Component of Future Manufacturing.		
Unit - II	**Data Types and its Preparation:**	**9**
Data Types – Structured – Unstructured – Static – Streamed – Attitudinal – Behavioral – Demographic - Data Driven Analytics - User Driven Analytics - Data Validity – Variety - Velocity of Constantly Changing – Attributes - Converting Raw Data into Matrix - Data Clustering - K means Algorithm - Nearest Neighbors - Identifying Objective of Data - Cleaning the Data - Structuring the Data – Data Preparation – Normalization - Binning – Sampling.		
Unit - III	**AI and Predictive Analytics:**	**9**
Introduction, Enabling Technologies for Industry 4.0 - Data Technologies (DT): Data Pre-processing, Feature Engineering, Data-driven Analytics, Cyber Physical Production systems and Digital Twin - Platform Technologies (PT) - Operations Technology (OT): Product Lifecycle Management (PLM), Enterprise Resource Planning (ERP), Manufacturing Execution System (MES), Customer Relationship Management (CRM), Supply Chain Management (SCM) - Case study: Intelligent Bandsaw System & Challenges.		
Unit – IV	**AI on Global Business and Sustainability:**	**9**
Introduction – Need for AI in Global Business – Future Impact of AI in Global Business Practices, Achieving Sustainability – Smart Manufacturing – Futuristic Agriculture – Transforming Construction – Revolutionizing Manufacturing – Strategic Retailing – Revamping Media and Entertainment – Remodelling Financial Services – Reshaping Education, Adverse Impacts of AI in Sustainability.		
Unit - V	**Smart Applications of AI:**	**9**
Smart Agriculture – Smart Healthcare – Smart Education – Smart Grids – Smart Transportation and Autonomous Vehicles – Smart Homes – Smart Cities – AI in metal cutting.		
		Total:45

TEXT BOOKS:

1.	Stuart J. Russell and Peter Norvig, “Artificial Intelligence A Modern Approach”, Prentice Hall, 2010 for Units I,III
2.	Kaushik Kumar, Divya Zindani, Paulo Davim, “Artificial Intelligence in Mechanical and Industrial Engineering”, 1st Edition, CRC Press, New York, 2021 for Unit II
3.	Geeta Rana, Alex Khang, Ravindra Sharma, Alok Kumar Goel, Ashok Kumar Dubey, “Reinventing Manufacturing and Business Processes Through Artificial Intelligence”, 1st Edition, CRC Press, New York, 2022 for Unit IV
4.	Masoud Soroush, Michael Baldea, Thomas F. Edgar, “Smart Manufacturing Concepts and Methods”, 1st Edition, Elsevier, United States, 2020 for Unit V

REFERENCES:

1.	John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, “Fundamentals of Machine Learning for Predictive Data Analytics”, 2nd Edition, MIT Press, Cambridge, 2020.
2.	U. Dinesh Kumar, “Business Analytics The Science of Data-driven Decision Making”, Wiley India, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the need for AI in manufacturing sector	Understanding(K2)
CO2	identify and prepare data for predictive analytics	Applying(K3)
CO3	illustrate the concepts of industrial AI and predictive analytics	Applying(K3)
CO4	describe the various concepts of AI in global business and its sustainability	Understanding(K2)
CO5	explain the different types of smart applications using AI	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			1	1			2				1	2
CO2	3	2	1		2	1			2				2	3
CO3	3	2	1		2	1			2				2	3
CO4	2	1			1	1			2				1	2
CO5	2	1			1	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	20	50	30				100
CAT2	20	50	30				100
CAT3	30	70					100
ESE	10	60	30				100

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

22MEL51 - CAM AND ROBOTICS LABORATORY							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology, Engineering Drawing, Machine Drawing and AutoCAD Laboratory**	**5**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides hands-on experience in CAD / CAM software, generation of machine codes to interface with machines. Also offers knowledge in the virtual reality software, industrial robots and CNC operations.

LIST OF EXPERIMENTS / EXERCISES:

1.	Study of G codes and M codes for machining centre and turning centre.
2.	Part program generation and machining of given component using CNC Turning Centre (JOBBER XL).
3.	Part program generation and machining of given component using CNC Vertical Milling Centre (L Mill 55).
4.	Simulate a given Part and Generate CNC code for a given Component using MASTER CAM (Mill) and interfacing it to CNC Machining Center.
5.	Simulate a given Part and Generate CNC code for a given Component using MASTER CAM (Lathe) and interfacing it to CNC Turning Center.
6.	Manufacturing a Model of Mechanical Component using CNC Laser Cutting Process.
7.	Performing Engraving Operation of a simple art or details over a component using CNC Laser Engraving Machine.
8.	Point to Point Programming for a given application using 6 Axis Articulated Arm Robot.
9.	Continuous Programming for a given application using 6 Axis Articulated Arm Robot.
10.	Robot programming using Virtual Reality software for a given application (Identification of colours in pallet).
11.	Robot programming using Virtual Reality software for a given application (Pick and Place applications).
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manuals.
2.	Master CAM X5 software.
3.	Groover M. P, "Automation, Production System and Computer Integrated Manufacturing", 3rd Edition, Prentice-Hall of India, New Delhi, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop CNC program for different operations and production with JOBBER XL and L Mill 55 machines	Applying (K3), Manipulation (S2)
CO2	simulate using CAM package and interface the developed program with the CNC machine.	Applying (K3), Manipulation (S2)
CO3	develop robot programming for industrial operation using virtual reality software.	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	1			3				2				3	2
CO2	2	1			3				2				3	2
CO3	2	1			3				2				3	2

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

22MEL52 - SURFACE AND SHEET METAL DESIGN LABORATORY							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Drawing, Machine Drawing and AutoCAD Laboratory**	**5**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides the practical knowledge on using the CAD tools for drafting a component design and advanced modeling of components.

LIST OF EXPERIMENTS / EXERCISES:

1.	Create a Simple Surface with General Option Extrude, Revolve, Sweep and Blend.
2.	Performing Surface Trim, Merge, Extend, Project, Fill and Mirror options to Create Complex Surfaces.
3.	Creating A Surface with Boundary Blend And Variable Section Sweep Operations.
4.	Converting the Surfaces into a Solid Component Using Thicken and Solidify.
5.	Creating a Simple Surface with Freestyle option.
6.	Introduction and Creating Primary Sheet Metal Wall features.
7.	Creating Secondary Sheet Metal Wall features with Flange.
8.	Creating Bending and Unbending in Sheet Metal Walls.
9.	Conversion from Solid Model to Sheet Metal Model and Developing the Surfaces.
10.	Creating a Simple Bracket with Gusset Design and Punch Form.
11.	Creating a Hopper and Developing the Surfaces for Sheet Cutting Operations.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Sham Tickoo, "PTC Creo Parametric 6.0 for Designers", 6th Edition, CAD CIM Technologies, New Delhi.
2.	CREO 9.0, SOLID WORKS-2020, 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	apply the concept of CAD parametric with advanced surface creating options	Applying (K3), Manipulation (S2)
CO2	apply the concept of wall creation to make the simple sheet metal brackets and mounting designs	Applying (K3), Manipulation (S2)
CO3	apply the development process to determine the shape and sheet required for fabrication	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				2			2	3	2
CO2	3		1		3				2			2	3	2
CO3	3		1		3				2			2	3	2

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

22GEL51 - PROFESSIONAL SKILLS TRAINING - II								
(Common to All BE/ BTech Engineering and Technology branches)								
Programme & Branch	**All BE/ BTech Engineering and Technology branches**	**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 – 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 and 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:45	

TEXT BOOK:

1.	Edgar Thorpe and Showick 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, New Delhi, 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 individualand 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	0	3	2		
CO2	3	2				3	3		3	0	3	2		
CO3		2				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	20	40	40				100
CAT2		50	50				100
CAT3		50	50				100
ESE	NA						

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

<table>
<tr><td colspan="8">22MET61 - DESIGN OF MACHINE ELEMENTS</td></tr>
<tr><td colspan="8">(Use of PSG Design Data book / Machine Design Data book by V.B.Bhandari is permitted for the End Semester Examination)</td></tr>
<tr><td>Programme & Branch</td><td>BE & Mechanical Engineering</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Engineering Mechanics, Strength of Materials</td><td>6</td><td>PC</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">This course imparts the design of machine components like brackets, shaft, coupling, springs, bearing and its failure criteria to meet the desired needs. It also explores the design of threaded fasteners and welded joints.</td></tr>
<tr><td>Unit – I</td><td colspan="6">Steady Stresses and Variable Stresses in Machine Members</td><td>9+3</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit – II</td><td colspan="6">Design of Shafts and Couplings</td><td>9+3</td></tr>
<tr><td colspan="8">Design of Solid and Hollow Shafts based on Strength and Rigidity – Design of Keys and Key Ways – Design of Rigid and Flexible Couplings.</td></tr>
<tr><td>Unit – III</td><td colspan="6">Design of Fasteners and Welded Joints</td><td>9+3</td></tr>
<tr><td colspan="8">Threaded Fasteners – Design of Bolted Joints Including Eccentric Loading – Design of Welded Joints – Axially Loaded Unsymmetrical Welded Joints - Eccentric Load in the Plane of Welds - Welded Joint Subjected to Bending Moment and Twisting Moment. Description on Designing of Riveted Joints.</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Design of Springs and Power Screws</td><td>9+3</td></tr>
<tr><td colspan="8">Design of Helical and Leaf Springs - Theory of Disc and Torsional Springs under Constant Loads and varying loads – Description of Concentric Springs and Belleville Springs. Power Screws: Torque requirement – Design of Screw and Nut – Description of Screw Jack and Recirculating Ball Screw.</td></tr>
<tr><td>Unit – V</td><td colspan="6">Design of Bearings</td><td>9+3</td></tr>
<tr><td colspan="8">Design of Bearings - Preloading, Design of Rolling Contact Bearings - Load Carrying Capacity – Bearing Life - Cubic Mean Load - Design of Journal Bearings - Mckee‘S Equation - Calculation of Bearing Dimensions – Bearing Materials – Lubricating Oils – Bearing Failure Causes and Remedies.</td></tr>
<tr><td colspan="8" align="right">Lecture:45, Tutorial:15, Total:60</td></tr>
<tr><td colspan="8">TEXT BOOK:</td></tr>
<tr><td>1.</td><td colspan="7">Bhandari V.B., “Design of Machine Elements”, 5th Edition, Tata McGraw-Hill, New Delhi, 2020.</td></tr>
<tr><td colspan="8">REFERENCES:</td></tr>
<tr><td>1.</td><td colspan="7">Shigley J.E. and Mischke C.R., “Mechanical Engineering Design”, 11th Edition, McGraw Hill International Education, New York, 2020.</td></tr>
<tr><td>2.</td><td colspan="7">Robert L. Norton., “Machine Design”, 5th Edition, Pearson, Chennai, 2018.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	design the machine components subjected to steady stress and variable stress under various loading conditions	Applying (K3)
CO2	select and design the shafts and couplings for different applications	Applying (K3)
CO3	design the screw fasteners and welded joints for different applications	Applying (K3)
CO4	design the helical, leaf springs and power screws for different applications	Applying (K3)
CO5	identify, design and predict the life of 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	2	2												3
CO2	2	2												3
CO3	2	2												3
CO4	2	2												3
CO5	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	15	15	70				100
CAT2	15	15	70				100
CAT3	15	15	70				100
ESE	15	15	70				100

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

22MET62 - FINITE ELEMENT ANALYSIS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Strength of Materials, Heat and Mass Transfer**	**6**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides the knowledge on finite element modeling techniques and use of numerical methods for solving the governing equations over the given discretized domain with the proper boundary conditions and loads. The course deals with the solving the various 1D and 2D engineering problems for structural, thermal aspects and introduces advanced concepts.

Unit – I	**Fundamental of Finite Element Analysis**	**9**
Historical Background – Matrix Approach – Coordinates – Numerical Simulation – Gauss Elimination Based Solvers – FEA General Procedure – Basic Element Shapes – Discretization Process – Node Numbering Scheme – Interpolation – Ritz Techniques – Weighted Residual Method – Applications of FEA.		
Unit – II	**One Dimensional Problems**	**9**
One Dimensional Finite Element Modeling – Element Types – Linear Elements – Linear Element Shape Function – Finite Element Equation – Galerkin's Method – Solid Mechanics – Heat Transfer – Fin Pin and Composite Wall – Beam Element.		
Unit – III	**Two Dimensional Problems**	**9**
Introduction to 2-D Finite Element Modeling – Constant Strain Triangular – Finite Element Formulation – Shape Functions – Strain Displacement and Stress Strain Relationship Matrix – Plane Stress and Plane Strain – Temperature Effects.		
Unit – IV	**Axisymmetric Continuum**	**9**
Axisymmetric Formulation – Element Stiffness Matrix and Force Vector – Body Forces and Temperature Effects – Stress Calculations – Boundary Conditions – Applications to Cylinders under Internal or External Pressure.		
Unit – V	**Iso-parametric Elements for Two Dimensional Continuum**	**9**
Natural Co-ordinate Systems – Iso-parametric Elements – The Four Node Quadrilateral – Shape Functions – Element Stiffness Matrix and Force Vector – Jacobian Matrix – Stress Calculations – Numerical Integration – Gauss Quadrature. Introduction to Finite Element Analysis Programming.		
		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	apply the finite element theory procedures for various applications	Analyzing (K4)
CO2	analyze 1D structural and thermal problems with various boundary conditions	Analyzing (K4)
CO3	analyze the 2D problems with various boundary conditions	Analyzing (K4)
CO4	analyze the 2 D axisymmetric problem with various boundary conditions	Analyzing (K4)
CO5	apply the concepts of Iso-parametric formulation in 2D problems	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1											3
CO2	2	3	1											3
CO3	2	3	1											3
CO4	2	3	1											3
CO5	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	10	10	40	40			100
CAT2	10	10	40	40			100
CAT3	10	10	40	40			100
ESE	10	10	40	40			100

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

22MEL61 - SIMULATION LABORATORY

Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Strength of Materials, Fluid Mechanics and Hydraulic Machines,Heat and Mass Transfer**	**6**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides the basic knowledge of deriving the boundary conditions of real time practical engineering problems in structure, thermal and flow. It also provides the best way of reducing the complex problems to simple one.

LIST OF EXPERIMENTS / EXERCISES:

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

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	ANSYS Laboratory 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	analyze the deflections and stresses of various structural problems with different boundary conditions using finite element method	Analyzing (K4), Manipulation (S2)
CO2	analyze the mechanisms of heat transfer modal and harmonic of varying engineering problems using finite element method	Analyzing (K4), Manipulation (S2)
CO3	analyze the fluid flow phenomena in various applications with and without obstacles using finite volume method	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	2		1		3				2				3	3
CO2	2		1		3				2				3	3
CO3	2		1		3				2				3	3

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

22MEP61 - PROJECT WORK I								
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamental knowledge on Design, Manufacturing and Thermal Engineering**	**6**	**EC**	**0**	**0**	**8**	**4**

Preamble	This course deals with identifying technical problems and formulate remedial solutions through fabrication of novel prototypes or upgradation of existing products under the basic principles of design, manufacturing and thermal sciences.

Project Work I

- Identifying project area based on the research interest
- Perform literature survey related to selected area or undergo field trip to industries
- Identify a technical problem
- Formulate solutions based on the basic principles and new advancements in design, manufacturing and thermal sciences
- Prepare detailed methodology
- Perform comprehensive design based on the engineering Inputs.
- Fabricate new models
- Perform test runs and analyze the results
- Exhibit the models in technical forums and disseminate the creation across technical community

Total:120

Fabricate

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	select domain centric industrial or social problems	Understanding (K2)
CO2	prepare detailed work flow chart	Understanding (K2)
CO3	develop a conceptual and detailed design using modern engineering tools	Creating (K6)
CO4	fabricate new project models	Creating (K6)
CO5	perform test run and explore the findings in technical forum	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	1			3	3	2	3	2	2	2	3	3
CO2	3	3	3	2		3	3	2	3	2	2	2	3	3
CO3	3	3	3	2	3	3	3	2	3	2	3	2	3	3
CO4	3	3	2	2	3	3	3	2	3	2	3	2	3	3
CO5	3	2			1	3	3	3	3	3	3	3	2	3

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

22MEP62 - PROJECT WORK I							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamental knowledge on Design, Manufacturing and Thermal Engineering**	**6**	**EC**	**0**	**0**	**8**	**5**

Preamble	This course deals with identifying technical problems and formulate remedial solutions through fabrication of novel prototypes or upgradation of existing products under the basic principles of design, manufacturing and thermal sciences.

Project Work I

- Identifying project area based on the research interest
- Perform literature survey related to selected area or undergo field trip to industries
- Identify a technical problem
- Formulate solutions based on the basic principles and new advancements in design, manufacturing and thermal sciences
- Prepare detailed methodology
- Perform comprehensive design based on the engineering Inputs.
- Fabricate new models
- Perform test runs and analyze the results
- Exhibit the models in technical forums and disseminate the creation across technical community

Total:120

Fabricate

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	select domain centric industrial or social problems	Understanding (K2)
CO2	prepare detailed work flow chart	Understanding (K2)
CO3	develop a conceptual and detailed design using modern engineering tools	Creating (K6)
CO4	fabricate new project models	Creating (K6)
CO5	perform test run and explore the findings in technical forum	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	1			3	3	2	3	2	2	2	3	3
CO2	3	3	3	2		3	3	2	3	2	2	2	3	3
CO3	3	3	3	2	3	3	3	2	3	2	3	2	3	3
CO4	3	3	2	2	3	3	3	2	3	2	3	2	3	3
CO5	3	2			1	3	3	3	3	3	3	3	2	3

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

22GET31 - UNIVERSAL HUMAN VALUES

(Common to All Engineering and Technology Branches)

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

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:**	**6**

Human Being 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:**	**6**

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:**	**6**

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:**	**6**

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:30

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	restate the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society	Applying (K3)
CO2	distinguish between the Self and the Body, understand the meaning of Harmony in the Self, the Co–existence of Self and Body	Applying (K3)
CO3	infer 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	Applying (K3)
CO4	transform themselves to co-exist with nature by realising interconnectedness and four order of nature	Applying (K3)
CO5	distinguish between ethical and unethical practices, and extend ethical and moral practices for a better living	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	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	25	75					100
CAT2	25	75					100
ESE	NA						100

* ±3% may be varied (CAT 1&2 – 60 marks & ESE – 100 marks)

22GCT71 - ENGINEERING ECONOMICS AND MANAGEMENT							
(Common to All BE/BTech branches)							
Programme & Branch	**All BE/BTech branches**	**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		
CO2		1	2			2	2	2	2	2	3	2		
CO3	1	2	1			2		2	2	2	3	2		
CO4	1	2	1			2		2	2	2	3	2		
CO5	2	2				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	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)

22MEP71 - PROJECT WORK II PHASE I							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamental knowledge on Design, Manufacturing and Thermal Engineering**	**7**	**EC**	**0**	**0**	**10**	**5**

Preamble	This course deals with identifying domain centric or interdisciplinary research problems through literature or industrial survey, framing objective to provide remedial solution, prepare detailed work line, perform preliminary design analysis and prepare test specimens / prototypes.

Project Work I

- Identify domain centric or interdisciplinary research problems through literature or industrial survey
- Frame objective in-line with identified problem
- Prepare detailed work line
- Perform preliminary design analysis
- Prepare test specimens / prototypes

Total:150

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	formulate domain centric or interdisciplinary research problems through literature or industrial survey	Understanding (K2)
CO2	frame objective in-line with identified problem	Understanding (K2)
CO3	prepare detailed work line	Understanding (K2)
CO4	perform preliminary design analysis	Analysis (K4)
CO5	fabricate test specimens / prototypes	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	3	1				3	3	2	3	2	3	2		3
CO2	3	3				3	3	2	3	2	1	3		3
CO3	3	3		2		3	3	2	3	2	1	3		3
CO4	3	3		2	2	3	3	2	3	2			2	3
CO5	3	2		2	2	3	3	3	3	3	2	3	2	3

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

22MEP72 - PROJECT WORK II PHASE I							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamental knowledge on Design, Manufacturing and Thermal Engineering**	**7**	**EC**	**0**	**0**	**12**	**6**

Preamble	This course deals with identifying domain centric or interdisciplinary research problems through literature or industrial survey, framing objective to provide remedial solution, prepare detailed work line, perform preliminary design analysis and prepare test specimens / prototypes.

Project Work I

- Identify domain centric or interdisciplinary research problems through literature or industrial survey
- Frame objective in-line with identified problem
- Prepare detailed work line
- Perform preliminary design analysis
- Prepare test specimens / prototypes

Total:150

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	formulate domain centric or interdisciplinary research problems through literature or industrial survey	Understanding (K2)
CO2	frame objective in-line with identified problem	Understanding (K2)
CO3	prepare detailed work line	Understanding (K2)
CO4	perform preliminary design analysis	Analysis (K4)
CO5	fabricate test specimens / prototypes	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	3	1				3	3	2	3	2	3	2		3
CO2	3	3				3	3	2	3	2	1	3		3
CO3	3	3		2		3	3	2	3	2	1	3		3
CO4	3	3		2	2	3	3	2	3	2			2	3
CO5	3	2		2	2	3	3	3	3	3	2	3	2	3

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

22MEP81 - PROJECT WORK II PHASE II

Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamental knowledge on Design, Manufacturing and Thermal Engineering**	**8**	**EC**	**0**	**0**	**8**	**4**

Preamble	The course deals with performing technical characterization of prepared test specimens / prototypes, analyzing their performance in comparison to conventional system, prepare report and research manuscript / invention disclosure document for publication in reputed journal / patent.

Project Work I

- Perform technical characterization of prepared test specimens / prototypes
- Analyze technical performance of developed specimens in comparison with conventional system
- Prepare report and research manuscript / invention disclosure document for publication in reputed journal / patent.

Total:120

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	perform technical characterization of prepared test specimens / prototypes	Applying (K3)
CO2	analyze technical properties of developed specimens	Analyzing (K4)
CO3	compare the performance of developed specimens with conventional system	Analyzing (K4)
CO4	prepare project report	Analyzing (K4)
CO5	prepare research manuscript / invention disclosure document for publication in reputed journal / patent	Analyzing (K4)

Mapping of COs with POs and PSOs

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

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

22MEE01 - FLUID POWER SYSTEM

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

Preamble	This course provides knowledge and skill to generate, control and transmission of power using both hydraulic and pneumatic systems. It offers designing of fluid power circuit for various industrial application and knowledge of industrial circuits ,sealing devices, service & maintenance.

Unit – I Fundamentals of Hydraulic System 9

Basics of Fluid Power System – Advantages and Applications of Fluid Power Systems – Fluid Properties – Pascal’s Law and its Application – Losses in Pipes – Valves and Fittings – Fluid Power Symbols – Hydraulic Pumps - Gear – Vane and Piston Pumps – Pump Performance – Characteristics and Selection – Sizing of Pumps.

Unit – II Control Components of Hydraulic System 9

Direction Control Valves - Three Way Valve – Four Way Valve – Check Valve and Shuttle Valve – Actuation Mechanisms in DCV Pressure Control Valves - Pressure Relief – Pressure Reducing – Counter Balance – Sequencing and Unloading Valves – Flow Control Valves and its Types – Proportional Valves – Servo Valves - Mechanical Type and Electrohydraulic Servo Valves.

Unit – III Pneumatic System and Actuators 9

Pneumatic System: Properties of Air – Perfect Gas Laws – Compressors - Piston – Screw and Vane Compressor – Fluid Conditioning Elements - Filter Regulator and Lubricator Unit – Pneumatic Silencers – After Coolers – Air Dryers – Air Control Valves. Actuators: Linear And Rotary Actuators – Types – Cushioning Mechanism in Cylinders – Sizing of Actuators.

Unit – IV Fluid Power Circuit Design 9

Basic Pneumatic Circuits – Pneumatic Vacuum Systems – Electrical Components and Electrical Controls for Fluid Power Circuits – Cascade Circuit Design Method (Two / Three Cylinder Circuits) – Introduction to Fluid Logic Devices and Applications – Accumulator –Types and Application Circuits – Pressure Intensifier Circuits – PLC Applications in Fluid Power Circuit.

Unit – V Industrial Circuits and Maintenance 9

Industrial Circuits: Speed Control Circuits – Regenerative Cylinder Circuits – Pump Unloading Circuit – Double Pump Circuit – Counter Balance Valve Circuit – Hydraulic Cylinder Sequencing Circuit – Automatic Cylinder Reciprocating Circuit – Cylinder Synchronizing Circuits – Fail Safe Circuits – Sealing Devices - Types and Materials – Safety Aspects – Installation.
Maintenance: Maintenance and Trouble Shooting of Fluid Power Systems.

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, 2019.
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	Applying (K3)
CO2	choose appropriate control valves for fluid power applications	Applying (K3)
CO3	select pneumatic components and fluid power actuators for low-cost automation	Applying (K3)
CO4	design and construct a fluid power circuit for real time applications	Applying (K3)
CO5	design, construct, installation, maintenance and troubleshooting of fluid power circuits for engineering 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											3
CO2	3	1												3
CO3	3	1	3											3
CO4	3	1	3											3
CO5	3	2	2											3

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

ASSESSMENT PATTERN - THEORY

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

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

22MEE02 - PIPING DESIGN							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Strength of Materials, Engineering Materials**	**5**	**PE**	**3**	**0**	**0**	**3**
Preamble	This course is designed to impart the knowledge of piping design with the help of standards and codes.						
Unit - I	**Introduction to Piping**						**9**
Evolution of Piping – Piping and Pipeline Codes – ASME B31 Codes – Boiler and Pressure Vessel Codes – ASME B16 Standards – API Standards and Recommended Practices – Classification of Pipes: Process, Line, Structural – Manufacturing Methods.							
Unit - II	**Piping Materials**						**9**
Ferrous pipe – Non-ferrous pipe – Fabrication of Steel pipe – Fabrication of Pipe Fittings and Components – Mechanical Properties – Procurement.							
Unit - III	**Pressure Design for Piping**						**9**
Thin wall approximation – Pipeline Design Equation – Pressure Design of Plant Piping – Yield and Burst Pressure – Design Pressure – Buckling Pressure – Rating – High Pressure Design.							
Unit - IV	**Basic Piping Components and Piping Equipment**						**9**
Basic Piping Components: Elbows – Weld Tee – Couplings – Reducers – Cap – Flanged fittings – Flanges – Types – P-T Ratings and Facings – Major Valves – Types – Operations – Applicability – Gaskets – Bolts and Nuts. 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 of Pipe Ways – 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, 2018.

REFERENCES:

1.	George A. Antaki, “Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair”, Special Indian Edition, Taylor & Francis, USA, 2020
2.	Rudomino B., “Steam Power Plant Piping Design”, MIR Publishers, Moscow, 1986.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify and select standard codes for piping practice	Understanding (K2)
CO2	describe the properties of piping materials	Applying (K3)
CO3	use an appropriate pipe design for desired working pressure	Applying (K3)
CO4	illustrate the functions of pipe fittings and piping equipment used in industries	Understanding (K2)
CO5	prepare pipe layouts and explain the types of 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	1	3												2
CO2	1	3	2											2
CO3	1	3	2											2
CO4	1	3												2
CO5	1	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	90					100
CAT2	5	60	35				100
CAT3	5	60	35				100
ESE	5	75	20				100

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

22MEE03 - UNCONVENTIONAL MACHINING PROCESSES							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Machining and Measurements**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course covers the fundamentals of various unconventional machining processes as well as the influence of process parameters on machining performance in diverse applications.	
Unit – I	**Introduction and Mechanical Energy Based Processes**	**9**
Unconventional Machining Processes – Needs – Classifications – Process Selection – Limitations – Advantages. Abrasive Jet Machining (AJM) – Water Jet Machining (WJM) – Abrasive Water Jet Machining (AWJM) - Ultrasonic Machining (USM) - Working Principles – Equipment Used – Process Parameters – MRR – Applications.		
Unit – II	**Electrical Energy Based Processes**	**9**
Electric Discharge Machining (EDM) - Working Principle - Equipment - Process Parameters - Surface Finish and Material Removal Rate (MRR) - Electrode / Tool – Power and Control Circuits -Tool Wear – Dielectric – Flushing – Wire Cut EDM – Applications.		
Unit – III	**Chemical and Electrochemical Energy Based Processes**	**9**
Chemical Machining (CHM) - Etchants – Maskant - Techniques of Applying Maskant– Process Parameters – Surface Finish and MRR – Applications - Principles of Electrochemical Machining (ECM) – Equipment - Surface Roughness and MRR - Electrical Circuit - Process Parameters – Applications.		
Unit – IV	**Thermal Energy Based Processes**	**9**
Laser Beam Machining (LBM) - Plasma Arc Machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment – Types – Process Parameters - Beam Control Techniques - MRR – Applications.		
Unit – V	**Hybrid Processes and Advanced Finishing Processes**	**9**
Electro Chemical Grinding (ECG) – Electro Chemical De-burring (ECD) – Shaped Tube Electrolytic Machining (STEM) – Working Principle – Applications – Limitations. Advanced Finishing Processes: Abrasive Flow Machining (AFM) – Magnetic Abrasive Finishing (MAF) – Chemical Mechanical Polishing (CMP) – Working Principles – Mechanism of Material Removal – Surface Quality – Applications.		
		Total:45

TEXT BOOKS:

1.	Vijay.K. Jain., “Advanced Machining Processes”. 1st Edition ,Allied Publishers Pvt. Ltd., New Delhi, 2021 for Units I, II, III, IV
2.	Pandey P.C. and Shan H.S., “Modern Machining Processes”. 1st Edition, Tata McGraw-Hill, New Delhi, 2017 for Unit V.

REFERENCES:

1.	Paul De Garmo, J.T.Black, and Ronald. A.Kohser., “Material and Processes in Manufacturing” Prentice Hall of India Pvt. Ltd., 8th Edition, New Delhi 2008.
2.	Kapil Gupta, N.K.Jain and R.F.Laubscher., “Hybrid Machining Process: Perspectives on Machining and Finishing”, Springer International Publishing, 2016.
3.	Mc Geough., “Advanced Methods of Machining”, Springer, London, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	choose appropriate mechanical energy based unconventional machining process.	Applying (K3)
CO2	identify a suitable electrical energy based unconventional machining process application.	Applying (K3)
CO3	explain the concept of machining the hard material using chemical energy and electrochemical energy.	Applying (K3)
CO4	illustrate various thermal energy-based process for engineering applications.	Applying (K3)
CO5	illustrate the hybrid processes and advanced finishing processes used 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								3	3
CO2	3				3								3	3
CO3	3				3								3	3
CO4	3				3								3	3
CO5	3				3								3	3

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

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1	35	65					100
CAT 2	35	65					100
CAT 3	35	65					100
ESE	45	55					100

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

22MEE04 - DESIGN FOR MANUFACTURE AND ASSEMBLY							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology, Engineering Materials and Metallurgy, Machining and Measurements**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the essential concepts behind manufacturing and assembly orient design. It also provides design guidelines for machining, casting and injection molding to achieve cost effective design

Unit – I	**Tolerance Analysis**	**9**
Geometric Tolerances – Tolerance Analysis – Worst Case Method – Assembly Limits – Design and Manufacturing Datum – Conversion of Design Datum into Manufacturing Datum – Tolerance Stacks – True Position Theory – Zero True Position Tolerance –Process Capability.		
Unit – II	**Materials Selection and Design for Assembly**	**9**
Principal Materials – Selection of Materials and Processes –Design – Possible Solutions – Evaluation Method. General Design Principles for Manufacturability – General Design Guidelines for Manual Assembly – Assembly Efficiency – Effects of Part Symmetry – Part Thickness and Weight on Handling Time – Types of Manual Assembly Methods – Design for High Speed Automatic Assembly and Robot Assembly.		
Unit – III	**Design for Machining**	**9**
Design Features to Facilities Machining – Single Point and Multipoint Cutting Tools – Choice and Shape of Work Material – Accuracy and Surface Finish – Design Recommendations for Turning and Milling Operations: Process Description – Suitable Materials. Guidelines for Machining of Rotational and Non-Rotational Components – Reduction of Machined Area – Design for Clamp ability – Design for Accessibility.		
Unit – IV	**Design for Injection Molding and Powder Metal Processing**	**9**
Injection Molding Materials – The Molding Cycle – Molding Systems and Molds – Cycle Time and Mold Cost Estimation – Estimation of Optimum Number of Cavities – Design Guidelines for Injection Molding. Design for Powder Metal Processing: Introduction to Powder Metal Processing – Materials and Manufacturing Cost – Design Guidelines for Powder Metal Parts.		
Unit – V	**Design for Sand and Die Casting**	**9**
Sand Casting Alloys – Sand Cores – Design Rules for Sand Castings – Identification of Uneconomical Design – Modifying the Design. Die Casting Alloys – The Die Casting Cycle – Determination of Number of Cavities and Appropriate Machine Size in DieCasting – 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, 2011.

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	Applying (K3)
CO4	analyze the design requirement for injection molded components and demonstrate the design recommendations for powder metal processing	Analyzing (K4)
CO5	identify uneconomical design to modify design for sand and die castings	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MEE05 - AUTOMOBILE ENGINEERING

Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the structure and construction of automobiles and also, the working principles of functional components. In addition, an insight is provided about electric vehicles, pollution norms and safety standards.

Unit – I	**Vehicle Structure and Engine**	**9**

Vehicle Structure: Types of Automobiles – Vehicle Construction – Chassis – Types – Frame and Body Types. Engine: Types – Components of Engine – Functions and Materials – Turbo Chargers – Superchargers – Turbo Lag – Introduction to Electronic Engine Management System.

Unit – II	**Fuel Supply Systems and Electrical Systems**	**9**

Fuel Supply System: Carburetion and Simple Carburetor – Electronically Controlled Gasoline Fuel Injection System – Monopoint and Multi Point Fuel Injection Systems (MPFI) – Gasoline Direct Injection (GDI) – Fuel Stratified Injection (FSI). Diesel Engine Fuel Supply System – Types – Electronically Controlled Diesel Fuel Injection System – Common Rail Direct Injection (CRDI) – Introduction to Hydrogen fuel based Engines.

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 – Lithium-ion Battery, Battery Thermal Management System (BTMS) – Issues and Challenges – Starting Motor and Drives.

Emission Control: Global Standards – Indian Pollution Norms for Petrol and Diesel Vehicles – Data analytics on Exhaust Emission.

Safety: Safety Measures in Automobiles – Airbag – Passenger Safety – Vehicle Safety.

Total:45

TEXT BOOK:

1.	Kirpal Singh, "Automobile Engineering", 14th Edition, Volume I & II, Standard Publishers Distributor, New Delhi, 2021.

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.
3.	P.S.Gill, " A Text Book of Automobile Engineering", 2nd Edition, S.K.Kataria & Sons, New Delhi, 2012.

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

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		3											3
CO2	2		3											3
CO3	2		3											3
CO4	2		3											3
CO5	1		3		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	50	30	-	-	-	100
CAT2	20	50	30	-	-	-	100
CAT3	20	50	30	-	-	-	100
ESE	20	50	30	-	-	-	100

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

22MEE06 - FUELS AND COMBUSTION TECHNOLOGY							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides an overview of fuel properties and their composition. It also describes combustion thermodynamics, sources of pollution and their controlling measures.

Unit – I	**Fuel Characteristics**	**9**
Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels - Calorific Value - Gross and Net Calorific Values - Calorimetry - Dulong's Formula for Calorific Value Estimation - Flue Gas Analysis - Orsat Apparatus – Gas Chromatograph.		
Unit – II	**Solid Fuels and Liquid Fuels**	**9**
Solid Fuels: Wood and Wood charcoal-Origin of Coal- Composition of Coal - Analysis Fuels- Proximate and Ultimate Analysis - Moisture Determination and Properties of Different Grades of Coal-Preparation and Storage of Coal-Coal washing – Briquetting-Coke Preparation Techniques – Gasification and Liquefaction of Solid Fuels. Liquid Fuels: Origin of Petroleum Fuels-Production - Composition-Petroleum Refining- Various Grades of Petro-Products-Properties and Testing - Gasification of Liquid Fuels		
Unit – III	**Gaseous Fuels**	**9**
Classification - Composition and Properties – Fractional Distillation – Gas Calorimeter- Rich and Lean Natural gases and LPG - Producer gas - Water gas – Hydrogen – Acetylene		
Unit – IV	**Stoichiometry and Kinetics**	**9**
Stoichiometry: Mass Basis and Volume Basis - Excess Air Calculation - Fuel and Flue Gas Compositions - Calculations - Rapid Methods. Kinetics: Combustion Processes -Stationary Flame - Flameless Combustion - Submerged Combustion- Mechanism of Combustion -Ignition and Ignition Energy - Spontaneous Combustion - Flame Propagation -Adiabatic Flame Temperature.		
Unit – V	**Air Pollution**	**9**
Types- Combustion Generated Air Pollution - Effects of Air Pollution - Fossil Fuel Generated Pollution and its Control - Automobiles Generated Pollution and Power Plants Generated Pollution and its Control.		
		Total:45

TEXT BOOK:

1.	Om Prakash Gupta., "Elements of Fuels & Combustion Technology", 4th Edition, Khanna Book Publishing Company (P) Ltd., New Delhi, 2018.

REFERENCES:

1.	Mishra D.P., "Fundamentals of Combustion", 1st Edition, PHI Learning Pvt Ltd, India, 2010.
2.	Samir Sarkar., "Fuels & Combustion", 3rd Edition, CRC Press, India, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine the fuel properties using standard approaches	Applying (K3)
CO2	explain the composition and preparation methods of solid & liquid fuels	Applying (K3)
CO3	explain the composition and properties of gaseous fuels	Applying (K3)
CO4	describe the stoichiometry and kinetics of combustion of fuels	Applying (K3)
CO5	recognize the types of air pollution and explain their controlling 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		3											3
CO2	3		2											3
CO3	3		2											3
CO4	3		2											3
CO5	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	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	50	30				100

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

22MEE07 - INDUSTRIAL ENGINEERING							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology, Machining and Measurements**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course brings with fundamental aspects of various Industrial Engineering tools like work study, resource planning, forecasting techniques and value engineering that involves enlightening the efficiency of an organization.	
Unit – I	**Work System 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 – 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 – Influencing Factors – Plant Location – Single Location Problems.		
Unit – IV	**Material Requirement Planning and Capacity Planning**	**9**
Material Requirement Planning (MRP): Objectives – Terminologies – Systems – Outputs – Management Information to MRP – Manufacturing Resource Planning – Capacity Requirement Planning – Measures of Capacity – Capacity – Need. Capacity Planning: Influencing – Aggregate Planning-Guidelines Master Production Schedule- Introduction to Enterprise Resource Planning (ERP) – Strategy – Need – Benefit-Modules – Introduction to Lean Manufacturing – Comparison with conventional manufacturing.		
Unit – V	**Production Cost Estimation**	**9**
Importance of Costing and Estimation – Methods of Costing – Elements of Cost Estimation – Types of Estimates – Estimating Procedure – Estimation Labour Cost, Material Cost – Allocation of Overhead Charges – Calculation of Depreciation Cost. Estimation of few Types of Jobs From Forming and Machining Operations.		
		Total:45

TEXT BOOKS:

1.	Martand T Telsang ., "Industrial Engineering and Production Management", 3rd Edition, S. Chand and Company, New Delhi, 2019 for Units I,II,III,IV.
2.	Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill Publishing Co, 1995 for Unit V.

REFERENCES:

1.	Buffa Elwood S., and Sarin Rakesh K, "Modern Production/Operations Management", 8th Edition, Wiley, New York, 2007.
2.	Chase, Richard B., "Operations Management for Competitive Advantage", 11th Edition Tata McGraw-Hill, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the different industrial engineering principles & techniques for enhancement of industry performance	Applying (K3)
CO2	apply the concept of production, planning and control techniques for industrial cases	Applying (K3)
CO3	Make use of forecasting models to identify the demand	Applying (K3)
CO4	analyse the various resource in an organization	Analyzing (K4)
CO5	examine the different types of cost estimation in industry	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		1									3	3
CO2	3	2		1									3	3
CO3	3	2		1									3	3
CO4	3	2		1							1		3	3
CO5	3	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	25	30	35				100
CAT2	20	40	40				100
CAT3	20	30	25	25			100
ESE	20	30	35	15			100

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

22MEE08 - PRODUCTION PLANNING AND CONTROL							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course offers insight on various functions and decision making process involved in planning and controlling of production activities adopted in industries.

Unit – I	**Introduction**	**9**

Definition − Objectives and Functions of Production Planning and Control − Elements of Production Control − Types of Production − Organization of Production Planning and Control Department − Internal Organization of Department - Break Even Analysis - Economics of a New Design – Aesthetic Aspect.

Unit – II	**Forecasting, Product Planning and Process Planning**	**9**

Forecasting: Demand Forecasting, Forecasting Techniques. Product Planning: Extending the Original Product Information-Value Analysis-Problems in Lack of Product Planning. Process Planning: Pre Requisite Information Needed for Process Planning - Steps in Process Planning - Quantity Determination in Batch Production-Machine Capacity - Balancing.

Unit – III	**Routing and Scheduling**	**9**

Routing − Definition − Routing Procedure − Route Sheets − Bill of Material − Factors Affecting Routing Procedure, Schedule − Definition − Difference with Loading. Scheduling Policies − Techniques, Standard Scheduling Methods - Aggregate Planning, Chase Planning − Expediting and Controlling Aspects.

Unit – IV	**Dispatching**	**9**

Dispatching Activities − Dispatching Procedure − Follow Up − Reason for Existence of Functions - Manufacturing Lead Time- Techniques for Aligning Completion Times and Due Dates − Applications of Computer in Production Planning and Control.

Unit – V	**Inventory Control and Trends in PPC**	**9**

Inventory Control: Inventory Management − Functions of inventories − Purpose of Holding stock - Effect of Demand on Inventories – Deterministic models: Always Better Control (ABC) analysis – Inventory Production Quantity – Economic Order Quantity (EOQ) model− Safety Stock Inventory Control Systems. Trends in PPC: Enterprises Resource Planning (ERP) - Line of Balance (LOB) – Just in Time (JIT) and KANBAN system.

Total:45

TEXT BOOK:

1.	Jain K.C. & Agarwal L.N., "Production Planning 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, 2009.
2.	Norman Gaither G. & Frazier., "Operations Management", 9th Edition, Thomson Learning, 2002.

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

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3										1			2
CO2	3	2	1										3	2
CO3	3	2	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	20	60	20				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	60	20				100

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

22MEE09 - DESIGN OF TRANSMISSION SYSTEMS								
(Use of PSG Design Data book / Machine Design data book by V.B.Bhandari is permitted for the End Semester Examination)								
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Strength of Materials, Design of Machine Elements**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts the knowledge on design of various transmission devices like belt, chain, rope, gear and gear box which aid in effective working of mechanical systems. Apart from these, this course give detailed view about design of power screws, lead screw and coupling as per standards.	
Unit – I	**Design of Belt, Rope and Chain Drives**	**9**
Design of Belt, Rope and chain: Classification of Belt Drives – Selection of Flat Belts, 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**
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 Brakes and Clutches**	**9**
Types of Brake -Simple and Compound - Internal and External Shoe Brakes – Disc Brakes (Description Only) - Design of Single Plate Clutches – Multi-Disk clutches – Cone Clutches – Description of Centrifugal Clutches.		
		Total:45

TEXT BOOK:

1.	PrabhuT.J., "Design of Transmission Elements", 5th Edition, New age International Publisher, Chennai, 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, NewYork,2019.
3.	Norton R.L., "Design of Machinery", 6th Edition, McGraw Hill, New Delhi,2019.

STANDARDS:

1. IS4460:Parts1to3:1995-Gears–Spur and Helical Gears–Calculation of Load Capacity
2. IS7443:2002,Methods of Load Rating of Worm Gears
3. IS15151:2002,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: Part1 Flat Belt Drives.
5. IS2122:Part2:1991,Code of practice for selection, storage, installation and maintenance of belting for power transmission: Part 2V-Belt Drives.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	choose proper assumptions, perform analysis and select appropriate belt drives and chain drives	Applying (K3)
CO2	select suitable dimensions for spur and helical gear drives for given application	Applying (K3)
CO3	design the bevel gear and worm gear for the suitable loading conditions	Applying (K3)
CO4	draw and analyse the speed calculation of different stages in a multi speed gear box	Applying (K3)
CO5	design the clutch and brakes 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	2	1	3											3
CO2	2	1	3											3
CO3	2	1	3											3
CO4	2	1	3											3
CO5	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	70				100
CAT2	15	15	70				100
CAT3	15	15	70				100
ESE	15	15	70				100

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

22MEE10 - VIBRATION AND NOISE CONTROL							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Matrices and Ordinary Differential Equations, Multivariable Calculus and Complex Analysis, Dynamics of Machinery, Strength of Materials**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts the knowledge on natural frequency of vibration system, vibration measuring instruments and sensors, basics source of noise, measurement of sound and its control.	
Unit – I	**Basics of Vibration and One degree of Freedom System**	**9**
Introduction, Classification of Vibration: Free and Forced Vibration – Undamped and Damped Vibration – Linear and Non-Linear Vibration – Response of Damped and Undamped Systems Under Harmonic Force – Analysis of Single Degree of Freedom Systems – Torsional Vibration – Determination of Natural Frequencies.		
Unit – II	**Two Degree of Freedom System and Vibration Control**	**9**
Vibration of Two Degree of Freedom System - Semi Definite System - Forced Vibration of Two Degree of Freedom System – Spring Coupled and Mass Coupled system Vibration Absorber – Vibration Isolation – Random Vibration.		
Unit – III	**Vibration Measurement**	**9**
Vibration Measuring Instruments – Types of Exciters - Types of Sensors – Vibration Test – Free and Forced Vibration Tests – Case Studies – Balancing – Single and Double Plane Balancing – Modal Analysis techniques.		
Unit – IV	**Basics of Noise**	**9**
Introduction – Amplitude – Frequency – Wavelength and Sound Pressure Level – Addition – Subtraction and Averaging Decibel Levels – Noise Dose Level – Legislation – Measurement and Analysis of Noise – Measurement Environment – Equipment – Frequency Analysis – Tracking Analysis – Sound Quality Analysis.		
Unit – V	**Source of Noise and Control**	**9**
Methods for Control of Engine Noise – Combustion Noise – Mechanical Noise – Predictive Analysis – Palliative Treatments and Enclosures – Automotive Noise Control Principles – Sound in Enclosures – Sound Energy Absorption – Sound Transmission through Barriers.		
		Total:45

TEXT BOOKS:

1.	Singh V.P., “Mechanical Vibrations”. 6th Edition, Dhanpat Rai & Co. Ltd., New Delhi, 2016 for Units I,II,III.
2.	Pujara Kewal., “Vibrations and Noise for Engineers”, 4th Edition, Dhanpat Rai & Sons, New Delhi, 2018 for Units IV, V.

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve the frequency response of single degree of freedom system	Analyzing (K4)
CO2	solve and design vibration absorber for the two degrees of freedom system	Analyzing (K4)
CO3	apply the vibration measuring instruments and analyze machine signature for identifying the vibration signal	Applying (K3)
CO4	apply the noise related parameters for identify the noise level	Applying (K3)
CO5	identify and analyze the sources of noise and control	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	10	40	40			100
CAT2	10	10	40	40			100
CAT3	15	15	70				100
ESE	10	10	40	40			100

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

22MEE11 - INTELLIGENT MANUFACTURING SYSTEMS

Programme & Branch	BE & Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**Manufacturing Technology, Artificial Intelligence in Mechanical Systems**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course delves into the fundamental principles through a comprehensive understanding of various concepts and technologies that are integral to smart manufacturing including their underlying principles, functions, and practical applications.

Unit	Title	Hours
Unit – I	**Intelligent Manufacturing – Introduction and Implementation**	**9**

Introduction - People and Process Culture Enablers - Technology Enablers. Strategy: Understanding the Business / Operations and Customers – Technology Considerations – Strategy Development – Other Considerations. Execution: Recommendations to Support the Execution Phase. Implementing Smart Manufacturing: Organization Specific Strategy – Intelligent Manufacturing Examples.

Unit	Title	Hours
Unit – II	**Industry 4.0**	**9**

Introduction - RAMI 4.0: Motivation – Layers – Life Cycle and Value Stream – Hierarchy Levels – Example Usage of RAMI 4.0. Asset Administration Shell: Motivation – AAS Requirements – AAS Design. Applications: Value-Based Services – Adaptable Factories – Order - Controlled Production – Seamless Dynamic Engineering Plants – Roadmap - Research Scope.

Unit	Title	Hours
Unit – III	**Cyber Infrastructure**	**9**

Cyber Infrastructure - Intelligent Manufacturing from a Business Perspective, Complexity of Interconnectedness, Reducing the Heavy Lift of Data Modeling and Contextualization, The Data-Centric View of Smart / Intelligent Manufacturing, Building Blocks of Smart Manufacturing. Operational Data Models: Smart Manufacturing Profiles – Machine Example. Overarching R&D Considerations: Discretized Modeling - Smart Manufacturing Innovation Platform – Technical Foundations.

Unit	Title	Hours
Unit – IV	**Industrial Internet of Things (IIoT)**	**9**

Overview of IoT: IoT Architecture – Protocols – Cloud Computing – Sensor Cloud – Big data. IIoT: Introduction - Industrial Internet Systems – Industrial Sensing – Industrial Process, Machine Learning and Data Science in Industries, Inventory Management and Quality Control – Case Studies.

Unit	Title	Hours
Unit – V	**Digital Twin Driven Smart Manufacturing**	**9**

Background - Concept of Digital Twin - Value of Digital Twin - Digital Twin in Product Lifecycle - Digital Twin in Industrial Applications. Digital Twin Shop Floor: Evolution Path of Shop Floor - Related Works - Concept of Digital Twin Shop Floor - Implementation of Digital Twin Shop Floor – Characteristics – Key Technologies – Challenges.

Total:45

TEXT BOOKS:

1. Masoud Soroush, Michael Baldea and Thomas F. Edgar., “Smart Manufacturing Concepts and Methods”, 1st Edition, Elsevier, United States, 2020 for Units I, II, III.
2. Anandarup Mukherjee, Chandana Roy and Sudip Misra., “Introduction to Industrial Internet of Things and Industry 4. 0”, 1st Edition, CRC Press, New York, 2021 for Unit IV.
3. Fei Tao, Meng Zhang and A.Y.C. Nee., “Digital Twin Driven Smart Manufacturing”, 1st Edition, Academic Press, United Kingdom, 2019 for Unit V.

REFERENCE:

1. Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, "Smart Manufacturing Applications and Case Studies", 1st Edition, Elsevier Publication, Netherlands, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop the smart manufacturing strategies and their execution	Applying (K3)
CO2	illustrate the roadmap for Industry 4.0 and build the profiles for smart manufacturing	Applying (K3)
CO3	develop technical basis for a cyber-infrastructure of an Industry	Applying (K3)
CO4	interpret the various concepts of IIoT, design considerations of the Industrial Internet, and its impact	Understanding (K2)
CO5	identify and implement the applications of digital twin in shop floor	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											3
CO2	3	1	1		2								1	2
CO3	3	1	1										3	3
CO4	3	1			2								2	3
CO5	3	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	50	30				100
CAT2	20	50	30				100
CAT3	20	60	20				100
ESE	20	55	25				100

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

22MEE12 - MANUFACTURING INFORMATION SYSTEM							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course provides the importance of databases and its application in manufacturing systems by offering the information on the database concepts, database designing and manufacturing considerations.	
Unit – I	**Introduction**	**9**
Introduction - Goals for Manufacturing - Evolution of Order Policies from Material Requirement Planning (MRP) to Manufacturing Resource Planning (MRP II) to Enterprise Resource Planning (ERP) - Role of Production Organization - Operation Control.		
Unit – II	**Database**	**9**
Data Modelling for Database - Records and Files - Abstraction and Data Integration - Three Level Architecture for Data Base Management System (DBMS) - Components of DBMS - Advantages and Disadvantages of DBMS.		
Unit – III	**Designing Database**	**9**
Relationship Among Entities - Entity Relationship (ER) Diagram - Data Models – Relational – Network – Hierarchical - Relational Model – Concepts – Principles – Keys - Relational Operations - Functional Dependency – Normalization - Query languages.		
Unit – IV	**Manufacturing Consideration**	**9**
The product and its Structure - Inventory and Process Flow - Shop Floor Control - Data Structure and Procedure - Various Models - Order Scheduling Module – Input / Output Analysis Module (IOM) - Stock Status Database - Complete IOM Database.		
Unit – V	**Information System for Manufacturing**	**9**
Parts Oriented Production Information System – Concepts and Structure - Computerized Production Scheduling - Online Production Control Systems – Computerized Production Management System and Manufacturing Information Systems – Indian Emission Control Norms and Regulation for Manufacturing Sector – Case Studies.		
		Total:45

TEXT BOOKS:

1.	Luca G. Sartori., “Manufacturing Information Systems”, London Prentice Hall, 2003 for Units I,IV,V.
2.	Date C.J., “An Introduction to Database Systems”. 8th Edition, Pearson Education, 2021 for Units II,III.

REFERENCES:

1.	Orlicky G. “Material Requirements Planning”. 3rd 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	demonstrate the concept of data base management systems	Applying (K3)
CO3	illustrate the concept involved in designing of data base	Applying (K3)
CO4	describe the shop floor control and inventory management in an organization	Applying (K3)
CO5	describe the concept and parameters involved in computerized production planning and control	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			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	15	45	40				100
CAT2	10	40	50				100
CAT3	20	35	45				100
ESE	10	50	40				100

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

22MEE13 - ALTERNATIVE ENERGY SYSTEMS AND APPLICATIONS							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics, Fluid Mechanics and Hydraulic Machines**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course discusses various technologies behind renewable power generation from various sources and the challenges in integrating the renewable energy power plants with grid.

Unit – I	**Need of Renewable Power Generation and Grid Integration**	**9**
Energy Resources and Classification – Energy Reserves and Consumption at International and National Level – Energy Scarcity – Cuses – Lifetime of Fossil Fuels – Issues and Challenges in Conventional Power Generation – Energy Intensity and GDP – Need of Renewable Energy (RE) – Sources – Worldwide RE Availability – RE in India – RE Conversion Technologies – Advantages and Limitations – Integrating RE into the Grid – Issues and Challenges – Variability – Intermittency – Dispatchability – Smart Grid – Micro Grid - Advantages.		
Unit – II	**Solar Energy and Wind Energy**	**9**
Solar Energy: Solar Collectors – Types – Solar Water Heating Applications – Active System – Passive System – Solar Dryers – Crop Drying – Space Cooling – Solar Pond – Solar Chimney – Solar Cookers – Solar Stills. Wind Energy: Wind Availability – Site Selection – Wind Mills – Characteristics of Wind Mill Rotors – Wind Turbines – Classification – Horizontal Axis Wind Turbine Generators – Vertical Axis Wind Turbine Generators – Types – Applications – Environmental Effects.		
Unit – III	**Biomass Energy**	**9**
Sources and Availability – Biomass Conversion Technologies – Direct Combustion – Thermochemical – Gasification – Biomass Gasifiers – Updraft – Downdraft –Fluidized Bed Gasifier – Pyrolysis – Biochemical Conversion – Aerobic digestion – Anaerobic Digestion – Biogas Plants – Floating Drum Type – Fixed Dome Type – Fermentation – Factors Affecting Biogas Production – Ethanol production – Biomass Cogeneration – Case Study in Rice Mill – Energy Recovery from Urban Waste – Power Generation from Liquid Waste – Applications.		
Unit – IV	**Hydrogen Energy and Fuel Cells**	**9**
Hydrogen Energy: Sources – Properties – Generation Technologies – Electrolysis – Thermolysis – Thermochemical – Bio-photolysis – Storage Techniques – Compressed Gas Storage – Liquid Storage – Solid State Storage – Transport Techniques – Applications – Power Generation – Automobiles – Safety Issues. Fuel Cell: Principle – Types – Alkaline Fuel Cells – Polymer Electrolyte Membrane Fuel Cells – Phosphoric Acid Fuel Cell – Molten Carbonate Fuel Cells – Solid Oxide Fuel Cell – Direct Methanol Fuel Cells – Heat generation – Applications – Advantages – Limitations.		
Unit – V	**Hydro Energy, Ocean Energy and Thermoelectric Power Generation**	**9**
Hydro Energy: Mini and Micro-hydel Power Plants – Site Selection – Challenges – Economics – Applications. Ocean Energy: Ocean Thermal Energy Conversion – Open Cycle– Closed Cycle – Hybrid Cycle – Advantages – Applications Tidal Plants – Single basin – Two Basin – Wave Energy Conversion Machines – Types – Buoy - Dolphin - Oscillating Duck -Challenges - Applications. Thermoelectric and Thermionic: Principle – Thermoelectric Materials – Thermoelectric Converter Module – Applications. Thermionic Converter – Vacuum Thermionic – Vapour Thermionic – Applications.		
		Total:45

TEXT BOOK:

1.	Shobh Nath Singh., “Non-Conventional Energy Resources” 1st Edition, Pearson Education India, New Delhi,2015.

REFERENCES:

1.	Rai G.D., "Non-Conventional Energy Sources", 6th Edition, Khanna Publishers, New Delhi, 2017.
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.	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.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify the necessity of renewable based power generation and discuss the grid integration of renewable power generation.	Understanding (K2)
CO2	describe the construction, working and applications of solar and wind energy systems along with its challenges.	Applying (K3)
CO3	describe the biomass-based power production techniques along with its challenges and applications.	Applying (K3)
CO4	describe the working of hydrogen energy, fuel cells, with its applications and challenges.	Applying (K3)
CO5	describe the working of hydro energy, Ocean energy and thermoelectric conversion systems along with its challenges and 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							3
CO2	3		1			1	3							3
CO3	3		1			1	3							3
CO4	3					1	3							3
CO5	3					1	3							3

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

ASSESSMENT PATTERN - THEORY

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

<table>
<tr><th colspan="9">22MEE14 - INSTRUMENTATION IN THERMAL ENGINEERING</th></tr>
<tr><td>Programme & Branch</td><td>BE & Mechanical Engineering</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td colspan="2">Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>6</td><td>PE</td><td>3</td><td>0</td><td>0</td><td colspan="2">3</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td>Preamble</td><td colspan="8">This course introduces the characteristics of measuring instruments, techniques and importance of error and uncertainty analysis. Modern measurement techniques for gas properties are specifically covered through this course.</td></tr>
<tr><td>Unit – I</td><td colspan="7">Measurement Characteristics</td><td>9</td></tr>
<tr><td colspan="9">Instrument Classification-Characteristics of Instruments - Static and Dynamic Responses - Experimental Error Analysis - Systematic and Random Errors - Statistical Analysis – Uncertainty - Experimental Planning and Selection of Measuring Instruments - Reliability of Instruments.</td></tr>
<tr><td>Unit – II</td><td colspan="7">Microprocessors and Computers in Measurement</td><td>9</td></tr>
<tr><td colspan="9">Data Logging and Acquisition - Use of Sensors for Error Reduction - Elements of Microcomputer Interfacing - Intelligent Instruments in Use.</td></tr>
<tr><td>Unit – III</td><td colspan="7">Measurement of Physical Quantities</td><td>9</td></tr>
<tr><td colspan="9">Measurement of Thermo - Physical Properties -Temperature – Pressure - Flow variables - Use of Sensors for Physical Variables.</td></tr>
<tr><td>Unit – IV</td><td colspan="7">Advanced Measurement Techniques</td><td>9</td></tr>
<tr><td colspan="9">Shadowgraph – Schlieren Interferometer - Laser Doppler Anemometer - Hot Wire Anemometer - Heat Flux Sensors - Telemetry in Measurement.</td></tr>
<tr><td>Unit – V</td><td colspan="7">Measurement Analyzers</td><td>9</td></tr>
<tr><td colspan="9">Chemical – Thermal-Magnetic - Optical Gas Analyzers - Measurement of Smoke-Dust and Moisture - Gas Chromatography - Spectrometry - Measurement of pH.</td></tr>
<tr><td colspan="9" align="right">Total:45</td></tr>
<tr><td colspan="9">TEXT BOOK:</td></tr>
<tr><td>1.</td><td colspan="8">Holman J.P., "Experimental Methods for Engineers", 8th Edition, McGraw-Hill, New York, 2012.</td></tr>
<tr><td colspan="9">REFERENCES:</td></tr>
<tr><td>1.</td><td colspan="8">Nakra, B.C., Choudhry K.K., "Instrumentation, Measurements and Analysis", 4th Edition, Tata McGraw Hill, New Delhi, 2016.</td></tr>
<tr><td>2.</td><td colspan="8">Bolton W, "Industrial Control & Instrumentation", 2nd Edition, Universities Press, Pvt. Ltd, Hyderabad, 2004.</td></tr>
<tr><td>3.</td><td colspan="8">Rangan C.S., Sarma G.R., Mani V.S.V., "Instrumentation Devices and Systems", 2nd Edition, McGraw-Hill, New Delhi, 2017.</td></tr>
<tr><td colspan="9"></td></tr>
</table>

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	classify the instruments and perform error analysis	Applying (K3)
CO2	illustrate the integration of microprocessors and computers with physical instruments	Applying (K3)
CO3	describe the measurement methods of thermo-physical properties	Applying (K3)
CO4	illustrate the principles of modern measurement techniques	Applying (K3)
CO5	explain the principles of exhaust gas measurement analysis	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MEE15 - DIGITALIZATION IN SUPPLY CHAIN MANAGEMENT							
Programme& Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course delivers the concept of supply chain management its network design, forecasting, sourcing and information systems for making effective decision.

Unit – I **Introduction Supply Chain Management** **9**

Introduction – Types of Supply Chains with and Examples – Evolution of SCM Concepts – Supply Chain Performance – Strategic Fit – Drivers of Supply Chain Performance – Key Decision Areas – External Drivers of Change. Supply Contracts – Centralized Vs. Decentralized System.

Unit – II **Supply Chain Network Design** **9**

Need for Distribution Network Design – Factors Affecting – Design Options for Distribution Network. Network Design Decisions – Framework – Factors Influencing – Models of Facility Location and Capacity Allocation – Role of Transportation in Supply Chain – Modes of Transportation Modal Selection – Classification of Carriers – Carrier Selection – Transportation Execution and Control. Food Mile Concept – Design Options – Software Cases.

Unit – III **Demand and Supply in Supply Chain** **9**

Forecasting in Supply Chain – Methods – Approach – Errors – Aggregate Planning in Supply Chain – Problem – Strategies and Implementation – Predictable Variability in Supply Chain – Managing Supply and Demand – Distribution Strategies – Direct Shipment – Traditional Warehousing – Cross Docking – Inventory Pooling – Transhipment – Choosing Appropriate Strategy – Milk Run Model – Software Cases.

Unit – IV **Sourcing and Inventory Decisions in Supply Chain** **9**

Purchasing Vs Procurement Vs Strategic Sourcing – Item Procurement Importance Matrix – Strategic Sourcing Methodology – Managing Sourcing and Procurement Process – Supplier Selection and Evaluation – Bullwhip Effect and its Management – Economies of Scale in Supply Chain – Cycle Inventory – Estimation – Quantity Discounts – Multiechelon Cycle Inventory. Uncertainty in Supply Chain – Safety Inventory – Determination Of Appropriate Level – Impact on Uncertainty – Cases.

Unit – V **Supply Chain and Information Systems** **9**

Information in Supply Chain – Role of Information Technology – it Framework in Supply Chain – Supplier and Customer Relationship Management. Role of E-Business in Supply Chain – E-Sourcing and E-Procurement. Technology Drivers in Supply Chain.

Total:45

TEXT BOOK:

1. Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning, and Operation”, Pearson Education, 7th Edition, 2019.

REFERENCES:

1. V.V.Sople., “Supply Chain Management, Text and Cases”, 1st Edition, Pearson Education, South Asia, 2011.
2. John Mangan., “Global Logistics and Supply Chain Management”, 4th Edition, John Wiley & Sons, New Delhi, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recall the role of supply chain management in an organization.	Understanding (K2)
CO2	identify the various aspects of supply chain management and the factors affecting them.	Applying (K3)
CO3	implement the relationship among various factors involved in planning, organising and controlling supply chain operations.	Applying (K3)
CO4	examine the sourcing and inventory decisions involved in supply chain operations with cases	Analyzing (K4),
CO5	use and investigate of information technology in supply chain management based on customer perspective and decisions	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
CO2	3	2		2										3
CO3	3	2	2											3
CO4	3	2		2										3
CO5	3	2			2									3

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

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	25	30	45				100
CAT3	20	20	25	35			100
ESE	20	25	35	20			100

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

22MEE16 - LEAN SIX SIGMA							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals the implementation concept of lean, six sigma, project selection, process tools and design tools in industries.	
Unit – I	**Introduction to Lean and Six Sigma**	**9**
Definition-Purpose, Features of lean, Top seven wastes and Need for lean management. The philosophy of lean management – Creating a lean enterprise, Elements of lean, Lean principles, Lean metric and Hidden time traps. Introduction to quality - Definition of six sigma, Origin, Concept and Critical success factors for six sigma.		
Unit – II	**Integration of Lean and Six Sigma**	**9**
Evolution, synergy, definition, principles, scope and features of Lean Six Sigma (LSS). Laws of LSS - Elements of LSS - LSS model and benefits of LSS. Initiation - Top management commitment – Infrastructure and deployment planning, Process focus, Organizational structures. Measures – Rewards and Recognition, Infrastructure tools and Structure of transforming.		
Unit – III	**Project Selection and Team Building**	**9**
Resource and project selection, Selection of black belts, Training of black belts and Champions and Identification of potential projects .Top down (Balanced score card) and bottom up approach – Methods of selecting projects - Benefit/effort graph, Process mapping, Value stream mapping, Predicting and Improving team performance, Nine team roles and Team leadership.		
Unit – IV	**Design Measure Analyse Improve Control (DMAIC) Process and Tools**	**9**
The DMAIC process - Toll gate reviews. The DMAIC tools - Project definition form and SIPOC diagram. Measure Tools-Process mapping, Lead time/cycle time, Cause and effect matrix. Generating and organizing tools- Brainstorming, Nominal group technique and Multi voting. Data collection and accuracy tools- Check sheet, Gage Repeatability and Reproducibility-Understanding and Eliminating variation- run charts. Analyse tools - scatter plots, ANOVA, Regression analysis and Time trap analysis.		
Unit – V	**Institutionalizing and Design for Six Sigma**	**9**
Institutionalizing lean six sigma – Improving design velocity, creating cycle time base line, Valuing projects, Gating the projects, Reducing product line complexity. Design for lean six sigma -Quality Function Deployment (QFD), Theory of Inventive Problem solving(TRIZ), Robust Design-Case study presentations.		
		Total:45

TEXT BOOKS:

1.	Salman Taghizadegan, “Essentials of Lean Six Sigma”, 4th Edition Elsevier, 2010 for Units I,II and III
2.	Michael L. George, “Lean Six Sigma”, 5th Edition, McGraw-Hill., Europe, 2002 for Units IV and V

REFERENCES:

1.	Erick Jones, "Quality Management for Organizations Using Lean Six Sigma Techniques", 1st Edition, CRC Press, 2014.
2.	Matthew John Franchetti, "Lean Six Sigma for Engineers and Managers: With Applied Case Studies", 1st Edition, CRC Press, 2021.

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

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2			1				1				3	3
CO2	3	2			1				1				3	3
CO3	3	2			1				1				3	3
CO4	3	2			1				1				3	3
CO5	3	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	30	70					100
CAT2	25	35	40				100
CAT3	15	20	25	40			100
ESE	20	20	35	25			100

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

22GEE01 - FUNDAMENTALS OF RESEARCH

(Common to All BE/BTech branches)

Programme & Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**GE**	**3**	**0**	**0**	**3**

Preamble	This course familiarizes 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 - Outcomes 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 – Data Collection – Primary Data Analysis – Experimental Methods 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**
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”. 2nd edition, Routledge, 2017., for Units I, II, III, IV & V

REFERENCES:

1. Mishra, S.B. and Alok, S. “Handbook of research methodology” Educreation Publishing, 2017
2. Kumar, Ranjit. “Research Methodology: A step-by-step guide for beginners”. SAGE Publications Limited, 2019.
3. Nayak, J.K. and Singh, P. “Fundamentals of Research Methodology Problems and Prospects”. SSDN Publishers & Distributors, 2021.

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	Applying (K3)
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	2	1	1	3	3	1	1	3	3	3
CO2	3	3	3	3	2	1	1	3	3	3	3	3	3	3
CO3	3	3	3	3	3	1	1	3	3	3	1	3	3	3
CO4	3	2	1	1	2	1	1	3	2	1	1	3	3	3
CO5	3	3	2	2	3	1	1	3	3	3	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		40	50	10			100
CAT2		30	50	10	10		100
CAT3		20	30	30	10	10	100
ESE		40	40	10	10		100

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

22MEE17 - MECHANICS OF COMPOSITE MATERIALS

Programme & Branch	**BE & 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 designing of composite materials for various static and dynamic applications.

Unit – I | Basics of Fibers, Matrices and Composites | 9

Basics of Fibers: Definition – Need – General Characteristics and Applications. Fibers: Glass – Carbon – Ceramic – Aramid - Polyester and Natural Fibers. Matrices: Polymer - Ceramic and Metal Matrices - Characteristics of Fibers and Matrices - Fiber Surface Treatments - Fillers and Additives - 3D Printer Filament Wires.

Unit – II | Composite Manufacturing | 9

Hand Layup - Spray up - Bag Molding - Compression Molding – Pultrusion – Filament Winding – Resin Film Infusion - Elastic Reservoir Molding - Tube Rolling – Quality Inspection Methods- Processing of Metal Matrix Composites (MMC) – Diffusion Bonding – Stir Casting – Squeeze Casting and Powder Metallurgy Technique – 3D Printer Wires – Composites Manufacturing Techniques.

Unit – III | Composite Performance and Analysis | 9

Static Mechanical Properties – Dynamics Mechanical Analysis – Thermogravimetric Analysis - Fatigue and Impact Properties – Environmental Effects – Long Term Properties - Service Life Predication - Fracture Behavior and Damage Tolerance – Creep Behaviors.

Unit – IV | Composite Mechanics | 9

Fiber Content - Density and Void Content - Rule of Mixture - Volume and Mass Fractions - Evaluation of Four Elastic Moduli Based on Strength of Materials Approach and Semi-Empirical Model - Longitudinal Young's Modulus - Transverse Young's Modulus –Major Poisson's Ratio-in-Plane Shear Modulus - Ultimate Strengths of a Unidirectional Lamina - Characteristics of Fiber-Reinforced Lamina – Laminates – Lamination Theory.

Unit – V | Design of Composites | 9

Failure Predictions - Theories of Failure - Laminate Design Consideration - Design Criteria - Design Allowable - Design Guidelines - Joint Design - Bolted and Bonded Joints - Design Examples - Design of a Tension Member - Design of a Compression Member – Design of a Beam - Design of a Torsional Member - Application of Finite Element Method (FEM) for Design and Analysis of Laminated Composites - Design of Layering Thickness - Infill Pattern - Infill Density of 3D Printer Wires 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, 2009.

REFERENCES:

1. Autar K. Kaw, "Mechanics of Composite Materials", 2nd Edition, CRC Press, New York, 2018.
2. Bhagwan D. Agarwal, Lawrence J. Broutman & Chandrashekhar K., "Analysis and Performance of Fiber Composites", 4th Edition,John Wiley & Sons, New York, 2021.

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, 3D printer wires and composites	Applying (K3)
CO2	describe the various manufacturing processes involved in the fabrication of composite material	Applying (K3)
CO3	evaluate the performance of composite materials	Applying (K3)
CO4	calculate the physio-mechanical properties of composite materials	Applying (K3)
CO5	design appropriate fiber reinforced composites for suitable applications	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MEE18 - DESIGN OF JIGS, FIXTURES AND PRESS TOOLS							
Programme & Branch	**BE & 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 and dies for industrial applications.

Unit – I **Introduction to Jigs and Fixture** **9**

Tool Design Objectives - Production Devices –Inspection Devices- Materials used in Jigs and Fixtures — Types of Jigs - Types of Fixtures – Mechanical - Pneumatic Actuation - Hydraulic Actuation- Analysis of Clamping Force- Tolerance and Error Analysis.

Unit – II **Jigs** **9**

Drill Bushes - Different Types of Jigs-Plate Latch- Channel- Box- Post- Angle Plate- Angular Post- Turnover- Pot Jigs Automatic DrillJigs-Rack and Pinion Operated- Air Operated Jig Components- Design of Jigs.

Unit – III **Fixtures** **9**

General Principles - Boring- Lathe- Milling and Broaching Fixtures- Grinding- Planning and Shaping Fixtures Assembly- Inspection andWelding 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- GuidePins – Bushes- strippers – Knockouts-Stops –Pilots-Selection of Standard Die sets-Strip Layout Calculations.

Unit – V **Design of Dies** **9**

Design of Progressive and Compound Dies — Blanking and Piercing Operations- Bending Dies Design –Forming and Drawing DieDesign-Design of Drawing Dies. Design Considerations: Forging- Extrusion- Casting-Plastic Dies.

Total:45

TEXT BOOKS:

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 analyze the related forces	Applying (K3)
CO2	identify and design the suitable jigs for various components.	Analyzing (K4)
CO3	identify and design the suitable fixtures for various components.	Analyzing (K4)
CO4	demonstrate the function of various parts of dies and design the strip layout for various pressworks.	Analyzing (K4)
CO5	design and select the various types of dies.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1											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	10	10	60	20			100
CAT2	10	10	40	40			100
CAT3	10	10	40	40			100
ESE	10	10	40	40			100

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

22MEE19 - CNC TECHNOLOGY							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Machining and Measurements**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course focus on Computer Numerical Control (CNC) machines and tools with automation processes in manufacturing industry, programming and tooling methods for CNC machines and also provides the aspects of economic operation.	
Unit- I	**Basic Concepts of Metal Cutting and CNC Machines**	**9**
Introduction – Mechanics of Chip Formation - Mechanics of Oblique Cutting – Cutting Forces and Power – Tool Life – Surface Finish – Machinability – Classification of CNC Machines - Construction Details – Structure - Configuration of CNC System – Interfacing – Monitoring – Diagnostics – Machine Data – Compensations for Machine Accuracy – Direct Numerical Control (DNC) Machine – Adaptive Control CNC Systems.		
Unit- II	**Drives and Controls**	**9**
Drive Mechanism – Gearbox - Spindle Drives - Axes Drives – Magnetic Levitation and Linear Motors – Timing Belts and Pulleys – Spindle Bearing – Arrangement and Installation – Slide Ways - Re-Circulating Ball Screws – Backlash Measurement and Compensation - Linear Motion Guide Ways.		
Unit- III	**Part Programming in CNC Machines**	**9**
Part Program Terminology - G and M Codes – Types of Interpolation - CNC Part Programming – Manual Part Programming (Turning and Milling) - Various Programming Techniques – Automatically Programmed Tool (APT) Programming for Various Machines in ISO and FANUC - CAM Packages for CNC Machines.		
Unit- IV	**Tooling For CNC Machines**	**9**
Interchangeable Tooling System – Preset and Qualified Tools – Coolant Feed Tooling System – Modular Fixturing – Quick Change Tooling System – Automatic Head Changers – Tooling Requirements for Turning and Machining Centers –Tool Holders – Tool Assemblies – Tool Magazines – Automatic Tool Changer (ATC) Mechanisms – Automatic Pallet Changer Tool Management - Principles of Location - Clamping and Work Holding Devices.		
Unit- V	**Economics of CNC Machines and Retrofitting**	**9**
Factors Influencing Selection of CNC Machines – Cost of Operation of CNC Machines – Practical Aspects of Introducing CNC Machines in Industries – Maintenance Features of CNC Machines – Preventive Maintenance - Other Maintenance Requirements – Retrofitting - Necessary for Retrofitting - Advantages.		
		Total:45

TEXTBOOKS:

1.	Kalpakjian. S. and Schmid. S. R., "Manufacturing Engineering and Technology", 8th Edition, Pearson Education India, New Delhi, 2020 for Unit I.
2.	Radhakrishnan P, "Computer Numerical Control Machines", 1st Edition, New Central Book Agency, Kolkata, 2018 for Units I, II, III, IV, V.

REFERENCES:

1.	HMT Limited,"Mechatronics",1st Edition, TataMcGraw-Hill,NewDelhi,2008.
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.,NewDelhi,2018.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MEE20 - PRECISION ENGINEERING

Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology, Machining and Measurements**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with precision manufacturing, micro machining and fundamental design requirements of precision machine tools. It also provides insights on machine surface characteristics and error detection methods.

Unit – I	**Precision Manufacturing**	**9**

Introduction - Need for Precision Manufacturing - Taniguchi Diagram - Four Classes of Achievable Machining Accuracy – Normal Precision – High-Precision - Ultra-Precision Processes and Nanotechnology.

Unit – II	**Precision Machining and Unconventional Micromachining Techniques**	**9**

Overview of Micro and Nano Machining - Conventional Micro Machining Techniques - Micro-Turning - Micro-Milling - Micro-Grinding - Ultra-Precision Diamond Turning. Unconventional Micromachining Techniques: Abrasive Jet and Water Jet Micromachining - Ultrasonic Micromachining - Micro Electrical Discharge Machining - Photochemical Machining - Electrochemical Micromachining - Laser Beam Micromachining - Electron Beam Micromachining - Focused Ion Beam Micromachining.

Unit – III	**Machine Design For Precision Manufacturing**	**9**

Philosophy of Precision Machine Design - Ultra-Precision Machine Elements: Guide Ways - Drive Systems - Friction Drive - Linear Motor Drive - Spindle Drive. Bearings: Principle - Construction and Application of Rolling - Hydrodynamic and Hydrostatic Bearings - Aerostatic Bearings - Magnetic Bearings.

Unit – IV	**Mechanical and Thermal Errors**	**9**

Sources of Error - Principles of Measurement - Errors due to Machine Elements – Bearings – Spindles - Kinematic Design - Structural Compliance – Vibration - Thermal Effects - Environmental Control of Precision Machinery. Error Mapping and Error Budgets.

Unit – V	**Dimensional Metrology for Micro Machining**	**9**

Machine Vision - Laser Tracking Systems - Laser Scanners – White Light– 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 BOOKS:

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

REFERENCES:

1.	Venkatesh V.C., Izman,Sndir., "Precision Engineering", 2^{nd} Edition, Tata McGraw-Hill, New Delhi, 2015.
2.	Jain V.K., "Introduction to Micromachining", 2^{nd} Edition, Narosa Publishers, New Delhi, 2022.

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

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1											2	2
CO2	3	1	3										2	3
CO3	3	1	3										2	3
CO4	3	1	3				1						2	3
CO5	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	25	50	25				100
CAT2	25	25	50				100
CAT3	25	25	50				100
ESE	25	30	45				100

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

22MEE21 - COMPUTATIONAL FLUID DYNAMICS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fluid Mechanics and Hydraulic Machines, Heat and Mass Transfer**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the application of numerical methods in solving fluid flow and heat transfer problems. Grid generation techniques and turbulence models are covered extensively through this course.	
Unit – I	**Governing Equations and Boundary Conditions**	**9**
Governing Equations: Basics of Computational Fluid Dynamics – Governing Equations – Continuity - Momentum and Energy Equations – General Transport Equation. Boundary Conditions: Physical Boundary Conditions – Discretization – Mathematical Behavior of PDEs on CFD –Elliptic - Parabolic -Hyperbolic Equations.		
Unit – II	**Finite Difference Method**	**9**
Finite Difference Method – Taylors Series – Forward - Central - Backward Differences – Explicit Method – Implicit Method – Tridiagonal Matrix-Application of the TDMA to Two-Dimensional Problems– ADI Method –Solution Methodology for Parabolic and Elliptic Equations – Errors.		
Unit – III	**Finite Volume Method**	**9**
Finite Volume Formulation for Steady-State – One and Two - Dimensional Diffusion Problems –Parabolic Equations – Explicit – Implicit Schemes - Unsteady Heat Conduction on Elliptic and Parabolic Equations - Steady State One-Dimensional Convection and Diffusion problems – Central - Upwind Differencing Schemes- Hybrid - Power-Law - QUICK Schemes –Properties of Discretization Schemes.		
Unit – IV	**Grids**	**9**
Types of Grid – Grid Generation – Grid Transformation – Calculation of Flow Field Variable – Staggered Grid – Pressure and Velocity Correction – SIMPLE Algorithm – SIMPLER Algorithm - SIMPLEC Algorithm – PISO Algorithm.		
Unit – V	**Turbulence Models**	**9**
Turbulence – Effect of Turbulence on Time Averaged Navier Stokes Equation – Characteristics of Simple Turbulent Flow – Flat Plate Boundary Layer – Pipe Flow – Turbulence Models – Mixing Length Model – K-ε Models – Reynolds Stress Equation Model – Algebraic Stress Model-Internal flow analysis using ANSYS-FLUENT.		
		Total:45

TEXT BOOKS:

1.	Anderson John D., "Computational Fluid Dynamics: Basic with Applications", Indian Edition, Tata McGraw-Hill, India, 2017 for Units I, II.
2.	Versteeg H. K. & Malalasekera W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd Edition, Pearson Education Ltd., UK, 2007 for Units III, IV,V.

REFERENCE:

1.	Jiyuan Tu, Guan Yeoh, Chaoqun Liu, “Computational Fluid Dynamics: A Practical Approach”, 3rd Edition, Elsevier, USA, 2019

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	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)

22MEE22 - GAS DYNAMICS AND JET PROPULSION

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

Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics, Thermal Engineering**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with concepts of compressible fluid flow in variable and constant area ducts. The principles behind aircraft and space propulsion systems along with their performance calculations are covered through this course.

Unit – I	**Fundamentals of Compressible Flow and Isentropic Flow through Variable Area Ducts**	**9**

Fundamentals of Compressible Flow: Adiabatic Energy and Momentum Equations for Compressible Fluid Flows - Stagnation State - Critical State - Mach Number - Reference Velocities - Various Regions of Flow - Mach Cone - Mach Angle - Effect of Mach Number on Compressibility. Isentropic Flow through Variable Area Ducts: T-s and h-s Diagrams for Nozzle and Diffuser - Area Ratio as a Function of Mach Number - Mass Flow Rate Through Nozzles and Diffusers.

Unit – II	**Flow Through Constant Area Ducts**	**9**

Flow in Constant Area Ducts with Friction - Fanno Curves and Fanno Flow Equation - Variation of Flow Properties - Variation of Mach Number with Duct Length - Flow in Constant Area Ducts with Heat Transfer - Rayleigh Line and Rayleigh Flow Equation - Variation of Flow Properties - Maximum Heat Transfer

Unit – III	**Flow Across Shock**	**9**

Generation of Shock in Shock Tubes - Desirable and Undesirable Effects of Shock -Governing Equations of Normal Shock – Variation of Flow Parameters Across the Normal Shock - Prandtl Meyer Equation - Impossibility of Shock in Subsonic Flows - Strength of Shock Wave - Introduction to Oblique Shock.

Unit – IV	**Aircraft Propulsion**	**9**

Types of Jet Engines - Energy Flow through Jet Engines - Study of Turbojet Engine Components – Diffuser – Compressor -Combustion Chamber - Turbine and Exhaust Systems - Performance of Turbo Jet Engines – Thrust - Thrust Power - Propulsive and Overall Efficiencies - Ram Jet, Scram Jet and Pulse Jet Engines

Unit – V	**Rocket Propulsion**	**9**

Types of Rocket Engines - Solid Propellant Rocket - Liquid Propellant Rocket and Hybrid Rocket - Thrust Equation - Effective Jet Velocity - Specific Impulse - Rocket Engine Performance - Solid and Liquid Propellants - Comparison of Different Propulsion Systems - Stages of a Rocket during Course of Travel.

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

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	analyze the compressible flow through variable area ducts	Analyzing (K4)
CO2	examine the flow through constant area duct with heat transfer and friction	Analyzing (K4)
CO3	evaluate the flow associated with normal shock	Analyzing (K4)
CO4	explain the working of aircraft engines	Applying (K3)
CO5	explain the types of rocket engines and their working principles	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3									1		3
CO2	2		3									1		3
CO3	2		3									1		3
CO4	3		2											2
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	35	35			100
CAT2	10	20	40	30			100
CAT3	20	30	50				100
ESE	10	20	40	30			100

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

22MEE23 - PROJECT MANAGEMENT							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides market analysis, financial analysis and systems approach in industrial case study projects. It provides different industrial management techniques for various applications.	
Unit – I	**Introduction**	**9**
An Overview – Types – Characteristics of Projects – Project Life Cycle – Identification of Investment Opportunities – Screening and Selection – Project Appraisal.		
Unit – II	**Market and Demand Analysis**	**9**
Market Survey – Demand Forecasting Methods – Technical Analysis – Manufacturing Process – Materials – Product Mix – Plant Location Project Charts and Layouts.		
Unit – III	**Financial Management**	**9**
Budgeting Techniques – Net Present Value – Profitability Index – Internal Rate of Return – Payback Period – Accounting Rate of Return.		
Unit – IV	**Mathematical Techniques for Project Management**	**9**
Mathematical Techniques for Project evaluation – Linear Programming – Goal Programming – Network Technique for Project Management – CPM – PERT – Multiple Projects and Constraints – Scheduling.		
Unit – V	**Project Implementation**	**9**
Organization Systems for Project Implementation – Work Breakdown – Coordination and Control – Project Management Software.		
		Total:45

TEXT BOOK:

1.	Prasanna Chandra, "Projects – Planning, Analysis, Financing, Implementation and Review", 9th Edition, McGraw Hill, Noida, 2019.

REFERENCES:

1.	Choudhury S, "Project Management". 32nd Reprint, Tata McGraw Hill Education Private Limited, India, 2009.
2.	Mike Field & Laurie Keller, "Project Management", 3rd Edition, Thompson Business Press, Washington, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the project life cycle and appraise the projects	Understanding (K2)
CO2	perform market and demand analysis	Understanding (K2)
CO3	perform financial analysis of projects	Applying (K3)
CO4	evaluate the projects using mathematical techniques	Analyzing (K4)
CO5	categorize the different phases of project implementation	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2									3			3
CO2	2	1									3			3
CO3	1	2									3			3
CO4	1	2									3			3
CO5	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	50	50					100
CAT2	25	25	50				100
CAT3	20	20	30	30			100
ESE	20	25	35	20			100

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

22GEE02 - TOTAL QUALITY MANAGEMENT

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

Preamble	This course deals with quality concepts and Total Quality Management (TQM) principles focusing on process quality for customer perspective. It also deals with the basic and modern quality management tools including ISO standards

Unit – I	**Quality Concepts and Principles**	**9**

Definition of Quality - Dimensions of Quality - Quality Planning - Quality Assurance and Control - Quality Costs with Case Studies - Elements / Principles of TQM - Historical Review – Leadership – Qualities / Habits - Quality Council - Quality Statements, Strategic Planning – Importance - Case Studies - Deming Philosophy - Barriers to TQM Implementation – Cases with TQM Success and Failures.

Unit – II	**TQM-Principles and Strategies**	**9**

Customer Satisfaction - Customer Perception of Quality - Customer Complaints - Customer Retention, Employee Involvement – Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal, Continuous Process Improvement - Juran's Trilogy - PDSA Cycle - 5S - Kaizen, Supplier Partnership - Partnering - Sourcing - Supplier Selection - Supplier Rating - Relationship Development, Performance Measures – Purpose – Methods - Cases.

Unit – III	**Control Charts for Process Control**	**9**

Basic Seven Tools of Quality and its Role in Quality Control, Statistical Fundamentals - Measures of Central Tendency and Dispersion, Population and Sample - Normal Curve - Control Charts for Variables and Attributes - Process Capability - Case Study - Introduction to Six Sigma.

Unit – IV	**TQM-Modern Tools**	**9**

New Seven Tools of Quality, Benchmarking - Need - Types and Process, Quality Function Deployment - House of Quality (HOQ) Construction - Case Studies, Introduction to Taguchi's Robust Design - Quality Loss Function - Design of Experiments (DOE), Total Productive Maintenance (TPM) - Uptime Enhancement, Failure Mode and Effect Analysis (FMEA) - Risk Priority Number (RPN) – Process - Case Studies.

Unit – V	**Quality Systems**	**9**

Need for ISO 9000 and Other Quality Systems - ISO 9000: 2015 Quality System – Elements - Implementation of Quality System - Documentation - Quality Auditing, Introduction to ISO 14000 - IATF 16949 - TL 9000-IEC 17025 - ISO 18000 - ISO 20000 - ISO 22000 - ISO21001. Process of Implementing ISO - Barriers in ISO Implementation.

Total:45

TEXT BOOK:

1.	Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, UrdhwaresheRashmi. "Total Quality Management", 5th Edition, Pearson Education, Noida, 2018.

REFERENCES:

1.	Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education, New Delhi, 2017.
2.	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, Cengage Learning, 2012.
3.	David Goetsch & Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", 8th Edition,Pearson, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the evolution of TQM principles	Understanding (K2)
CO2	illustrate the principles and strategies of TQM	Understanding (K2)
CO3	use control charts and identify process capability of a process	Applying (K3)
CO4	apply various quality tools and techniques in both manufacturing and service industry	Applying (K3)
CO5	choose appropriate quality standards and implement them in the respective industry	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				1						1		3
CO2	2	2				1						1		3
CO3	2	2				1						1		3
CO4	2	2				1						1		3
CO5	1	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	25	45	30				100
CAT2	20	40	40				100
CAT3	25	45	30				100
ESE	20	40	40				100

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

22MEE24 - INDUSTRIAL TRIBOLOGY								
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fluid Mechanics and Hydraulic Machines, Design of Machine Elements**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the fundamentals of friction, wear, lubrication and design aspects of bearing.	
Unit – I	**Surfaces and Friction**	**9**
Topography of Engineering Surfaces–Contact Between Solids –Sources of Sliding Friction – Friction Characteristics of Metals – Friction of Non-Metals – Friction of Ceramics and Polymers –Rolling Friction – Source of Rolling Friction – Stick Slip Motion.		
Unit – II	**Wear and Lubrication**	**9**
Types of Wear – Simple Theory of Sliding Wear Mechanism – Adhesive and Abrasive Wear – Corrosive Wear – Surface Fatigue Wear – Brittle Fracture – Wear of Ceramics and Polymers. Types and Properties of Lubricants –Testing Methods.		
Unit – III	**Film Lubrication Theory**	**9**
Hydrodynamic Lubrication – Fluid Film in Simple Shear–Viscous Flow Between Very Close Parallel Plates-Reynolds Equation for Film Lubrication – Solid Lubrication – Hydrostatic Lubrication.		
Unit – IV	**Journal Bearings**	**9**
Bearing Geometry – Pressure Distribution – Load Capacity – Friction Force – Coefficient of Friction – Lubricant Flow rate – Practical and Operational Aspects of Journal Bearings –Thermal Effects in Bearings – The Somerfield Diagram.		
Unit – V	**Bearing Materials**	**9**
Surface Treatments – Reduction of Friction – Wear Resistant Coatings – Materials for Rolling Element Bearings – Materials for Fluid Film Bearings – Materials for Marginally Lubricated and Dry Bearings.		
		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, 2004.
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	Illustrate the hydrodynamic and hydrostatic lubrications.	Applying(K3)
CO4	analyze the performance of journal bearings and design for different assembly	Applying(K3)
CO5	select the suitable materials for bearings in different 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	3	1										1		3
CO2	3	2										1		3
CO3	3	2										1		3
CO4	3	2										1		3
CO5	3	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				100
CAT2	10	45	45				100
CAT3	10	60	30				100
ESE	10	45	45				100

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

22MEE25 - ADVANCED MECHANICS OF MATERIALS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Mechanics, Strength of Materials**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts the knowledge on three-dimensional theory of elasticity, shear centre, unsymmetrical section bending stresses, stress analysis on curved beams, the torsion on non-circular members, and membrane stresses on shells, rotating disc and the beam on elastic foundation.	
Unit – I	**Theory of Elasticity**	**9**
Theory of Stresses - Infinitesimal and Finite Strains - Strain-Displacement Relationships - Compatibility - Stress-Strain Relationship Elastic Constants - Stress and Displacement Functions- Plane Stress Problems in Cartesian and Polar Coordinates – Boundary Conditions - Representations of Three - Dimensional Stress of a Tension-Generalized Hooke's Law – St.Vennant's Principle – Plane Strain - Plane Stress – Airy's Stress Function.		
Unit – II	**Shear Centre and Unsymmetrical Bending**	**9**
Location of Shear Center for Various Sections – Shear Flow. Unsymmetrical Bending: Stresses and Deflection in Beams Subjected to Unsymmetrical Loading – Kern of a Section.		
Unit – III	**Stresses on Curved Beams**	**9**
Curved Flexural Members - Analysis of Stresses in Beams with Large Curvature – Stress Distribution in Curved Beams – Stresses in Crane Hooks and C Clamps - Closed Ring Subjected to Concentrated Load and Uniform Load – Chain Link.		
Unit – IV	**Stresses Due to Rotation**	**9**
Stresses Due to Rotation – Radial and Tangential Stresses in Solid Disc and Ring of Uniform Thickness and Varying Thickness – Allowable Speed.		
Unit – V	**Beams on Elastic Foundation**	**9**
Infinite Beam Subjected to Concentrated Load – Boundary Conditions – Infinite Beam Subjected to a Distributed Load Segment – Triangular Load - Semi Infinite Beam Subjected to Loads at the Ends and Concentrated Load near the Ends – Short Beams.		
		Total:45

TEXT BOOKS:

1.	Sadhu Singh, "Applied Stress Analysis", 19th Edition, Khanna Publishers, New Delhi, 2016 for Units I
2.	Rajput R. K. , "Strength of Materials", 7th Edition, S. Chand & Co, New Delhi, 2018 for Units II, III, IV,V

REFERENCES:

1.	Timoshenko S.P., "Strength of Materials", 4th Edition, CBS Publishers, New Delhi, 2012.
2.	Timoshenko S.P. & Goodier J.N., "Theory of Elasticity", 3rd Edition, McGraw Hill Education, New York, 2017
3.	Rattan S.S., "Strength of Materials", 4th Edition, McGraw Hill Education, New York, 2017

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.	Applying(K3)
CO2	calculate analytically the shear centre and stresses in unsymmetrical bending.	Applying(K3)
CO3	determine the stresses and deflections on Curved beams	Applying(K3)
CO4	solve the stresses due to rotation on various components	Applying(K3)
CO5	analyze the stresses in beams under elastic foundation	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	3	2											3
CO2	1	3	2											3
CO3	1	3	2											3
CO4	1	3	2											3
CO5	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	70				100
CAT2	15	15	70				100
CAT3	15	15	70				100
ESE	15	15	70				100

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

22MEE26 - ADDITIVE MANUFACTURING								
Programme & Branch	**BE & 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 and technological aspects of various additive and formative rapid manufacturing processes for mass customization.	
Unit - I	**Introduction to Additive Manufacturing (AM)**	**9**
Evolution - Fundamental Fabrication Processes - Product Design and Development - Conceptual Design - Detail Design - History of Additive Manufacturing (AM) Systems - Need for AM - Classification of AM Systems - Benefits of AM - AM Process Chain – Computer Aided Design for AM - 3D Modeling - 3D Solid Modeling Softwares and their Role in AM - Data Format - STL files.		
Unit - II	**Liquid and Solid-based AM systems**	**9**
Liquid-based AM systems: Stereo Lithography Apparatus (SLA) - Principle, Photo Polymers - Post Processes - Process Parameters - Machine Details - Advantages. Mask Projection VP Technology - Principle - Process Parameters - Process Details - Machine Details - Advantages and Applications Solid-based AM systems: Fusion Deposition Modeling (FDM) - Principle - Raw materials - Support System - Process Parameters - Machine Details - Advantages and Limitations. Laminated Object Manufacturing (LOM) - Principle - Process Parameters - Process Details - Advantages and Limitations.		
Unit - III	**Powder-based AM systems**	**9**
Selective Laser Sintering (SLS) - Principle - Process Parameters - Process Details - Machine Details - Raw Materials - Advantages and Applications. Laser Engineered Net Shaping (LENS) - Principle - Process Details - Advantages and Applications. Binder Jetting (BJ) - Principle - Process Parameters - Process Details - Machine Details - Raw Materials - Advantages and Applications.		
Unit - IV	**Directed Energy Deposition (DED) and Direct Write AM Technologies**	**9**
DED Processes: Principle - Process Description - Material Delivery – Systems – Process Parameters - Benefits and Drawbacks – Applications Direct Write Technologies: Background - Ink-Based Technologies - Laser Transfer - Beam Deposition - Liquid-Phase Direct Deposition - Hybrid Technologies – Applications		
Unit - V	**Design for AM (DFAM) and Applications of AM**	**9**
DFAM: Introduction - AM Unique Capabilities - Core DFAM Concepts and Objectives - Exploring Design Freedoms - Synthesis Methods. AM Application Domains: Aerospace – Electronics - Health Care – Defense – Automotive – Construction - Food Processing - Tooling and Machine Tools.		
		Total:45

TEXT BOOKS:

1.	Chua.C.K., Leong K.F. and Lim C.S., "Rapid Prototyping: Principles and Applications", World Scientific, NewJersy, 2010 for Units I, II, III and V.
2.	Ian Gibson, David Rosen, Brent Stucker, “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, 2nd Edition, Springer, UK, 2015 for Unit IV.

REFERENCES:

1.	Pham D.T. and Dimov S.S., "Rapid Manufacturing", Springer -Verlag, London, 2011.
2.	Amitabha Ghosh., "Rapid Manufacturing a brief Introduction", Affiliated East West Press, New Delhi, 2011.
3.	Sabrie Soloman, “3D Printing and Design”, 1st Edition, Khanna Publishing House, Delhi, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	define the concepts of additive manufacturing for new product development	Understand (K2)
CO2	select the suitable liquid and solid-based AM system for a specific application	Applying (K3)
CO3	identify the suitable powder-based AM system for a specific application	Applying (K3)
CO4	select the suitable DED/Direct write based AM system for a specific application	Applying (K3)
CO5	choose the suitable DFAM procedure for new product development	Understand (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												3
CO2	1	3	2											3
CO3	1	3	2											3
CO4	1	3	2											3
CO5	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	90					100
CAT2	5	60	35				100
CAT3	5	60	35				100
ESE	5	60	35				100

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

22MEE27 - WELDING TECHNOLOGY

Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology, Engineering Materials and Metallurgy**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the knowledge on various advanced welding processes, welded joint designs and testing of weldment.

Unit - I **Welding Principles, Gas and Arc Welding Processes** **9**

Classifications of Welding Processes – Power Sources – Arc Characteristics – V-I Characteristics – Metal Transfer Modes – Electrodes and Fluxes – Types of Weld Joints – Weld Position – Gas Welding: Oxy-Acetylene Welding – Oxy-Hydrogen Welding – Arc Welding: Shielded Metal Arc Welding – Submerged Arc Welding – Gas Tungsten Arc Welding – Gas Metal Arc Welding – Plasma Arc Welding – Electro Slag Welding – Electro-Gas Welding Process – Advantages – Limitations and their Applications.

Unit - II **Resistance Welding Processes** **9**

Spot Welding – Seam Welding – Projection Welding – Resistance Butt Welding – Flash Butt Welding – Percussion Welding – High Frequency Resistance Welding Process – High Frequency Induction Welding Process – Advantages – Limitations and their Applications.

Unit - III **Solid State Welding Processes** **9**

Forge Welding – Friction Welding – Friction Stir Welding - Explosive Welding – Ultrasonic Welding – Cold Welding – Diffusion Bonding – Roll Welding – Hot Pressure Welding Processes – Advantages – Limitations and its Applications.

Unit - IV **Special Welding Processes and Design of Weld Joints** **9**

Thermit Welding – Atomic Hydrogen Welding – Electron Beam Welding – Laser Beam Welding – Under Water Welding – Welding Symbols – Welding Dimension – Design of Various Welded Joints: Weldability of Aluminium, Copper, Cast Iron and Stainless Steels.

Unit - V **Testing of Weldments, Codes & Standards and Welding Automation** **9**

Destructive Tests: Tensile Test – Ductility Test – Toughness Test – Fatigue Test – Non-Destructive Test: Visual Inspection – Liquid Penetrant Test – Magnetic Particle Test – Radiographic Test – Ultrasonic Testing of Weldments.
Codes and Standards: Introduction to Codes and Standards – Welding and Welder Qualification – Procedure Qualification Record – Welding Procedure Specification – Welder Performance Qualification – Welding Automation in Aerospace, Nuclear and Surface Transport Vehicles.

Total:45

TEXT BOOK:

1. David Phillips. H., "Welding Engineering: An Introduction", 2nd Edition, John Wiley & Sons, Ltd.,United States, 2023.

REFERENCES:

1. Parmer R.S., "Welding Engineering and Technology", 3rd Edition, Khanna Publishers, New Delhi, 2022.
2. Nadkarni S.V., "Modern Arc Welding Technology", 1st Edition, Oxford IBH Publishers, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the working principle of welding process and select the parameters for the given applications	Understanding (K2)
CO2	demonstrate the basic concepts of different resistance welding process and select an appropriatetechnique for industrial requirement	Understanding (K2)
CO3	demonstrate the basic concepts of various solid state welding processes and apply appropriatetechnique based on specified applications	Applying (K3)
CO4	illustrate the need for special welding techniques and apply these principle on different materials	Applying (K3)
CO5	select weld codes, standards and procedure to examine the weldment for industrial application	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	3												3
CO2	1	3	2											3
CO3	1	3	2											3
CO4	1	3	2											3
CO5	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	90					100
CAT2	5	70	25				100
CAT3	5	70	25				100
ESE	5	70	25				100

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

22MEE28 - POWER PLANT ENGINEERING							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics, Thermal Engineering**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge on layout and working of various power plants and also the terminologies involved in economic analysis of the power plants.	
Unit – I	**Energy Scenario and Thermal Power Plant**	**9**
Energy Scenario: Indian and Global Energy Scenario – Environmental Issues of Present Day Power Generation. **Thermal Power Plant:** Layout of Thermal Power Plant – Selection Criteria – Boilers – Fluidized Bed Boilers – Boiler Trial and Testing – Fuel and Ash Handling Systems – Pulverizer – Stokers – Dust Collectors – Cooling Towers – Feed Water Treatment – Distributed Control System (DCS).		
Unit – II	**Gas Turbine Power Plant and Diesel Power Plant**	**9**
Gas Turbine Power Plant: Gas Turbine Cycles – Thermodynamic Analysis of Cycles – Reheating – Regeneration and Intercooling - Layout of Gas Turbine Power Plant- Selection Criteria – Binary and Combined Cycle – IGCC. **Diesel Power Plant:** Layout –Types – Selection Criteria – Selection of Engine.		
Unit – III	**Nuclear Power Plant and Hydel Power Plant**	**9**
Nuclear Power Plant: Layout – Selection Criteria – Types of Reactors – Radioactivity – Fission Process – Reaction Rates – Diffusion Theory – Elastic Scattering and Slowing Down – Global Standards in Waste Disposal and Nuclear Safety. **Hydel Power Plant**: Layout – Site Selection Criteria – Selection of Turbines – Micro Hydel Developments.		
Unit – IV	**Other Types of Power Generation**	**9**
MHD Power Generation – Solar Thermal and PV System - WECS – Types – Biomass - Geo thermal – OTEC - Micro Fuel Cells and Portable Power – Comparative Analysis of Combined Heat and Power Cycles.		
Unit – V	**Power Plant Economics**	**9**
Cost of Electric Energy – Load Duration Curves – Fixed and Operating Costs – Energy Rates – Types of Tariffs – Economics of Load Sharing – Comparison - Selection and Economics of Various Power Plants – Energy Auditing – Types – Energy Auditing for Thermal Power Plant – Waste Heat Recovery Boilers in Cement, Sugar and Steel Plants.		
		Total:45

TEXT BOOK:

1.	Rajput R.K, "Power Plant Engineering", 5^{th} Edition, Laxmi Publications, New Delhi, 2016

REFERENCES:

1.	Arora S.C. and Domkundwar S., "A Course in Power Plant Engineering", 8^{th} Edition, Dhanpat Rai, New Delhi, 2016.
2.	Nag P.K, "Power Plant Engineering", 4^{th} Edition, Tata McGraw-Hill, New Delhi, 2017.
3.	Hegde R.K, "Power Plant Engineering", 1^{st} 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 thermal power plant	Applying (K3)
CO2	explain the working of gas and diesel power plants with layouts	Applying (K3)
CO3	explain the basic theory of nuclear processes and working of nuclear and hydel power plants with their layouts	Applying (K3)
CO4	describe the concepts of utilizing renewable energy sources for power generation	Applying (K3)
CO5	identify the terminologies related to power plant economics and discuss the energy saving measures 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					1	1							3
CO2	3					1	1							3
CO3	3					1	1							3
CO4	3					1	1							3
CO5	1		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	40	50				100
CAT2	10	40	50				100
CAT3	10	30	40	20			100
ESE	10	40	40	10			100

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

22MEE29 - DESIGN OF HEAT EXCHANGERS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics, Fluid Mechanics and Hydraulic Machines, Heat and Mass Transfer**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course provides the fundamental aspects on designing different types of heat exchangers. The global standards andfactors to be considered in the design process of heat exchangers are covered extensively.	
Unit – I	**Fundamentals of Heat Exchangers**	**9**
Introduction - Types - Application - Overall Heat Transfer Coefficient –Fouling - Effect of Fouling on Heat Transfer - Fouling Factor - Techniques to Control Fouling - Logarithmic Mean Temperature Difference (LMTD) Method - Effectiveness-Number of Transfer Units (NTU) Method of Heat Exchanger Analysis - Selection of Heat Exchangers.		
Unit – II	**Design of Double Pipe Heat Exchangers**	**9**
Introduction - Thermal and Hydraulic Design of Inner Tube and Annulus - Hairpin Heat Exchanger with Bare and Multi Tube FinnedInner Tube - Parallel-Series Arrangements of Hairpins - Total Pressure Drop.		
Unit – III	**Design of Shell and Tube Heat Exchangers**	**9**
Introduction - Basic Components - Classification - Basic Design Procedure - Tubular Exchanger Manufacturers Association (TEMA)Code - Heat Transfer and Pressure Drop Analysis on Shell Side and Tube Side - Bell Delaware Method.		
Unit – IV	**Design of Compact Heat Exchangers**	**9**
Introduction - Heat Transfer Enhancement - Plate Fin Heat Exchangers - Tube Fin Heat Exchangers - Heat Transfer and Pressure DropAnalysis of Finned Tube and Plate Fin Heat Exchangers.		
Unit – V	**Design of Condensers and Evaporators**	**9**
Introduction - Classification - Thermal Design of Shell and Tube Condensers - Thermal Analysis of Evaporators - Condensers andEvaporators 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",4th Edition, CRC Press, USA, 2020.

REFERENCES:

1.	Kuppan Thulukkanam, "Heat Exchanger Design Handbook", 2nd Edition, CRC Press, USA, 2013.
2.	Ramesh K. Shah, Dusan P. Sekulic. , "Fundamentals of Heat Exchanger Design", 1st Edition, John Wiley & Sons Inc, USA, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the design parameters of a heat exchanger.	Applying (K3)
CO2	analyze the thermal performance and design the double pipe heat exchangers.	Analyzing (K4)
CO3	analyze and design the shell and tube heat exchangers.	Analyzing (K4)
CO4	design the compact heat exchangers.	Analyzing (K4)
CO5	design condensers and evaporators using standard codes	Analyzing (K4)

Mapping of COs with POs and PSOs

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

22MEE30 - QUALITY CONTROL AND RELIABILITY ENGINEERING							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course deals with basic concepts of quality, various tools and techniques involved in improving the customer satisfaction of the product. It also deals with concepts of reliability and its improvement techniques.	
Unit – I	**Introduction**	**9**
Definition of Quality - Basic Concept of Quality - Definition of Statistical Quality Control (SQC) - Benefits and Limitation of SQC-Quality Assurance-Quality Control Quality Cost-Variation in Process- DMAIC Process.		
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 – 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 Models – 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 – Unit Redundancy and Standby Redundancy –Optimization in Reliability – Reliability cost – Trade off.		
		Total:45

TEXT BOOKS:

1.	Douglas.C. Montgomery, "Introduction to Statistical Quality Control", 8th Edition, John Wiley, United States, 2019 for Units I,II,III.
2.	Srinath L.S, "Reliability Engineering", 4th Edition, Affiliated East West Press, 2016 for Units IV,V.

REFERENCES:

1.	Robert James Oakland, John S Oakland, "Statistical Process Control", 7th Edition, Taylor & Francis, 2018.
2.	Patrick O’Connor and Andre Kleyner, "Practical Reliability Engineering", 5th Edition , Wiley , 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	define quality concepts and explain quality assurance process	Understanding (K2)
CO2	use control chars for solving process control problems	Applying(K3)
CO3	apply sampling techniques by considering producers and consumers risk	Applying(K3)
CO4	construct a reliability model and perform failure data analysis	Applying(K3)
CO5	explain the reliability improvement techniques	Applying(K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MEE31 - MULTI – VARIATE ARTIFICIAL INTELLIGENCE DATA ANALYSIS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course aims to data reduction or simplify the process without compromising the valuable information.	
Unit – I	**REGRESSION**	**9**
Simple Regression and Correlation – Estimation using the Regression Line, Correlation Analysis, Multiple Regression and Correlation Analysis –Multiple Regression Equation, Modelling Techniques, Making Inferences about the Population Parameters-Case Studies.		
Unit – II	**MULTIVARIATE METHODS**	**9**
An overview of Multivariate Methods, Multivariate Normal Distribution, Eigen Values and Eigen Vectors with AI – Case Studies.		
Unit – III	**FACTOR ANALYSIS**	**9**
Principal Component Analysis – Objectives, Estimation of Principal Components, Testing for Independence of Variables, Factor Analysis Model – Factor Analysis Equations and Solution – AI Exploratory Factor Analysis – Confirmatory Factor Analysis- Case Studies.		
Unit – IV	**DISCRIMINANT ANALYSIS**	**9**
Discriminant Analysis – Discrimination for Two Multivariate Normal Populations – Discriminant Functions – Structured Equation Modelling (SEM) - Case Studies.		
Unit – V	**CLUSTER ANALYSIS**	**9**
Cluster analysis – Concept development – Necessity – Decision Process – Steps – Illustrative Examples and Cases – Advanced Artificial Intelligence Applications.		
		Total:45

TEXT BOOK:

1.	Dallas E Johnson, Applied Multivariate methods for data analysis, Duxbury Press, 2018.

REFERENCES:

1.	Joseph F. Hair, Jr. William C. Black Barry J. Babin, Rolph E. Anderson, Multivariate Data Analysis, Pearson Edition, 2019.
2.	Richard I Levin, Statistics for Management, PHI, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the parameters which used in regression analysis	Understanding (K2)
CO2	select appropriate methods for different data type	Understanding (K2)
CO3	interpret the results of factor analysis and make decision	Understanding (K2)
CO4	examine the real world data set and make decisions in various engineering applications	Analyzing (K4)
CO5	sort and group 'similar' objects or variables are created, based upon measured 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		1										3
CO2	3	2		1										3
CO3	2	3		1										3
CO4	2	3		1	1								1	3
CO5	2	3		1	1								1	3

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

ASSESSMENT PATTERN - THEORY

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

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

<table>
<tr><th colspan="8">22MEE32 - HYBRID VEHICLE TECHNOLOGY</th></tr>
<tr><td>Programme & Branch</td><td>BE & Mechanical Engineering</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>7</td><td>PE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">This course provides the basic knowledge on the components of hybrid vehicles, modeling fundamentals, energy storage and simulation models of driving cycles.</td></tr>
<tr><td>Unit – I</td><td colspan="6">Introduction and Components of Hybrid Vehicles</td><td>9</td></tr>
<tr><td colspan="8">Introduction: General Architectures - Vehicle System Components and Analysis - Controls of Hybrid Vehicle
Components of Hybrid Vehicles: Prime Mover - Electric Motor with DC/DC Converter and Inverter - Energy Storage System Transmission System in Hybrid Vehicle.</td></tr>
<tr><td>Unit – II</td><td colspan="6">Hybrid Vehicles System Modeling</td><td>9</td></tr>
<tr><td colspan="8">Modeling - Internal Combustion Engine - Electric Motor- Battery System - Transmission System - Final Drive and Wheel - Vehicle Body – PID-Based Driver Model.</td></tr>
<tr><td>Unit – III</td><td colspan="6">Power Electronics and Electric Motor Drives</td><td>9</td></tr>
<tr><td colspan="8">Power Electronics: Power Electronic Devices- DC/DC Converter - DC–AC Inverters
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.</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Energy Storages System Modeling and Control</td><td>9</td></tr>
<tr><td colspan="8">Methods of Determining State of Charge- Estimation of Battery Power Availability - Battery Life Prediction - Cell Balancing - Estimation of Cell Core Temperature - Battery System Efficiency.</td></tr>
<tr><td>Unit – V</td><td colspan="6">Simulation of Driving Cycles</td><td>9</td></tr>
<tr><td colspan="8">Simulation System - Typical Test -Driving Cycles - Preliminary Sizing of Main Components of Hybrid Vehicle - Fuel Economy - Emissions and Electric Mileage Calculations.</td></tr>
<tr><td colspan="8" align="right">Total:45</td></tr>
<tr><td colspan="8">TEXT BOOK:</td></tr>
<tr><td>1.</td><td colspan="7">Wei Liu, " Hybrid Vehicle System Modeling and Control", 2nd Edition, John Wiley & Sons, Inc., New Jersey, 2017.</td></tr>
<tr><td colspan="8">REFERENCES:</td></tr>
<tr><td>1.</td><td colspan="7">Iqbal Husain, "Electric and Hybrid Vehicles", 3rd Edition, CRC Press, Boca Raton, 2021.</td></tr>
<tr><td>2.</td><td colspan="7">Mehrdad Ehsani, YiminGao,Stefano Longo, Kambiz Ebrahimi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles ", 2nd Edition, CRC Press, Boca Raton, 2018.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

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	model the hybrid vehicle system using various system components	Applying(K3)
CO3	classify and explain electronic devices and motor drives	Understanding (K2)
CO4	identify the parameters influencing the energy storage Systems	Applying(K3)
CO5	infer the results from simulation of driving cycles	Applying(K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											3
CO2	3	2	1											3
CO3	3	2	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	20	50	30				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	40	40				100

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

22MEE33 - INTRODUCTION TO AIRCRAFT SYSTEMS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fluid Mechanics and Hydraulic Machines**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on various aircraft systems, basic principles of flight and aircraft performance.	
Unit – I	**Introduction to Aircrafts**	**9**
Basic Components of an Aircraft- Structural Members - Aircraft Axis System - Aircraft Motions- Control Surfaces and High lift Devices - Types of Aircrafts - Lighter than Air/Heavier than Air - Aircrafts Conventional Design Configurations Based on Power Plant Location- Wing Vertical Location- Intake Location- Tail Unit Arrangements- Landing Gear Arrangements- Unconventional Configurations-Biplane- Variable Sweep- Canard Layout- Twin Boom Layouts- Span Loaders- Advantages and Disadvantages of these Configurations.		
Unit – II	**Aircraft Systems**	**9**
Aircraft Systems -Types of Aircraft Systems - Mechanical Systems-Engine Control System- Fuel System- Hydraulic System- Electrical Systems- Electronic and Avionics Systems.		
Unit – III	**Basic Principles of Flight**	**9**
Aero foil Nomenclature- Types of Aero foil- Wing Section- Aerodynamic Center - Aspect Ratio- Significance of Speed of Sound- Air Speed and Ground Speed- Properties of Atmosphere- Lifting surfaces-Lift and Drag- Angle of Attack- Pressure Distribution Over a Wing Section- Centre of Pressure and its Effects- Generation of Lift- Drag- Pitching Moments- Types of Drag- Lift Curve- Drag Curve- Lift/Drag Ratio Curve- Factors Affecting Lift and Drag.		
Unit – IV	**Stability and Control**	**9**
Stability and Control: Degree of Stability- Lateral, Longitudinal and Directional Stability- Controls of Aircraft- Taxying – Landing - Gliding and Turning		
Unit – V	**Aircraft Performance and Maneuvers**	**9**
Taking off- Climbing- Power Curves- Maximum and Minimum Speeds of Horizontal Flight- Effects of Changes of Engine Power and Effects of Weight on Performance- Effects of Altitude on Power Curves- Forces acting on an Aero plane 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, Richard S "Fundamentals of Flight", 2nd Edition, Pearson Education, New Delhi, 2004.
2.	John David Anderson, "Introduction to Flight", McGraw-Hill Higher Education, New Delhi, 2005.
3.	Ian Moir & Allan Seabridge, "Aircraft Systems: Mechanical - Electrical and Avionics Subsystems Integration", Willey international, England, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the various aircrafts components and its types	Understanding (K2)
CO2	describe various aircraft systems and its functioning	Understanding (K2)
CO3	demonstrate the flight mechanics and infer the principles	Applying (K3)
CO4	illustrate the stability and control of aircrafts with various actuation mechanisms	Applying (K3)
CO5	investigate the performance and control of various aircrafts with respect to various working condition	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													3
CO2	3													3
CO3	3	2	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	30	70					100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	10	50	40				100

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

22MEE34 - MECHATRONICS AND IOT

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

Preamble	This course provides the importance of sensors, actuators, control systems, controllers and IoT components involved in industrial automation System.	
Unit – I	**Automation and Mechanical Measurements**	**9**
Automation: Automation in Production System - Principles and Strategies of Automation - Basic Elements of an Automated System - Advanced Automation Functions - Levels of Automations. Mechanical Measurements: Measurement of Displacement - Velocity - Force - Strain - Temperature - Pressure – Flow.		
Unit – II	**Control System**	**9**
Open Loop and Closed Loop Control - Block Diagrams - Transfer Functions - Laplace Transforms - Mathematical Model of Physical System – Proportional Integral (PI) and Proportional Integral Derivative (PID) Controllers.		
Unit – III	**Microprocessor and Its Interfacing**	**9**
Organization of 8085 – Addressing Modes – Instruction Set – Simple Programs involving Logical - Branch/Call - Sorting - Evaluating Arithmetic Expressions and String Manipulation Instructions - A/D and D/A Converters.		
Unit – IV	**Programmable Logic Controller (PLC)**	**9**
Introduction - Architecture of PLC – I/O Modules – Distributed I/O Modules – Programming of PLC - Conversion of Relay Logic to Ladder Logic Programming - Math Instructions - Logical Instructions - Timer and Counter – Selection of PLC.		
Unit – V	**IoT and Machine Learning**	**9**
IoT: Definition – Characteristics – Physical Design – Logical Design – Functional Block. Machine to Machine(M2M) – Difference between IoT and M2M IoT applications and case studies IoT applications and case studies Overview of machine learning..		
		Total:45

TEXT BOOKS:

1.	Bolton W., "Mechatronics: A Multidisciplinary Approach", 4th Edition, Pearson Education, UK, 2016 for Unit I.
2.	Nagoor Kani.A., “Control Systems” 3rd Edition, RBA Publication, Chennai, 2017 for Unit II.
3.	Ramesh Gaonkak., “ Microprocessor Architecture, Programming and Applications with the 8085” 6th Edition, New Age International Publishers, New Delhi, 2013 for Unit III.
4.	Frank D.Petruzella., “ Programmable Logic Controllers” 5th Edition, Mc Graw Hill, New Delhi, 2019 for Unit IV.
5.	Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On Approach", 1st Edition, Orient Blackswan Pvt. Ltd., New Delhi 2015 for Unit V.

REFERENCES/ MANUAL / SOFTWARE:

1.	Francis H. Raven, "Automatic Control Engineering", 5th Edition, McGraw-Hill, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the suitable sensors based on the functional requirement in industrial automation system	Applying (K3)
CO2	apply knowledge about the different forms of control system in real time interfacing	Applying (K3)
CO3	develop the programming and interfacing of 8085 microprocessor and for automatic system design	Applying (K3)
CO4	develop the various programmes using programmable logic controller.	Applying (K3)
CO5	present the concepts of internet of things and machine learning	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3								3	
CO2	1		2		3								3	
CO3			2		3								3	
CO4			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	20	40	40				100
CAT2	20	40	40				100
CAT3	20	50	30				100
ESE	20	40	40				100

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

22MEE35 - MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology, CAD/CAM/CIM for Automation**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the knowledge on design and analysis methodologies for the purpose of computing quantity and quality related performance measures in manufacturing systems.

Unit – I	**Manufacturing Systems and Models**	**9**
Types and Principles of Manufacturing Systems - Types and uses of Manufacturing Models - Physical Models - Mathematical Models - Uses of Model - Model Building.		
Unit – II	**Material Flow Systems**	**9**
Assembly Lines - Reliable Serial Systems - Approaches to Line Balancing - Sequencing - Mixed Models. Transfer Lines and General Serial Systems - Paced Lines without Buffers - Unpaced Lines. Shop Scheduling with many Products.		
Unit – III	**Material Flow on Flexible Manufacturing Systems (FMS)**	**9**
FMS - System Components - Planning and Control. Group Technology - Assigning Machines to Groups - Assigning Parts to Machines. Facility Layout - Quadratic Assignments Problem Approach - Graphic Theoretic Approach.		
Unit – IV	**Supporting Components**	**9**
Machine Setup and Operation Sequencing - Integrated Assignment and Sequencing. Material Handling Systems – Conveyor Analysis - AGV Systems. Warehousing - Storage and Retrieval Systems - Order Picking.		
Unit – V	**Generic Modeling Approaches**	**9**
Analytical Queuing Models - A Single Workstation - Open Networks - Closed Networks. Empirical Simulation Models - Event Models - Process Models - Simulation System - Example Manufacturing System.		
		Total:45

TEXT BOOK:

1.	Ronald G. Askin, and Charles R. Standridge, “Modeling and Analysis of Manufacturing Systems”, 1st Edition, John Wiley & Sons,NewYork,1993.

REFERENCES:

1.	Mengchu Zhou, “Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach”, World Scientific Publishing Co. Pvt. Ltd., 2000.
2.	Groover, Mikell P., “Automation, Production Systems, and Computer-Integrated Manufacturing”, Pearson Education India, 2016

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the type of manufacturing systems and models	Understanding (K2)
CO2	demonstrate the assembly lines, transfer lines and shop scheduling	Applying (K3)
CO3	infer the material flow systems in FMS and various facility layout	Understanding (K2)
CO4	describe the material flow supporting components through multiple work station.	Understanding (K2)
CO5	Simulate the sequence of workflow using generic modeling approach	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											3
CO2	3	2	1											3
CO3	3	2	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	40	40	20				100
CAT2	40	40	20				100
CAT3	40	40	20				100
ESE	30	40	30				100

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

22MEE36 - MICRO ELECTRO MECHANICAL SYSTEMS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Physics for Mechanical Engineering, Engineering Mechanics**	**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 Systems. 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	**Micro sensors and Actuators**						**9**
Micro sensors and Actuators: Micro Sensors - Micro Actuation Techniques - Micro Pump - Micro Motors - Micro Valves – Micro Grippers - 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: Automotive - Bio medical - Aerospace – Telecommunication.							
							Total:45

TEXT BOOK:

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

REFERENCES:

1.	Marc Madou., "Fundamentals of Micro fabrication", 2^{nd} Edition, CRC press, New York, 2011.
2.	Zhang, Dan, Wei & Bin (Eds.), "Advanced Mechatronics and MEMS Devices", 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	explain the fabrication process of microsystem.	Applying(K3)
CO4	describe the micro machining process and packaging.	Applying(K3)
CO5	Interpret the applications of micro system for various industries	Applying(K3)

Mapping of COs with POs and PSOs

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

22MEE37 - REFRIGERATION AND AIR CONDITIONING							
(Use of Approved Steam Table, Refrigeration and Air-Conditioning Data Book are permitted in the End Semester Examination)							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics, Thermal Engineering**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge on the working cycles of refrigeration and the processes involved in air-conditioning systems. The method of selection of refrigerants and usage of psychrometric charts are also covered through this course	
Unit – I	**Review of Fundamentals and Refrigeration Cycles**	**9**
Review of Fundamentals: First and Second Laws of Thermodynamics - Heat Engine - Heat Pump - Refrigeration Systems-COP-Condition for Maximum COP - Ton of Refrigeration. Refrigeration Cycles: Reverse Carnot Cycle -Bell Coleman Cycle - Vapor Compression Refrigeration Cycle – Superheating - Sub cooling – Multistage - Multi Evaporator - Cascade System.		
Unit – II	**Non-Conventional Refrigeration Systems**	**9**
Vapour Absorption Refrigeration (VAR) System - Aqua Ammonia - LiBr Water Systems- COP Estimation of VAR System - Steam Jet Refrigeration - Thermoelectric Refrigeration - Thermionic Refrigeration - Ejector Refrigeration – Magnetic Refrigeration – Vortex and Pulse Tube Refrigeration and its Application.		
Unit – III	**Refrigerants and System Components**	**9**
Refrigerants: Classification-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 - Capacity Control - Types of Evaporators and Condensers with their Functional Aspects - Expansion Devices and their Behavior with Fluctuating Load - Methods of Defrosting.		
Unit – IV	**Psychrometry and Duct Design**	**9**
Psychrometry: Properties of Air-Psychrometric Processes - Sensible Cooling and Heating-Humidification and Dehumidification - Psychrometric Calculations for Simple Air Conditioning System. Duct Design: Dynamic and Frictional Pressure Drop in Ducts - Methods of Duct Design - Fan Total Pressure - Fan Characteristics in Duct Systems.		
Unit – V	**Air Conditioning System**	**9**
Requirements of Comfort Air Conditioning – Summer - Winter Air Conditioning - Working Principles - Centralized Air Conditioning Systems - Air Handling Unit - Split - Ductable Split - Transport Air Conditioning Systems - Indoor Air Quality - Air Conditioning System Controls – Heating and Cooling load Calculations (Summer and Winter conditions only) - Energy Efficiency Ratio (EER) Calculations.		
		Total:45

TEXT BOOK:

1.	Arora C.P., "Refrigeration and Air Conditioning", 4th Edition, Tata McGraw Hill, New Delhi, 2020.

REFERENCES:

1.	Prasad Manohar., "Refrigeration and Air Conditioning", 3rd Edition, New Age International Pvt. Ltd, New Delhi, 2021
2.	Roy J. Dossat. , "Principles of Refrigeration", 4th Edition, Pearson Education Asia, New Delhi, 2009
3.	Ibrahim Dincer., " Refrigeration Systems and Applications", 3rd Edition, John Wiley and sons, England, 2017.

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 non-conventional refrigeration systems with their practical applications.	Applying (K3)
CO3	illustrate the characteristics of refrigerants and explain the functions of refrigeration system components	Applying (K3)
CO4	perform calculations in psychrometric processes and duct design in simple air-conditioning systems	Applying (K3)
CO5	calculate the cooling load for air-conditioning systems and discuss the types of air-conditioning system	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
CO2	3													3
CO3	3		1			2								3
CO4	3	2												3
CO5	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	20	40	40				100
CAT3	20	40	40				100
ESE	10	40	40	10			100

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

22MEE38 - ENERGY AUDITING AND MANAGEMENT							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics, Thermal Engineering, Heat and Mass Transfer**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides insights on energy conservation measures in thermal & electrical utilities, energy audit and energy monitoring procedures to be followed by Energy Managers in industries.

Unit – I	**Energy Audit**	**9**
Introduction - Types - Methodology-Energy Management-Definition and Objectives-Managerial Functions and Responsibilities of Energy Manager- Top Management Commitment and Support for Energy Action Planning-Management Tools for Effective Implementation- Utility Rate Structures- Portable and Online Instruments for Survey-Energy Monitoring and Targeting - EMIS – PAT Cycle.		
Unit – II	**Energy Conservation and Water Management**	**9**
Energy Conservation: Introduction – Energy Conservation Programme (ENCON) - Need for Energy Conservation- Energy Security - Energy Efficiency - Development of Energy Balance - Energy Conservation in Domestic Sector-Standards and Labeling of Appliances. Water Management: Water Audit-Indoor and Outdoor Water Management.		
Unit – III	**Energy Audit Applied to Buildings**	**9**
Building Envelope Analysis– Internal Heat Gain - Thermal Comfort - Air Quality and Air Tightness -Thermal Insulation - Reflective and Radiant Barriers -Energy Conservation Building Code (ECBC) and its Guidelines - Star Rating - Energy Saving Measures in New Buildings - IOT in Building Energy Management - Indian Green Building Council (IGBC) – Rating System.		
Unit – IV	**Electrical System Audit**	**9**
Load Management - Power Factor - Efficiency Improvements-Harmonics- Selection of Electric Motor-Energy Performance Assessment of Electric Motors and Variable Speed Drives-Energy Efficient Motors- Lighting System Audit –Terminology- Light Sources and Lamp Types – Electronic Ballasts - Energy Saving Opportunities in Lighting - Case Study.		
Unit – V	**Energy Efficiency in Thermal Utilities**	**9**
Performance Assessment of Thermodynamic Systems – Boilers –Furnaces – Compressors - HVAC Systems - Water Pumps - Fans - Blowers-Heat Exchangers.		
		Total:45

TEXT BOOK:

1.	Sonal Desai, "Handbook of Energy Audit", 1st Edition, McGraw Hill Education, New Delhi,2015 for Units II, III
2.	“Guide Books (Volume - 1 to Volume - 4) for National Certification Examination for Energy Auditors and Energy Managers”, 4th Edition, India, 2015 for Units I, IV,V

REFERENCES:

1.	Albert Thumann, Terry Niehus &,William J. Younger, "Handbook of Energy Audits", 9th Edition, Fairmont Press, Lilburn, 2013.
2.	Stephen A. Roosa, Steve Doty &Wayne C. Turner, "Energy Management Handbook”, 9th Edition, River Publishers, New York, 2018

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the energy audit procedures and usage of Energy Audit Instruments.	Understanding (K2)
CO2	apply the various techniques and standards for energy conservation and waste management.	Applying(K3)
CO3	apply the energy and green audit principles in buildings.	Applying(K3)
CO4	explain the procedure for conducting electrical audit.	Applying(K3)
CO5	assess the performance of thermal utilities.	Applying(K3)

Mapping of COs with POs and PSOs

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

ASSESSMENT PATTERN - THEORY

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

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

22MEE39 - MAINTENANCE ENGINEERING							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course describes the industrial maintenance system with recent trends of maintenance activities. It also deals with the reliability of engineering components and its safety adopted in industrial maintenance.	
Unit – I	**Principles and Maintenance System Planning**	**9**
Introduction to Repair and Maintenance – Maintenance as Business – Objectives and Principles of Planned Maintenance Activity - Importance and Benefits of Sound Maintenance Systems - Maintenance Systems – Reactive - Preventive or Proactive Systems – Maintainability – Inherent and Overall Availability – Mean Time Between Failures - Mean Time to Repairs - Mean Down Time - Hazard Rate.		
Unit – II	**Maintenance Techniques**	**9**
Total Productive Maintenance (TPM) – Relationship between Overall Equipment Effectiveness (OEE) and World Class Maintenance – Seven Modern Tools - Applications - Ladder of Maintenance Improvement - Computerized Online Health Monitoring of Machine - Data Acquisition for Effective Management of Computerized Maintenance Management System (CMMS) - Logic Tree Analysis - Criticality Matrix.		
Unit – III	**Condition Based Maintenance**	**9**
Condition Monitoring (CM) Techniques - Vibration Analysis – Ultrasonic Detection Techniques - Thermograph - Lubrication Methods and its Analysis – Motor Condition Monitoring (MCM) - Cost Comparison with and without CM - On-load Testing and off - Load Testing Methods – Temperature Sensitive Tapes – Pistol Thermometers – Wear-Debris Analysis.		
Unit – IV	**Failure Analysis and Repair Methods of Basic Elements**	**9**
Failure Analysis: Defect/Failure Definition; Failure - Rate - Mode -Reporting - Date Collection - Failure Analysis - Tools - Fault Tree Analysis - Event Tree Analysis - Root Cause Analysis - Failure Mode and Effect Analysis (FMEA) – Failure Mode, Effect and Criticality Analysis (FMECA) - Electrical Stress Analysis – Failure of System and its Root Cause Analysis. Repair Methods: Sideways – Spindles – Gears - Lead Screws and Bearings – Repair Methods for Material Handling Equipment – Equipment Records – Job Order Systems.		
Unit – V	**Reliability Engineering and Safety in Maintenance**	**9**
Reliability Engineering: 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 – Quantification of Safety - Code and Standards - Hazards and its Management – Case Studies.		
		Total:45

TEXT BOOK:

1.	Srivastava S.K., "Maintenance Engineering (Principles - Practices and Management)", 2nd Edition, S. Chand & Co., New Delhi, 2021.

REFERENCES:

1.	Bhattacharya S.N., "Installation, Servicing and Maintenance", 2nd Edition, S. Chand & Co., New Delhi, 2018.
2.	Venkataraman.K., "Maintenance Engineering and Management", PHI Learning Pvt. Ltd., New Delhi, 2012.
3.	Srinath L.S., "Reliability Engineering", 1st Edition, East-West Press, New Delhi, 2016.

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.	Understanding (K2)
CO2	select and implement maintenance management systems.	Applying (K3)
CO3	choose the appropriate condition based maintenance system to enhance machine life	Applying (K3)
CO4	analyse the various failures and identify the suitable repair methods	Analyzing (K4)
CO5	Illustrate the functional concepts of reliability and safety engineering	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3		2											3
CO2	3	2	1		1								3	2
CO3	3	2	1		1								3	2
CO4	3	3	1										2	3
CO5	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	40	40				100
CAT2	20	40	40				100
CAT3	20	25	35	20			100
ESE	15	40	35	10			100

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

22MEE40 - INDUSTRIAL SAFETY ENGINEERING							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course explores the awareness and knowledge on safety aspects, procedures and guidelines to be followed in the industry while performing various types of operations in industry.	
Unit – I	**Safety Management**	**9**
Evolution of Management Thoughts- Need for Safety- Progress in Modern Safety Concept -Safety Management and its Responsibilities Planning for Safety-Formulation of Safety Policy- Job Safety Analysis- Safety Sampling Technique -Plant Safety Inspection- Major Accident Hazard Control- Hazard and Operability (HAZOP) Study- Hazard Ranking (DOW and MOND index)- Safety Organization Safety Audit -Safety Education and Training-Good Housekeeping- Personal Protection and First Aid.		
Unit – II	**Accident Causation and Prevention**	**9**
Nature and Causes of Accidents - Incidents of Accident- Factors - Root Cause Analysis - Heinrich's and Frank Bird's Domino Theory - Accident Prevention Steps - Organization- Fact Finding- Analysis of Facts- Selection of Remedy- Application of Remedy- Monitoring Models- Kepner-Tregoe Model - Error Reduction Model- Performance Cycle Model- Updated Safety Management Model - 5E's of Accident Prevention. Case Study of Major Accidents.		
Unit – III	**Safe Handling of Materials and Tools**	**9**
Operation Safety- Personal Protective Equipment -Safe Methods of Lifting & Handling-Safe Use of Accessories of Manual Handling Safety in Mechanical Handling-Lifting Machines- Tackles-Cranes-Conveyors-Trucks-Causes and Control of Tool Accidents-Safe Use of Hand and Power Tools. Machine Guarding-Basic Need & Importance- Principles of Machine Guarding-Materials for Guard Construction Electrical Safety- Reactor Control and Explosion Prevention System- Radiation Shielding and Control- Radiation Measuring Instruments - Noise and Vibration Measurement and Control- Air Pollution Control- Air Sampling and Pollution Measuring Instruments.		
Unit – IV	**Safety in engineering industry**	**9**
Safety in Mechanical Working - Safety Measures in Machining Process- Safety in Use of Power Tools-Safety in Welding and Cutting Safety in Foundry Shops - Safety Measures in Heat and Cold Process - Safety in Usage of Dies - Safe Operations and Maintenance of Machines - General Health Hazards and Control Measures in Engineering Industry - Hazard Communication System - Storage Vessels and their Safety Aspects- Safety in Boilers- Safe Storage & Handling of Gas Cylinders-Safety in Laboratory –Safe Transfer and Transportation of Chemicals.		
Unit – V	**Fire and explosion**	**9**
Nature, Stages and Spread of Fire - Classification of Fire and Extinguishers - Statutory Provisions and Indian Standards - NFPA Code Design for Fire Safety- Fire Detection and Alarm Systems - Fire Load Determination - Fire Suppression or Extinguishing Systems - Control of Fire and Explosion in Flammable Substances - Explosive Testing - Thermal Sensitivity Analysis - Accelerated Rate Calorimeter Ignition Test - Electrical Fires- Fire Emergency Action Plan & Drill Rig Explosion –Types - Inspection, Maintenance and Training for Fire Protection.		
		Total:45

TEXT BOOK:

1.	Mistry. K.U "Fundamentals of Industrial safety and health", 2nd Edition, Siddharth Prakashan Publisher,Gujarat,2009.

REFERENCES:

1.	Jane Bluent, Nigel &Balchin C., "Health and Safety in Welding and Allied Processes", 5th Edition, Wood Head Publishing, England, 2002.
2.	Rao S, Jain R.K. & Saluja H.L., "Electrical Safety - Fire Safety Engineering and Safety Management", 2nd Edition, Khanna Publishers, Delhi, 1997.
3.	Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
4.	Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK, 2nd Edition 1990 (Vol.I, II & III).

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the significance of safety in industry.	Understanding(K2)
CO2	identify the factors causing accidents and prevent them from occurring.	Applying(K3)
CO3	choose the safe operating practices in material handling and tool usage.	Applying(K3)
CO4	identify the safety measures in the engineering industry.	Applying(K3)
CO5	employ the prevention strategies for fire and explosion.	Applying(K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MEE41 - INTRODUCTION TO AIRCRAFT STRUCTURES							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Mechanics, Strength of Materials, Design of Machine Elements**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course offers the fundamentals of aircraft design process, materials , properties, failures, structural members, joints, associated vibrations and flutter	
Unit – I	**Overview of the Aircraft Design Process, Aircraft Loads, Aircraft Structures Description**	**9**
Introduction- Phases of Aircraft Design- Aircraft Conceptual Design Process- Conceptual Stage- Preliminary Design- Detailed Design-Design Methodologies-Airworthiness- Definition- Airworthiness Regulations- Regulatory Bodies-Type of Certification- General Requirements- Requirements Related to Aircraft Design Covers- Performance and Flight Requirements- Airframe Requirements- Landing Requirements- Fatigue and Failsafe Requirements- Aerodynamic Loads- Inertial Loads- Loads due to engine- Actuator Loads-Maneuver Loads- VN diagrams-Gust Loads- Types of Structural Members of Fuselage and Wing Section and Empennage Ribs- Spars- Frames- Stringers- Longeron- Splices- Types of Structural Joints- Type of Loads on Structural Joints.		
Unit – II	**Aircraft Materials and Properties**	**9**
Introduction- Basic Construction- Material Forms-Metallic Materials and Forms- Alloy Designations-Mechanical Properties- Strength- Static- Stress Strain Curves		
Unit – III	**Static and Fatigue Failures**	**9**
Fatigue Properties-Crack Growth- Brief Review of Principal Stresses-Principal Strains- Mohr's Circle for Stress and Strain- Fatigue Failures- Fatigue Theory- Introduction to Low Cycle Fatigue- Stress Life and Strain Life Techniques- Mean Stress Effects- Multi-Axial Effects- Isothermal and Thermo mechanical Fatigue- Introduction to High Cycle Fatigue.		
Unit – IV	**Box Beams, Buckling of Thin Sheets**	**9**
Box Beams- Introduction- Shear Flow Due to Shear-Shear Flow Due to Torsion-Bredt Batho- Single and Multi cell Boxes- Buckling of Thin Sheets- Buckling of Flat Plate in Compression and Shear- Buckling of Curved Plates in Compression and Shear- Buckling of Stiffened Panels-Post Buckling- Effective Width- Concept of Diagonal Tension-Buckling Under Combined Loads.		
Unit – V	**Aircraft Structural Joints, Advanced materials, Vibrations and Flutter**	**9**
Introduction to Fasteners- Splices- Eccentric joints-Bolt Group Analysis-Welded joints- Bonded joints- Lug Analysis- Tension Fitting and Clips-Introduction to Composite Materials- Matrices-Fibers-Forms- Characteristics of Composite Materials-Study of Vibration and Flutter.		
		Total:45

TEXT BOOK:

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

REFERENCES:

1.	Megson T.H.G, "Aircraft Structures For Engineering Students", 6th Edition, Butterworth Heinemann, USA, 2017.
2.	Michael Niu, "Airframe Structural Design", 2nd Edition, Conmilit Press, Hong Kong, 1988.
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 and structures	Understanding (K2)
CO2	select and identify aircraft materials and their properties	Applying (K3)
CO3	predict static and fatigue failures of aircraft members	Applying (K3)
CO4	apply the shear flow in box beams and buckling of thin sheets	Applying (K3)
CO5	identify the nature of aircraft structural joints, vibrations and flutter of aircraft	Applying (K3)

Mapping of COs with POs and PSOs

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

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	20	30	50				100
CAT3	20	30	50				100
ESE	10	40	50				100

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

22MEE42 - PRODUCT DESIGN AND OPTIMIZATION							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on new product development, product planning and the process of concept generation through identifying the product specification. Furthermore this course provides various ways to optimize the product design using mathematical techniques.	
Unit – I	**Development Processes and Organizations**	**9**
Introduction to New Product and Product design - Characteristics of Successful Product – The Challenges in Product Development - Product Development Process – Adapting Generic Product Development Process - Product Development Process Flows - Product Development Organizations.		
Unit – II	**Product Planning**	**9**
Types of Opportunities - Structure of Opportunity Identification – Opportunity Identification Process – Product Planning Process – Four Types of Product Development Projects – Steps in Product Planning – Identifying Customer Needs.		
Unit – III	**Product Specifications and Concept Development**	**9**
Product Specifications – Target and Final Specifications. Concept Generation: Five Step Method - Concept Selection - Concept Screening – Concept Scoring – Concept Testing.		
Unit – IV	**Introduction to Optimization**	**9**
Introduction to Optimum Design - Global and Local – Problems - General Characteristics of Mechanical Elements – Adequate and Optimum Design – General Principles of Optimization – Formulation of Objective Function – Design Constraints – Classification of Optimization Problem – Saddle Point – Single Variable Optimization – Multi Variable Optimization with no Constraints.		
Unit – V	**Unconstrained Optimization Techniques**	**9**
Single Variable and Multi variable Optimization with Constraints – Techniques of Unconstrained Minimization - Golden Section - Pattern and Gradient Search Methods - Interpolation Methods – Quadratic Function Method.		
		Total:45

TEXT BOOKS:

1.	Eppinger, S.D. and Ulrich, K.T. " Product design and development", 6th Edition, McGraw-Hill Higher Education, 2020 for Units I, II, III
2.	Rao Singaresu S. "Engineering Optimization – Theory and Practice". 4th Edition, New Age International Pvt. Ltd., New Delhi, 2015 for Units IV, V

REFERENCES:

1.	Devdas Shetty, "Product Design For Engineers", 1st Edition Cengage Learning, 2015.
2.	Kalyanamoy Deb. "Optimization for Engineering Design Algorithms and Examples". 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the basic need for new product design and development process	Understanding (K2)
CO2	identify opportunities and customer needs for new product development	Applying (K3)
CO3	discover the product specification and develop concepts for new product	Analyzing (K4)
CO4	solve optimization problems for design and manufacturing applications	Applying (K3)
CO5	make use of unconstrained optimization techniques to identify optimum value	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3											3
CO2	3	1				2	1							3
CO3	3	1				2	1							3
CO4	3	2					2							3
CO5	1	1	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	60	30				100
CAT2	10	10	50	30			100
CAT3	10	40	50				100
ESE	10	30	40	20			100

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

22MEE43 - NANOTECHNOLOGY FOR MECHANICAL ENGINEERS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course imparts the basics of Nanotechnology. It emphasize on the fabrication procedures, characterization techniques, technical properties and applications of several nanostructured materials

Unit – I	**Fundamentals of Nanotechnology**	**9**
Nanoscience and Nanotechnology – Fundamentals - Classification and General Themes of Nanotechnology - Nanoscale Science - Fabrication and Processing Technology - Size Dependence of Materials Properties - Characterization Tools - Properties of Nanomaterials - Structural Properties - Thermal Properties - Chemical Properties - Mechanical Properties - Magnetic Properties - Optical Properties - Electronic Properties - Biological Properties.		
Unit – II	**Nanoscale Fabrication and Characterization**	**9**
Nanoscale Fabrication - Bottom-up Approach - Chemical Synthesis - Self-Assembly - Top-down approach – Photolithography - Electron Beam Lithography - Focused Ion Beam Lithography - Extreme Ultraviolet Lithography – Nano Imprint Lithography - X-ray Lithography - Soft Lithography. Characterization of Nanomaterials - Atomic Structure and Chemical Composition - Vibrational Spectroscopies - Ultraviolet–Visible Spectroscopies - Electron Microscopy - Zeta Potential Analyzer - Laser Granulometry.		
Unit – III	**Metal and Ceramic Nanoparticles**	**9**
Classifications of Nanostructured Materials – Nano powders - Metal Nanopowders - Metal Oxide Nanopowders – Nanoporous Materials - Silica - Transition Metal Oxides - Metal Sulfides – Metal Aluminum Phosphates - Silicon Nitrides - Aluminum Oxides – Nano dusts – Nanowires - Zinc oxide Nanostructures.		
Unit – IV	**Carbon Nanoparticles**	**9**
Carbon Allotropes - Molecule Structures - Physical and Chemical Properties - Synthesis Methods - Electric Arc Method - Laser Ablation Method - Solar Energy Method. Carbon Nanotubes – Structure and Synthesis - Arc Discharge Method - Laser Ablation Method - Chemical Vapor Deposition Method. Properties: Electrical Conductivity - Optical Properties - Vibrational Properties - Mechanical Strength - Specific Heat and Thermal Conductivity – Applications - Defects in Carbon Nanotubes - Fullerenes - Synthesis – Properties – Applications.		
Unit – V	**Nanocomposites and Nanofluidics**	**9**
Overview of Nanocomposites - Metal Matrix composites: Fabrication Techniques – Solid State Methods – Semi-Solid State Methods – Liquid State Methods. Polymer Matrix Nanocomposites: Solution Mixing Method – Melt Mixing Method – Insitu Polymerization – Electrospinning – Selective Laser Sintering Technique. Properties: Mechanical Testing – Wear Properties – Permeability – Thermal Stability – Flammability. Nano Fluidics: Synthesis – Properties – Applications		
		Total:45

TEXT BOOK:

1.	Vijay K Varadan, Sivathanu Pillai A, Debashish Mukherji, Mayank Dwivedi, Linfeng Chen, "Nanoscience and Nanotechnology in Engineering ", 1st Edition, World Scientific, Singapore, 2010.

REFERENCES:

1.	Maria Stepanova, Steven Dew, "Nanofabrication Techniques and Principles", 1st Edition, Springer International Publishing, Switzerland, 2012.
2.	Thangadurai, T.D., Manjubaashini, N., Thomas, S., Maria, H.J, "Nanostructured Materials", 1st Edition, Springer International Publishing, Switzerland, 2020.
3.	Paulo Davim J. and Constantinos A. Charitidis, "Nanocomposites - Materials, Manufacturing and Engineering", 1st Edition, De Gruyter, Germany, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the fundamental of nanotechnology	Understanding (K2)
CO2	present the different techniques involved in nanoscale fabrication and characterization	Understanding (K2)
CO3	demonstrate the synthesis route, properties and applications of metal and ceramic nanoparticles	Applying (K3)
CO4	describe the synthesis route and correlate the structure – property relationship of carbon nanomaterials	Applying (K3)
CO5	select appropriate materials and fabrication techniques to prepare nanocomposites and nanofluidics for desired applications	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MEE44 - NON-DESTRUCTIVE EVALUATION TECHNIQUES

Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Materials and Metallurgy, Manufacturing Technology**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course covers the principles and procedures of various non-destructive testing methods used in engineering to inspect and evaluate defects without causing damage to the engineering components.

Unit – I	**Introduction and Liquid Penetrant Testing**	**9**

Non-Destructive Testing (NDT) - Importance - Principles - Limitations - Safety considerations - Preparation of Test Materials - Visual Examination - Basic Principles - Types of Defects - Optical Aids used and Applications – Standards - Liquid Penetrant Testing (LPT) - Principles - Procedure for LPT - Light Sources and Special Lighting - Calibration – Penetrant Testing Methods: Water washable - Post Emulsifiable Method - Solvent Removable Developers - Properties of Liquid Penetrant - Sensitivity - Applications and Limitations – Standards.

Unit – II	**Magnetic Particle Testing**	**9**

Principles - Theory of Magnetism - Characteristics of Magnetic Fields - Types of Defects - Surface and Sub-surface Cracks - Limitations - 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**

Principles of Ultrasonic Testing – Properties of Sound Beam - Transducers - Inspection Methods - Techniques for Normal and Angle Beam Inspection – Flaw Characterization - Equipment and Tools of Ultrasonic Testing - 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) - Limitations – Standards – Application.

Unit – IV	**Radiography**	**9**

Electromagnetic Radiation Sources - X-ray Production and Gamma Ray Sources - Properties - Radiation - Attenuation and Effects in Film - Exposure Charts - Equipment and tools of Radiography Testing - Radiographic Imaging - Inspection Techniques - Image Quality Indicators (IQI) - Types of Defects - Applications and Limitations - Safety in Industrial Radiography - Neuron Radiography – Standards - Case Studies.

Unit – V	**Other NDT Techniques and Selection Methods**	**9**

Eddy Current: Principles - Electromagnetic Induction - Electrical Conductivity - Magnetic Permeability - Instrumentation - Techniques - Probe - Sensitivity - Advanced Test Methods - Applications & Limitations - Standards - Other Techniques: Acoustic Emission Testing - Principle - Techniques - Instrumentations - Applications and Standards - Thermography - Principles - Equipment - Techniques - Applications and Standards - Leak Testing Methods – Detection and Standards.

Selection of NDT Methods: Comparison of NDT techniques - Selection of Instrumentation. Applications of NDT: Aerospace - Automotive - Manufacturing Industries – Case Studies.

Total:45

TEXT BOOKS:

1.	Baldev Raj, Jayakumar T. & Thavasimuthu M., "Practical Non Destructive Testing", 3rd Edition, Narosa Publishing House, New Delhi, 2019 for Units I, II, III & IV.
2.	Paul E. Mix, P.E., E.E “Introduction to Non destructive Testing: A Training Guide” 2nd Edition, Wiley, 2005 for Unit V.

REFERENCES:

1.	Hull Barry & John Vernon., "Non-Destructive Testing", 3rd Edition, Macmillan, London, 2015.
2.	Hellier C., "Handbook of Non-Destructive Evaluation", 3rd Edition, McGraw-Hill Education, 2020.
3.	Shull Peter J., "Non-Destructive Evaluation: Theory - Techniques and Applications", Marcel Dekkar Inc., New York, USA, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	depict the significance of NDT methods and deliver knowledge of liquid penetrant/visual inspection methods for various applications.	Understanding (K2)
CO2	compare the various magnetic particle testing methods to identify the defects	Understanding (K2)
CO3	illustrate the principle of ultrasonic testing and its modern methods	Understanding (K2)
CO4	demonstrate radiographic principles and its various inspection methods	Understanding (K2)
CO5	demonstrate the principles of eddy current, acoustic emission, thermography techniques and identify the appropriate NDT inspections method for various engineering 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		3								3	2
CO2	3		1		3								3	2
CO3	3		1		3								3	2
CO4	3		1		3								3	2
CO5	3		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	40	60					100
CAT2	40	60					100
CAT3	20	60	20				100
ESE	25	50	25				100

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

22MEE45 - TURBOMACHINES

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

Preamble	This course provides the knowledge on the energy transfer principles of centrifugal fans, blowers, centrifugal & axial flow compressors and axial & radial flow turbines. Efficiency calculations for the rotating machineries based on velocity triangles are also covered.	
Unit – I	**Energy Principles**	**9**
Energy Transfer between Fluid and Rotor – Classification of Fluid Machinery – Dimensionless Parameters – Specific Speed – Applications – Stage Velocity Triangles – Work and Efficiency.		
Unit – II	**Centrifugal Fans and Blowers**	**9**
Types – Design Parameters – Types of Impeller Blades – Volute and Diffusers – Losses Fan Noise – Fan Bearing – Fan Drives.		
Unit – III	**Centrifugal Compressor**	**9**
Construction Details – Stage Velocity Triangles – Stage Parameters – Enthalpy Diagram – Degree of Reaction – Slip Factor – Types of Diffuser – Stage Losses – Performance Characteristics.		
Unit - IV	**Axial Flow Compressor**	**9**
Stage Velocity Diagrams – Enthalpy – Entropy Diagrams – Stage Losses and Efficiency – Work done – Simple Stage Design Problems and Performance Characteristics.		
Unit - V	**Axial and Radial Flow Turbines**	**9**
Stage Velocity Diagrams – Reaction Stages – Losses and Efficiencies – Blade Design Principles –Performance Characteristics.		
		Total:45

TEXT BOOK:

1.	Yahya S. M., "Turbines, Compressors and Fans", 4th Edition, Tata McGraw- Hill, New Delhi, 2017.

REFERENCES:

1.	Seppo A. Korpela "Principles of Turbomachinery", 2nd Edition, John Wiley& Sons, USA, 2019.
2.	Erick Dick, "Fundamentals of Turbomachines", 1st Edition, Springer, Netherlands, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the energy principles and classify the turbo machinery	Understanding (K2)
CO2	illustrate the principles and applications of the centrifugal Fans and Blowers	Applying (K3)
CO3	illustrate the construction details and do performance calculations of centrifugal compressor	Applying (K3)
CO4	draw the velocity triangle and calculate the efficiency of axial flow compressor	Applying (K3)
CO5	sketch the velocity diagrams for axial and radial flow turbines and determine their efficiencies	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22MEE46 - ENERGY CONSERVATION IN HVAC SYSTEM							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Thermodynamics, Thermal Engineering**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides significant information on energy conservation, energy audit and management practices adoptable for Heating, Ventilation and Air-Conditioning (HVAC) systems.

Unit – I	**Fundamentals of Thermodynamics**	**9**
Introduction to Energy Conservation – Second Law of Thermodynamics – Exergy Analysis – Reversibility and Irreversibility – Air Conditioning Systems and Cycles – Heat pumps – Psychrometry.		
Unit – II	**Climates and Buildings**	**9**
Climate – Types - Factors that Determine Climate - Climatic Variations – Thermal Properties and Energy Content of Building Materials – Effect of Geographic Locations – Building Aesthetics and Infiltration.		
Unit – III	**Indoor Environmental Requirements**	**9**
Thermal Comfort – Ventilation and Air Quality – Air Conditioning Requirement – Energy Management Options – Energy Audit and Energy Targeting – Design Consideration in Different Climatic Conditions.		
Unit – IV	**Heating and Ventilation Systems**	**9**
Energy Conservation and Feasibility Analysis – Conventional Ventilation Systems – Constant Volume and Variable Volume Induction Systems – Indoor Air Quality – Duct Design and Installation.		
Unit – V	**Air conditioning Systems**	**9**
Energy Conservation in Air Handling Units – Fans - Air Condition Apparatus– Window Air Condition System – Central Air Condition System – Energy Efficient Motors – Cooling Load Estimation – Bypass Factor - Room Sensible Heat Factor – Grand Sensible Heat Factor – Effective Room Sensible Heat Factor.		
		Total:45

TEXT BOOK:

1.	Faye C.McQuiston, Jerald D.Paeker and Jeffrey D.Spitler, Hessam Taherian ,"Heating, Ventilating, and Air Conditioning: Analysis and Design", 7th Edition, John Wiley & Sons Inc., Singapore, 2023.

REFERENCES:

1.	Carter Stanfield, David Skaves, AHRI, "Fundamentals of HVACR", 4th Edition, Pearson, Canada,2020.
2.	Jan F. Kreider & Peter S. Curtiss, "Heating and Cooling of Buildings: Design for Efficiency", 2nd Edition, CRC Press, New York, 2010.
3.	ASHRAE Handbook, "HVAC Systems and Equipment 2011, HVAC Applications", ASHRAE Inc., Atlanta, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	define the fundamental thermodynamic principles.	Understanding (K2)
CO2	determine the thermal properties and energy content of building materials for different climates.	Applying(K3)
CO3	prepare the requirement of indoor environmental conditions based on standards.	Applying(K3)
CO4	analyze the duct design in heating and ventilation systems.	Analyzing (K4)
CO5	perform the cooling load calculations involved in air-conditioning systems.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											3		3
CO2	1		2				3					1		3
CO3	1		2			2	3					1		3
CO4	1		3				2					2		3
CO5	1		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	50	30				100
CAT2	15	45	40				100
CAT3	15	30	30	25			100
ESE	15	30	40	15			100

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

22MEE47 - INDUSTRIAL MARKETING							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the behaviour of customers and marketing strategies. It improves the skills for solving the real time engineering marketing problems and useful to design the channel of market and product development.	
Unit – I	**Introduction**	**9**
Introduction to Industrial Markets - Marketing System - Concepts - Characteristics – Definition – Exchange Processes – Characteristics of Industrial and Consumer Markets – Market Demand – Cross Elasticity of Demand - Business Ethics		
Unit – II	**Industrial Purchasing**	**9**
Types of Industrial Customers - Purchasing Practices - Industrial Buyer Behaviour – Industrial Buying Situation – Decision Making Units – Models of Organizational Buying Behaviour - Modern Purchasing Terminologies- Case Studies.		
Unit – III	**Marketing Planning and Research**	**9**
Marketing Planning: Business Marketing – Marketing Planning – Corporate Strategic Planning – Target Marketing – Marketing Information Systems. Marketing Research: Market Evaluation - Role of IT in Marketing Information Systems - Definition and Process of Marketing Research - Research Instruments.		
Unit – IV	**Product Development and Pricing**	**9**
Industrial Products and Services - Definition - New Industrial Product Development – Product Life Cycle - Marketing Strategies - Industrial Pricing Characteristics - Influencing Factors in Pricing Decisions of Industrial Markets - Classification of Costs, Pricing Strategies.		
Unit – V	**Channel Design**	**9**
Economic Performances and Channel Management Decisions- Industrial Logistics System - Role and Characteristics of Industrial Distributors - Sales Promotion – Personal Selling - Sales Force Management – Advertising in Marketing – Industrial Communication Programs – Case Studies.		
		Total:45

TEXT BOOK:

1.	Havaldar, K. Krishna, "Industrial Marketing", 4th Edition, Tata McGraw Hill, New Delhi, 2018.

REFERENCES:

1.	Philip Kotler, Gary Armstrong & Prafulla Agnihotri, "Principles of Marketing", 17th Edition , Pearson Education, 2020.
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 the characteristics of industrial marketing system	Understanding (K2)
CO2	apply the purchasing practices for organizational models	Applying (K3)
CO3	develop effective marketing strategies and conduct research to support decision making	Applying (K3)
CO4	Identify appropriate pricing model for a new product and service	Understanding (K2)
CO5	Infer the role of marketing channel in delivering products/service to customers	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
CO2	2	3								3			3	2
CO3	1	3			3					1			3	2
CO4	1	2			3					1		1	3	2
CO5	1	2			1					1		1	3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
CAT3	20	40	40				100
ESE	20	35	45				100

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

22MEE48 - DECISION SUPPORT SYSTEMS							
Programme & Branch	**BE & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course delivers the concept of decision systems through intelligent systems in industries.	
Unit – I	**Decision Making**	**9**
Managerial Decision Making, System Modelling and Support-Preview of the Modelling Process - Phases of Decision - Making Process - Case Studies.		
Unit – II	**Decision Support System (DSS)**	**9**
DSS Components - Data Warehousing, Access, Analysis, Mining and Visualization - Modelling and Analysis - Development – Case Studies related Support Systems.		
Unit – III	**Knowledge Management**	**9**
Group Support Systems - Enterprise DSS - Supply Chain and DSS - Knowledge Management Methods, Technologies and Tools - Application and Uses – Cases in Knowledge Management Decision Making.		
Unit – IV	**Intelligent Systems**	**9**
Artificial Intelligence and Expert Systems - Concepts, Structure, Types - Knowledge Acquisition and Validation, Knowledge Representation – DSS Cases in AI and Expert Systems.		
Unit – V	**Implementation of DSS**	**9**
Implementation - Overview - Transformation – E-Commerce Activities – Steps - Integration and Impact of Management Support System - Benefits - Limitations – Case Study with examples – E-Procurement Success- Cases.		
		Total:45

TEXT BOOK:

1.	Efraim Turban and Jay E Aronson., “Decision Support and Intelligent Systems”, 8th Edition, Pearson Education Asia, 2019.

REFERENCES:

1.	Elain Rich and Kevin Knight., “Artificial intelligence”, Tata McGraw Hill, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make decisions in the semi structured and unstructured problem situations using systems and semantic networks.	Understanding (K2)
CO2	understand various components of DSS and modeling & analysis phases of DSS	Understanding (K2)
CO3	apply the concepts of knowledge management methods in DSS.	Applying(K3)
CO4	perform the measurements of knowledge on artificial intelligence systems	Applying(K3)
CO5	incorporate the management support systems in industries.	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	1		1				1				1	3
CO2	2	2	1		1				1				1	3
CO3	2	2	1		1				1				1	3
CO4	2	2	1		1				1				1	3
CO5	2	2	1		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	45	55					100
CAT2	30	35	45				100
CAT3	30	30	40				100
ESE	25	30	45				100

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

22MEX01 - 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 various technologies behind renewable energy conversion process and the challenges in integrating power from renewable energy plants with grid.

Unit – I **Grid Integration of Renewable Energy** **9**

Global Energy Use- Energy Status in India -Lifetime of Fossil Fuels- Energy Conversion Technologies - Thermodynamic Efficiency – Variability – Intermittency - Dispatchability - Electric Grid Infrastructure - Integrating Renewable Energy into the Grid - 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- Challenges – Economics- Leadership in Energy Environment Design (LEED) Certification.

Wind Energy: Basic Terms – Types - Horizontal Axis Wind Turbine-Vertical Axis Wind Turbine - Building Integrated Wind Turbines - Wind Turbine Generator and its Performance - Wind Turbine Applications - Recent Developments in Offshore Wind Turbines and Energy Storage - Hybrid Systems - Challenges - Economics.

Unit – III **Bioenergy** **9**

Biomass Resources - Biomass Conversion Technologies - Factors Affecting Biogas Production -Biogas Plant – Types – KVIC Model - Deenbandhu Model - Cogeneration Plant in Rice Mill- Ethanol Production - Energy Recovery from Urban Waste. Transportation –Challenges - Economics.

Unit - IV **Geothermal Energy and Ocean Energy** **9**

Geothermal Energy: Geothermal Resources-Structure of Earth’s Interior - Electricity Production - Conversion Technology - Challenges - Economics.

Ocean Energy: Ocean Thermal Plants - Types-Tidal Plants – Types - Energy Estimation - Grid Interfacing of Tidal Power - Wave Energy Conversion Machines–Types – Buoy - Dolphin - Oscillating Water Column - 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 EXPERIMENTS / EXERCISES:

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.	Determine the thermal energy gain at the focal point of a concentrating collector.
4.	Determine the efficiency of solar (Liquid/Air) collector.
5.	Plot the effect of variation of tilt angle on the PV module output.
6.	Plot the effect of variation of Solar intensity on the PV module output.
7.	Study on rooftop Solar PV plant.
8.	Study on weather monitoring station.
9.	Study the battery management system of solar PV module.
10.	Innovative model development based on renewable energy sources.

Lecture:45, Practical:30, Total:75

TEXT BOOK:	
1.	John Twidell., "Renewable Energy Resources", 4th Edition, Routledge ,New York, 2021.
REFERENCES/ MANUAL / SOFTWARE:	
1.	Kothari D.P., Singal K.C., Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", 3rd Edition, PHI Learning Pvt. Ltd., New Delhi, 2022.
2.	Rai G.D., "Non-Conventional Energy Sources", 6th Edition, Khanna Publishers, New Delhi, 2022.
3.	Laboratory Manual.

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 .	Applying (K3) Manipulation (S2)
CO2	describe the working and applications of solar and wind energy systems and evaluate the performance of solar and wind energy system	Applying (K3) Manipulation (S2)
CO3	illustrate the bio-energy production techniques and the challenges in energy conversion	Applying (K3)
CO4	explain the working of geothermal and Ocean energy conversion technologies along with their economics and challenges.	Applying (K3)
CO5	explain the direct energy conversion systems and new energy sources.	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	3							
CO2	1		2	3	2	3	3		3					
CO3	2					2	3							
CO4	2					2	3							
CO5	2					2	3							

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

ASSESSMENT PATTERN - THEORY

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

22MEX02 - DESIGN OF EXPERIMENTS
(Offered by Department of Mechanical Engineering)

Programme & Branch	**All BE/BTech branches except Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
		6	**OE**	**3**	**0**	**2**	**4**
Pre requisite	Nil						

Preamble	The course explores the fundamentals of experimental design, single factor and multifactor experiments, optimization techniques like ANOVA, Factorial Design, Response Surface Methodology, Taguchi Method.	
UNIT – I	**Experimental Design Fundamentals**	**9**
Importance of Experiments - Experimental Strategies-Basic Principles of Design-Terminology - ANOVA-Steps in Experimentation - Sample Size - Normal Probability Plot - Linear Regression Model.		
UNIT – II	**Multifactor Experimental Design**	**9**
Classical Experiments: Factorial Experiments - Terminology-Factor Levels - Interactions-Treatment Combination- Randomization-Two Level Experimental Designs for Two Factors and Three Factors. Three Level Experimental Designs for Two Factors and Three Factors-Factor Effects - Factor Interactions - Fractional Factorial Design - Saturated Designs-Central Composite Designs - Illustration Through Numerical Examples.		
UNIT – III	**Analysis and Interpretation Methods**	**9**
Measures of Variability-Ranking Method-Column Effect Method-Plotting Method-Analysis of Variance (ANOVA) in Factorial Experiments-YATE's Algorithm for ANOVA-Regression Analysis-Mathematical Models from Experimental Data-Illustration Through Numerical Examples.		
UNIT – IV	**Special Experimental Designs**	**9**
Fractional Factorial Design - Nested Designs - Split Plot Design-Introduction - Response Surface Methodology - Experiments with Random Factors - Rules for Expected Mean Squares - Approximate F-Tests.		
UNIT – V	**Taguchi Methods**	**9**
Steps in Experimentation-Design using Orthogonal Arrays-Data Analysis-Robust Design - Control and Noise Factors-S/N Ratios-Parameter and tolerance design concepts - Case Studies.		

List of Exercises / Experiments :

1. Design of experiments for turning operations by Taguchi method.
2. Design of experiments for milling operations by Taguchi method.
3. Optimize the parameters which affects the quality of CNC turning operation by Taguchi method.
4. Optimize the parameters which affects the quality of CNC milling operation by the Taguchi method.
5. Process parameter optimization in turning using central composite design method.
6. Process parameter optimization in turning using the Box–Behnken design method.
7. Process parameter optimization in surface grinding by Response Surface Method
8. Mathematical model development for turning operation
9. Mathematical model development for milling operation
10. Mathematical model development for drilling operation

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Douglas C. Montgomery, "Design and Analysis of Experiments", 10th Edition, John Wiley and sons, United States, 2020.

REFERENCES/MANUAL/SOFTWARE:

1.	Phillip J.Rose, **"**Taguchi Techniques for Quality Engineering", 2nd Edition, McGraw Hill, 2005.
2.	Nicolo Belavendram,"Quality by Design; Taguchi techniques for industrial experimentation", Prentice Hall, London, 1995.
3.	Krishnaiah, K and Shahabudeen, P, "Applied Design of Experiments and Taguchi Methods", PHI learning private Ltd., New Delhi, 2014.
4.	Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the fundamental concepts in experimental design.	Understanding (K2) Manipulation (S2)
CO2	identify and design the single and multifactor experiments.	Applying (K3) Manipulation (S2)
CO3	select suitable analysis and interpretation methods for experimental results and also develop mathematical model using regression analysis.	Applying (K3) Articulation (S4)
CO4	apply the concepts of special experiment designs and conduct experiments using response surface method	Applying (K3) Manipulation (S2)
CO5	analyze the concepts of taguchi experiment design for practical problems and conduct experiments using taguchi method	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	2					2					
CO2	2	3	2	3	1				2					
CO3	2	3	2	3	1				2					
CO4	2	3	2	3	1				2					
CO5	2	3	2	3	1				2					

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	40	45				100
CAT2	10	35	55				100
CAT3	10	25	45	20			100
ESE	15	25	40	20			100

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

22MEO01 - 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	**Introduction to Ergonomics**	**9**
Fundamentals of Ergonomics / Human Factors - Disciplines - Physical - Cognitive and Organizational - Needs of Ergonomics in Workplace - Ergonomic Principles - Applications - Ergonomic Evaluation - Questionnaire Survey.		
Unit – II	**Anthropometry**	**9**
Human Body - Structure and Function - Types of Anthropometric Data - Application of Anthropometry in Design - Anthropometric Measuring Techniques - Statistical Treatment of Data and Percentile Calculations.		
Unit – III	**Posture and Movement**	**9**
Posture : Biomechanical Background - Physiological Background - Sitting - Standing Change of Posture - Hand and Arm Postures **Movement:** Lifting - Carrying - Pulling - Pushing - Repetitive Motions - Rapid Upper Limb Assessment (RULA) – Rapid Entire Body Assessment (REBA) and Ovako Working Posture Assessment (OWAS) Method.		
Unit – IV	**Work Counter Behavior and Perception**	**9**
Work Counter: Environmental Issues - Physical Work Capacity - Factors Affecting Work Capacity - Communication and Cognitive Issues. **Information Processing and Perception:** Interaction with Machines - Mental Workload.		
Unit – V	**Work System Evaluation and Safety**	**9**
Work system Evaluation: Contribution of Ergonomics to Workstation Design - Analysis of Workplace Design - Work Envelopes - Workplace Evaluation Tools - Case Studies. **Safety:** Occupational / Ergonomic Safety and Stress at Various Workplace - Health Management Rules - Scope of Ergonomics in India - Case Studies.		
		Total:45

TEXT BOOK:

1.	Bridger, Robert. “Introduction to Human Factors and Ergonomics”, United Kingdom, CRC Press, 2017.

REFERENCES:

1.	Pamela McCauley-Bush, "Ergonomics: Foundational Principles, Applications, and Technologies", 1st Edition, Taylor & Francis, CRC Press, New York, 2011.
2.	Dul, Jan, and Weerdmeester, Bernard. “Ergonomics for Beginners: A Quick Reference Guide”, 3rd Edition. United Kingdom, Taylor & Francis, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	define ergonomics and its components.	Understanding (K2)
CO2	make use of anthropometry of data in product design..	Applying (K3)
CO3	examine the common risk factors and areas for ergonomic improvement.	Applying (K3)
CO4	apply ergonomic principles in assigning task to the workers	Applying (K3)
CO5	plan the essential elements for an effective ergonomics programme.	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		
CO2	2		2		3	3						1		
CO3	2			1	2	3	2					1		
CO4	2					3	1					1		
CO5	2				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	45	35				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	10	45	45				100

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

22MEO02 - 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	Title	Hours
Unit – I	**Principles of Management**	**9**

Definition and Significance of Management - Evolution of Modern Management - Scientific Management - Development of Management Thought - Approaches to the study of Management - Basic Functions of Management.

Unit	Title	Hours
Unit – II	**Planning and Organizing**	**9**

Planning: Objectives and Strategies - Policies and Planning Premises - Decision Making – Organizing: Nature and Process – Organization Structure- Premises - Departmentalization - Decentralization - Organizational Culture

Unit	Title	Hours
Unit – III	**Staffing, Leading and Controlling**	**9**

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	Title	Hours
Unit – IV	**Industrial Psychology- Job Analysis and Organization Development**	**9**

Industrial Psychology: Introduction - Concept and Meaning - Characteristics and Scope - Historical Development - Individual Behavior. Job Analysis: Importance- Conducting Job Analysis – Job Evaluation – Internal and External Pay Equity - The Legal Process – Organization Development: Managing Change – Empowerment – Down Sizing- Work Schedules.

Unit	Title	Hours
Unit – V	**Employ Satisfaction, Motivation and Group Behavior**	**9**

Employ Satisfaction: Measuring Job Satisfaction – Consequences of Dissatisfaction. Employee Motivation: Organizational Communication - Group Behavior, Teams, and Conflict - Stress Management- Predisposition – Sources – Consequences – Managing Stress.

Total:45

TEXT BOOKS:

1.	Harold Koontz & Heinz Weihrich., "Essentials of Management: An International, Innovation and Leadership Perspective",11th Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2020 for Units I,II,III.
2.	Michael G Aamodt., "Industrial Psychology", 7th Edition, Cengage Learning, India, 2013 for Units IV,V.

REFERENCE:

1.	Spector, P.E., “Industrial and organizational psychology: Research and practice”. John Wiley & Sons, 2021.

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	Infer the knowledge of planning and organizing activities in an industry	Understanding (K2)
CO3	present the functions of staffing, leading and controlling of an organization	Understanding (K2)
CO4	develop an intuitive understanding of the job analysis and employee selection in an organization.	Understanding (K2)
CO5	Identify employee satisfaction and understand the art of managing groups.	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				2	1			
CO2	2					2				2	1			
CO3	2					2				2	1			
CO4	2					2				2	1			
CO5	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	35	65					100
CAT2	35	65					100
CAT3	35	65					100
ESE	40	60					100

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

22MEO03 - WASTE HEAT RECOVERY SYSTEM AND STORAGE
(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 explores the fundamentals of waste heat recovery and thermal energy storage technologies applicable for diverse industrial processes to enhance energy efficiency and sustainability.	
Unit – I	**Introduction**	**9**
Thermodynamics Laws -Types of Waste Heat Sources - Principles of Energy Conversion - Rankine Cycle, Combined Cycles - Diesel Engines and Power Plant - Combined Plants- Potential for Energy Conservation -Total Energy Approach.		
Unit – II	**Waste Heat Recovery Systems**	**9**
Heat Transfer Fundamentals- Conduction, Convection, and Radiation- Selection Criteria for Waste Heat Recovery Technologies - Recuperators - Regenerators -Economizers - Plate Heat Exchangers - Thermic Fluid Heaters - Waste Heat Boilers - Fluidized Bed Heat Exchangers - Heat Pipe Exchangers - Heat Pumps – Sorption Systems.		
Unit – III	**Cogeneration**	**9**
Introduction - Topping Cycle -Bottoming Cycle – Combined Heat and Power (CHP) Cycle - Steam Turbine Co-generation Systems – Gas Turbine Co-generation Systems – Reciprocating IC Engines Co-generation Systems – Combined Cycles Co-generation Systems – Advantages of Co-generation Technology- Co-generation Application. - Basic Performance Calculations. Selection of Cogeneration Technologies.		
Unit – IV	**Thermal Energy Storage**	**9**
Thermal Energy Storage, Sensible and Latent Heat - Sensible Heat Storage Materials- Ice Storage- Phase Change Materials –Thermochemical Storage - Molten Salt, Metal Hydrides, Sorption Materials - Hybrid Thermal Energy Storage Systems – Potential for Energy Storage – Mass and Energy Balance Analysis of Thermal Energy Storage.		
Unit – V	**Economic and Environmental Considerations**	**9**
Investment Cost – Economic Concepts – Measures of Economic Performance – Procedure for Economic Analysis – Examples – Procedure for Optimized System Selection and Design – Load Curves - Sensitivity Analysis – Regulatory and Financial Framework. Sustainability and Environmental Impact of Waste Heat Recovery, Co-generation and Energy Storage Systems.		
		Total:45

TEXT BOOKS:

1.	Hussam Jouhara “Waste Heat Recovery in Process Industries “John Wiley & Sons, 2022. for Units I,II.
2.	Horlock, J. H “Cogeneration--combined heat and power (CHP) : thermodynamics and economics” Krieger Publishing Company; Reprint edition, 1996 for Unit III.
3.	Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2010. for Unit IV.
4.	David Flin, “Cogeneration - A User's Guide” Institution of Engineering and Technology, London, United Kingdom, 2009. for Unit V

REFERENCES:

1.	Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
2.	Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
3.	Sengupta Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983
4.	De Nevers, Noel., Air Polllution Control Engineering, McGrawHill, New York,1995

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the basic thermodynamic principles and concepts of waste heat recovery and energy storage systems.	Understanding (K2)
CO2	acquire knowledge pertaining to various waste heat recovery systems and their applications.	Applying(K3)
CO3	apply the principles of energy conversion and distribution to design of cogeneration systems.	Applying(K3)
CO4	Identify and analyze the sensible, latent, and thermochemical storage systems and their applications.	Understanding (K2)
CO5	Evaluate the economic viability and environmental impact of heat recovery and storage system	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	2	1											
CO3	3	2		2										
CO4	3		1											
CO5	3	1	1				2							

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

ASSESSMENT PATTERN - THEORY

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

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

22MEO04 - 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 equipment's and risk assessment procedures.	
Unit – I	**Safety Management and Accident Prevention**	**9**
Safety Management: Need for Safety - Safety and Productivity - Safety Management Techniques - Job Safety Analysis – Safety Sampling Technique - Incident Recall Technique - Plant Safety Inspection. **Accident Prevention**: Nature and Causes of Accidents - Accident Proneness - Cost of Accident - Accident Prevention Methods - Accident Reporting and Investigation - Safety Education and Training.		
Unit – II	**Electrical and Fire Safety**	**9**
Usefulness and Hazards of Electricity - Statutory Provisions - Indian Standards - Effects of Electrical Parameters on Human Body - Safety Measures for Electric work - Overload and Other Protections - Portable Electrical Apparatus - Electric Work in Hazardous Atmosphere - Static Electricity - Energy Conservation and Safety Fire Phenomena - Classification of Fire and Extinguishers - Statutoryand other standards - Design for Fire Safety - Fire Prevention and Protection System - Explosion Phenomena - Inspection, Maintenance and Training for Fire Protection.		
Unit – III	**Safety in Chemical Industry**	**9**
Types of Chemical Industry - Statutory Provisions - Indian Standards – Types of Chemical Hazards & Controls – Material(Property)Hazards and Controls – Storage Hazards & Controls - Process Hazards & Controls - Utility Hazards & Controls – Pollution Hazards & Controls - Instrumentation for Safe Plant Operations - Safe Transfer of Chemicals - Inspection, Testing & Maintenance - Work Permits of Hazardous Work- case studies		
Unit – IV	**Personnel Protection Equipment (PPE) and Test Standards**	**9**
Need and Limitation - Statutory Provisions - Indian & Other standards - Selection and Classification - Non Respiratory Equipment - Respiratory Equipment - Training, Maintenance, Precaution and Care of PPE - Detection Equipment - PPE Testing Procedures & Standards		
Unit – V	**Risk Assessment**	**9**
Basic Concepts of Risk - Safety Appraisal, Analysis and Control Techniques - Accident Investigation, Analysis and Reporting - Hazardand 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 CapelliSchellpfeffer& 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.	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					3	2	1						
CO2	1					3	2	1						
CO3	1					3	2	1						
CO4	1					3	2	1						
CO5	1					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	15	45	40				100
CAT2	20	40	40				100
CAT3	30	30	40				100
ESE	30	35	35				100

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

22MEO05 - 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 methods to conserve energy in thermal equipment after a detailed evaluation of the performance parameters.	
Unit – I	**Basics of Energy**	**9**
Energy – Forms of Energy – Power – Units – Estimation of Energy Requirement – Electricity – Voltage – Current – Resistance – Measurement of Electrical Quantities - Energy Efficiency and Conservation – Plant Energy Performance – Production Factor Plant Energy Performance – Energy Audit and Survey Instruments - Energy related CO_2 emissions – Strategies for Energy Savings in Industries.		
Unit – II	**Energy Conservation in Steam System**	**9**
Steam Phase Diagram - Steam Distribution - Steam Pipe Design and Sizing – Steam Traps – Selection – Operation – Maintenance - Performance Assessment Methods -– Energy Saving Opportunities.		
Unit – III	**Energy Conservation in Boilers and Furnaces**	**9**
Boiler: Water Treatment – Water to Steam Conversion – Hot Water Systems – Heat transfer Coefficients – Boiler Performance Assessment using Direct and Indirect Method – Energy Conservation Opportunities. **Furnace:** Performance Evaluation – General Fuel Economy Measures- Estimation of fuel savings.		
Unit – IV	**Energy Conservation in Air conditioners**	**9**
Load Characteristics and Calculation - Factors Affecting Cooling Rate - Air conditioner – Working – Types – Efficiency – Sizing - Energy Conservation Opportunities – Energy Monitoring and Control System.		
Unit – V	**Cogeneration**	**9**
Need – Classification – Commercial Cogeneration Systems – Factors and Technical Parameters Influencing the Selection of Cogeneration Systems – Energy Savings through Cogeneration Systems - Relative Merits of Cogeneration Systems – Performance Assessment.		
		Total:45

TEXT BOOK:

1.	Guide Books for National Certification Examination for Energy Managers and Auditors, 4th Edition, Bureau of Energy Efficiency, 2015.

REFERENCES:

1.	Sonal Desai, "Handbook of Energy Audit", 1st Edition, McGraw Hill Education, New Delhi, 2017.
2.	Stephan A Roosa, Steve Doty, Wayne C Turner, "Energy Management Handbook", 9th Edition, River Publishers, New York, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the basics of energy with reference to energy conservation.	Understanding (K2)
CO2	explain the energy conservation opportunities in steam system.	Applying(K3)
CO3	discuss the energy conservation opportunities in boilers and furnaces.	Applying(K3)
CO4	elucidate the energy conservation opportunities in air conditioners.	Applying(K3)
CO5	quantify the energy savings through cogeneration	Applying(K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2				1	1	3					1		
CO2	2					1	3					1		
CO3	2		2			1	3					1		
CO4	2		2			1	3					1		
CO5	3		2			1	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	30	50	20				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	15	50	35				100

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

22MEO06 - CLIMATE CHANGE AND NEW ENERGY TECHNOLOGY
(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 an overview on global and national climate change implications. In addition, the future energy technologies for sustainable development are also covered in this course.	
Unit – I	**Climate Change**	**9**
Preliminary Concepts of Climate Change - International Climate Policy - Causes of Climate Change - Enhanced Greenhouse Effect – Green House Gases in Atmosphere - Global Warming - Effects of Global Warming - Climate Change Scenario of India - Impact of Climate Change on Agriculture – Forest - Water Resources - Monsoon System of India.		
Unit – II	**Energy Transition**	**9**
Personal Energy Needs - Personal Carbon Dioxide Balance - Carbon Dioxide Sequestration - Combined Heat and Power System - Energy Transition in Heat Sector - Transport Sector - Electricity Sector - Direct and Indirect Emissions in Energy Sector - Net-zero Emissions - Carbon-free Technology.		
Unit – III	**Renewable Energy System**	**9**
Solar Thermal Systems - Domestic Solar Water Heating – Space Heating - Solar PV Systems - Designing Stand-alone Systems - Designing Grid-connected Systems - Renewable Power Plants – Solar Photovoltaic Power Plants - Concentrating Solar Thermal Power Plants - Grid-connected Wind Turbines - Geothermal Heat and Power Plants - Biomass Heat and Power Plants.		
Unit – IV	**Battery Technologies**	**9**
Introduction to Batteries – Electrochemical Principles and Reactions - Classification - Primary Batteries - Types - Service Time - Voltage Data - Service Life - Ohmic Load Curve - Effect of Operating Temperature on Service Life - Reserve Batteries – Types - Secondary Batteries – Types - Discharge Curves - Terminal Voltages - Plateau Voltage - Lead Acid Batteries – Construction – Application – Battery Performance Evaluation - Factors Affecting Battery Performance - Advanced Batteries for Electric Vehicles.		
Unit – V	**Energy Storage Technology**	**9**
Demand for Power Systems - Overview of Energy Storage Technologies - Energy Storage Methods – Electrical Storage Systems - Efficiency of Energy Storage systems -Thermal Energy Storage (TES) using Phase Change Materials - Energy Conservation with TES - Planning and Implementation of TES - Environmental impact of TES systems.		
		Total:45

TEXT BOOKS:

1.	Volker V. Quaschning, “Renewable Energy and Climate Change”, 2nd Edition, Wiley Publications, USA, 2019 for Units I,II,III.
2.	Beard Kirby W, “Linden’s Hand Book of Batteries”, 5th Edition, McGraw Hill Book Company, New York, 2019 for Units IV,V.

REFERENCES:

1.	Ibrahim Dincer and Marc A. Rosen, “Thermal Energy Storage: Systems and Applications”, 3rd Edition, Wiley Publications, USA, 2021
2.	Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, “Fundamentals and Applications of Renewable Energy”, 1st Edition, McGraw Hill Book Company, New York, 2020.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22GEO01 - 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	**Nil**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course serves as an introduction to the German language and awareness towards German lifestyle and cultural aspects of Germany and German speaking countries. One can learn to introduce oneself and able to gain the basic day to day vocabulary. On keen learning one would be able to understand the sentence structure and be able to reciprocate to basic questions

Unit – I	**Good Day (Guten Tag)**	**12**
Greetings, Self-introduction and introducing others, Numbers, Alphabets, Countries and languages spoken. Grammar – W questions, Simple sentences, Verb conjugation and personal pronoun.		
Unit – II	**Friends & Colleague (Freund und Kollegen):**	**12**
Hobbies, Profession, Week, Months, Season and Generate Profile. Grammar – Articles, Plural, Verbs – have and to be, Yes/No questions.		
Unit – III	**n the City (In der Stadt):**	**12**
Name of places/buildings in the city, asking for directions, Understanding means of transport. Grammar – definite and indefinite articles, Negation articles and Imperative		
Unit – IV	**Food and Appointment (Essen und Termin):**	**12**
Food, Shopping, initiate conversations to understand and do shopping. Grammar – Accusative case, Verbs with Accusative. Understanding time and reciprocating, Appointments, Asking excuse, Family. Grammar – Prepositions: *am, um, von...bis,* Possessive articles- *mein, dein*.., Modal verbs- *müssen, können, wollen*		
Unit – V	**Socializing (Zeit mit Freunden):**	**12**
Planning together, Birthday, Invitation, Restaurant, looking for specific information in texts. Grammar – Separable verbs, Prepositions with Accusative case, Past tense of have and to be, Personal pronoun with Accusative.		
		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 structure of language and introducing each other	Remembering (K1)
CO2	understand vocabulary on seasons and basic verbs	Understanding (K2)
CO3	ask for directions in a new place and avail transport as required	Understanding (K2)
CO4	understand food habits of German and ask for appointments.	Understanding (K2)
CO5	learn to socialize in a German speaking country	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)

22GEO02 - JAPANESE 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	**Nil**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	The basic level of Japanese which provides understanding of Hiragana, Katakana and 55 Kanjis also enables one to greet, introduce oneself and other person and also provides the ability to understand basic day to day conversations	
Unit – I	**Introduction to Hiragana and Katakana:**	**12**
Chart 1, Chart 2, Chart 3, Annexures 1 and 2 and basic Japanese rules along with similar sounded vocabularies for each chart.		
Unit – II	**Introduction to Nouns, various particles and usages:**	**12**
Forming simple sentences, asking questions, positioning differentiation and owning fundamentals – new particles and usages		
Unit – III	**Introduction of Verbs, time and place markers:**	**12**
Usage of action words in sentences and framing them – place and time markers usages – giving and receiving – omission of certain particles in a sentence.		
Unit – IV	**Introduction of Adjectives, Adverbs and usages:**	**12**
Describing nouns and verbs and framing them to relate day to day conversations- positive and negative ending of the same – introduction of the likes and dislikes expressions		
Unit – V	**Introduction to Counters and Kanji:**	**12**
How to use numbers-How to use quantifiers-Present form of adjectives and Nouns-Other necessary particles-How to use numbers and quantifiers – 55 kanji characters		
		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	read and understand typical expression in Hiragana and Katakana	Remembering (K1)
CO2	greet and introduce oneself and other	Understanding (K2)
CO3	communicate day to day conversations – basic level	Understanding (K2)
CO4	understand the Kanjis in Japanese Script	Understanding (K2)
CO5	comprehend concept of numbers, days, months, time and counters	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)

22GEO03 - DESIGN THINKING FOR ENGINEERS							
(Offered by Department of Computer Science and Engineering)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	Design Thinking is human-centered problem solving tool which emphasize on empathy, collaboration, co-creation and stakeholder feedback to unlock creativity and innovation, to devises feasible and viable idea/solutions.	
Unit – I	**Design Thinking and Explore:**	**9+3**
Design Thinking: Key Principles and Mindset – Five Phases, Methods and Tools of Design Thinking – User Guide – Foundation Building for Design Thinking – **Explore**: Methods & Tools – STEEP Analysis – Strategic Priorities – Activity System – Stakeholder Mapping – Opportunity Framing.		
Unit – II	**Empathize**	**9+3**
Empathize: Methods & Tools – Field Observation – Deep User Interview – Empathy Map – User Journey Map - Need Finding – User Insights - User Persona Development.		
Unit – III	**Experiment**	**9+3**
Experiment: Methods & Tools – Ideation – SCAMPER – Analogous Inspiration – Deconstruct & Reconstruct – User Experience Journey – Prototyping– Idea Refinement.		
Unit – IV	**Engage**	**9+3**
Engage: Methods & Tools – Story Telling – Art of Story Telling – Storyboarding – Co-Creation with Users – Collect Feedback from Users.		
Unit – V	**Evolve**	**9+3**
Evolve: Methods & Tools – Concept Synthesis – Strategic Requirements –Evolved Activity Systems – Activity System Integration – Viability Analysis – Innovation Tools using User Needs, CAP, 4S – Change Management - Quick Wins.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Lee Chong Hwa, "Design Thinking The Guidebook”, Design Thinking Master Trainers of Bhutan, 2017. (E-Book)

REFERENCES:

1. Jeanne Liedtka and Tim Ogilvie, "Designing for Growth: A Design Thinking Tool Kit for Managers", Columbia University Press, 2011.
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	Construct design challenge and reframe the design challenge into design opportunity.	Applying (K3)
CO2	Interview the user, and know the feelings of users to foster deep user understanding and be able to uncover the deep user insights and needs.	Applying (K3)
CO3	Develop ideas and prototypes by brain storming using the ideation tools.	Applying (K3)
CO4	Organize the user walkthrough experience using ideal user experience journey.	Applying (K3)
CO5	Develop smart strategies & implementation plan that will deliver/achieve the idea/solution deduced from earlier phases.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

Tests	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1	10	20	70				100
CAT 2	10	15	75				100
CAT 3	10	15	75				100
ESE	10	15	75				100

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

22GEO04 - 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**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will inspire the students to think innovation concepts and ideas for business model developments.	
Unit - I	**Innovation and Design Thinking:**	**9+3**
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+3**
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+3**
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+3**
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+3**
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		
		Lecture:45, Tutorial:15, Total:60

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

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

ASSESSMENT PATTERN - THEORY

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

22GEO05 - 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	**All**	**OE**	**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, 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, 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.
2.	

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	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)

22GEO06-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	**All**	**OE**	**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
2.	

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	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)

22GEO07-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**	**All**	**OE**	**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	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)

22GEO08 - 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**	**All**	**OE**	**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)

22GEO09 - 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**	**All**	**OE**	**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)

22GEO10 -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**	**All**	**OE**	**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", 2^{nd} Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

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

22GEO11 - FRENCH 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	**Fundamentals of French Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course provides a foundation of the French language as well as an understanding of the French culture and lifestyle of France and other French-speaking nations. The student will be learning how to introduce him/herself and acquire basic everyday vocabulary. By following the structured curriculum and practicing the same as per the learning process, one can comprehend the structure of sentences and respond to basic communications	
Unit – I	**Introduction**	**12**
French and French culture, alphabets, pronunciation, accents, rules, and terms for pronunciation (mas-fem), Salutations, numbers.		
Unit – II	**Daily Life**	**12**
Subject Pronoun, Francophonie's, adjectives – colors, week, months, seasons.		
Unit – III	**Articles and Verbs**	**12**
Articles - Indefinite, definite, partitive, and contracted, (examples), introductions to verbs, 1st group of verb		
Unit – IV	**In the City**	**12**
2nd group of verbs, irregular verbs (avoir, etre, faire …..) present yourself & negative sentences. (faire and Jouer verb with the expressions)		
Unit – V	**Food and Culture**	**12**
Prepositions – preposition of places (country, cities and etc), Imperative mode, invitations, culture – food (wine, cheese ….) Future (recent future)		
		Total:60

TEXT BOOK:

1.	A1 – saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G, Les idees – 0 and 1

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Understand the grammatical structure of the language and introduce self to others.	Remembering (K1)
CO2	Understand basic verbs and appropriate vocabulary.	Understanding (K2)
CO3	Ask for directions and arrange for transportation, etc, as needed.	Understanding (K2)
CO4	Understand the food habits of France and ask for appointments	Understanding (K2)
CO5	Learn to socialize in French-speaking countries	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		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	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	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)

22GEO12 -FRENCH 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	**Fundamentals of French Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course is designed to assist students in developing vocabulary in accordance with the Common European Framework of Reference for Languages at the A2 level. This course will aid in the integration of basic grammar structures as well as the acquisition of vocabulary necessary to comprehend and respond in everyday circumstances. The learner will be able to develop a thorough comprehension of French grammar and confidently express themselves in everyday circumstances.	
Unit – I	**French and You**	**12**
Habits, Strengths & Weakness, Recommendations, Sentiments, Motivations, about favorite films and Types of screens in the movie world, Verbs (Regulars and irregulars), Reflexive Verbs, Prepositions		
Unit – II	**Eat and Repeat**	**12**
Favorite foods, Recopies, Types of meals, Describing House and Kitchen, Presentation of the recipe, Comparatives, Possessive pronouns, Present continuous tense, Simple conditional form		
Unit – III	**Vacation**	**12**
Invitations, presentation, Greetings, Goodbyes, Activities on vacation, past experiences, Describing favorite place, Recommendations on various tours, Past perfect, Past imperfect tense		
Unit – IV	**Likes and Views**	**12**
Favorite persons & things, Giving advice, Experience, Moods, Illness, Discomforts, Symptoms, Roleplay (Doctor & Patient, Guide & Tourist, Pharmacist & Patient), Past perfect, Past indefinite, Imperative		
Unit – V	**Then and Now**	**12**
Habits, customs, circumstances of the past and present, Debates on past and present situations and feelings. Past imperfect tense, Past perfect and Present comparatives.		
		Total:60

TEXT BOOK:

1.	A2 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G .Les idees – 0 and 1

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand the French language in deep and its usage	Remembering (K1)
CO2	Preparation of their Favorite recipes, Know the Objects used in Kitchen and house.	Understanding (K2)
CO3	Converse about their vacation, their Favorite Destination	Understanding (K2)
CO4	Understand complex verbs and be able to communicate about their past experiences	Understanding (K2)
CO5	Know the difference between Past and Present and Compare them.	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)

22GEO13- FRENCH 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	**Fundamentals of French Language**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course gives knowledge regarding a variety of personal and professional circumstances, as well as improving vocabulary and speaking abilities to reply to and seek information in those settings. It also gives you the ability to articulate yourself and arrange appointments. With perseverance, one can master all of the essential grammatical structures needed to respond confidently in everyday circumstances. It almost gives you an idea of how Natives communicate.	
Unit – I	**Start Over**	**9**
Use of periphrases, Discuss a day in life, work, problems in the world, Predictions about the future (actions and situations), Hypothetical situations, Imperfect and future tense.		
Unit – II	**Prohibitions and More**	**9**
Prohibitions, Obligations, Habits to change, social customs, Use of the subjunctive, Describe synopsis of Movie and its relation to real life, Debate on books vs movies, usage of connectors, Object Direct and Indirect.		
Unit – III	**Let's be Creative**	**9**
Write a letter by describing the problem, talk about desires and Necessities, propose solutions, Recommendations and Suggestions, Create an Advertisement, Give Instructions, Imperative negative, Use of Object Direct, and Indirect		
Unit – IV	**Travel and Communication**	**9**
Talk about Tours, Types of tourism and communication, Send messages, petitions, Talk to people on the telephone, Roleplay (Tourists and Guide, Tourists and Travel agents), Past Pluscumperfect, All Past tenses.		
Unit – V	**Let's Talk**	**9**
Expression of Interests, Sentiments, Feelings, Sensations, Manias etc. Certain suggestions to make a better future, the use of superlatives, Exclamatory phrases, subjunctives.		
		Total:45

TEXT BOOK:

1.	B1 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G Les idees – 0 and 1

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Learn on Future tense.	Remembering (K1)
CO2	Understand Permissions and Prohibitions.	Understanding (K2)
CO3	Knowing about Letter writing, Creating Ads, Expressing Desires, and Instructing Others.	Understanding (K2)
CO4	Understanding rules for travel and Enhancing communications.	Understanding (K2)
CO5	Expressing the feelings and emotions using advanced grammar	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		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	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	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)

22GEO14 - SPANISH 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	**Fundamentals of Spanish Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course provides a foundation of the Spanish language as well as an understanding of the Spanish culture and lifestyle of Spain and other Spanish-speaking nations. The student will be learning how to introduce him/herself and acquire basic everyday vocabulary. By following the structured curriculum and practicing the same as per the learning process, one can comprehend the structure of sentences and respond to basic communications.

Unit – I	**Greetings and Good byes (Los Saludos y Despidirse):**	**12**
Greetings,Self-Introduction , Formal and Informal ways of introducing oneself and others, Alphabets& Numbers, Countries and Languages Spoken, Parts of Grammar – Noun, Personal Pronoun, Describe surroundings and its vocabulary		
Unit – II	**Vida Cotidiana (Daily Life):**	**12**
Time of the day, Days of the week, Months of the year, Seasons, Verb (To be, To Have), Adverbs, Likes and Dislikes, Personality and physical description, simple sentences		
Unit – III	**Friends and Family (Amigos y La Familia):**	**12**
Vocabulary of family, Animals, Professions, Parts of the body, Opinions on family cultures, Articles – Definite and Indefinite, Hobbies, Regular and Irregular verbs.		
Unit – IV	**In the City (En la Cuidad):**	**12**
Buildings in the city, Name of the places, asking for directions, Helping each other, Description of house and its components, Modes of Transport, Grammar - Possessive articles, prepositions		
Unit – V	**Food and Culture(La comida y cultura):**	**12**
Food (types and varieties) , shopping, ordering at a restaurant, inviting to parties, Roleplay (as diner and customer, salesman and customer…etc.) Past tense (all three tenses-Past Participle, Indefinite past and past imperfect- (to be and to have)		
		Total:60

TEXT BOOK:

1.	Chicos Chicas Libro de Alumno nivel 1, Ma Angeles Palomino , edelsa, GRUPO DIDASCALIA, S.A., plaza cuidad de salta,3-28043 MADRID(ESPANA).

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the grammatical structure of the language and introduce self to others.	Remembering (K1)
CO2	understand basic verbs and appropriate vocabulary.	Understanding (K2)
CO3	ask for directions and arrange for transportation, etc, as needed.	Understanding (K2)
CO4	understand the food habits of Spain and Latin countries and ask for appointments	Understanding (K2)
CO5	learn to socialize in Spanish speaking countries	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		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	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	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)

22GEO15 - SPANISH 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	**Fundamentals of Spanish Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course aims to help the Learner to acquire the vocabulary as per theframework of Spanish language A2 level competence. This course will help to assimilate the basicgrammar 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 Spanish grammar and confidently articulate in day today situations.	
Unit – I	**Spanish and You (El Español y tú)**	**12**
Habits, Strengths & Weakness, Recommendations, Sentiments, Motivations, About favorite films and Types of screens in the movie world, Verbs(Regulars and irregulars), Reflexive Verbs, Prepositions		
Unit – II	**Eat and Repeat (**Comer y repetir**)**	**12**
Favorite foods, Recipies, Types of meals, Describing House and Kitchen, Presentation of recipe, Comparatives, Possessive pronouns, Present continuous tense, Simple conditional form		
Unit – III	**Its Vacation Time (**Tiempo de vacaciones)	**12**
Invitations, presentation, Greetings, Goodbyes, Activities on vacation, past experiences, Describing favorite place, Recommendations on various tours, Past perfect, Past imperfect tense, Usage of Todavia or No		
Unit – IV	**Likes and Views (**Gustasyvistas)	**12**
Favorite persons & things, Giving advices, Experience, Moods, Illness, Discomforts, Symptoms, Roleplay (Doctor & Patient, Guide & Tourist, Pharmacist & Patient), Past perfect, Past indefinite, Imperative		
Unit – V	**Then and Now(Antes y Ahora)**	**12**
Habits, customs, circumstances of the past and present, Debates on past and present situations and feelings. Past imperfect tense, Past perfect and Present comparatives.		
		Total:60

TEXT BOOK:

1.	AULA INTERNACIONAL 2 (A2) Jaime Corpas, AgusinGarmendia, Nuria Sanchez, Carmen Soriano Goyal Publishers and Distributors Pvt LTD, 86, UB Jawahar Nagar, Kamla Nagar, Delhi-110007.

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the Spanish language in deep and its usage	Remembering (K1)
CO2	prepare for their Favorite recipes, Know the Objects used in Kitchen and house.	Understanding (K2)
CO3	converse about their vacation, their Favorite Destination	Understanding (K2)
CO4	understand complex verbs and be able to communicate about their past experiences	Understanding (K2)
CO5	know the difference between Past and Present and Comparing them.	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		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	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	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)

22GEO16 - SPANISH 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	**Fundamentals of Spanish Language**	**All**	**OE**	**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. It almost gives a basic idea on how Natives speak.	
Unit – I	**Start Over(Volver a Empezar)**	**9**
Use of periphrases, Discuss a day in life, work, problems in the world, Predictions about future (actions and situations),Hypothetical situations, Imperfect and future tense.		
Unit – II	**Prohibitions and More(Prohibiciones y mas)**	**9**
Prohibitions, Obligations, Habits to change, social customs, Use of subjunctive, Describe synopsis of Movie and its relation to real life, Debate on books vs movies, usage of connectors, Object Direct and Indirect.		
Unit – III	**Let's be Creative (Seamoscreatives)**	**9**
Write a letter by describing the problem,talk about desires and Necessities, propose solutions, Recommendations and Suggestions, Create an Advertisement, Give Instructions, Imperative negative, Use of Object Direct and Indirect.		
Unit – IV	**Travel and Communication (Viajar y comunicar)**	**9**
Talk about Tours, Types of tourism and communication, Send messages, petitions, Talk to people on telephone, Role play(Tourists and Guide, Tourists and Travel agents), Past Pluscumperfect, All Past tenses.		
Unit – V	**Let's Talk(Hablemos)**	**9**
Expression of Interests, Sentiments, Feelings, Sensations, Manias etc. Certain suggestions to make a better future, use of superlatives, Exclamatory phrases, subjunctive.		
		Total:45

TEXT BOOK:

1.	Aula International 3 (B1) [Paperback] Jaime Corpas, Agusin Garmendia, Nuria Sanchez, Carmen Soriano Goyal Publishers and Distributors Pvt LTD, 86, UB Jawahar Nagar, Kamla Nagar, Delhi-110007.

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	learn on Future tense.	Remembering (K1)
CO2	understand about Permissions and Prohibitions.	Understanding (K2)
CO3	knowing about Letter writing, Creating Ads, Expressing Desires and Instructing Others.	Understanding (K2)
CO4	understanding rules for travel and Enhance communications.	Understanding (K2)
CO5	expressing the feelings and emotions using advanced grammar	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		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	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	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)

22GEO17 - ENTREPRENEURSHIP DEVELOPMENT							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Economics & Management**	**7**	**OE**	**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- Case Study		
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		
CO2	1	2	2	2		2	2	1	1		3	2		
CO3	2	2	2	2	2	2	2	2	2	2	3	2		
CO4	1	1	2	1		2	1	1	1	2	3	2		
CO5	1	1	2	1		2	1	1	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	40	40				100
CAT2	20	30	30	20			100
CAT3	30	30	40				100
ESE	10	30	40	20			100

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

<table>
<tr><th colspan="8">22GEX01 – NCC Studies (Army Wing) – I</th></tr>
<tr><th colspan="8">(Offered by Department of Electrical and Electronics Engineering)</th></tr>
<tr><td>Programme & Branch</td><td>All BE/BTech Engineering and Technology Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>5 / 6</td><td>OE</td><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">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.</td></tr>
<tr><td>Unit - I</td><td colspan="6">NCC Organisation & National Integration</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit - II</td><td colspan="6">Basic physical Training & Drill</td><td>9</td></tr>
<tr><td colspan="8">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)</td></tr>
<tr><td>Unit - III</td><td colspan="6">Weapon Training</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit - IV</td><td colspan="6">Social Awareness and Community Development</td><td>9</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>Unit - V</td><td colspan="6">Specialized Subject (ARMY)</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8" align="right">Lecture :45, Practical:30, Total:75</td></tr>
</table>

<table>
<tr><td colspan="2">TEXT BOOK:</td></tr>
<tr><td>1.</td><td>National Cadet Corps- A Concise handbook of NCC Cadets by Ramesh Publishing House, New Delhi, 2014</td></tr>
<tr><td colspan="2">REFERENCES:</td></tr>
<tr><td>1.</td><td>Cadets Handbook – Common Subjects SD/SW published by DG NCC, New Delhi.</td></tr>
<tr><td>2.</td><td>Cadets Handbook- Specialized Subjects SD/SW published by DG NCC, New Delhi</td></tr>
<tr><td>3.</td><td>NCC OTA Precise published by DG NCC, New Delhi.</td></tr>
</table>

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.						

22GEX02 - 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+3**
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+3**
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+3**
Laws of motion-Forces acting on aircraft – Bernoulli's theorem - Stalling - Primary control surfaces – secondary control surfaces - Aircraft recognition.		
Unit-IV	**Aero Engines**	**9+3**
Introduction of Aero engine -Types of engine - piston engine - jet engines - Turbo prop engines-Basic Flight Instruments - Modern trends.		
Unit–V	**Aero Modeling**	**9+3**
History of aeromodeling - Materials used in Aero-modeling - Types of Aero-models – Static Models - Gliders - Controlline models - Radio Control Models - Building and Flying of Aero-models.		

Lecture:45, Tutorial:30, Total:75

TEXT BOOK:

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

REFERENCES/ MANUAL / SOFTWARE:

1.	"Cadets Handbook – Common Subjects SD/SW", DGNCC, New Delhi.
2.	"Cadets Handbook – Specialised Subjects SD/SW", DGNCC, New Delhi.
3.	"NCCOTA Precise", DGNCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	build 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 air planes 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.						

22MBO01 - COST ACCOUNTING FOR ENGINEERS

(Offered by Department of Management Studies)

Programme& Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**NIL**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide an In-depth study of the Cost Accounting principles and techniques for identification, analysis and classification of costs components to facilitate decision Making.	
Unit – I	**Introduction to Cost Accounting**	**9 + 3**

Introduction to Cost Accounting: Meaning - Scope, objectives and significance of Cost Accounting its relationship with financial accounting and management accounting– cost centres – cost units – Elements of cost – classification of cost – preparation of cost sheet.

Unit – II	**Cost Ascertainment – Elements of cost**	**9 + 3**

Material Costs: Procurement of materials – Inventory management and control – scrap, spoilage, defectives and wastage
Labour Costs: Time Keeping, Time booking and payroll – Labour turnover – principles and methods of remuneration and incentive schemes.
Overheads: Collection, classification and apportionment and allocation of overheads.

Unit – III	**Basic Costing Methods**	**9 + 3**

Operating Costing - Meaning - Preparation of Operating Cost Sheet - Transport Costing - Power Supply Costing - Hospital Costing.

Unit – IV	**Advanced Costing Methods**	**9 + 3**

Features of Job Costing - Batch Costing - Preparation of Cost Sheet Under Job Costing, and Batch Costing - Process Costing - Process Loss - Normal and Abnormal Loss.

Unit – V	**Cost Accounting Techniques**	**9 + 3**

Budget and Budgetary Control: Budgetary control as a management Tool – Installation of Budgetary control system classification of budgets – Fixed and Flexible Budgeting.
Standard Costing and Variance Analysis: Budgetary control and standard costing – Suitability of standard costing – Standard costing as a management Tool – Cost variances – Direct material cost variances – Direct labour cost variances – Overhead variances – Sales variance.

Lecture: 45, Tutorial: 15, Total:60

TEXT BOOKS

1.	JawaharLal, SeemaSrivastava, Manisha Singh, “ Cost Accounting, Text, Problems and Cases”, 6th Edition, McGraw Hill Education, New Delhi, 2020.
2.	William Lanen, Shannon Anderson and Michael Maher, “Fundamentals of cost Accounting”,7th Edition, McGraw Hill Education, New Delhi, 2020.

REFERENCES

1.	M.N.Arora and PriyankaKatyal, “Cost Accounting”, 5th Edition, Vikas publishing House, New Delhi, 2023.
2.	Ravi M.Kishore, “ Cost and Management Accounting”, 6th Edition, Taxmann, New Delhi, 2021
3.	M.N.Arora, “Cost and Management Accounting”,11th Edition, Vikas Publishing, New Delhi, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the conceptual frame work of cost accounting	Understanding (K2)
CO2	understand the basic concepts and process in determination of cost of product and services	Understanding (K2)
CO3	use the basic costing methods in different business situation	Applying (K3)
CO4	demonstrate the advanced costing methods in various decision making situation	Applying (K3)
CO5	prepare various types of budgets and determine variance in different situations.	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		
CO2										2	3	1		
CO3										2	3	1		
CO4										2	3	1		
CO5										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	30	70					100
CAT2	15	35	50				100
CAT 3	15	35	50				100
ESE	25	25	50				100

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

22MBO02 Economic Analysis for Decision Making

(Offered by Department of Management Studies)

Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Basic understanding of differential calculus**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	The course aims at introducing a few vital techniques required for carrying out economic analysis for making informed managerial decisions.

Unit – I | **Economic Optimization** | **9 + 3**

Economic Optimization:
Theory of firm – Business versus Economic profit – Revenue relations – Cost relations – Profit relations – Marginal versus incremental concept.

Unit – II | **Forecasting** | **9 + 3**

Forecasting: Forecasting applications – Techniques –Naire method – Moving average – Exponential smoothing - Trend analysis – Linear Trend – Growth Trend – Sales, cost and revenue forecasting.

Unit – III | **Production and Cost Analysis** | **9 + 3**

Production: Production function – Returns to scale and returns to factor – Total, managerial and average product – Law of diminishing returns – Optimal input usage – Production function estimation.
Cost Analysis: Economic and Accounting costs – Time in cost analysis – Short run cost – Long run cost – cost relations – cost volume – profit analysis.

Unit – IV | **Competitive Market Analysis** | **9 + 3**

Competitive Market Analysis: Characteristics of competitive markets – Profit maximisation – Marginal analysis in competition – competitive market supply curve – Equilibrium in competitive markets - Monopoly – Monopolistic competition.

Unit – V | **Game theory and Competitive Strategy** | **9 + 3**

Game Theory Basics - Prisoner's Dilemma - Saddle Point - Two Person Zero Sum Game - Games without Saddle Points - Dominance Rule - Mixed Strategies.

Lecture: 45, Tutorial: 15, Total:60

TEXT BOOKS

1.	Mark Hirschey, “Managerial Economics”, 12th Edition, Cengage Learning, New Delhi, 2022.
2.	Geetika, PiyaliGhosh, Purba Roy Choudhury, “Managerial Economics”, 3rd Edition, McGraw Hill Education, New Delhi, 2019.

REFERENCES

1.	Gupta. G, “Managerial Economics”, 2nd Edition, McGraw Hill Education, New Delhi, 2019.
2.	Ahuja. H. L, “Principles of Microeconomics”, 22nd Edition, S. Chand Publishing, New Delhi, 2019.
3.	PanneerSelvam R, P. Sivasankaran, P. Senthilkumar., “Managerial Economics”, 1st Edition, Cengage Learning, New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand revenue, cost and profit relations and apply techniques to find best course of action.	Applying (K3)
CO2	Apply appropriate forecasting techniques for estimating sales, cost and revenue.	Applying (K3)
CO3	Understand the relation between inputs and output of production system and perform cost – volume – profit analysis	Applying (K3)
CO4	Apply market equilibrium concepts in monopoly and monopolistically competitive markets.	Applying (K3)
CO5	Understand game theory and apply in different strategic decisions	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	3			
CO2					2					1	3			
CO3					2					1	3			
CO4					2					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	35	35	30				100
CAT2	15	45	40				100
CAT 3	15	35	50				100
ESE	5	40	55				100

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

<table>
<tr><td colspan="9">22MBO03 Marketing Analytics</td></tr>
<tr><td colspan="9">(Offered by Department of Management Studies)</td></tr>
<tr><td>Programme& Branch</td><td>All BE/BTech Engineering and Technology Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Basic understanding of differential calculus</td><td>7</td><td>OE</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">Marketing analytics enables marketers to measure, manage and analyze marketing performance to maximize its effectiveness and optimize return on investment (ROI). This course exposes the students with the tools to measure customer value and apply analytic tools to various marketing decisions.</td></tr>
<tr><td>Unit – I</td><td colspan="6">Market & Marketing Analytics</td><td>9 + 3</td></tr>
<tr><td colspan="8">Introduction - Introduction to marketing analytics, Models & Metrics
Market Insight - Market sizing.
Market Segmentation –Segmentation, Targeting & Positioning</td></tr>
<tr><td>Unit – II</td><td colspan="6">Business & Competition</td><td>9 + 3</td></tr>
<tr><td colspan="8">Competitive Analysis - Competitor identification, analysis, and actions
Business Strategy –Scenarios, Decision Model, Metrics
Business Operations - Forecasting</td></tr>
<tr><td>Unit – III</td><td colspan="6">Product and Price</td><td>9 + 3</td></tr>
<tr><td colspan="8">Product and Service Analytics - Conjoint analysis and product/service metrics
Price Analytics - Pricing techniques and assessment</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Distribution & Promotion</td><td>9 + 3</td></tr>
<tr><td colspan="8">Distribution Analytics –Characteristics, Channel evaluation and selection, Multichannel distribution and metrics.
Promotion Analytics - Promotion budget estimation and allocation, Metrics</td></tr>
<tr><td>Unit – V</td><td colspan="6">Sales</td><td>9 + 3</td></tr>
<tr><td colspan="8">Sales Analytics - Metrics for sales, profitability, and support</td></tr>
<tr><td colspan="8" align="right">Lecture: 45, Tutorial: 15, Total:60</td></tr>
<tr><td colspan="8">TEXT BOOKS</td></tr>
<tr><td>1.</td><td colspan="7">Stephen Sorger, "Marketing Analytics: Strategic Models and Metrics", 1st Edition, Admiral Press, UK, 2016.</td></tr>
<tr><td>2.</td><td colspan="7">Wayne L. Winston, "Marketing Analytics: Data-Driven Techniques with Microsoft Excel", 1st Edition, Wiley, New Delhi, 2018.</td></tr>
<tr><td colspan="8">REFERENCES</td></tr>
<tr><td>1.</td><td colspan="7">Tommy Blanchard, "Data Science for Marketing Analytics", 1st Edition, Packt Publishing, UK, 2019.</td></tr>
<tr><td>2.</td><td colspan="7">Mike Grigsby, "Marketing Analytics", 2nd Edition, Kogan Page, UK, 2018.</td></tr>
<tr><td>3.</td><td colspan="7">David A. Aaker, V. Kumar, Robert P. Leone, George S. Day., "Marketing Research", 1st Edition, Wiley, New Delhi, 2019.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Understand the importance of Analytics in Marketing, size and segment the market	Understanding (K2)
CO2	Understand the Business, competition and its related decisions.	Understanding (K2)
CO3	Identify important features of a product and suitable pricing methods.	Applying (K3)
CO4	Assess Channel performance and Promotion Metrics.	Applying (K3)
CO5	Assess sales 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	3	1		
CO2										2	3	1		
CO3										2	3	1		
CO4										2	3	1		
CO5										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	35	65					100
CAT2	15	35	50				100
CAT 3	15	15	70				100
ESE	25	25	50				100

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

22MAO01 - MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING

(Offered by Department of Mathematics)

Programme & Branch	**All B.E/.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**

Real Vector spaces (Definition & Problems) – Subspaces – Linear Combinations – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space.

Unit – II	**Linear Transformations:**	**9+3**

Introduction – Rank and nullity. – Dimension theorem – Kernel and range – Change of basis – Composition and inverse transformations – Matrices of linear transformations.

Unit – III	**Inner Product Spaces:**	**9+3**

Norms – Inner products – Length and Distance – Angle and Orthogonality – Orthonormal Basis – Gram-Schmidt Process – QR-Decomposition.

Unit – IV	**Matrix Decomposition and Vector Calculus:**	**9+3**

Matrix Decomposition: Cholesky decomposition – Singular Value Decomposition.
Vector Calculus: Differentiation of Univariate Functions – Partial Differentiation and Gradients – Gradients of Vector valued functions – Gradients of matrices – Useful Identities for Computing Gradients – Higher Order Derivatives – Linearization and Multivariate Taylor Series.

Unit – V	**Optimization:**	**9+3**

Introduction – Classification of Optimization Problems – Constrained multivariable optimization with inequality constraints – Kuhn Tucker conditions – Lagrange's multiplier method –- Unconstrained optimization: Steepest descent method – Newton's method.

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Howard Anton and Chris Rorres, "Elementary Linear Algebra", 11th Edition, John Wiley & Sons, New Delhi, 2014 for Units I,II,III.
2.	M. P. Deisenroth, A. A. Faisal, and C. S. Ong, "Mathematics for Machine Learning", 1st Edition Cambridge University Press, 2019 for Units – IV, V.

REFERENCES:

1.	David C. Lay, Steven R. Lay, 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.	R. O. Duda, E. Hart, and D.G. Stork, "Pattern classification", 2nd Edition, John Wiley & Sons, 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	interpret the concepts of linear transformations.	Understanding (K2)
CO3	apply the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Applying (K3)
CO4	demonstrate the knowledge of factorisation of matrices and vectors in Machine learning.	Understanding (K2)
CO5	identify suitable optimization algorithms for machine learning applications.	Applying (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	1												
CO3	3	2												
CO4	3	3	3	1										
CO5	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	15	65	20				100
CAT2	15	65	20				100
CAT3	15	50	60				100
ESE	10	40	50				100

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

22MAO02 - NUMERICAL COMPUTING							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To impart knowledge in interpolation, numerical differentiation and integration. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations, finding eigen values and solve linear system of equations, ordinary differential equations.	
Unit – I	**Solution to Algebraic and Transcendental Equations and Eigen value problems:**	**9+3**
Solution to Algebraic and Transcendental Equations**:** Bisection method **-** Iteration method – Method of false position – Newton-Raphson method Iterative method for Eigen values: Power method – Jacobi's method.		
Unit – II	**Solution of Simultaneous Linear Algebraic equations:**	**9+3**
Introduction - Direct methods: Gauss elimination method – Gauss - Jordan method – LU decomposition method – Crout's method –Iterative methods: Gauss Jacobi and Gauss – Seidel methods.		
Unit – III	**Interpolation:**	**9+3**
Interpolation with equal intervals: Newton's forward and backward difference formulae – Central difference interpolation formulae: Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula.		
Unit – IV	**Numerical Differentiation and Integration:**	**9+3**
Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule – Simpsons 3/8th rule – Double integrals using Trapezoidal and Simpson's rules.		
Unit – V	**Numerical Solution of First order Ordinary Differential Equations:**	**9+3**
Single step methods**:** Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

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

REFERENCES:

1.	Kandasamy, P., Thilakavathy, K. and Gunavathy, K., "Numerical Methods", Reprint Edition, S.Chand & Co, New Delhi, 2016.
2.	Sankara Rao. K., "Numerical Methods for Scientists and Engineers", 3rd Edition, Prentice Hall of India Pvt. Ltd, , New Delhi, 2007.
3.	Steven C. Chapra, Raymond P. Canale., "Numerical Methods for Engineers", 7th Edition, McGraw-Hill Education, 2014.
4.	Sastry, S.S, "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning Pvt. Ltd, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply various numerical techniques to solve algebraic and transcendental equations.	Applying (K3)
CO2	solve simultaneous linear equations by numerical methods.	Applying (K3)
CO3	compute intermediate values of given evenly (or) unevenly spaced data.	Applying (K3)
CO4	apply the concepts of numerical differentiation and integration in real time applications.	Applying (K3)
CO5	identify the solution of first ordinary differential equations by numerical methods.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	15	75				100
CAT2	10	15	75				100
CAT3	10	15	75				100
ESE	10	15	75				100

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

22MAO03 - STOCHASTIC PROCESSES AND QUEUING THEORY							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide an in-depth knowledge in random variables, random process, correlation and promote the ability to apply suitable queuing models to real time applications.	
Unit – I	**Random Variables:**	**9+3**
Discrete and Continuous random variables – Probability Mass and Probability density functions – Mathematical expectation and Variance – Moments – Moment generating functions.		
Unit – II	**Random processes:**	**9+3**
General concepts and definitions – Classification – Stationary process – Markov chains – Transition probabilities – Poisson process.		
Unit – III	**Correlation and Spectral densities:**	**9+3**
Auto Correlation – Cross Correlation – Properties (Without Proof) – Power spectral density – Cross spectral density – Properties (Without Proof) – Wiener- Khintchine relation – Relationship between cross power spectrum and cross correlation function.		
Unit – IV	**Queuing Theory:**	**9+3**
Characteristics of a queueing system – Kendall's notation – Queuing model I (Infinite capacity single server Poisson queue model) (M/M/1) : (∞/FIFO) – Little's formulae – Queuing model II (Infinite capacity multiple server Poisson queue model (M/M/C): (∞/FIFO) – Queuing model III (Finite capacity single server Poisson queue model) (M/M/1): (N/FIFO) – Queueing model IV (Finite capacity multiple server Poisson model) (M/M/C) : (N/ FIFO).		
Unit – V	**Non-Markovian Queues and Queue Networks:**	**9+3**
Introduction to Non-Markovian queues – M/G/1 queue – Pollaczek-Khintchine formula – Series queues – Open and Closed queuing networks		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:	
1.	Veerarajan, T, “Probability and Statistics, Random Processes and Queuing Theory”, 1st edition, McGraw-Hill Education, Chennai, 2019.

REFERENCES:	
1.	Athanasios Papoulis, S. Unnikrishna Pillai., “Probability, Random Variables and Stochastic Processes”, 4th edition, McGraw Hill, New Delhi, 2017.
2.	Allen A.O., “Probability, Statistics and Queuing Theory”, 2nd Edition, Academic Press, New Delhi, 1990.
3.	Roy D. Yates and David J. Goodman, “Probability and Stochastic Processes - A friendly Introduction for Electrical and Computer Engineers”, 3rd edition, John Wiley & Sons, 2014.
4.	John F. Shortle, James M. Thompson, Donald Gross and Carl M. Harris, “Fundamentals of Queuing Theory”, 5th edition, John Wiley and Sons, New York, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		BT Mapped (Highest Level)
CO1	apply random variables suitably in practical problems.	Applying (K3)
CO2	apply the concept of random process in communication problems.	Applying (K3)
CO3	understand the concepts and properties of Spectral Density Function and Cross Correlation function.	Understanding (K2)
CO4	use the appropriate queuing model for a given practical application.	Applying (K3)
CO5	identify the real time queue in computer networks and take decision accordingly.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

22MAO04 - STATISTICS FOR ENGINEERS							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To impart the basic knowledge in presentation of data, descriptive statistical measures and provide skills to apply correlation, suitable non- parametric tests and control charts to control the variations in real time applications.	
Unit – I	**Organization and Presentation of Data:**	**9+3**
Introduction to Statistics – Collection of data – Classification and tabulation of data – Types of data: primary, secondary, quantitative and qualitative data – Types of Measurements: nominal, ordinal, discrete and continuous data – Presentation of data – Diagrammatic and Graphical Representation: Histogram - Frequency curve - Frequency polygon - Cumulative frequency distributions – Ogive curves – Stem and leaf chart.		
Unit – II	**Descriptive Statistics:**	**9+3**
Measures of location or central tendency: Arithmetic mean – Median – Mode – Geometric mean – Harmonic mean – Partition values: Quartiles – Deciles and percentiles – Measures of dispersion: Mean deviation – Quartile deviation – Standard deviation – Coefficient of variation – Measures of skewness – Kurtosis.		
Unit – III	**Correlation and Regression:**	**9+3**
Correlation and Regression: Scatter Diagram – Karl Pearson's Correlation Coefficient – Rank Correlation - Regression Coefficients – Fitting of Regression Lines. Multiple Correlation and Regression: Multiple and partial correlation – Method of least squares – Plane of regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and partial correlations in terms of lower order coefficient..		
Unit – IV	**Non-parametric tests:**	**9+3**
Introduction – Sign test: One sample sign test – Sign test for paired samples – Signed rank test – Rank Sum test: Mann Whitney U test – Kruskal-Wallis test – One sample run test – Tests of randomness.		
Unit – V	**Statistical Quality Control:**	**9+3**
Introduction to Statistical quality control – Control charts – Control chart for variables: $\bar{X}$-chart – R-chart – s-chart – Charts for attributes: np-chart – p-chart – c-chart.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	S.P.Gupta, "Statistical Methods", 44^{th} Revised Edition, Sultan Chand & Sons, New Delhi, 2011 for Units I,II, V
2.	S.C.Gupta, V.K.Kapoor, "Fundamentals of Mathematical Statistics", 12^{th} Edition, Sultan Chand & Sons, New Delhi, 2022. for Units III, IV.

REFERENCES:

1.	Jay L. Devore., "Probability and Statistics for Engineering and the Sciences", 9^{th} Edition, Cengage Learning, USA, 2016.
2.	G.C.Beri, "Business Statistics", 3^{rd} Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
3.	Johnson. R.A., Miller. I and Freund. J., "Probability and Statistics for Engineers", 9^{th} Edition, Pearson Education, India, 2018.
4.	Anthony Hayter, "Probability and Statistics for Engineers and Scientists", 4^{th} Edition, Cengage Learning, USA, 2012.
5.	J. K. Sharma, "Business Statistics", 5^{th} Edition, Vikas Publishing House Pvt Ltd, Noida, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		BT Mapped (Highest Level)
CO1	demonstrate the classification of data and present the data in various forms.	Understanding (K2)
CO2	compute and interpret descriptive statistical measures using numerical and graphical techniques.	Applying (K3)
CO3	apply statistical methods like correlation, regression analysis in analysing and interpreting experimental data.	Applying (K3)
CO4	use appropriate non-parametric test to analyze experimental data.	Applying (K3)
CO5	identify suitable control charts for monitoring 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												
CO2	3	2												
CO3	3	3	2											
CO4	3	3	1											
CO5	3	3	3											

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

ASSESSMENT PATTERN - THEORY

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

22PHO01 - 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 vacuum 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, Scanning Tunneling Microscope, X-ray Photoemission Spectroscopy, UV-vis spectroscopy and Four probe resistivity – Applications (qualitative): 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, Reprint, McGraw Hill Inc., New York, 1970, (Unit I – IV)
2.	Sam Zhang, Lin Li and Ashok Kumar, Materials Characterization Techniques, 1st edition, CRC Press, Boca Raton, 2008 (Unit V)

REFERENCES:

1.	Ohring M, Material Science of Thin Films, 2nd Edition, Academic Press, New Jersey, 2001
2.	Goswami A, Thin Film Fundamentals, Reprint, New Age International (P) Ltd, New Delhi, 2003
3.	Chopra K. L, Thin Film Phenomena, Illustrated, McGraw Hill Inc., New York, 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	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	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	25	35	40				100
CAT2	25	35	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)**

22PHO02 - HIGH ENERGY STORAGE DEVICES
(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 the fundamental principles and application areas of proven technologies and materials for energy storage solutions, together with an overview of development trends in this engineering field.	
Unit – I	**Introduction to Energy Storage:**	**9+3**
An overview of energy storage systems (qualitative): Thermal energy storage, mechanical energy storage, chemical energy storage, electrical energy storage, electrochemical energy storage, electrostatic energy storage, magnetic energy storage and optical energy storage – General criteria of energy storage systems – Conventional batteries: fundamentals and applications – Grid connected and off grid energy storage systems and requirements.		
Unit – II	**Thermal storage and Mechanical Storage:**	**9+3**
Thermal storage: Thermal properties of materials, principle of operations, efficiency factors, large scale and medium scale operations – Merits and demerits of thermal storage system – Recent development in thermal storage systems. Mechanical Storage: Types of mechanical storage systems, principle of operations, emerging advances and technologies in mechanical storage systems – Flywheel.		
Unit – III	**Magnetic storage, Electro-optic, Optical and Chemical Storage:**	**9+3**
Magnetic storage: Principle of operation, emerging challenges and a review on devices and technology. Electro-optic and optical storage: Emerging devices and upcoming technologies (qualitative). Chemical storage: Power to gas – Hydrogen and Methane. Power to liquid – Bio fuels – Aluminum-Boron, silicon, and zinc.		
Unit – IV	**Electrochemical Storage:**	**9+3**
Materials, Principle of operation, positive electrode materials, negative electrode materials, electrolytes. Li-ion batteries: Principle of operation, battery components, design of electrodes, cell and battery fabrications – Building block cells – Battery modules and packs –Li-polymer batteries – Applications – Future developments: Sodium-battery, magnesium battery, aluminum battery and silicon battery.		
Unit – V	**Fuel Cells, Hydrogen storage and Super capacitors:**	**9+3**
Fuel Cells: Introduction to fuel cells, PEM (polymer electrolyte membrane), Hydrogen PEM fuel cell, direct methanol fuel cell, alkaline fuel cells and solid oxide fuel cells. Hydrogen storage systems: Solid state hydrogen storage tanks, gas phase hydrogen storage tanks, cryogenic hydrogen storage tanks and liquid phase hydrogen storage tanks. Super capacitors: Features of super capacitors, basic principle of operation, performance and technologies of super capacitors.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Robert A. Huggins, Energy Storage, Springer, 2010, (Unit I – V)
2.	Ehsani, Y. Gao, S. Gay, A. Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press, New York, 2005 (Unit I - V)

REFERENCES:

1.	Yuping Wu, Lithium-Ion Batteries: Fundamentals and Applications (Electrochemical Energy Storage and Conversion), CRC Press, United Kingdom, 2015
2.	Trevor M. Letcher, Storing Energy: with Special Reference to Renewable Energy Sources, 2nd edition, Elsevier, 2022
3.	D. Linden and T. S. Reddy, Handbook of Batteries, 4th edition, McGraw Hill, Newyork, 2011

COURSE OUTCOMES: **On completion of the course, the students will be able to**		BT Mapped (Highest Level)
CO1	utilize the appropriate concepts and models to comprehend the basics of energy storage systems.	Applying (K3)
CO2	apply the principle of thermal and mechanical storage systems to explain the working and the recent advancements in thermal and mechanical storage systems.	Applying (K3)
CO3	ultilize the principle of operation of magnetic storage systems, electro-optic, optical and chemical storage systems to illustrate the respective process under gone in these techniques.	Applying (K3)
CO4	explain the principle of operation of electrochemical storage device and materials used and to elucidate the construction and working of various types of high energy storage batteries.	Applying (K3)
CO5	make use of various techniques to construct different types of fuel cells and to explain the advanced techniques involved in hydrogen storage systems and also to explain the principle and working of super capacitors.	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		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	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	25	35	40				100
CAT2	25	35	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)**

22PHO03 - 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**	**5**	**OE**	**3**	**1**	**0**	**4**

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+3**
Importance of materials characterization – Classification of characterization techniques – Crystalline materials – Reciprocal lattice – Theory of X-ray diffraction – Powder and Single crystal X-ray diffraction: Instrumentation (qualitative), XRD pattern, systematic procedure for structure determination (qualitative), crystallite size determination (Scherrer equation), strain calculation – Applications.		
Unit – II	**Electron Microscopy:**	**9+3**
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 and working – Different types of filaments – Field emission scanning electron microscope –Wavelength dispersive X-ray analysis – Three parameter equation for quantitative composition analysis.		
Unit – III	**Scanning Tunneling Microscopy:**	**9+3**
Introduction to quantum mechanical tunneling – Basic principles of scanning tunneling microscopy – Two modes of scanning: constant height mode and constant voltage mode – Instrumentation and working – Applications.		
Unit – IV	**Raman Spectroscopy:**	**9+3**
Introduction – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of light and Raman effect – Structure determination – Instrumentation and working – Near-Infra-Red Raman Spectroscopy – Applications.		
Unit – V	**Ultra Violet &Visible Spectroscopy:**	**9+3**
Regions of UV-Visible radiation – Colour and light absorption – Chromophore concept – Beer's and Lambert's laws – Theory of electronic transition – Frank-Condon principle – Instrumentation and working – Applications.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Cullity B. D. and Stock S. R, Elements of X-ray diffraction, 3rd Edition, Pearson Education, India, 2003 (Unit I)
2.	Banwell C. N, McCash E. M, Choudhury H. K, Fundamentals of Molecular Spectroscopy, 5th Edition, Tata McGraw-Hill Publ., New Delhi, 2013 (Unit II-V)

REFERENCES:

1.	Holt D. B. and Joy D. C, SEM micro characterization of semiconductors, 1st Edition, Academic Press, New Delhi, 1989
2.	Willard H. H., Merritt L. L., John A Dean, and Settle Jr. F. A, Instrumental methods of Analysis 7th Edition, Wadsworth Publishing Company, United States, 1988
3.	Elton N. Kaufman, Characterization of Materials (Volume1 & 2), 2nd, Wiley-Interscience, New Jersey, 2012

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	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)
CO3	utilize the concept and phenomenon of quantum mechanical tunneling to interpret the surface image recorded at atomic level using scanning tunneling microscopy.	Applying (K3)
CO4	make use of the concept of Raman effect and Raman spectroscopy to determine the crystal structure and related structural parameters of materials.	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	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

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

ASSESSMENT PATTERN - THEORY

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

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

22CYO01 - INSTRUMENTAL METHODS OF ANALYSIS

(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	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 – Structural elucidation using NMR spectra and quantitative analysis.		
Unit – III	**Surface Studies**	**9+3**
Surface Study – X-Ray Emission Spectroscopy (XES), X- Ray Photo Electron Spectroscopy (XPS) - Auger Electron 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) 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 Titration.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Chatwal. G. R., Anand, Sham K., “Instrumental Methods of Chemical Analysis” 5th Edition, Himalaya Publishing House, 2019.

REFERENCES:

1.	B.K. Sharma, Instrumental Method of Chemical Analysis, Krishna Prakashan Media (P) Ltd. 2019.
2.	Willard,H.H, Merritt,L.L, Dean,J.A, and Settle, F.A, “Instrumental methods of analysis” CBS Publishers & Distributors, 7 Ed, 2004.
3.	Kaur. H, “Instrumental Methods of Chemical Analysis”, XII Edition, Pragati prakashan, Meerat, 2018.

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)

22CYO02 - CHEMISTRY CONCEPTS FOR COMPETITIVE EXAMINATIONS
(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	This course aims to refresh the knowledge of chemistry required for competitive examinations and equip the students with a capacity to solve the problems in chemistry while participating various competitive examinations including TNFUSRC-FORESTER (paper-II: General science-chemistry), UPSC-IAS (prelims: General science-chemistry), GATE (thermodynamics concept for chemical & mechanical engineering).	
Unit – I	**Periodic Classification of Elements**	**9+3**
Mendeleev's periodic table-Law and classification of elements- Modern periodic law-Modern periodic table and its characteristics - Periodic properties – important aspects of s, p & d block elements -Reactivity series and Uses - Alloys-Uses of Alloys- Properties of nano metals and oxides.		
Unit – II	**Chemical Equations and Bonding**	**9+3**
Chemical Equations: Types of ions and radicals- oxidation and reduction-redox reactions - balancing ionic equations. **Chemical Bonding:** Octet rule -types of chemical bond -formation of ionic and covalent bond- common properties of ionic and covalent compounds- differences between ionic and covalent compounds-Coordinate covalent bond- Coordination compounds – nomenclature and isomerism - application in analytical chemistry.		
Unit – III	**Acids, Bases, Salts and Metallurgy**	**9+3**
Acid- base theory – Bronsted- Lowry theory- conjugate acid-base- Lewis concept- HSAB- applications- pH scale- Importance of pH in everyday life-salts-classification of salts-uses of salts. **Metallurgy:** introduction-terminologies in metallurgy-differences between minerals and ores-occurrence of metals- metallurgy of aluminum, copper and iron.		
Unit – IV	**Carbon and its Compounds**	**9+3**
Introduction-compounds of carbon-modern definition of organic chemistry- bonding in carbon and its compounds-allotropy-physical nature of carbon and its compounds-chemical properties of carbon compounds-homologous series-hydrocarbons and their types-functional groups- classification of organic compounds based on functional group-ethanol-ethanoic acid.		
Unit – V	**Thermodynamics**	**9+3**
Introduction- some important terms in thermodynamics-thermodynamic system, process, properties and energy- first law of thermodynamics: mathematical expression and interpretation- applications of first law of thermodynamics-molar heat capacity-reversible isothermal expansion/compression of an ideal gas-adiabatic expansion of an ideal gas-isobaric and isochoric processes in ideal gases- second laws of thermodynamics: entropy- entropy change for isolated system (system and surroundings)- entropy change for system only (ideal gas)- entropy change for mixing of ideal gases-entropy of physical changes- entropy of chemical changes-Maxwell relations.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Steven S. Zumdahl, Susan A. Zumdahl and Donald J. DeCoste , "Chemistry", 10th Edition, Cengage Learning, 2018., for Units-I, II, III, IV.
2.	Wiley editorial board. "Wiley Engineering Chemistry". 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019, for Units- I, II, III, V.

REFERENCES:

1.	B.R. Puri, L.R. Sharma, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co., 2020.
2.	Paula Bruise, "Organic Chemistry", 8th Edition, Pearson Education, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped** **(Highest Level)**
CO1	apply the basic concept of periodic classification of elements to explain the periodic properties and reactivity series of s, p & d block elements.	Applying (K3)
CO2	utilize the concepts of chemical equation and bonding to solve the problems in balancing ionic equation and differentiate ionic and covalent compounds.	Applying (K3)
CO3	apply the concept of acid, base, salts and metallurgy to explain HSAB concepts, Importance of pH in everyday life, classification of salts and metallurgy of Al, Cu & Fe.	Applying (K3)
CO4	make use of the concept of carbon and its compounds to explain bonding and classification of carbon compounds.	Applying (K3)
CO5	utilize the important terms and concepts of thermodynamics to explain the first law and second law of thermodynamics with examples.	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	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)

22CYO03 – ORGANIC CHEMISTRY FOR INDUSTRY

(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	Organic Chemistry for Industry aims to equip the students to have wide-range knowledge on organic chemistry in order to meet the industrial needs.	
Unit – I	**Basic aspects of Organic Chemistry**	**9+3**
Organic intermediates: carbocations, carbanions, free radicals, carbenes and nitrenes, their method of formation, stability and synthetic applications- Nucleophilic uni- and bimolecular reactions (SN1 and SN2)- Elimination reactions (E1 & E2; Hoffman & Saytzeff's rule).		
Unit – II	**Molecular Rearrangements**	**9+3**
Reactions involving electron deficient, carbon, nitrogen, oxygen centers, emphasis on synthetic utility of the rearrangements - Migration of carbon: Wagner-Meerwein, Pinacol-pinacolone, benzyl-benzilic acid rearrangement – Migration of nitrogen: Beckmann rearrangement, Hofmann, Curtius, Lossen rearrangements- Migration of oxygen: Bayer-Villiger oxidation.		
Unit – III	**Synthetic Reagents & Applications**	**9+3**
Lithium aluminium hydride- sodium borohydride- selenium-di-oxide- osmium tetroxide- phenyl isothiocyanate- N-bromosuccinamide (NBS)- lead tetraacetate - dicyclohexylcarbodiimide (DCC) – pyridinium chlorochromate (PCC) – Swern oxidation –p-toluenesulphonyl chloride – trifluoroacetic acid- lithium diisopropylamide (LDA) – 1,3- dithiane (reactive umpolung) - crown ethers-Trimethyl silyl iodide - dichlorodicyanobenzoquinone (DDQ) – Gilman reagent– phase transfer catalysts- Wilkinson's catalysts.		
Unit – IV	**Unit Operations**	**9+3**
Extraction: Liquid equilibria-extraction with reflux-extraction with agitation-counter current extraction. **Filtration:** Theory of filtration- pressure and vacuum filtration-centrifugal filtration. **Distillation:** Azeotropic and steam distillation. **Evaporation**: Types of evaporators-factors affecting evaporation. **Crystallization:** Crystallization from aqueous-non- aqueous solutions factors affecting crystallization-nucleation.		
Unit – V	**Unit Processes**	**9+3**
Nitration: Nitrating agents-aromatic nitration-kinetics and mechanism of aromatic nitration- process equipment for technical nitration-mixed acid for nitration. **Halogenation:** Kinetics of halogenations-types of halogenations-catalytic halogenations-Case study on industrial halogenation process. **Fermentation**: Aerobic and anaerobic fermentation. Production of Antibiotics: Penicillin and Streptomycin-Production of Vitamins: B2 and B12.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	P.S.Kalsi," Organic Reactions and their Mechanisms", 5th Edition, New Age International publishers, 2020, for Unit-I, II, III, V.
2.	Arun Bahl, B.S.Bahl, "Advanced Organic Chemistry", 6th Edition, S Chand, 2022, for Unit-IV, V.

REFERENCES:

1.	V.K.Ahluwalia, Rakesh Parashar, "Organic Reaction Mechanisms" Fourth Edition, 2011
2.	Jonathan Clayden, Nick Greeves, Stuart Warren, "Organic Chemistry", 2nd Edition, Oxford University Press, 2014.
3.	Paula Yurkanis Bruice, "Organic Chemistry",8th Edition, Pearson, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate the basic concept of organic intermediates to explain the SN1, SN2, E1 and E2 reactions.	Understanding (K2)
CO2	utilize the concepts of molecular rearrangement to explain reactions involving electron deficient, carbon, nitrogen, oxygen centers, emphasis on synthetic utility of the rearrangements.	Applying (K3)
CO3	select the suitable synthetic regents for various functional group conversions in organic synthesis.	Applying (K3)
CO4	make use of the concept of extraction, filtration, distillation, evaporation, crystallization for the purification of organic compounds.	Applying (K3)
CO5	apply the concept of nitration, halogenations and fermentation to explain the industrial unit process.	Applying (K3)

Mapping of COs with POs and PSOs

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

22MAO05 - GRAPH THEORY AND ITS APPLICATIONS								
(Offered by Department of Mathematics)								
Programme & Branch	**All B.E/.BTech 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 - Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm.		
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 - Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Kruskal's algorithm.		
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	**Matrix Representation and Applications:**	**9+3**
Matrix Representation: Incidence matrix – Circuit matrix - Cut-set matrix – Path Matrix – Adjacency matrix – Properties - The Chinese Postman Problem – Fleury's Algorithm – Travelling salesman problem.		
Unit – V	**Network Flows and Applications:**	**9+3**
Flows and cuts in networks - Max-flow Min-cut Theorem – Transport networks –Residual capacity and Residual network – Ford-Fulkerson Algorithm – Edmonds-Karp Algorithm – Maximal Flow Applications: Multiple sources and sinks – Maximum Bipartite matching.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", 1st Edition, Dover Publications, New York, 2016 for Units I, II, III.
2.	S. Saha Ray, "Graph Theory with Algorithms and Its Applications in Applied Science and Technology", 1st Edition, Springer, London, 2013 for Units IV,V.

REFERENCES:

1.	Douglas B West, "Introduction to Graph Theory", 2nd Edition, Pearson Education, New Delhi, 2002.
2.	Jonathan L. Gross and Jay Yellen, "Graph Theory and its Applications", 2nd Edition, CRC Press, New York, 2006.
3.	J.A.Bondy and U.S.R. Murty ,Graph Theory and Applications , 5th Edition, Elsevier Science Publishing Co., Inc., New York,1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply basic graph theoretic concepts in finding shortest path.	Applying (K3)
CO2	intrepret the concepts of tress and its types.	Applying (K3)
CO3	compute the Chromatic partition, Chromatic polynomial and Matching of a given graph.	Applying (K3)
CO4	apply the concepts of matrix representation of graph structures.	Applying (K3)
CO5	identify the maximal flow in network by means of suitable 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	2											
CO5	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	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)

22MAX01 - DATA ANALYTICS USING R PROGRAMMING								
(Offered by Department of Mathematics)								
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**2**	**4**

Preamble	To impart the basic knowledge in R and develop skills to apply the knowledge of R programming to statistical measures, data handling, probability, testing of hypothesis and design of experiments.	
Unit – I	**Introduction to R:**	**9**
Overview of R programming – Need for R – Installing R – Environment setup with R Studio – Packages: Installing packages – Running and manipulating packages – Basic objects: Vectors – Matrix – Array – Lists – Factors – Data frames.		
Unit – II	**R Programming Structures and Functions:**	**9**
Basic expressions: Arithmetic expressions – Control Statements: if and if-else statements –– switch statement – Loops: for loop – while loop – Function: Creating a function – calling a function – Default value for function arguments – Logical functions – Math functions – Statistical functions – Apply-family functions – Getting started with strings – Formatting data and time.		
Unit – III	**Descriptive Statistics:**	**9**
Summary command – Summarizing samples – cumulative statistics – summary statistics for data frames – summary tables – Linear Modeling: Simple linear regression – Multiple regression – Curvilinear regression – Plotting linear models and curve fitting.		
Unit – IV	**Working with data:**	**9**
Reading and writing data: Text-format in a file – Excel worksheets – Native data files – built-in datasets. Visualizing data: Scatter plots – line plots – bar charts – pie charts – Cleveland dot charts –Histogram and density plots – Box-whisker plots.		
Unit – V	**Probability Distributions, Testing of hypothesis and ANOVA:**	**9**
Probability Distributions: Binomial Distribution – Poisson Distribution – Normal Distribution. Testing of Hypothesis and ANOVA: Student's t-test – Non-Parametric tests: Wilcoxon U-test – Paired t and U-tests – Correlation and covariance – Tests for association – Analysis of variance: One-way ANOVA – Two-way ANOVA.		

List of Exercises / Experiments:	
1.	Implementation of operations of data objects such as vector, list and matrix.
2.	Implementation and use of array, factors and data frames in R.
3.	Programs using decision making statements and looping structures.
4.	Programs to demonstrate programming concepts using functions (Using built-in and user-defined functions)
5.	Performing various basic statistical measures for the given data.
6.	Calculate the regression coefficient and obtain the lines of regression for the given data.
7.	Creating and reading various types of data files.
8.	Create different charts for visualization of given set of data.
9.	Computation of probability using Binomial, Poisson and Normal distributions.
10.	Perform the t-test for testing significance of mean.
11.	Perform various non-parametric tests for the given sample data.
12.	Perform One way and two way ANOVA.

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1. Kun Ren, "Learning R Programming", 1st Edition, Packt Publishing Ltd, UK, 2016 for Units I, II.
2. Mark Gardener, "Beginning R-The Statistical Programming Language",1st Edition, John Wiley & Sons,Inc, USA, 2012 for Units III,IV, V.

REFERENCES:

1. Seema Acharya, "Data Analytics using R", 1st Edition, McGraw Hill Education, Chennai, 2018.
2. Norman Matloff, "The Art of R Programming", 1st Edition, No Starch Press, San Francisco, 2011.
3. Paul Teetor, "R Cookbook", 1st Edition, O'Reilly Media, USA, 2011.
4. Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the basics of fundamentals of R.	Understanding (K2) Manipulation (S2)
CO2	apply the concepts of decision, looping structures and functions in real time problems.	Applying (K3) Manipulation (S2)
CO3	apply R programming to descriptive statistics.	Applying (K3) Manipulation (S2)
CO4	apply the libraries for data manipulation and data visualization in R.	Applying (K3) Manipulation (S2)
CO5	use R studio to identify the probability and test statistical hypothesis.	Applying (K3) Manipulation (S2)

Mapping of COs with POs and PSOs

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

22MAO06 - OPERATIONS RESEARCH								
(Offered by Department of Mathematics)								
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide the skills for solving the real time engineering problems involving linear objective functions, transportation models and also impart knowledge in finding optimal solutions to problems involving limited resources, project management techniques and game theoretic concepts.	
Unit – I	**Linear Programming:**	**9+3**
Introduction to Operations research – Applications of OR – Linear Programming – Formation of Linear Programming Problem – Solution of LPP: Basic concepts – Graphical Solution – Simplex method – Artificial techniques: Big M method.		
Unit – II	**Transportation and Assignment Problems:**	**9+3**
Transportation Problem: Introduction – Mathematical formulation – Solution of transportation problem: Initial basic feasible solution: North-West Corner Rule – Vogel's Approximation Method – Optimal Solution: MODI method. Assignment Problems: Introduction – Mathematical Formulation – Hungarian Algorithm.		
Unit – III	**Game Theory:**	**9+3**
Introduction – Basic Terminology – Two-Person zero sum games – Pure strategies (Games with saddle point) – Mixed Strategies (Games without saddle points) – Rule of Dominance – Solution of Mixed Strategy games: Algebraic method – Arithmetic method – Graphical method.		
Unit – IV	**Sequencing models:**	**9+3**
Sequencing problems: Introduction – Johnson's algorithm – Processing of n jobs through two machines – Processing of n jobs through three machines – Processing of 'n' jobs through 'm' machines - Processing of two jobs through 'm' machines.		
Unit – V	**Network and Project Management:**	**9+3**
Introduction – Basic terminology **–** Rules of Network construction – Fulkerson's Rule for numbering of events – Construction of network – Critical Path Method (CPM) – Programme Evaluation and Review Technique (PERT).		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Sharma J.K, "Operations Research – Theory and Applications", 6th Edition, Trinity Press, India, New Delhi, 2017.

REFERENCES:

1.	Taha, Hamdy A., "Operation Research: An introduction", 9th edition, Pearson Education, 2010.
2.	Hiller, Frederick. S. and Lieberman, Gerald. J., "An introduction to Operations research- concepts and cases", Tata McGraw Hill (SIE) 8th edition, 2005.
3.	Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.
4.	Kanti Swarup, P.K. Gupta, Man Mohan, "Operations Research", 15th revised Edition, S. Chand & Sons Education Publications, New Delhi, 2017.
5.	Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 7th Revised Edition, S.Chand and Co. Ltd., New Delhi, 2014.

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 and assignment algorithms in engineering problems.	Applying (K3)
CO3	use game theory concepts in practical situations.	Applying (K3)
CO4	identify the minimum processing times for sequencing problems	Applying (K3)
CO5	apply the concepts of CPM and PERT in scheduling the project networks.	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											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	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	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)

22MAO07 - NUMBER THEORY AND CRYPTOGRAPHY								
(Offered by Department of Mathematics)								
Programme & Branch	**All B.E/.BTech 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:**	**9+3**
Division algorithm – Base-b representations – Number patterns – Prime and composite 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 linear congruences – Fermat's Little 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 – 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", Cengage Learning India, 1st Edition, New Delhi, 2010.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the concepts of divisibility and canonical decompositions.	Understanding (K2)
CO2	obtain the knowledge in theory of congruences and solution of linear congruences.	Understanding (K2)
CO3	use different number theoretic function suitably in cryptography.	Applying (K3)
CO4	apply Primality test and factorisation algorithms to network security problems.	Applying (K3)
CO5	apply 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)

22PHO04 - SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL APPLICATIONS OF NANOMATERIALS
(Offered by Department of Physics)

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

Preamble	This course aims to impart the knowledge on the fundamentals of nanomaterials, synthesis of nanomaterials, analysis of nanomaterials, carbon tubes and biological applications of nanomaterials.

Unit – I	**Introduction to nanomaterials**	**9+3**

Nanoscience and nanotechnology – Scientific revolution – Nanoscale – Nanosized effects – Surface-to-volume ratio – Quantum confinement effect – Classification of nanomaterials based on dimension – Properties of nanomaterials – Metal nanoparticles – Ceramic nanoparticles – Semiconductor nanoparticles – Polymer nanomaterials.

Unit – II	**Synthesis of nanomaterials**	**9+3**

Physical, chemical and mechanical methods of preparation – Top down approaches and bottom up approaches – Physical Vapor Deposition method – Colloidal precipitation method – Sol-Gel method – Chemical precipitation method – Green synthesis method of nanomaterials.

Unit – III	**Characterization of nanomaterials**	**9+3**

X-ray diffraction analysis – Grain size calculation – Lattice parameters - Cell volume – Photoluminescence analysis – Emission peak analysis – UV visible spectroscopy analysis – Bandgap estimation – HRTEM & AFM analysis (qualitative) – particle size analysis – BET (qualitative).

Unit – IV	**Carbon nanotubes**	**9+3**

Allotropes of carbon – Diamond – Graphite – Graphene – Fullerenes – Carbon nanotubes – Properties – SWCNT – MWCNT – Structure of Carbon nanotubes – Preparation: Laser ablation method – CVD – Applications.

Unit – V	**Biological applications**	**9+3**

Antibacterial activity – Mechanism – Antifungal activity – Microorganism – Gram positive bacteria – Gram negative bacteria – Disc diffusion method – Antioxidant activity – DPPH method – Anticancer activity – Cytotoxicity – MTT method –Toxicity of nanoparticles.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Charles P Poole Jr., and Frank J. Ownes ,. “Introduction to Nanotechnology”, John Wiley Sons, Inc., 2003.

REFERENCES:

1.	C. Kittel., “Introduction to Solid State Physics”, Wiley Eastern Ltd., (2005).
2.	Tamilarasan K. and Prabu K., “Materials Science”, 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the properties of nanomaterials using concepts such as surface to volume ratio and quantum confinement and also able to classify nanomaterials.	Applying (K3)
CO2	explain the synthesis of nanomaterials using select physical and chemical methods.	Applying (K3)
CO3	explain the characterization of nanomaterials using XRD, UV-vis, HRTEM & AFM and BET.	Applying (K3)
CO4	Illustrate the preparation of CNT and their applications.	Applying (K3)
CO5	explore the biological applications of nanomaterials such as antibacterial activity, antifungal activity, antioxidant activity and anticancer activity.	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		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

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

ASSESSMENT PATTERN - THEORY

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

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

22PHO05 - TECHNIQUES OF CRYSTAL GROWTH
(Offered by Department of Physics)

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

Preamble	This course aims to impart the knowledge on crystals, physics of crystal growth and crystal growth methods.	
Unit – I	**Introduction to Crystals**	**9+3**
Classification of solids – Crystalline and amorphous – Single and polycrystalline materials – Space lattice – Bravais lattice – Lattice planes – Miller indices – Indices of crystal direction – Symmetry – Symmetry elements in cubic crystal – Physical properties.		
Unit – II	**Theories of Crystal Growth**	**9+3**
Phase rule – Phase diagrams – Binary phase diagrams – Alloy and compounds – Binary system with complete solid solution and no solid solution (eutectic) – Invariant reactions – Eutectic, peritectic and peritectoid (qualitative) – Nucleation concept – Homogeneous, heterogeneous nucleation – Classical theory – Energy of formation of nucleus – Kinetic theory of nucleation (qualitative) – Atmospheric nucleation.		
Unit – III	**Melt growth**	**9+3**
Bulk crystal growth methods – Melt growth methods – Bridgman (vertical and horizontal) and Czochralski methods – Liquid encapsulated technique (LEC) for semiconductors – Vermeil growth technique for growing gem crystals – Zone melting.		
Unit – IV	**Solution growth**	**9+3**
Low temperature solution growth – High temperature solution growth – Electro crystallization – Crystal growth in gel – Growth of biological crystals – Hydrothermal technique.		
Unit – V	**Vapour growth**	**9+3**
Physical vapour transport – chemical vapour transport. Epitaxial growth techniques – Liquid phase epitaxy – Vapour phase epitaxy: chloride, hydride, metalorganic – Molecular beam epitaxy – Chemical beam epitaxy.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Introduction to Crystallography Philips, Read Books (9 June 2011), India.

REFERENCES:

1.	B. D. Cullity Addison, Elements of X-ray diffraction, Wesley Publishers, 1977.
2.	Santhana Raghavan and Dr. P. Ramasamy, Crystal growth processes and methods, KRU publications, 1999.
3.	Leonid V. Azaroff, Introduction to Solids, Tata McGraw Hill Publishing Company.
4.	C. Kittel Wiley, Introduction to Solid State Physics, Eastern University Edition.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	describe the physical properties of crystals using the concepts of crystalline materials, amorphous material, space lattice, unit cell, Miller indices and crystal symmetry.	Applying (K3)
CO2	explain nucleation in crystal growth using the concepts of phase diagrams and formation energy.	Applying (K3)
CO3	demonstrate the growth of bulk crystals using melt growth techniques.	Applying (K3)
CO4	demonstrate the growth of crystals using solution growth techniques.	Applying (K3)
CO5	comprehend the growth of epitaxy crystal using vapour growth techniques.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22CYO04 - CORROSION SCIENCE AND ENGINEERING

(Offered by Department of Chemistry)

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

Preamble	Corrosion science and engineering aims to equip the students to have a wide-range of knowledge on corrosion and prevention methods in order to meet the industrial needs.	
Unit – I	**Corrosion and its Units**	**9+3**
Introduction- electro chemical mechanism Vs chemical mechanism - emf series and Galvanic series – galvanic corrosion – area effect in anodic and cathodic metal coatings – prediction using emf series and galvanic series - Pilling Bedworth's ratio and it consequences (Problems) – units of corrosion rate: mdd (milligrams per square decimeter per day), mmpy (millie miles per year) and mpy (mils per year) –- importance of corrosion prevention in various industries: direct and indirect effects of determining corrosion rates - weight loss method, weight gain method and chemical analysis of solution.		
Unit – II	**Thermodynamics of Corrosion**	**9+3**
Electrode potentials, Electrical double layer, Gouy−Chapman model, Stern model, Bockris – Devanathan−Müller model - free energy and oxidation potential - criterion of corrosion (Problems) - basis of Pourbaix Diagrams - Pourbaix diagrams of water, magnesium, aluminium and Iron - limitations and applications.		
Unit – III	**Kinetics of Corrosion**	**9+3**
Electrochemical polarization – Evan's diagram – activation polarization – concentration polarization - mixed potential theory(Wagner and Traud) – application of mixed potential theory – effect of metal in acid solution – cathodic protection of iron in acid solution – effect of cathodic reaction – effect of cathodic area – passivity – Flade potential – theories of passivity - adsorption theory – oxide film theory – film sequence theory.		
Unit – IV	**Types of Corrosion**	**9+3**
Introduction - (i) Crevice - differential aeration corrosion (ii) pitting – mechanism and factors (iii) intergranular- chromium depletion theory, weld decay and knife line attack (iv) stress - SCC mechanism, corrosion fatique- Cavitation damage – fretting damage (v) stray current corrosion - causes and its control.		
Unit - V	**Prevention of Corrosion**	**9+3**
Inhibitors – types of inhibitors, chemisorption of inhibitors, effect of concentration, effect of molecular structure, vapour phase inhibitors – prevention of corrosion at the design stage and in service conditions – control of catastrophic oxidation and hydrogen disease – Langelier saturation index and its uses - corrosion prevention by surface coatings – phosphating and its uses -principles and procedures of cathodic protection: sacrificial anodes and external cathodic current impression- painting, vitreous enamels, plastic lining.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	E. McCafferty, Introduction to Corrosion Science, 2nd Edition, Springer, 2017.

REFERENCES:

1.	R. Winston, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, Revised 4th Edition, Wiley publisher, 2008.
2.	Fontanna, "Corrosion Engineering", (Materials Science and Metallurgy series), McGraw Hill international Ed., 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the mechanism, expression of rate of corrosion and importance of corrosion studies to familiarize for industrial needs.	Understanding (K2)
CO2	demonstrate the thermodynamics and kinetics of different models of corrosion with respect to the environment.	Applying (K3)
CO3	utilize the theories of corrosion to interpret with the real time applications.	Applying (K3)
CO4	organize the various types of corrosion to understand the corrosion problems.	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)

22CYO05 - CHEMISTRY OF COSMETICS IN DAILY LIFE

(Offered by Department of Chemistry)

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

Preamble	This course aims to provide knowledge on chemistry of cosmetics for engineering students.	
Unit - I	**Formulation of Cosmetic Product**	**9+3**
Introduction - basic sciences of cleansing – surfactant and adsorption, surfactant micelles, surfactants and cleansing, surfactants and foam (foam formation, stability, drainage, rupture and collapse and defoaming) - basics of dispersions - electrical charges associated with surfaces and barriers – basics of emulsion (stability, Ostwald ripening, prevention of creaming and sedimentation).		
Unit - II	**Structuring Materials and Regulation for Cosmetics**	**9+3**
Introduction - water/hydrophilic base materials, oleaginous/hydrophobic base materials and amphiphilic substances - adding functions and effects - materials that add or improve functional value, emotional value and materials for quality control – cosmetic and personal care product safety – potential contaminants in cosmetics – regulations related to cosmetics – cosmetic regulation in india - future challenges in cosmetics material development.		
Unit - III	**Polymers in Cosmetic Products**	**9+3**
Polymers in Cosmetics - polymer solubility and compatibility, polymer conformation - polymers that modify surfaces - film-forming polymers in cosmetics and personal care products - hair-conditioning polymers - polymers for the treatment of skin - polymers as controlled release matrices - dendritic polymers - polymeric antimicrobials and bacteriostats.		
Unit - IV	**Natural Products and Fragrance in Cosmetics**	**9+3**
Introduction – natural products – extraction methods - encapsulation and controlled release - allergens in cosmetics – testing for allergens - aroma chemicals - fragrance creation and duplication - fragrance applications -– malodor – fragrance allergies and sensitivities.		
Unit - V	**Preparation of Cosmetics**	**9+3**
Cosmetics in day to day life – characteristics, types, formulation, preparation and evaluation methods of lipstick, shampoo, powder, nail lacquer, creams, toothpaste and hair dye.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Kazutami Sakamoto, Robert Y. Lochhead, Howard I. Maibach, Yuji Yamashita, Cosmetic Science and Technology: Theoretical Principles and Applications, Elsevier, 2017 , for Units- I, II, III, IV, V.
2.	Gaurav Kumar Sharma, Jayesh Gadiya, Meenakshi Dhanawat A text book of cosmetic formulation, 2018, for Unit-V.

REFERENCES:

1.	R.K. Nema, K.S. Rathore , B.K. Dubey, Textbook of Cosmetics, CBS Publishers and Distributors, 2017.
2.	Bruno Burlando, Elisa Bottini-Massa, LuisellaVerotta, Laura Cornara, Herbal Principles in Cosmetics: Properties and Mechanisms of Action, CRC Press, 2010.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	outline the formulation of cosmetics products.	Understanding (K2)
CO2	identify the structuring materials and regulation involved in cosmetics development.	Applying (K3)
CO3	interpret the polymers and its role in cosmetics.	Understanding (K2)
CO4	develop knowledge about natural products and Fragrance in Cosmetics.	Applying (K3)
CO5	apply the knowledge of cosmetics to explain the characteristics, formulation, preparation and quality control of different cosmetic products used in day to day life.	Applying (K3)

Mapping of COs with POs and PSOs

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

22CYO06 – NANOCOMPOSITE MATERIALS
(Offered by Department of Chemistry)

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

Preamble	This course aims to equip the students to have knowledge on processing, characterization, properties, features and applications of nanocomposites.	
Unit – I	**Introduction of nanocomposites**	**9+3**
Introduction – nanocomposites – nanocomposites past and present – nomenclature – composite materials: introduction to solids - atomic and molecular solids – role of statistics in materials – primary, secondary and tertiary structure – transitions.		
Unit - II	**Properties and features of nanocomposites**	**9+3**
Properties: physics of modulus – continuum measurements – yield – fracture – rubbery elasticity and viscoelasticity – composites and nanocomposites – surface mechanical properties –diffusion and permeability – features of nanocomposites: basics of polymer nanocomposites - nano reinforcements – matrix materials – hazards of particles.		
Unit - III	**Processing of nanocomposites**	**9+3**
Viscosity: types of flow, experimental viscosity, non-newtonian flow -low-viscosity processing: solvent processing, particle behavior, in situ polymerization, post-forming, hazards of solvent processing - melt, high shear and direct processing: melting and softening, melt processes with small shears or low-shear rates flow, meltprocesses with large deformations or high-shear rates, thermo-kinetic processes.		
Unit - IV	**Characterization of nanocomposites**	**9+3**
Introduction to characterization – experiment design – sample preparation – imaging –structural characterization – scales in nanocomposites – texture – electromagnetic energy –visualization – physicochemical analysis – characterization of physical properties.		
Unit - V	**Applications of nanocomposites**	**9+3**
Nanocomposites – optical, structural applications – nanoparticulate systems with organic matrices – applications – biodegradable protein nanocomposites – applications-polypropylene nanocomposites – application as exterior automatic components – hybrid nanocomposite materials – application for corrosion protection.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Thomas E. Twardowski, “Introduction to Nanocomposite Materials – Properties, Processing, Characterization”, DesTech Publications, April 2007, for Units-I, II, III, IV.
2.	Klaus Friedrich, Stoyko Fakivov, Zhony Shang, “Polymer Composites from Nano – to Macro – scale”, Springer USA, 2005, for Units-I, II, V.

REFERENCES:

1.	Pulickel M. A, Linda S. S, Paul V.B, “Nanocomposite Science and Technology”, Wiley-VCH, 2006.
2.	Vikas Mittal, Characterization techniques for polymer nanocomposites, Wiley-VCH, 2012.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify the knowledge of nanocomposites and to explain its structure.	Applying (K3)
CO2	apply the knowledge on various properties and features of nanocomposites.	Applying (K3)
CO3	choose the various concepts involving in the processing of nanocomposites.	Applying (K3)
CO4	apply the acquired knowledge on characterization of nanocomposites.	Applying (K3)
CO5	organize the applications of nanocomposites in various fields.	Applying (K3)

Mapping of COs with POs and PSOs

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

22MAO08 - NON-LINEAR OPTIMIZATION

(Offered by Department of Mathematics)

Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	The course focuses on the basic concepts, various techniques and applications of engineering optimization.	
Unit – I	**Classical Optimization Techniques:**	**9**
Introduction to Optimization – Statement of an Optimization problem – Mathematical formulation – Multi variable optimization with equality constraints – Lagrange multipliers method – Multi variable optimization with inequality constraint – Kuhn Tucker conditions.		
Unit – II	**Non-Linear Programming: One-Dimensional Minimization Method:**	**9**
Introduction – Unimodal function – Elimination Methods: Unrestricted search – Exhaustive search – Dichotomous search – Interval halving method – Fibonacci method – Golden section method – Direct root methods: Newton method – Secant method.		
Unit – III	**Non-Linear Programming: Unconstrained Optimization Techniques:**	**9**
Introduction to Unconstrained optimization – Direct Search Methods: Grid search method – Univariate method – Hookes and Jeeve's method – Powell's method.		
Unit – IV	**Unconstrained Optimization Techniques (Indirect Methods):**	**9**
Gradient of a Function – Indirect Search Methods: Steepest descent method – Fletcher-Reeves method – Newton's method – Marquardt method.		
Unit – V	**Non-Linear Programming: Constrained Optimization Techniques:**	**9**
Introduction – Characteristics of a Constrained Problem – Direct Methods: Random search method – Sequential linear programming – Indirect methods: Transformation techniques – Exterior penalty function method – Interior penalty function method.		
		Total:45

TEXT BOOK:

1.	S.S.Rao, Engineering Optimization Theory and Practice, 5th Edition, John Wiley & Sons Ltd, USA, 2020.

REFERENCES:

1.	David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, 4th edition, Springer-Verlag, 2015
2.	A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Engineering Optimization: Methods and applications, 2nd Edition, Wiley India Pvt. Ltd., 2006.
3.	Yang, Xin-She. Optimization Techniques and Applications with Examples. 1st Edition, John Wiley & Sons, United Kingdom, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	solve problems with equality and inequality constraints.	Applying (K3)
CO2	solve nonlinear programming problems of functions of single variable.	Applying (K3)
CO3	use methods of unconstrained optimization to solve non linear problems	Applying (K3)
CO4	solve nonlinear optimization problems in the presence of inequality and equality constraints.	Applying (K3)
CO5	apply several modern methods of optimization for solving 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											
CO2	3	2												
CO3	3	3	1											
CO4	3	3	3											
CO5	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	10	80				100
CAT2	10	10	80				100
CAT3	10	10	80				100
ESE	10	10	80				100

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

22MAO09 - OPTIMIZATION FOR ENGINEERS							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech 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 and non-linear objective functions and also impart knowledge in finding optimal solutions to problems involving multi-level decision making and analyzing queuing models.	
Unit – I	**Linear Programming:**	**9**
Introduction to Operations research – Applications of OR – Linear Programming – Formation of Linear Programming Problem – Solution of LPP: Basic concepts – Graphical Solution – Simplex method – Artificial techniques: Big M method.		
Unit – II	**Integer Programming:**	**9**
Introduction – Types of Integer Programming Problems – Solution of Integer programming problems – Gomory's all integer cutting plane method - Gomory's Mixed-Integer Cutting Plane Method – Branch and Bound method.		
Unit – III	**Dynamic programming:**	**9**
Introduction – Characteristics – Formulation of Dynamic programming problems –Dynamic programming Algorithm – Solution of Discrete Dynamic programming problem – Solution of LPP by Dynamic programming.		
Unit – IV	**Queueing Theory:**	**9**
Characteristics of a queueing system – Kendall's notation – Queuing model I (Infinite capacity single server Poisson queue model) (M/M/1) : (∞/FIFO) – Little's formulae – Queuing model II (Infinite capacity multiple server Poisson queue model (M/M/C): (∞/FIFO) – Queuing model III (Finite capacity single server Poisson queue model) (M/M/1): (N/FIFO) – Queueing model IV (Finite capacity multiple server Poisson model) (M/M/C) : (N/ FIFO)..		
Unit – V	**Non-Linear Programming:**	**9**
Introduction – Mathematical formulation of Non-linear programing problems – Non-linear programing problem with equality constraints – Lagrange multipliers method – Non-linear programing problem with inequality constraint – Kuhn Tucker conditions.		
		Total:45

TEXT BOOK:

1.	Sharma J.K, "Operations Research – Theory and Applications", 6th Edition, Trinity Press, India, New Delhi, 2017.

REFERENCES:

1.	Taha, Hamdy A., "Operation Research: An introduction", 9th edition, Pearson Education, 2010.
2.	Hiller, Frederick. S. and Lieberman, Gerald. J., "An introduction to Operations research- concepts and cases", Tata McGraw Hill (SIE) 8th edition, 2005.
3.	Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.
4.	Kanti Swarup, P.K. Gupta, Man Mohan, "Operations Research", 15th revised Edition, S. Chand & Sons Education Publications, New Delhi, 2017.
5.	Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 7th Revised Edition, S.Chand and Co. Ltd., New Delhi, 2014.

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	solve Integer Programming problems that exist in real time applications.	Applying (K3)
CO3	demonstrate the theoretical workings of dynamic programming method to find shortest path for given network.	Applying (K3)
CO4	use the appropriate queuing model for a given practical application.	Applying (K3)
CO5	apply the concept of non-linear programming for solving the problems involving non-linear constraints and objectives.	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											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	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	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)

22CYO07 - 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**	**OE**	**3**	**0**	**0**	**3**

Preamble	Waste and Hazardous waste management aims to equip the students to have a wide-range of knowledge on waste management.	
Unit – I	**Solid Waste Management**	**9**
Solid wastes: definition, sources, types, composition of solid waste- Solid waste management system: collection, separation, processing and transformation of solid waste – combustion, aerobic composting, vermicomposting, pyrolysis, landfill-classification, types, methods and control of leachate in landfills - recycling of material found in municipal solid waste- recycling of paper and cardboard, recycling of plastics, recycling of glass.		
Unit – II	**Hazardous Waste Management**	**9**
Hazardous wastes: definition, nature and sources of hazardous waste, classification and characteristics of hazardous waste- chemical class of hazardous waste, generation, segregation, treatment and disposal: waste reduction, waste minimization, recycling - chemical treatment: acid base neutralization, chemical precipitation, oxidation/reduction, hydrolysis, electrolysis, chemical extraction and leaching, ion exchange, photolytic reaction- thermal treatment methods: incineration – biodegradation of hazardous waste: aerobic, anaerobic, reductive dehalogenations - land treatment and composting.		
Unit – III	**E- Waste & Biomedical Waste Management**	**9**
E-Waste Management: definition, sources, classification, collection, segregation, treatment and disposal. **Biomedical Waste Management :** Introduction-definition –components of biomedical waste-waste generation –waste identification and waste control-waste storage-labeling and color coding-handling and transportation-waste treatment and disposal- autoclave, hydroclave , microwave treatments- chemical disinfection – sanitary and secure landfill.		
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, sugar, petroleum refinery, fertilizer and dairy industries.		
Unit – V	**Solid Waste Management and Legislation**	**9**
Solid waste management plan - solid waste (management and handling) rules - biomedical waste (management and handling) rules-plastic waste management rules - e-waste management rules - hazardous and other wastes (management and transboundary movement) rules - construction and demolition waste management rules.		
		Total: 45

TEXT BOOK:

1.	George Tchobanoglous, Hillary Theisen, Samuel a Vigil, Integrated solid waste management (Engineering principle and management issues) McGraw hill Education (India) Pvt. Ltd., 2015, for Unit-I, II, V.
2.	SC Bhatia, Handbook of Industrial pollution and control (Volume-1), CBS Publisher and Distributers, New Delhi, 2002, for Unit-II, III, IV, V.

REFERENCES:

1.	Manual on Municipal Solid Waste management, Central public Health and Environmental Engineering Organization (CPHEEO), Govt. of India, May 2000.
2.	Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans, Hazardous waste management, MEDTEC, 2015.
3.	Majeti Narasimha Vara Prasad, Meththika Vithanage, Anwesha Borthakur, “Handbook of Electronic Waste Management: International Best Practices and Case Studies” 1st Edition, Butterworth-Heinemann, 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	explain the various disposal and treatment methods of hazardous wastes.	Understanding (K2)
CO3	organize the appropriate method for managing e-waste and biomedical waste.	Applying (K3)
CO4	identify the hazards from various industries and apply the waste management techniques for its treatment.	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)

22CYO08 - CHEMISTRY IN EVERY DAY LIFE
(Offered by Department of Chemistry)

<table>
<tr><td>Programme& Branch</td><td>All BE / BTech Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>7</td><td>OE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">This course aims to prepare the students to have the knowledge on oils, fats, sugar, adulterants in food, creams, milk powder, soil, fertilizer, pesticides, insecticides, fungicides and herbicides in order to know its chemistry in our everyday activities.</td></tr>
<tr><td>Unit – I</td><td colspan="6">Oils, Fats and Sugar</td><td>9</td></tr>
<tr><td colspan="8">Distinction between oils and fats – properties – classification – edible oils – vegetable oils –animal oils – manufacture of oils by solvent extraction – refining of crude vegetable oils – processing of animal fats – manufacture of cane sugar – manufacture of sucrose from beet root.</td></tr>
<tr><td>Unit – II</td><td colspan="6">Adulterants in food</td><td>9</td></tr>
<tr><td colspan="8">Food Adulteration and prevention – common food adulterants – food additives – food colorants– preservatives – flavourants – food poisoning – analysis of adulterants in edible oils, coffee powder, chilli powder, turmeric powder, meat , fish, ghee and milk – harmful effects of food adulterants</td></tr>
<tr><td>Unit – III</td><td colspan="6">Creams and Milk powder</td><td>9</td></tr>
<tr><td colspan="8">Creams: Composition-chemistry of creaming process- Factors influencing cream separation (Mention the factors only) - Estimation of fat in cream - Milk powder: Need for making powder-drying process- spraying, drum drying, jet drying and foam drying-principles involved in each.</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Soil and Fertilizers</td><td>9</td></tr>
<tr><td colspan="8">Soil analysis: Composition of soil - Organic and Inorganic constituents-Soil acidity - buffering capacity of soils -Liming of soil - Fertilizers: primary nutrients –role of Nitrogen, potassium and phosphorous on plant growth –Complex fertilizers and mixed fertilizers and its composition - Secondary nutrients – micronutrients and their functions in plants -optimal addition of Fertilizers to obtain estimated yield.</td></tr>
<tr><td>Unit – V</td><td colspan="6">Pesticides, Insecticides, Fungicides and Herbicides</td><td>9</td></tr>
<tr><td colspan="8">Pesticides – Classification – general methods of application and toxicity, Safety measures when using pesticides-Insecticides: Inorganic pesticides – borates - Organic pesticides – D.D.T. and BHC-Plant derivatives: pyrethrin and Nicotine - Synthetic organic pesticides: Endrin and Aldrin (Chemical name - Structure- functions and uses)-Fungicides: Inorganic (Bordeaux mixture) and organic (dithiocarbamate) fungicides - Industrial fungicides: Creosote fractions - Herbicides: Selective and non-selective - 2, 4-dicholorophenoxyacetic acid and 2,4,5-tricholorophenoxyaceticacid (structure and function).</td></tr>
<tr><td colspan="8" align="right">Total: 45</td></tr>
</table>

<table>
<tr><td colspan="2">TEXT BOOK:</td></tr>
<tr><td>1.</td><td>Sharma B K , Industrial Chemistry, Goel publishing house, New Delhi, 2011, for Units- I, II, IV</td></tr>
<tr><td>2.</td><td>Alex V Ramani, Food Chemistry, MJP Publishers, Chennai, 2009, for Units -II, III, V.</td></tr>
<tr><td colspan="2">REFERENCES:</td></tr>
<tr><td>1.</td><td>Dilip Kumar Das, Introductory Soil Science, 1st Edition, Kalyani Publishers, Reprint 2002.</td></tr>
<tr><td>2.</td><td>K. Bagavathi Sundari– “Applied Chemistry”, MJP Publishers, Chennai, 2006.</td></tr>
<tr><td>3.</td><td>Ashutosh Kar, Medicinal Chemistry, Wiley Eastern limited, New Delhi, 1993.</td></tr>
</table>

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the importance of oils, fats and sugar.	Understanding (K2)
CO2	identify the harmful effects of adulterants in food.	Applying (K3)
CO3	develop the knowledge on creams and milk powder.	Applying (K3)
CO4	interpret the nature and composition of soil and fertilizers.	Understanding (K2)
CO5	illustrate the difference of pesticides, insecticides, fungicides and herbicides.	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)

22CYO09 - CHEMISTRY OF NUTRITION FOR WOMEN HEALTH
(Offered by Department of Chemistry)

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

Preamble	This course aims to provide knowledge for engineering students on components of health, fitness and also the role of nutrition for women health.

Unit - I | **Nutrition** | **9**

Energy- functions, sources and concept of energy balance - recommended dietary allowances, dietary sources - effects of deficiency and/ or excess consumption on health of the following nutrients: carbohydrates and dietary fiber – lipids – proteins - fat soluble vitamins: A, D,E and K - water soluble vitamins: Thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C – minerals: calcium, iron, zinc and iodine.

Unit - II | **Women Health** | **9**

Disease pattern and reproductive health- menopause – hypothyroid- PCOD-diabetes - policies and programs for promoting maternal and child nutrition and health - concept of small family - methods of family planning - merits and demerits.

Unit - III | **Nutrition for Nursing Mother and Infants** | **9**

Physiology and psychology of lactation, hormonal control, composition of colostrums and breast milk, nutritional requirements of a nursing mother, advantages of breast feeding, food and nutritional requirements for infants, weaning and supplementary foods for infants and immunization.

Unit - IV | **Nutrition for Physical Fitness** | **9**

Significance of physical fitness and nutrition in the prevention and management of weight control, obesity, diabetes mellitus, CV disorders, bone health and cancer - nutrition and exercise regimes for pre and postnatal fitness - nutritional and exercise regimes for management of obesity - critical review of various dietary regimes for weight and fat reduction - prevention of weight cycling.

Unit - V | **Role of Women in National Development** | **9**

Women in family and community: Demographic changes menarche, marriage, fertility, morbidity, mortality, life expectancy, sex ratio, aging, widowhood. Women in society: Women’s role, their resources, and contribution to family, and effect of nutritional status.

Total: 45

TEXT BOOK:

1. Srilakshmi, B., Nutrition Science, New Age International (P) Ltd., New Delhi, 2017, for Units- I, IV, V.
2. Arpita Verma, Women's Health and Nutrition: Role of State and Voluntary Organizations, Rawat Publishers, 2017, for Units - II, III, IV.

REFERENCES:

1. Shubhangini A Joshi , Nutrition and Dietetics, TataMacGraw Hill, 2010.
2. Rujuta Diwekar, Women and The Weight Loss Tamasha, Westland ltd, 2010.
3. Swaminathan, M., Advanced Textbook on Food and Nutrition, Vol. 1, Second Edition, Bangalore Printing and Publishing Co. Ltd., Bangalore, 2012.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	make use of the knowledge of dietary sources in day to day life.	Applying (K3)
CO2	explain the disease pattern and policies towards women health.	Understanding (K2)
CO3	develop knowledge about nutrition during lactation and for infants.	Applying (K3)
CO4	utilize the knowledge of physical fitness and nutrition towards good health.	Applying (K3)
CO5	interpret the various role of women in society.	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											
CO2	3	1												
CO3	3	2	1											
CO4	3	2	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)

Honours degree with specialization in **Smart Manufacturing**

S.No	Course Title	Credits
1.	22MEH01 - Digital Manufacturing	4
2.	22MEH02 - Factory Automation	3
3.	22MEJ01 - 3D Modeling and Prototyping	4
4.	22MEH03- Smart Manufacturing Transformation	3
5.	22MEH04 - Industrial IOT	4
	TOTAL	**18**

22MEH01 – DIGITAL MANUFACTURING

Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Manufacturing Technology	**5/6/7**	**HN**	**3**	**1**	**0**	**4**

Preamble	This course provides the importance of information, sensors, actuators, controllers used in digital manufacturing. It additionally describes the digital twin technology and its implementation in shop floor.

Unit – I	**Introduction to Digital Manufacturing:**	**9+3**
Introduction - Development, Concepts and Connotation, Theory System of Digital Manufacturing Science - Operation mode and Architecture of Digital Manufacturing System - Modelling theory and Method of Digital Manufacturing Science - Computing Manufacturing in Digital Manufacturing Science – Methodology – Manufacturing - Theoretical units.		
Unit – II	**Manufacturing Informatics:**	**9+3**
Manufacturing Informatics in Digital Manufacturing - Principal Properties - Measurement and Synthesis - Integration, Sharing and Security. Intelligent Manufacturing in Digital Manufacturing Science - Sensing End Fusion - Knowledge Engineering - Autonomy, Self-Learning.		
Unit – III	**Bionic Manufacturing and Management Technology:**	**9+3**
Science of Bionic Manufacturing in Digital Manufacturing Science-Overview, Bionic Machinery - Biological Manufacturing - Development of Bio-Manufacturing. Management Technology in Digital Manufacturing Science - Management of Technology - Technological Strategies Management - Production Pattern - MOT mode. Key technology of Digital Manufacturing Science - Product Life Cycles - Resource and Environment Technology.		
Unit – IV	**Digital Twin:**	**9+3**
Digital Twin and Related Concepts - Value of Digital Twin - Application of Digital Twin and its Challenges - Three-Dimensional Digital Twin – Requirements - Three level Digital Twins - Rules for Digital Twin Modelling.		
Unit – V	**Equipment Energy Consumption Management (EECM) in Digital Twin Shop Floor:**	**9+3**
Implementation of EECM in Digital Twin Shop floor - Potential Advantages of EECM in Digital Twin Shop Floor – Cyber - Physical Fusion in Digital Twin Shop Floor Models Fusion - Data Fusion – Services - Digital Twin for Complex Equipment – Prognostics and Health Management (PHM) Method, Case study.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOKS:

1.	Zude Zhou, Shane Xie, Dejun Chen, “Fundamentals of Digital Manufacturing Science”, 1st Edition, Springer, New York, 2012 for units I, II, III
2	Fei Tao, Meng Zhang A.Y.C.Nee, “Digital Twin Driven Smart Manufacturing” 1st Edition, Academic press, London, 2019 for units IV, V

REFERENCES:

1.	Kaushik Kumar, Divya ZindaniJ. Paulo Davi.,” Digital Manufacturing and Assembly Systems in Industry 4.0”,4th Edition, CRC Press, London, 2019
2.	Surjya Kanta Pal, Debasish Mishra, Arpan Pal, Samik Dutta, Debashish Chakravarty, “Digital Twin – Fundamental Concepts to Applications in Advanced Manufacturing”, 1st Edition, Springer, New York, 2021

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Illustrate the digital manufacturing concepts in manufacturing applications	Understanding (K2)
CO2	conceptualize manufacturing informatics for digital manufacturing	Understanding (K2)
CO3	extend Bionic manufacturing and manufacturing technology to the real word problems	Applying (K3)
CO4	discriminate digital twin and its application	Understanding (K2)
CO5	select suitable equipment energy consumption management method in digital twin shop-floor	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	
CO2	3			3		2			2				2	
CO3	3			3		2			2				3	
CO4	3			3		2			2				1	
CO5	3			3		2			2				3	

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

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

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

22MEH02 – FACTORY AUTOMATION

Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**0**	**0**	**3**

Preamble	This course provides the significant role of automation in production lines, material handling systems, inspection and testing. It also impart the knowledge on several principles of condition monitoring for automation production.

Unit – I	**Automation in Production System:**	**9**
Introduction, Principles and Strategies of Automation - Basic Elements of an Automated System - Advanced Automation Functions - Levels of Automations. Automated Flow lines - Methods of Work part Transport - Transfer Mechanism - Design for Automated Assembly - Types of Automated Assembly Systems and Buffer Storage.		
Unit – II	**Advanced Material Handling Technologies:**	**9**
Automated handling and storage systems in manufacturing - Rail Guided Vehicles (RGVs), Automated Guided Vehicles (AGVs), Applications of RGVs and AGVs. Automated Storage and Retrieval Systems (AS/RS), Considerations for planning an AS /RS system, Robots and their applications in handling and storage.		
Unit – III	**Automated Inspection and Testing:**	**9**
Automated Inspection Principles and Methods - Sensor technologies for Automated Inspection - Contact inspection methods – Non-Contact inspection methods. Machine Vision: Resolution, Lighting, Connectivity analysis - Three dimensional vision and Future trends.		
Unit – IV	**Robotic inspection and Identification Techniques:**	**9**
Introduction - Types of robots - Fundamentals of robot control and programming – Intelligent robots – Robotic vision, Robotic testing and Inspection - Servo robots - Case study. Identification techniques - Micro sensors, Nano sensors, Bar code and RFID systems.		
Unit – V	**Condition Monitoring:**	**9**
Principles - Sensors for monitoring force - Vibration and noise - Selection of sensors and monitoring techniques. Machine tool condition monitoring - Direct tool wear assessment, Indirect tool wear assessment - Tool condition monitoring system.		

Total:45

TEXT BOOKS:

1.	Mikell P Groover," Automation, Production Systems and Computer Integrated Manufacturing",4th Edition, Pearson, 2019 for Units I & II
2	Stanley L. Robinson & Richard Kendall Miller, "Automated Inspection and Quality Assurance", 1st Edition, CRC press, 2019 for Units III & IV
3	Amiya R. Mohanty," Machinery Condition Monitoring Principles and Practices", 1st Edition, CRC Press, 2015 for Unit V

REFERENCE:

1.	Singh and John Wiley," System Approach to Computer Integrated Design and Manufacturing" 1st Edition, Wiley, 1995

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the principles, types and level of automation	Understanding (K2)
CO2	compare various material handling systems in automated industry	Understanding (K2)
CO3	contrast various types of inspection techniques	Applying (K3)
CO4	discuss the robotic based inspection and identification techniques used in industry	Understanding (K2)
CO5	appraise the role of condition monitoring in factory automation	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1			3							2	3	3
CO2	3	1			3							2	3	3
CO3	3	1			3							2	3	3
CO4	3	1			3							2	3	3
CO5	3	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	40	60					100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

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

22MEJ01 - 3D MODELING AND PROTOTYPING

Programme & Branch	BE . & Mechanical Engineering	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Machine Drawing Laboratory	**5/6/7**	**HN**	**3**	**0**	**2**	**4**

Preamble	This course emphasizes the strategic modeling considerations required for 3D printing. It also details the guidelines for material design considerations, part consolidation and computational tools. The 3D printing modules available in CAD packages are also dealt in this course. The theory, options and file formats of 3D printing files are covered. Practical classes are also included to have hands on experience.	
Unit – I	**Introduction to 3D Design for Prototyping:**	**9**
Introduction - Using prototype to Add Value to Products - General Guidelines for Designing Additive Manufacturing (AM) Parts - Design to Avoid Anisotropy - Economics of AM - Design to Minimize Print Time - Design to Minimize Post-processing - Topology Optimization of Lattice Structures.		
Unit – II	**Design for Plastic Prototyping:**	**9**
General design guidelines - Designing for Material Extrusion: Material Extrusion Accuracy and Tolerances - Layer Thickness - Support Material - Fill Style - Other Considerations – Various Feature Types. Designing for Vat Photopolymerization: Resolution - Print Orientation - Support Material – Overhangs – Isotropy - Hollowing Parts and Resin Removal – Details - Horizontal Bridges – Connections – Various Feature Types.		
Unit – III	**Design for Metal Prototyping:**	**9**
Designing for Metal Powder Bed Fusion - Metal Powder Production - Powder Morphology - Metal AM Material Characteristics - Topology Optimization - Lattice Structures - Overhangs and Support Material - Residual Stress - Stress Concentrations - Setting up a Metal AM Print Job - Design for Laser Powder Bed Fusion and Electron Beam Melting.		
Unit – IV	**Computational Tools and Part Consolidation:**	**9**
Computational Tools: Aims of Using Design Analysis - Special Considerations for Analysis – Meshing - Boundary Conditions – Optimisation - Parametric or Size Optimisation. Guidelines for Part Consolidation: Design for Function - Material Considerations - Conventional Design For Manufacture (DFM) /Design For Assembly(DFA) - Assembly Considerations.		
Unit – V	**Software related to Rapid Prototyping:**	**9**
Introduction - The Stereolithography (STL) File - Problems with STL Files - STL File Manipulation - Beyond the STL File - Prototype File Types – Other file formats – Prototyping modules in CAD packages (Solidworks and Creo) - Introduction to Cura and Ideamaker software and its features.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Modeling and 3D printing of a tea cup.
2.	Modeling and 3D printing of a mechanical component.
3.	Modeling and 3D printing of a functional mechanical assembly.
4.	Modeling and 3D printing of an innovate component/structure.
5.	Creating skin surface for simple scanned components for 3D printing.
6.	Perform complex surface for 3D printing design.
7.	Modeling and 3D printing for style components.
8.	Analysis of 3D printed components through mechanical testing.

Lecture:45, Practical:30, Total:75

TEXT BOOKS:

1.	Olaf Diegel, Axel Nordin, Damien Motte, “A Practical Guide to Design for Additive Manufacturing” 1st Edition, Springer Nature, Singapore, 2019 for Units –I, II, III and IV.
2.	Ian Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd Edition, Springer, USA, 2015 for Unit – V.

REFERENCES/ MANUAL / SOFTWARE:	
1.	Samuel N. Bernier, BertierLuyt, Tatiana Reinhard, “Make: Design for 3D Printing”, 1st Edition, Maker Media Inc, Canada, 2015.
2.	Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, 1st Edition, Hanser Publisher, Germany, 2011.
3.	Creo 7.0, SolidWorks 2018, CATIA V5R12, UltimakerCura 4.3.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped** **(Highest Level)**
CO1	recognize the various principles in design for additive manufacturing	Understanding (K2)
CO2	choose suitable design for polymer AM	Applying (K3)
CO3	select the correct design for metal AM	Applying (K3)
CO4	describe the computational tools for checking AM designs and guidelines for part consolidation	Understanding (K2)
CO5	develop proper CAD model and STL file for performing 3D printing	Applying (K3)
CO6	perform 3D modeling and 3D printing of a mechanical component	Applying (K3), Manipulation (S2)
CO7	perform 3D modeling and 3D printing of a functional mechanical component	Applying (K3),
CO8	analyze a 3D printed object as per design guidelines	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	1	3	3										1	2
CO2	1	3	3										1	2
CO3	1	3	3										1	2
CO4	1	3	3		2								1	3
CO5	1	3	3		3								3	2
CO6		3	2	1	3								3	2
CO7		3	2	1	3								3	2
CO8		3	2	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	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
CAT3	20	30	50	-	-	-	100
ESE	20	40	40	-	-	-	100

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

22MEH03 – SMART MANUFACTURING TRANSFORMATION							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology**	**5/6/7**	**HN**	**3**	**0**	**0**	**3**

Preamble	This course details the application concepts of smart manufacturing in various manufacturing sectors. It also outlines the importance of smart additive manufacturing for a sustainable future.	
Unit – I	**Introduction to Manufacturing 4.X:**	**9**
Introduction to Manufacturing 4.x for Smart Digital Manufacturing: From Industry 4.0 to Manufacturing 4.x - The Framework for Manufacturing 4.x - The Manufacturing 4.x Roadmap - Finding the Tipping Points.		
Unit – II	**Manufacturing 4.x for Specific Approaches:**	**9**
Manufacturing 4.x for Repetitive Operations - Manufacturing 4.x for Process Industries - Manufacturing 4.x for Complex Manufacturing - Manufacturing 4.x for Small and Medium Businesses, Cloud Adoption.		
Unit – III	**Big Data Analytics in Semiconductor Manufacturing:**	**9**
Semiconductor Manufacturing - The Big Data Revolution and Associated Challenges - Analytics Approaches in Semiconductor Manufacturing - Next Generation Fault Detection and Classification - Predictive Maintenance - Big Data Architectures - Emergence of Artificial Intelligence and Other Big Data-Friendly Analytics - Realizing the Complete Smart Manufacturing, Vision.		
Unit – IV	**Cyber Physical System Integrated Smart Manufacturing Workshops:**	**9**
Construction of Cyber-Physical System–Integrated Smart Manufacturing Workshops- Framework of Smart Manufacturing Workshops - Maturity Model for Smart Manufacturing Workshop - A case study in Automotive Industry - Maturity Assessment – Case study Inferences.		
Unit – V	**Sustainable and Smart Additive Manufacturing:**	**9**
Introduction to Sustainable and Smart Additive Manufacturing (SSAM) - Additive Manufacturing and its Qualification - Sustainability and Additive Manufacturing - Big Data Analytics Framework for SSAM - Key Technologies for Big Data analytics SSAM - Benefits of SSAM - Managerial Implications - Case study scenario.		
		Total:45

TEXT BOOK:

1.	René Wolf and Raffaello Lepratti, **“**Smart Digital Manufacturing: A Guide for Digital Transformation with Real Case Studies Across Industries**”** 1st Edition, Wiley-VCH, Germany, 2020.

REFERENCES:

1.	Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, “Smart Manufacturing Concepts and Methods” 1st Edition, Elsevier, United Kingdom, 2020
2.	Feitao, Meng Zhang, A.Y.C. Nee, “Digital Twin Smart Manufacturing”, 1st Edition, Academic Press, United Kingdom, 2019.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	discuss the concepts of Manufacturing 4.x	Understanding (K2)
CO2	select desired approach during implementation of Manufacturing 4.x	Understanding (K2)
CO3	implement the application of big data analytics in manufacturing sector	Applying (K3)
CO4	apply the concepts of cyber-physical system–integrated smart manufacturing workshops	Applying (K3)
CO5	infer the importance of smart additive manufacturing	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			1								2	3
CO2	2	1			1								2	3
CO3	3	2	1		1								2	3
CO4	3	2	1		1								2	3
CO5	2	1			1								2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	60	-	-	-	-	100
CAT2	30	45	25	-	-	-	100
CAT3	30	45	25	-	-	-	100
ESE	20	50	30	-	-	-	100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MEH04 – INDUSTRIAL IOT							
Programme & Branch	**B.E. & Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**1**	**0**	**4**

Preamble	The course will provide a thorough understanding of the components used in Industrial Internet of Things (IIOT) and information communication systems utilized in manufacturing plants.	
Unit – I	**IIOT and Cloud Computing:**	**9+3**
Introduction, Physical Design of IOT - Logical Design of IOT - IOT Enabling Technologies - Domain Specific IOTs, IOT Design Methodology - IOT Physical Devices: Raspberry Pi, pcDuino, Beaglebone Black, Cubieboard. Introduction to Cloud Computing: Cloud Models, Cloud based Services and Applications, Cloud Service and Platforms.		
Unit – II	**Machine to Machine Communication and Technologies:**	**9+3**
Introduction to M2M, Description of M2M Market, Segments/Applications – Automotive, Smart Telemetry, Surveillance and Security - M2M Industrial Automation - M2M Terminals and Modules. Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, Bluetooth Low Energy (BLE), Near Field Communication (NFC), Radio Frequency Identification (RFID) Industry Standards Communication Technology: LoRAWAN, Open Platform Communication (OPC) Unified Architecture, Message Queuing Telemetry Transport (MQTT). Connecting into Existing Modbus and Profibus Technology - Wireless Network Communication.		
Unit – III	**IIoT Components:**	**9+3**
Mechatronics Applications and Trends - Sensors and Transducers - Signal Conditioning - Mechanical Components - Software Development - Pneumatic and Hydraulic Actuators – Microcontrollers - Basic Closed-Loop Control.		
Unit – IV	**Information Systems in Manufacturing:**	**9+3**
Manufacturing Organizations and Management - Networked Enterprises - Globalization Challenges and Opportunities - Dimensions of Information Systems - Approaches to Study Information System - Technical and Behavioural Approach - Information Technology Infrastructure.		
Unit – V	**Applications of IIOT:**	**9+3**
Smart Metering - e-Health Body Area Networks - City Automation - Energy Applications - Home Automation - Retail - Industry - Real Life examples of IIOT in Manufacturing Sector.		
		Lecture:45, Tutorial:15, Total:60

TEXTS BOOKS:

1.	A. Bahga and V. Madisetti, “Cloud Computing, A hands-on approach”, 1st Edition, Universities Press (India) Private Limited, Hyderabad, 2014 for Unit I.
2.	D. Boswarthick, O. Elloumi, and O. Hersent, “M2M Communications: A Systems Approach”, 1st Edition, Wiley, 2012 for Unit II.
3.	A. Bahga and V. Madisetti, “Internet of Things: A hands-on approach”, 1st Edition, Universities Press (India) Private Limited, Hyderabad, 2016 for Units I, II and V.
4.	J. Edward Carryer, Matthew Ohline, Thomas Kenny, “Introduction to Mechatronic Design”, 1st Edition, Prentice Hall, 2010 for Unit III.

REFERENCES:

1.	A. Suresh, Malarvizhi Nandagopal, Pethuru Raj, E. A. Neeba, Jenn-Wei Lin, “Industrial IoT Application Architectures and Use Cases”, 1st Edition, Auerbach Publications, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	describe an IOT system with cloud infrastructure	Understanding (K2)
CO2	explain the M2M Communication protocols in a prototype	Understanding (K2)
CO3	present the basic concepts of the sensors used in electromechanical systems	Understanding (K2)
CO4	demonstrate the system information in manufacturing units	Understanding (K2)
CO5	perform the case study on Industrial IOT 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		3					1			3	3
CO2	2	1	1		3					1			3	3
CO3	2	1	1		3					1			3	3
CO4	2	1	1		3					1			3	3
CO5	3	2	2		3					1			3	3

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

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	35	65					100
CAT2	35	65					100
CAT3	20	50	30				100
ESE	30	55	15				100

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