VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF MECHANICAL ENGINEERING

B. Tech Mechanical with Specialization in Energy Engineering

(B. Tech BEM)

Curriculum

(*2018-2019 admitted students*)

B. Tech Mechanical with Specialization in Energy Engineering

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

To be a leader in imparting world class education in Mechanical Engineering, leading to nurturing of scientists and technologists of highest caliber who would engage in sustainable development of the globe.

MISSION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

The mission of the school is to create and maintain an environment for Excellence in Instruction, Learning and Applied Research in the area of Mechanical and allied disciplines so as to equip our students with necessary knowledge and skills for higher education/employment and to meet the societal demands.

B. Tech Mechanical with Specialization in Energy Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.

2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.

3. Graduates will function in their profession with social awareness and responsibility.

4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.

5. Graduates will be successful in pursuing higher studies in engineering or management.

6. Graduates will pursue career paths in teaching or research.

B. Tech Mechanical with Specialization in Energy Engineering

PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_02: Having a clear understanding of the subject related concepts and of contemporary issues and apply them to identify, formulate and analyse complex engineering problems.

PO_03: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_04: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_05: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_06: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_07: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_08: Having a clear understanding of professional and ethical responsibility

PO_09: Having cross cultural competency exhibited by working as a member or in teams

PO_10: Having a good working knowledge of communicating in English – communication with engineering community and society

PO_11: Having a good cognitive load management skills related to project management and finance

PO_12: Having interest and recognise the need for independent and lifelong learning

B. Tech Mechanical with Specialization in Energy Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of B. Tech (Mechanical with Specialization in Energy Engineering) programme, graduates will be able to

PSO_01: Model, design & analyze Energy Engineering systems and components taking into account social, economic and environmental implications

PSO_02: Realize components and products pertaining to Energy Engineering using appropriate materials and processes

PSO_03: Work professionally in mechanical, energy and related systems

B. Tech Mechanical with Specialization in Energy Engineering

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University core (UC)	70
Programme core (PC)	61
Programme elective (PE)	37
University elective (UE)	12
Bridge course (BC)	-
Total credits	180

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B. Tech Mechanical with Specialization in Energy Engineering

DETAILED CURRICULUM

University Core

S. No	Course Code	Course Title	L	T	P	J	C
1.	STS4097	Soft Skills* [6x1 credit each]	0	0	0	0	6
2.	FLC4097	Foreign Language (basket)	2	0	0	0	2
3.	ENG1011	English for Engineers	0	0	4	0	2
4.	CSE1001	Problem Solving and Programming	0	0	6	0	3
5.	CSE1002	Problem Solving and Object Oriented Programming	0	0	6	0	3
6.	MAT1011	Calculus for Engineers	3	0	2	0	4
7.	MAT2001	Statistics for Engineers	2	2	2	0	4
8.	PHY1701	Engineering Physics	3	0	2	0	4
9.	CHY1701	Engineering Chemistry	3	0	2	0	4
10.	HUM1021	Ethics and Values	2	0	0	0	2
11.	EXE4097	Personality Development (Co/Extra-curricular Activity)	0	0	0	0	2
12.	MGT1022	Lean Start-up Management	1	0	0	4	2
13.	PHY1999	Introduction to Innovative Projects (IIP)	1	0	0	4	2
14.	CHY1002	Environmental Sciences	3	0	0	0	3
15.	MEE3999	Tech Answers for Real world Problems (TARP)	1	0	0	8	3
16.	MEE3099	Industry Internship	0	0	0	0	2
17.	MEE4098	Comprehensive Examination	0	0	0	0	2
18.	MEE4099	Capstone Project (1 Semester)	0	0	0	0	20
		Total					**70**

Programme Core

S. No	Course Code	Course Title	L	T	P	J	C
1.	EEE1001	Basic Electrical & Electronics Engineering	2	0	2	0	3
2.	MAT2002	Applications of Differential and Difference Equations	3	0	2	0	4
3.	MAT3003	Complex variables and Partial Differential Equations	3	2	0	0	4
4.	MAT3005	Applied Numerical Methods	3	2	0	0	4
5.	MEE1001	Engineering Drawing	1	0	4	0	3
6.	MEE1002	Engineering Mechanics	2	2	0	0	3
7.	MEE1003	Engineering Thermodynamics	2	2	0	0	3
8.	MEE1032	Mechanics of Solids and Fluids	3	0	2	0	4
9.	MEE1005	Materials Engineering and Technology	3	0	2	0	4
10.	MEE1007	Manufacturing Processes	2	0	2	0	3
11.	MEE1011	Renewable Energy Sources	2	2	2	0	4
12.	MEE2052	Sustainable Energy	2	0	0	4	3
13.	MEE2003	Thermal Engineering Systems	2	2	2	0	4
14.	MEE2005	Heat Transfer	2	2	2	0	4
15.	MEE2022	Power Plant Engineering	3	0	0	0	3
16.	MEE2026	Turbo Machines	2	2	2	0	4
17.	MEE4006	Computational Fluid Dynamics	2	2	2	0	4
		TOTAL CREDITS					**61**

Programme Elective

S. No	Course Code	Course Title	L	T	P	J	C
1.	MEE2051	Design of Mechanical Components	2	1	0	0	3
2.	MEE2001	Machine Drawing	1	0	4	0	3
3.	MEE2007	CAD/CAM	2	0	4	0	4
4.	MEE3004	Internal Combustion Engines	3	0	0	0	3
5.	CHE2006	Fuels and Combustion	3	0	0	0	3
6.	MEE3006	Automobile Engineering	2	0	2	0	3
7.	MEE1012	Alternative Fuels	3	0	0	0	3
8.	MEE2030	Energy Systems Analysis and Design	3	0	0	0	3
9.	MEE2027	Nuclear Power Engineering	3	0	0	0	3
10.	MEE1067	Wind Energy Engineering	2	0	0	4	3
11.	MEE2058	Small Hydro Power Systems	3	0	0	4	4
12.	MEE1013	Fuel Cells	3	0	0	0	3
13.	MEE1038	Solar Photovoltaic System Design	2	0	0	4	3
14.	MEE1071	Bio-Energy Technology	3	0	0	4	4
15.	MEE2061	Exergy Analysis of Energy Systems	3	0	0	0	3
16.	MEE2063	Design and Selection of Heat Transfer Equipment	3	0	0	4	4
17.	MEE2064	Conventional and Solar Refrigeration and Air Conditioning	3	0	0	0	3
18.	EEE2003	Electromechanical Energy Conversion	3	0	0	0	3
19.	MEE1068	Remote Sensing and GIS in Resource Management	3	0	0	0	3
20.	MEE3011	Solar Thermal Power Engineering	2	0	2	0	3
21.	MEE2065	Energy In Built Environment	3	0	0	4	4
22.	MEE1074	Energy, Environment and Impact Assessment	2	0	0	4	3
23.	MEE2060	Integrated Energy Systems	3	0	0	0	3
24.	MEE1024	Operations Research	2	2	0	0	3
25.	MEE2029	Energy Conservation, Audit and Management	2	0	0	4	3

S. No	Course Code	Course Title	L	T	P	J	C
26.	MEE1014	Industrial Engineering and Management	3	0	0	0	3
27.	MEE1030	Robotics	2	0	2	0	3
28.	MEE1027	Instrumentation and Control Engineering	3	0	2	0	4

University Elective Baskets

Management courses

Sl.No	Code	Title	L	T	P	J	C
1	MGT1001	Basic Accounting	3	0	0	0	3
2	MGT1002	Principles of Management	2	0	0	4	3
3	MGT1003	Economics for Engineers	2	0	0	4	3
4	MGT1004	Resource Management	2	0	0	4	3
5	MGT1005	Design, Systems and Society	2	0	0	4	3
6	MGT1006	Environmental and Sustainability Assessment	2	0	0	4	3
7	MGT1007	Gender, Culture and Technology	2	0	0	4	3
8	MGT1008	Impact of Information Systems on Society	2	0	0	4	3
9	MGT1009	Technological Change and Entrepreneurship	2	0	0	4	3
10	MGT1010	Total Quality Management	2	2	0	0	3
11	MGT1014	Supply Chain Management	3	0	0	0	3
12	MGT1015	Business Mathematics	3	0	0	0	3
13	MGT1016	Intellectual Property Rights	3	0	0	0	3
14	MGT1017	Business Regulatory Framework For Start-ups	3	0	0	0	3
15	MGT1018	Consumer Behaviour	3	0	0	0	3
16	MGT1019	Services Marketing	3	0	0	0	3
17	MGT1020	Marketing Analytics	2	0	2	0	3
18	MGT1021	Digital and Social Media Marketing	3	0	0	0	3

19	MGT1022	Lean Start-up Management	1	0	0	4	2
20	MGT1023	Fundamentals of Human Resource Management	3	0	0	4	4
21	MGT1024	Organizational Behaviour	3	0	0	4	4
22	MGT1025	Foundations of Management And Organizational Behaviour	3	0	0	4	4
23	MGT1026	Information Assurance and Auditing	2	0	0	4	3
24	MGT1028	Accounting and Financial Management	2	2	0	4	4
25	MGT1029	Financial Management	2	1	0	4	4
26	MGT1030	Entrepreneurship Development	3	0	0	4	4
27	MGT1031	International Business	3	0	0	4	4
28	MGT1032	Managing Asian Business	3	0	0	4	4
29	MGT1033	Research Methods in Management	2	1	0	4	4
30	MGT1034	Project Management	3	0	0	4	4
31	MGT1035	Operations Management	3	0	0	0	3
32	MGT1036	Principles of Marketing	3	0	0	4	4
33	MGT1037	Financial Accounting and Analysis	2	1	0	4	4
34	MGT1038	Financial Econometrics	2	0	0	4	3
35	MGT1039	Financial Markets and Institutions	2	0	0	4	3
36	MGT1040	Personal Financial Planning	2	0	0	4	3
37	MGT1041	Financial Derivatives	2	1	0	4	4
38	MGT1042	Investment Analysis and Portfolio Management	2	0	0	4	3
39	MGT1043	Applications in Neuro Marketing	3	0	0	4	4
40	MGT1044	Global Brand Marketing Strategies	3	0	0	4	4
41	MGT1045	Industrial Marketing	3	0	0	4	4
42	MGT1046	Sales and Distribution Management	3	0	0	4	4
43	MGT1047	Social Marketing	3	0	0	4	4
44	MGT1048	Political Economy of Globalization	3	0	0	4	4
45	MGT1049	Sustainable Business Models	3	0	0	4	4
46	MGT1050	Software Engineering Management	2	0	0	4	3

47	MGT1051	Business Analytics for Engineers	2	2	0	0	3
48	MGT1052	Bottom of the Pyramid Operations	3	0	0	0	3
49	MGT1053	Entrepreneurship Development, Business Communication and IPR	1	0	2	0	2
50	MGT1054	Product Planning and Strategy	2	2	0	0	3
51	MGT1055	Design Management	2	2	0	0	3
52	MGT1056	Accounting and Financial Management	3	0	0	4	4
53	MGT6001	Organizational Behaviour	2	0	0	4	3

Humanities courses

Sl.No	**Code**	**Title**	**L**	**T**	**P**	**J**	**C**
1	HUM1001	Fundamentals of Cyber Laws	3	0	0	0	3
2	HUM1002	Business Laws	3	0	0	0	3
3	HUM1003	Basic Taxation for Engineers	3	0	0	0	3
4	HUM1004	Corporate Law for Engineers	3	0	0	0	3
5	HUM1005	Cost Accounting for Engineers	3	0	0	0	3
6	HUM1006	Business Accounting for Engineers	3	0	0	0	3
7	HUM1007	Contemporary Legal Framework for Business	3	0	0	0	3
8	HUM1009	International Business	3	0	0	0	3
9	HUM1010	Foreign Trade Environment	3	0	0	0	3
10	HUM1011	Export Business	3	0	0	0	3
11	HUM1012	Introduction to Sociology	3	0	0	0	3
12	HUM1013	Population Studies	3	0	0	0	3
13	HUM1021	Ethics and Values	2	0	0	0	2
14	HUM1022	Psychology in Everyday Life	2	0	0	4	2
15	HUM1023	Indian Heritage and Culture	2	0	0	4	2
16	HUM1024	India and Contemporary World	2	0	0	4	2
17	HUM1025	Indian Classical Music	1	0	2	4	1
18	HUM1033	Micro Economics	3	0	0	0	3

19	HUM1034	Macro Economics	3	0	0	0	3
20	HUM1035	Introductory Econometrics	2	0	2	0	2
21	HUM1036	Engineering Economics and Decision Analysis	2	0	0	4	2
22	HUM1037	Applied Game Theory	2	0	0	4	2
23	HUM1038	International Economics	3	0	0	0	3
24	HUM1039	Community Development in India	2	0	0	4	2
25	HUM1040	Indian Social Problems	3	0	0	0	3
26	HUM1041	Indian Society Structure and Change	3	0	0	0	3
27	HUM1042	Industrial Relations and Labour Welfare in India	3	0	0	0	3
28	HUM1043	Mass Media and Society	2	0	0	4	2
29	HUM1044	Network Society	3	0	0	0	3
30	HUM1045	Introduction to Psychology	2	0	2	0	2
31	HUM1706	Business Accounting for Engineers	3	0	0	0	3

Course code	Introduction to Soft Skills	L	T	P	J	C
STS1001		3	0	0	0	1
Pre-requisites	None	Syllabus Version				
		v.2.0				

Course Objectives:

- To understand the importance of ethics plotted in exploring the moral landscape to meet global expectations.

Expected Course Outcome:

- Enabling students to know themselves and interact better with peers

Module:1	Lessons on excellence:	10 hrs

Ethics and integrity

1. Importance of ethics in life
2. Intuitionism vs Consequentialism
3. Non-consequentialism
4. Virtue ethics vs situation ethics
5. Integrity - listen to conscience
6. Stand up for what is right

Change management

1. Who moved my cheese?
2. Tolerance of change and uncertainty
3. Joining the bandwagon
4. Adapting change for growth - overcoming inhibition

How to pick up skills faster?

1. Knowledge vs skill
2. Skill introspection
3. Skill acquisition
4. "10,000 hours rule" and the converse

Habit formation

1. Know your habits
2. How habits work? - The scientific approach
3. How habits work? - The psychological approach
4. Habits and professional success
5. "The Habit Loop"
6. Domino effect
7. Unlearning a bad habit

Analytic and research skills.

1. Focused and targeted information seeking
2. How to make Google work for you
3. Data assimilation

Team skills:

Goal setting
1. SMART goals
2. Action plans
3. Obstacles -Failure management

Module:2	Motivation	11 hrs

Motivation
1. Rewards and other motivational factors
2. Maslow's hierarchy of needs
3. Internal and external motivation

Facilitation
1. Planning and sequencing
2. Challenge by choice
3. Full Value Contract (FVC)
4. Experiential learning cycle
5. Facilitating the Debrief

Introspection
1. Identify your USP
2. Recognize your strengths and weakness
3. Nurture strengths
4. Fixing weakness
5. Overcoming your complex
6. Confidence building

Trust and collaboration
1. Virtual Team building
2. Flexibility
3. Delegating

Shouldering responsibilities

Module:3	Emotional Intelligence - L1	12 hrs

Transactional Analysis 1.Introduction
2.Contracting, ego states 3.Life positions
Brain storming 1.Individual Brainstorming 2.Group Brainstorming
3.Stepladder Technique 4.Brain writing
4.Crawford's Slip writing approach 5.Reverse brainstorming
6.Star bursting 7.Charlette procedure
8.Round robin brainstorming **Psychometric Analysis** 1.Skill Test
2.Personality Test
Rebus Puzzles/Problem Solving
1. More than one answer

Unique ways

Module:4	Adaptability:	12 hrs

Theatrix 1.Motion Picture 2.Drama

3. Role Play 4. Different kinds of expressions **Creative expression** 1.Writing 2.Graphic Arts 3.Music 4.Art and Dance **Flexibility of thought** 1.The 5'P' framework (Profiling, prioritizing, problem analysis, problem solving, planning) **Adapt to changes(tolerance of change and uncertainty)** 1. Adaptability Curve Survivor syndrome

	Total Lecture Hours	**45 hrs**

Mode of Evaluation: Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)

Reference Books:

Spencer Johnson(1998) Who moved my cheese. New York. G.P.Putham's Sons MalcomGladwel(2008) Outliers. London.. Little, Brown and Company Daniel Goleman(1995) Emotional Intellegence. New York City. Bantam Books Scott Peck. M(1978) Road Less Travelled. New York City. M. Scott Peck.

Websites: www.chalkstreet.com www.skillsyouneed.com www.mindtools.com www.thebalance.com www.eguru.ooo

Recommended by Board of Studies	09-06-2017		
Approved by Academic Council	45	Date	15-06-2017

Course code	Reasoning Skill Enhancement	L	T	P	J	C
STS2001		3	0	0	0	1
Course Pre-requisites	None	Syllabus Version				
		v.2.0				

Course Objectives:

- To understand the importance of ethics plotted in exploring the moral landscape to meet global expectations.

Expected Course Outcome:

- Understanding the various strategies of conflict resolution among peers and supervisors and respond appropriately

Module:1	Social interaction and social media	6 hrs

Effective use of social media :
Moderating personal information
3. Social media for job/profession
4. Communicating diplomatically
Networking on social media
1. Maximizing network with social media
2. How to advertise on social media
Event management
1. Event management methods
2. Effective techniques for better event management
Influencing
1. How to win friends and influence people
2. Building relationships
3. Persistence and resilience
4. Tools for talking when stakes are high
Conflict resolution
1. Definition and strategies
2. Styles of conflict resolution

Module:2	Non Verbal Communication proximecs	6 hrs

1.Types of proximecs
2. rapport building

Reports and Data Transcoding
1.Types of reports

Negotiation Skill
1.Effective negotiation strategies

Conflict Resolution
1.Types of conflicts

Module:3	Interpersonal Skill Social Interaction	8 hrs

.Interpersonal Communication,
2.Peer Communication,
3.Bonding,
4.Types of social interaction

Responsibility

1.Types of responsibilities
2. Moral and personal responsibilities
Networking
1.Competition
2. collaboration
3. content sharing
Personal Branding
1. Image Building
2. Grooming
3. Using social media for branding
4. **Delegation and compliance** 1.Assignment and responsibility 2.Grant of authority
3.Creation of accountability

Module:4	**Quantitative Ability -L1**	**10 hrs**

Number properties 1.Number of factors 2.Factorials
3.Remainder Theorem 4.Unit digit position 5.Tens digit position **Averages**
1.Averages 2.Weighted Average **Progressions**
1. Arithmetic Progression
2. Geometric Progression
3. Harmonic Progression
Percentages
1.Increase & Decrease or successive increase
Ratios
Types of ratios and proportions

Module:5	**Reasoning Ability-L1**	**8 hrs**

Analytical Reasoning
1. Data Arrangement(Linear and circular & Cross Variable Relationship)
2. Blood Relations 3.Ordering/ranking/grouping 4.Puzzletest
5.Selection Decision table

Module:6	**Verbal Ability:** **Strengthening Grammar Fundamentals**	**7 hrs**

Vocabulary Building 1.Synonyms & Antonyms 2.One word substitutes 3.Word Pairs
4.Spellings 5.Idioms
6. Sentence completion
Analogies

	Total Lecture Hours	**45 hrs**

Mode of Evaluation: Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)

References:

Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler(2001)Crucial Conversations: Tools for Talking When Stakes are High. Bangalore. McGraw- Hill Contemporary
Dale Carnegie,(1936) How to Win Friends and Influence People. New York. Gallery

Books FACE(2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications ETHNUS(2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd.			
Recommended by Board of Studies	09-06-2017		
Approved by Academic Council	45	Date	15-06-2017

Course code	Introduction to Etiquette	L	T	P	J	C
STS2002		3	0	0	0	1
Course Pre-requisites	None	Syllabus Version				
		v.2.0				

Course Objectives:

- To develop skills on etiquette, thought process, quantitative, verbal and reasoning.

Expected Course Outcome:

- Enabling students enhance knowledge of relevant topics and evaluate the information

Module:1	Impression Management Types and techniques	8 hrs

Importance of impression management
1. Types of impression management
2. Techniques and case studies
3. Making a good first impression in an interview (TEDOS technique)
4. How to recover from a bad impressions/experience
5. Making a good first impression online

Non-verbal communication and body language
1. Dressing, Appearance and Grooming
2. Facial expression and Gestures
3. Body language (Kinesics)
4. Keywords to be used

Voice elements (tone, pitch and pace)

Module:2	Thinking Skills	4 hrs

Introduction to problem solving process
1.Steps to solve the problem 2.Simplex process
Introduction to decision making and decision making process
1.Steps involved from identification to implementation 2.Decision making model

Module:3	Beyond Structure Art of questioning	4 hrs

1.How to frame questions 2.Blooms questioning pyramid 3.Purpose of questions Etiquette
1.Business 2.Telephone etiquette 3.Cafeteria etiquette 4.Elevator etiquette 5.Email etiquette
6.Social media etiquette

Module:4	Quantitative Ability-L2	9 hrs

Profit and Loss
1.Cost Price & Selling Price 2.Margins & Markup **Interest**
Calculations
Simple Interest, Compound Interest, Recurring
Mixtures and solutions 1.Ratio & Averages 2.Proportions
Time and Work 1.Pipes & Cisterns, 2.Man Day concept

3.Division Wages **Time Speed and Distance** 1.Average speed, Relative speed, Boats and streams. **Proportions & Variations**		
Module:5	**Reasoning Ability-L2**	**11 hrs**
Logical Reasoning 1.Sequence and series 2.Coding and decoding 3.Directions Visual Reasoning 1.Abstract Reasoning 2.Input Type Diagrammatic Reasoning 3.Spatial reasoning 4.Cubes Data Analysis And Interpretation 1.DI-Tables/Charts/Text		
Module:6	**Verbal Ability-L2** **Grammar**	**9 hrs**
1.Spot the Errors 2.Sentence Correction 3.Gap Filling Exercise 4.Sentence Improvisations 5.Misc. Grammar Exercise		
	Total Lecture Hours	**45 hrs**
Mode of Evaluation: Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)		
Kenneth H. Blanchard and Spencer Johnson(2003) The One Minute Manager. New York. William Morrow& Co David Allen(2002) Getting Things done : The Art of Stress -Free productivity. New York. Simon and Schuster. FACE(2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications ETHNUS(2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd. **Websites: www.chalkstreet.com www.skillsyouneed.com**		

Recommended by Board of Studies	09-06-2017		
Approved by Academic Council	45	Date	15-06-2017

Course code	Preparedness for External Opportunities	L	T	P	J	C
STS3001		3	0	0	0	1
Course Pre-requisites	None	Syllabus Version: v.2.0				

Course Objectives:

- To understand the importance of ethics plotted in exploring the moral landscape to meet global expectations.

Expected Course Outcome:

- Enabling students to acquire skills in preparing for interviews, presentations and higher education

Module:1	Interview skills	3 hrs

Types of interview
1. Structured and unstructured interview orientation
2. Closed questions and hypothetical questions
3. Interviewers' perspective
4. Questions to ask/not ask during an interview

Techniques to face remote interviews
1. Video interview
2.Recorded feedback
3. Phone interview preparation

Mock Interview
1.Tips to customize preparation for personal interview
2. Practice rounds

Module:2	Resume skills	2 hrs

Resume Template
1. Structure of a standard resume
2. Content, color, font

Use of power verbs
1. Introduction to Power verbs and Write up

Types of resume
1. Quiz on types of resume

Customizing resume
1. Frequent mistakes in customizing resume
2. Layout - Understanding different company's requirement
3. Digitizing career portfolio

Module:3	Presentation skills	6 hrs

Preparing presentation
1. 10 Tips to prepare PowerPoint presentation
2. Outlining the content
3. Passing the Elevator Test

Organizing materials
1. Blue sky thinking
2. Introduction , body and conclusion
3. Use of Font, Use of Color

4. Strategic presentation

Maintaining and preparing visual aids

1.Importance and types of visual aids
2.Animation to captivate your audience
3.Design of posters

Dealing with questions

1. Setting out the ground rules
2. Dealing with interruptions
3. Staying in control of the questions

Handling difficult questions

Module:4	**Quantitative Ability-L3**	**14 hrs**

Permutation-Combinations 1.Counting
2.Grouping
3.Linear Arrangement
4.Circular Arrangements **Probability** 1.Conditional Probability
2.Independent and Dependent Events **Geometry and mensuration**
1.Properties of Polygon
2.2D & 3D Figures 3.Area & Volumes **Trigonometry** 1.Heights and distances
2.Simple trigonometric functions
Logarithms 1.Introduction 2.Basic rules **Functions**
1.Introduction 2.Basic rules

Quadratic Equations

1.Understanding Quadratic Equations
2.Rules & probabilities of Quadratic Equations

Set Theory

1.Basic concepts of Venn Diagram

Module:5	**Reasoning ability-L3**	**7 hrs**

Logical reasoning 1.Syllogisms
2.Binary logic
3.Sequential output tracing 4.Crypto arithmetic

Data Analysis and Interpretation

1.Data Sufficiency
2.Data interpretation-Advanced

Interpretation tables, pie charts & bar chats

Module:6	**Verbal Ability-L3**	**8 hrs**

Comprehension and Logic 1.Reading comprehension 2.Para Jumbles
3..Critical Reasoning :
a) Premise and Conclusion
b) Assumption & Inference

Strengthening & Weakening an Argument

Module:7	**Writing skills**	**5 hrs**

Note making

1.What is note making 2.Different ways of note making **Report writing**

1.What is report writing 2.How to write a report 3.Writing a report & work sheet **Product description** 1.Designing a product 2.Understanding it's features 3.Writing a product description **Research paper** 1.Research and it's importance Writing sample research paper		
	Total Lecture Hours	**45 hrs**

Mode of Evaluation: Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)

References

Michael Farra and JIST Editors(2011)Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Saint paul, Minnesota.Jist Works

Daniel Flage Ph.D(2003)The Art of Questioning: An Introduction to Critical Thinking. London. Pearson

David Allen(2002) Getting Things done : The Art of Stress -Free productivity. New York City. Penguin Books.

FACE(2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications ETHNUS(2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd.

Websites: www.chalkstreet.com www.skillsyouneed.com www.mindtools.com www.thebalance.com www.eguru.ooo

Recommended by Board of Studies	09-06-2017		
Approved by Academic Council	45	Date	15-06-2017

Course code	Code Mithra	L	T	P	J	C
STS3005		3	0	0	0	1
Pre-requisite	None	Syllabus version				
		v.2.0				

Course Objectives:

1. To develop logics which will help them to create programs, applications in C.
2. To learn how to design a graphical user interface (GUI) with Java Swing.
3. To present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively.

Expected Course Outcome:

1. Enabling students to write coding in C,C++,Java and DBMS concepts

Module:1	C Programming	15 hours

Introduction to C, Execution and Structure of a C Program, Data Types and Operators, Control Statements, Looping, Arrays, Structure, Pointers, Memory Management in C, Functions.

Module:2	C++ Programming	15 hours

Introduction to C++, Need for OOP, Class & Objects, Create C++ & Java class and show the similarity Encapsulation, Access Specifiers, Relationship, Polymorphism, Exception Handling, Abstract Classes, Interfaces.

Module:3	JAVA	10 hours

Introduction to Java, Data Types and Operators, Control Statements, Looping, Arrays, Need for OOP, Class & Objects, Create C++ & Java class and show the similarity Encapsulation, Access Specifiers, Relationship, Polymorphism, Exception Handling, Abstract Classes, Interfaces.

Module:4	Database	5 hours

Introduction to database, DDL, Data Manipulation, SELECT, Joins.

	Total Lecture hours:	45 hours	

Reference Books

1. Data Structures and Algorithms: https://ece.uwaterloo.ca/~dwharder/aads/Lecture_materials/
2. C Programming: C Programming Absolute Beginner's Guide (3rd Edition) by Greg Perry, Dean Miller
3. Java: Thinking in Java, 4th Edition
4. **Websites: www.eguru.ooo**

Mode of Evaluation: FAT, Assignments, Projects 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	45	Date	15/06/2017

Course code	Preparedness for Recruitment	L	T	P	J	C
STS3007		3	0	0	0	1
Pre-requisite	None	Syllabus version				
		v.2.0				

Course Objectives:

- To enrich the logical thinking ability for better analysis and decision making
- To hone the competence in solving problems and reasoning skills
- To build a good vocabulary and use it in effective communication

Expected Course Outcome:

2. Students will be able to solve mathematical, reasoning and verbal questionnaires

Module:1	Quantitative Ability	15 hours

Time and Work, Time Speed and Distance, Number System, Equations, Percentages, Profit and Loss, Permutation and Combination, Probability, Geometry and Mensuration, Averages, Progression, Allegations and Mixtures, Ages

Module:2	Reasoning Ability	12 hours

Data Arrangement - Linear, Circular and Cross Variable Relationship**,** Data Sufficiency, Data Interpretation - Advanced Interpretation Tables**,** Coding and Decoding, Abstract Reasoning, Input Type Diagrammatic Reasoning, Spatial Reasoning, Cubes, Clocks and Calendar

Module:3	Verbal Ability	18 hours

Vocabulary Building
Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies, Cloze Test.
Comprehension and Logic
Reading comprehension
Para Jumbles
Critical Reasoning :
Premise and Conclusion, Assumption & Inference, Strengthening & Weakening an Argument.
Sentence Correction
Modifiers, parallelism, Verb time sequences, Comparison, Determiners.
Building personal lexicon
Benefits of becoming a logophile, Etymology – Root words, Prefix and suffix.

Text Book(s)

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S.

	Chand Publishing, Delhi.			
Reference Books				
1.	Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.			
Mode of evaluation: Assignments, Projects, Case studies, FAT (Computer Based Test)				
Recommended by Board of Studies		09/06/2017		
Approved by Academic Council		45	Date	15/06/2017

Course code	ESPAÑOL FUNDAMENTAL	L	T	P	J	C
ESP1001		2	0	0	0	2
Pre-requisite	Nil	Syllabus version				
		v.1.0				

Course Objectives:

The course gives students the necessary background to:

- demonstrate Proficiency in reading, writing, and speaking in basic Spanish. Learning vocabulary related to profession, education centres, day today activities, food, culture, sports and hobby, family set up, workplace, market and classroom activities is essential.
- demonstrate the ability to describe things and will be able to translate into English and vice versa.
- describe in simple terms (both in written and oral form) aspects of their background, immediate environment and matters in areas of immediate need.

Expected Course Outcome:

The students will be able to

3. remember greetings, giving personal details and Identify genders by using correct articles
4. apply the correct use of SER, ESTAR and TENER verb for describing people, place and things
5. create opinion about time and weather conditions by knowing months, days and seasons in Spanish
6. create opinion about people and places by using regular verbs
7. apply reflexive verbs for writing about daily routine and create small paragraphs about hometown, best friend and family

Module:1	Abecedario, Saludos y Datos personales: Origen, Nacionalidad, Profesión	**3 hours**

Competencia Gramática: Vocales y Consonantes. Artículos definidos e indefinidos (Numero y Genero).
Competencia Escrita: Saludos y Datos personales

Module:2	Edad y posesión. Números (1-20)	**3 hours**

Competencia Gramática: Pronombres personales. Adjetivos. Los verbos SER y TENER.
Competencia Escrita: Escribe sobre mismo/a y los compañeros de la clase

Module:3	Vocabulario de Mi habitación. Colores. Descripción de lugares y cosas.	**5 hours**

Competencia Gramática: Adjetivos posesivos. El uso del verbo ESTAR. Diferencia entre SER y ESTAR.
Competencia Escrita: Mi habitación

Module:4	Mi familia. Números (21-100).	**5hours**

	Direcciones.Expresar la hora. Los meses del año.	
Competencia Gramática: Frases preposicionales. Uso del HAY. La diferencia entre MUY y MUCHO. Uso del verbo GUSTAR Competencia Escrita: Mi familia. Dar opiniones sobre tiempo		
Module:5	Expresar fechas y el tiempo. Dar opiniones sobre personas y lugares.	**5 hours**
Competencia Gramática: Los verbos regulares (-AR, -ER, -IR) en el presente. Adjetivos demostrativos. Competencia Escrita: Mi mejor amigo/a. Expresar fechas. Traducción ingles a español y Español a Ingles.		
Module:6	Describir el diario. Las actividades cotidianas.	**3 hours**
Competencia Gramática: Los Verbos y pronombres reflexivos. Los verbos pronominales con e/ie, o/ue, e/i, u/ue. Competencia Escrita:El horario. Traducción ingles a español y Español a Ingles.		
Module:7	Dar opiniones sobre comidas y bebidas. Decir lo que está haciendo.Describir mi ciudad y Ubicar los sitios en la ciudad.	**4hours**
Competencia Gramática: Los verbos irregulares. Estar + gerundio. Poder + Infinitivo. Competencia Escrita: Conversación en un restaurante. Traducción ingles a español y Español a Ingles.Mi ciudad natal. Mi Universidad. La clase.Mi fiesta favorita.		
Module:8	**Guest Lectures/ Native Speakers**	**2 hours**
	Total Lecture hours:	**30hours**

Text Book(s)

1.	**Text Book:"Aula Internacional 1", Jaime Corpas, Eva Garcia, Agustin Garmendia, Carmen Soriano GoyalPublication ; reprintedEdition, (2010)**

Reference Books

1	"¡AcciónGramática!", Phil Turk and Mike Zollo, Hodder Murray, London 2006. "Practice makes perfect: Spanish Vocabulary", Dorothy Richmond, McGraw Hill Contemporary, USA,2012.
2	"Practice makes perfect: Basic Spanish", Dorothy Richmond, McGraw Hill Contemporary, USA 2009.
3	"Pasaporte A1 Foundation", Matilde Cerrolaza Aragón, Óscar Cerrolaza Gili, Begoña Llovet Barquero, Edelsa Grupo, España, 2010.

Recommended by Board of Studies	22-02-2016		
Approved by Academic Council	No. 41	Date	17-06-2016

Course code	Français Quotidien	L	T	P	J	C
FRE1001		2	0	0	0	2
Pre-requisite		Syllabus version				
NIL		v.1.0				

Course Objectives:

The course gives students the necessary background to:

1. learn the basics of French language and to communicate effectively in French in their day to day life.
2. Achieve functional proficiency in listening, speaking, reading and writing
3. Recognize culture-specific perspectives and values embedded in French language.

Expected Course Outcome:

The students will be able to :

1. identify in French language the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations and interrogations.
2. communicate effectively in French language via regular / irregular verbs.
3. demonstrate comprehension of the spoken / written language in translating simple sentences.
4. understand and demonstrate the comprehension of some particular new range of unseen written materials
5. demonstrate a clear understanding of the French culture through the language studied

Module:1	Expressions simples	3 hours

Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les Pronoms Sujets, Les Pronoms Toniques, La conjugaison des verbes irréguliers- avoir / être / aller / venir / faire etc.

Savoir-faire pour:

Saluer, Se présenter, Présenter quelqu'un, Etablir des contacts

Module:2	La conjugaison des verbes réguliers	3 hours

La conjugaison des verbes réguliers, La conjugaison des verbes pronominaux, La Négation, L'interrogation avec 'Est-ce que ou sans Est-ce que'.

Savoir-faire pour:

Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.

Module:3	La Nationalité du Pays, L'article (défini/ indéfini), Les prépositions	6 hours

La Nationalité du Pays, L'article (défini/ indéfini), Les prépositions (à/en/au/aux/sur/dans/avec etc.), L'article contracté, Les heures en français, L'adjectif (La Couleur, L'adjectif possessif, L'adjectif démonstratif/ L'adjectif interrogatif (quel/quelles/quelle/quelles), L'accord des adjectifs avec le nom, L'interrogation avec Comment/ Combien / Où etc.

Savoir-faire pour:

Poser des questions, Dire la date et les heures en français,		
Module:4	**La traduction simple**	**4 hours**
La traduction simple :(français-anglais / anglais –français), Savoir-faire pour : Faire des achats, Comprendre un texte court, Demander et indiquer le chemin.		
Module:5	**L'article Partitif, Mettez les phrases aux pluriels**	**5 hours**
L'article Partitif, Mettez les phrases aux pluriels, Faites une phrase avec les mots donnés, Trouvez les questions. Savoir-faire pour : Répondez aux questions générales en français, Exprimez les phrases données au Masculin ou au Féminin, Associez les phrases.		
Module:6	**Décrivez :**	**3 hours**
Décrivez : La Famille / La Maison / L'université /Les Loisirs/ La Vie quotidienne etc.		
Module:7	Dialogue	**4 hours**
Dialogue : 1. Décrire une personne. 2. Des conversations à la cafeteria. 3. Des conversations avec les membres de la famille 4. Des dialogues entre les amis.		
Module:8	**Guest lecures**	**2 hours**
Guest lecures/ Natives speakers		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Fréquence jeunes-1, Méthode de français, G. Capelle et N.Gidon, Hachette, Paris, 2010.
2.	Fréquence jeunes-1, Cahier d'exercices, G. Capelle et N.Gidon, Hachette, Paris, 2010.
Reference Books	
1.	CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau,Les Éditions Didier, 2010.
2	CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2010
3	ALTER EGO 1, Méthode de français, Annie Berthet, Catherine Hugo, Véronique M. Kizirian, Béatrix Sampsonis, Monique Waendendries, Hachette livre Paris 2011
4	ALTER EGO 1, Le cahier d'activités, Annie Berthet, Catherine Hugo, Béatrix Sampsonis, Monique Waendendries , Hachette livre, Paris 2011
Mode of Evaluation: CAT / Assignment / Quiz / Seminar / FAT	

Recommended by Board of Studies	26.02.2016		
Approved by Academic Council	No.41	Date	17.06.2016

Course code	Grundstufe Deutsch	L	T	P	J	C
GER1001		2	0	0	0	2
Pre-requisite	Nil	Syllabus version				
		v.1.0				

Course Objectives:

The course gives students the necessary background to:

1. demonstrate Proficiency in reading, writing, and speaking in basic German. Learning vocabulary related to profession, education centres, day-to-day activities, food, culture, sports and hobby, family set up, workplace, market and classroom activities are essential.
2. make the students industry oriented and make them adapt in the German culture.

Expected Course Outcome:

The students will be able to

1. remember greeting people, introducing oneself and understanding basic expressions in German.
2. understand basic grammar skills to use these in a meaning way.
3. remember beginner's level vocabulary
4. create sentences in German on a variety of topics with significant precision and in detail.
5. apply good comprehension of written discourse in areas of special interests.

Module:1	3 hours

Begrüssung, Landeskunde, Alphabet, Personalpronomen, Verben- heissen, kommen, wohnen, lernen, Zahlen (1-100), W-Fragen, Aussagesätze, Nomen- Singular und Plural, der Artikel - Bestimmter- Unbestimmter Artikel)

Lernziel :

Sich vorstellen, Grundlegendes Verständnis von Deutsch, Deutschland in Europa

Module:2	3 hours

Konjugation der Verben (regelmässig /unregelmässig),das Jahr- Monate, Jahreszeiten und die Woche, Hobbys, Berufe, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit „Sie''

Lernziel:

Sätze schreiben, über Hobbys, Berufe erzählen, usw

Module:3	6 hours

Possessivpronomen, Negation, Kasus (Bestimmter- Unbestimmter Artikel) Trennbareverben, Modalverben, Uhrzeit, Präpositionen, Lebensmittel, Getränkeund Essen, Farben, Tiere

Lernziel :

Sätze mit Modalverben, Verwendung von Artikel, Adjektiv beim Verb

Module:4	4 hours

Übersetzung: (Deutsch – Englisch / Englisch – Deutsch)

Lernziel :

Die Übung von Grammatik und Wortschatz		
Module:5		**5 hours**
Leserverständnis. Mindmap machen, Korrespondenz- Briefe und Email **Lernziel:** Übung der Sprache, Wortschatzbildung		
Module:6		**5 hours**
Aufsätze : Die Familie, Bundesländer in Deutschland, Ein Fest in Deutschland, **Lernziel :** Aktiver, selbständiger Gebrauch der Sprache		
Module:7		**4 hours**
Dialoge: a) Gespräche mit einem/einer Freund /Freundin. b) Gespräche beim Einkaufen ; in einem Supermarkt ; in einer Buchhandlung ; c) in einem Hotel - an der Rezeption ; ein Termin beim Arzt. d) Ein Telefongespräch ; Einladung–Abendessen		
Module:8		**2 hours**
Guest Lectures/ Native Speakers (Einleitung in die deustche Kultur und Politik		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Netzwerk Deutsch als Fremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, Klett-Langenscheidt Verlag, München : 2013
Reference Books	
1.	Lagune, Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, 2012.
2	Deutsche Sprachlehre für Ausländer, Heinz Griesbach, Dora Schulz, 2013
3	Studio d A1, Hermann Funk, Christina Kuhn, CorneslenVerlag, Berlin :2010
4	Tangram Aktuell-I, Maria-Rosa, SchoenherrTil, Max Hueber Verlag, Muenchen :2012
	www.goethe.de wirtschaftsdeutsch.de hueber.de klett-sprachen.de www.deutschtraning.org

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	17.06.2016		
Approved by Academic Council	No.41	Date	17.06.2016

Course code	Chinese for Engineers	L	T	P	J	C
CHI1001		2	0	0	0	2
		Syllabus version				
		v.1.0				

Course Objectives:

The course gives students the necessary background to:

1. develop Chinese cross-cultural communicative competence.
2. understand basic language materials related to common daily settings.
3. Gain introductory Chinese cultural knowledge

Expected Course Outcome:

The students will be able to:

1. remember greeting people in Chinese and use of personal pronouns and interrogative pronouns
2. remember family names and understand yes – no question and correct use of phonetics
3. create expressions related to nationality, place of origin and special questions.
4. remember Occupations in Chinese, Adverbials of time and place and noun and pronouns
5. create expressions related to age, numbers, special questions in Chinese

Module:1	3 hours

- Greetings (Learn the basic ways to greet people, and tell one's own name and other's name)
- The personal pronouns"你，我，他/她，您，您们"

Module 2	3 hours

- Question with the interrogative pronoun."谁"
- Phonetics: Syllable initials:/ n// h/; Syllable finals:/ a //o// e//i/;

Tones: /1// 2 // 3/ /4/

Module:3	4 hours

- Family names, given names (Learn to ask and tell Family names, given names)
- Special questions with"什么"
- The yes-no questions
- Phonetics: Syllable initials:/ b/ / p/ /m/; Syllable finals::/ ai // ao

//ei//en/

Module 4	3 hours

- Nationality and place of one's origin (Learn to ask and tell one's Nationality and origin)
- Using "不" to express negation

Module:5	3 hours

- Special questions with "哪儿"or "什么地方"
- Phonetics: Syllable initials: / b/ / p/ /m/; Syllable finals: /ai // ao// ei // en/

Module:6		**6 hours**
• Occupations (Learn to ask and tell one's occupation) • Adverbials of time and place • Noun/pronoun+"的"+noun • Phonetics: Syllable initials:/ d//t/ /f/; Syllable finals: /u // an// ie //uo/		
Module:7		**6 hours**
• Age(Learn to ask and tell one's age) • The numerals • The special questions with "几" • Phonetics: Syllable initials:/l//g//x/; Syllable finals: /ang //ong//iang// iong/		
Module 8	**Guest Lectures/ Native Speakers**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Great Wall Chinese---Essentials in Communication》 By Beijing Language and Culture University Press
Reference Books	
1.	Liu Xun , (2002) 《New Practical Chinese Reader》 Worbook-1, Beijing, Beijing Language and Culture University Press, ISBN 7-5619-1042-8
2	Liu Fuhua, (2005) 《Chinese Paradise》 Teacher's Book-1, Beijing, Beijing Language and Culture University Press, ISBN 7-5619-1440-0
3	Chen Bo, (2003) 《Learn Chinese With Me》 Teacher's Book-1, Beijing, People's Education Press, ISBN7-107-16684-6
4	Zhai Xun (2007) 《Step By Step Chinese》Intensive Chinese Elementary, Beijing,, Sinolingua, ISBN7-80200-261-6
5	Ma Jianfei (2006)《Great Wall Chinese---Essentials in Communication》 Workbook, Beijing, Beijing Language and Culture University Press, ISBN 7-5619-1622-1
6	Jiang Liping (2014) 《HSK Standard Course 1》Beijing, Beijing Language and Culture University Press, ISBN7-5619-3709-9

Mode of Evaluation: CAT / Assignment / Quiz / Seminar / FAT			
Recommended by Board of Studies	17.06.2016		
Approved by Academic Council	No.41	Date	17.06.2016

Course code	English for Engineers	L	T	P	J	C
ENG1011		0	0	4	0	2
Pre-requisite	Cleared EPT / Effective English	Syllabus version				
		v. 2.2				

Course Objectives:

1. To facilitate effective language skills for academic purposes and real-life situations.
2. To enhance students' language and communication with focus on placement skills development.
3. To aid students apply language and communication skills in professional reading and reporting.

Expected Course Outcome:

1. Apply language skills with ease in academic and real-life situations.
2. Build up a job winning digital foot print and learn to face interviews confidently.
3. Develop good interpreting and reporting skills to aid them in research.
4. Comprehend language and communication skills in academic and social contexts.
5. Acquire vocabulary and learn strategies for error-free communication.

Module:1	**Listening**	**4 hours**
Casual and Academic		
Module:2	**Speaking**	**4 hours**
Socializing Skills - Introducing Oneself- His / Her Goals & SWOT		
Module:3	**Reading**	**2 hours**
Skimming and Scanning		
Module:4	**Writing**	**2 hours**
Error-free sentences, Paragraphs		
Module:5	**Listening**	**4 hours**
News (Authentic Material): Analyzing General and Domain Specific Information		
Module:6	**Speaking**	**4 hours**
Group Discussion on factual, controversial and abstract issues		
Module:7	**Reading:**	**2 hours**
Extensive Reading		
Module:8	**Writing**	**2 hours**
Email Etiquette with focus on Content and Audience		
Module:9	**Listening**	**4 hours**

Speeches : General and Domain Specific Information		
Module:10	**Speaking**	**4 hours**
Developing Persuasive Skills - Turncoat and Debate		
Module:11	**Reading**	**2 hours**
Intensive Reading		
Module:12	**Writing**	**2 hours**
Data Transcoding		
Module:13	**Cross Cultural Communication**	**4 hours**
Understanding Inter and Cross-Cultural Communication Nuances		
Module:14	**Speaking**	**4 hours**
Public Speaking/Extempore /Monologues		
Module:15	**Reading for research**	**2 hours**
Reading Scientific/Technical Articles		
Module:16	**Writing**	**2 hours**
Creating a Digital/Online Profile – LinkedIn (Résumé/Video Profile)		
Module:17	**Speaking:**	**4 hours**
Mock Job/Placement Interviews		
Module:18	**Writing**	**2 hours**
Report Writing		
Module:19	**Speaking**	**4 hours**
Presentation using Digital Tools		
Module:20	**Vocabulary**	**2 hours**
Crossword Puzzles/Word games		
	Total Lecture hours:	**60 hours**

Text Book(s)

1. Clive Oxenden and Christina Latham-Koenig, New English File: Advanced: Teacher's Book with Test and Assessment CD-ROM: Six-level general English course for adults Paperback –Feb 2013, Oxford University Press, UK
2. Clive Oxenden and Christina Latham-Koenig,New English File: Advance Students Book Paperback – Feb 2012, Oxford University Press, UK
3. Michael Vince, Language Practice for Advanced - Students Book, Feb. 2014, 4th Edition,

	Macmillan Education, Oxford, United Kingdom
Reference Books	
1.	Steven Brown, Dorolyn Smith, Active Listening 3, 2011, 3rd Edition, Cambridge University Press,UK
2.	Tony Lynch, Study Listening, 2013, 2nd Edition, Cambridge University Press, UK
3.	Liz Hamp-Lyons, Ben Heasley, Study Writing, 2010, 2nd Edition, Cambridge University Press, UK
4.	Kenneth Anderson, Joan Maclean, Tony Lynch, Study Speaking, 2013, 2nd Edition, Cambridge, University Press, UK
5.	Eric H. Glendinning, Beverly Holmstrom, Study Reading, 2012, 2nd Edition Cambridge University Press, UK
6.	Michael Swan, Practical English Usage (Practical English Usage), Jun 2017, 4th edition, Oxford University Press, UK
7.	Michael McCarthy, Felicity O'Dell, English Vocabulary in Use Advanced (South Asian Edition), May 2015, Cambridge University Press, UK
8.	Michael Swan, Catherine Walter, Oxford English Grammar Course Advanced, Feb 2012, 4th Edition, Oxford University Press, UK
9.	Heather Silyn-Roberts, Writing for Science and Engineering: Papers, Presentations and Reports, Jun 2016, 2nd Edition, Butterworth-Heinemann, UK
Mode of Evaluation: Assignment and FAT- Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities	

List of Challenging Experiments (Indicative)		
1.	Create a Digital or Online Profile or a Digital Footprint	6 hours
2.	Prepare a video resume	8 hours
3.	Analyse a documentary critically	4 hours
4.	Turn Coat- Speaking for and against the topic / Activities through VIT Community Radio	6 hours
5.	Present a topic using 'Prezi'	6 hours
6.	Analyse a case on cross cultural communication critically	6 hours
7.	Create a list of words relating to your domain	4 hours
8.	Listen to a conversation of native speakers of English and answer the following questions	6 hours
9.	Read an article and critically analyse the text in about 150 words	6 hours
10.	Read an autobiography and role play the character in class by taking an excerpt from the book	8 hours
	Total Practical Hours	**60 hours**

Mode of assessment:			
Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 47	Date	24.08.2017

Course code	Problem Solving and Programming	L	T	P	J	C
CSE1001		0	0	6	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To develop broad understanding of computers, programming languages and their generations
2. Introduce the essential skills for a logical thinking for problem solving
3. To gain expertise in essential skills in programming for problem solving using computer

Expected Course Outcome:

1.Understand the working principle of a computer and identify the purpose of a computer programming language
2. Learn various problem solving approaches and ability to identify an appropriate approach to solve the problem
3. Validate the program against file inputs towards solving the problem
4. Solve various engineering problems using different data structures
5. Able to modulate the given problem using structural approach of programming
6. Eefficiently handle data using at les to process and store data for the given problem

List of Challenging Experiments (Indicative)

1.Steps in Problem Solving Drawing Flowchart using yEd tool/Raptor Tool	4 hours
2. Introduction to Python, Demo on IDE, Keywords, Identifiers, I/O Statements,Simple Program to display Hello world in Python.	4 hours
3. Operators and Expressions in Python	4 hours
4. Algorithmic Approach 1: Sequential	2
5.Algorithmic Approach 2: Selection (if, elif, if.. else, nested if Else	2 hours
6. Algorithmic Approach 3: Iteration (while and for)	4 hours
7. Strings and its Operations	2 hours
8.Regular Expressions	2 hours
9.List and its operations.	2 hours
10.Dictionaries: operations	2 hours
11. Tuples and its operations	2 hours
12.Set and its operations	2 hours
13. Functions, Recursions	2 hours
14. Sorting Techniques (Bubble/Selection/Insertion)	4 hours

15. Searching Techniques : Sequential Search and Binary Search			3 hours
16. Files and its Operations			4 hours
		Total Laboratory hours	**45 hours**
Text Book(s)			
1.	John V. Guttag., 2016. Introduction to computation and programming using python: with applications to understanding data. PHI Publisher.		
Reference Books			
1.	Charles Severance.2016.Python for everybody: exploring data in Python 3, Charles Severance.		
2	Charles Dierbach.2013.Introduction to computer science using python: a computational problem-solving focus. Wiley Publishers.Mode of Evaluation: PAT / CAT/ FAT		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	04-04-2014		
Approved by Academic Council	38th	Date	23-10-2015

CSE1002	Problem Solving and Object Oriented Programming	L	T	P	J	C
		0	0	6	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To emphasize the benefits of object oriented concepts
2. To enable the students to solve the real time applications using object oriented programming features.
3. To improve the skills of a logical thinking and to solve the problems using any processing elements

Expected Course Outcome:

1. Recall the basics of procedural programming and to represent the real world entities as programming constructs
2. Enumerate object oriented concepts and translate real-world applications into graphical representations
3. Demonstrate the usage of classes and objects of the real world entities in applications
4. Discriminate the reusability and multiple interfaces with same functionality based features to solve complex computing problems
5. Propose possible error-handling constructs for unanticipated states/inputs and to use generic programming constructs to accommodate different datatypes
6. Validate the program against file inputs towards solving the problem

Module:1	Structured Programming	12 hours

Structured Programming conditional and looping statements-arrays – functions - pointers – dynamic memory allocation - structure

Module:2	Introduction to object oriented approach	10 hours

Introduction to object oriented approach: Why object oriented programming?- Characteristics of object oriented language: classes and objects - encapsulation-data abstraction- inheritance - polymorphism - Merits and Demerits of object oriented programming. UML- class diagram of OOP - Inline function – default argument function- Exception handling (Standard) - reference: independent reference – function returning reference – pass by reference.

Module:3	Classes and objects	14 hours

Classes and objects: Definition of classes – access specifier – class versus structure – constructor – destructor – copy constructor and its importance – array of objects – dynamic objects- friend function-friend class

Module:4	Polymorphism and Inheritance	26 hours

Polymorphism and Inheritance: Polymorphism-compile time polymorphism – function overloading – operator overloading - . Inheritance-types of inheritance- constructors and destructors in inheritance – constraints of multiple inheritance-virtual base class - run time polymorphism-

function overriding.			
Module:5	**Exception handling and Templates**		**18 hours**
Exception handling and Templates Exception handling(user-defined exception)- Function template , Class template – Template with inheritance , STL – Container, Algorithm, Iterator -vector, list, stack, map.			
Module:6	**IO Streams and Fi les**		**10 hours**
IOstreams and Files IOstreams, Manipulators- overloading Inserters(<<) and Extractors(>>)Sequential and Random files – writing and reading objects into/from files			
	Total Lab hours:	**90 hours**	

Text Book(s)	
1.	Stanley B Lippman, Josee Lajoie, Barbara E, Moo, "C++ primer", Fifth edition, Addison-Wesley, 2012.
2.	Ali Bahrami, Object oriented Systems development, Tata McGraw - Hill Education, 1999
3.	Brian W. Kernighan, Dennis M. Ritchie , The „C" programming Language, 2nd edition, Prentice Hall Inc., 1988.
Reference Books	
1.	Bjarne stroustrup, The C++ programming Language, Addison Wesley, 4th edition, 2013
2.	Harvey M. Deitel and Paul J. Deitel, C++ How to Program, 7th edition, Prentice Hall, 2010.
3.	Maureen Sprankle and Jim Hubbard, Problem solving and Programming concepts, 9th edition, Pearson Eduction, 2014
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
List of Challenging Experiments (Indicative)	
1.	**Postman Problem** A postman needs to walk down every street in his area in order to deliver the mail. Assume that the distances between the streets along the roads are given. The postman starts at the post office and returns back to the post office after delivering all the mails. Implement an algorithm to help the post man to walk minimum distance for the purpose.
2.	**Budget Allocation for Marketing Campaign** A mobile manufacturing company has got several marketing options such as Radio advertisement campaign, TV non peak hours campaign, City top paper network, Viral marketing campaign, Web advertising. From their previous experience, they have got a statistics about paybacks for each marketing option. Given the marketing budget (rupees in crores) for the current year and details of paybacks for each option, implement an algorithm to determine the amount that shall spent on each marketing option so that the company attains the maximum profit.
3.	**Missionaries and Cannibals** Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Implement an algorithm to find a way to get everyone to the other side of the river, without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place.
4.	**Register Allocation Problem**

	A register is a component of a computer processor that can hold any type of data and can be accessed faster. As registers are faster to access, it is desirable to use them to the maximum so that the code execution is faster. For each code submitted to the processor, a register interference graph (RIG) is constructed. In a RIG, a node represents a temporary variable and an edge is added between two nodes (variables) t1 and t2 if they are live simultaneously at some point in the program. During register allocation, two temporaries can be allocated to the same register if there is no edge connecting them. Given a RIG representing the dependencies between variables in a code, implement an algorithm to determine the number of registers required to store the variables and speed up the code execution.
5.	**Selective Job Scheduling Problem** A server is a machine that waits for requests from other machines and responds to them. The purpose of a server is to share hardware and software resources among clients. All the clients submit the jobs to the server for execution and the server may get multiple requests at a time. In such a situation, the server schedule the jobs submitted to it based on some criteria and logic. Each job contains two values namely time and memory required for execution. Assume that there are two servers that schedules jobs based on time and memory. The servers are named as Time_Schedule_Server and memory_Schedule_Server respectively. Design a OOP model and implement the time_Schedule_Server and memory_Schedule_Server. The Time_Schedule_Server arranges jobs based on time required for execution in ascending order whereas memory_Schedule_Server arranges jobs based on memory required for execution in ascending order.
6.	**Fragment Assembly in DNA Sequencing:** DNA, or deoxyribonucleic acid, is the hereditary material in humans and almost all other organisms. The information in DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). In DNA sequencing, each DNA is sheared into millions of small fragments (reads) which assemble to form a single genomic sequence ("superstring"). Each read is a small string. In such a fragment assembly, given a set of reads, the objective is to determine the shortest superstring that contains all the reads. For example, given a set of strings, {000, 001, 010, 011, 100, 101, 110, 111} the shortest superstring is 0001110100. Given a set of reads, implement an algorithm to find the shortest superstring that contains all the given reads.
7.	**House Wiring :** An electrician is wiring a house which has many rooms. Each room has many power points in different locations. Given a set of power points and the distances between them, implement an algorithm to find the minimum cable required.

		Total Laboratory Hours	90 hours
Recommended by Board of Studies	29-10-2015		
Approved by Academic Council	No. 39	Date	17-12-2015

Course Code	Course Title	L	T	P	J	C
MAT-1011	**Calculus for Engineers**	3	0	2	0	4
Pre-requisite	**10+2 Mathematics or MAT1001**			**Syllabus Version**		
				v.1.0		

Course Objectives (CoB):

1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.
2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.
3. To impart the knowledge of Laplace transform, an important transform technique for Engineers which requires knowledge of integration

Course Outcome (CO):

At the end of this course the students should be able to

1. apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions
2. understand basic concepts of Laplace Transforms and solve problems with periodic functions, step functions, impulse functions and convolution
3. evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints
4. evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.
5. understand gradient, directional derivatives, divergence, curl and Greens', Stokes, Gauss theorems
6. demonstrate MATLAB code for challenging problems in engineering

Module:1	**Application of Single Variable Calculus**	**9 hours**

Differentiation- Extrema on an Interval-Rolle's Theorem and the Mean Value Theorem-Increasing and Decreasing functions and First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution -

Module:2	**Laplace transforms**	**7 hours**

Definition of Laplace transform-Properties-Laplace transform of periodic functions-Laplace transform of unit step function, Impulse function-Inverse Laplace transform-Convolution.

Module:3	**Multivariable Calculus**	**4 hours**

Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and its properties.

Module:4	**Application of Multivariable Calculus**	**5 hours**

Taylor's expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange's multiplier method.

Module:5	**Multiple integrals**	**8 hours**

Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - Evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates- Beta and Gamma functions–interrelation - evaluation of multiple integrals using gamma and beta functions.			
Module:6	**Vector Differentiation**		**5 hours**
Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials–Statement of vector identities-Simple problems			
Module:7	**Vector Integration**		**5 hours**
line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems -verification and evaluation of vector integrals using them.			
Module:8	**Contemporary Issues:**		**2 hours**
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	
Text Book(s)			
[1] Thomas' Calculus, George B.Thomas, D.Weir and J. Hass, 13th edition, Pearson, 2014. [2] Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley India, 2015.			
Reference Books			
1. Higher Engineering Mathematics, B.S. Grewal, 43rd Edition ,Khanna Publishers, 2015 2. Higher Engineering Mathematics, John Bird, 6th Edition, Elsevier Limited, 2017. 3. Calculus: Early Transcendentals, James Stewart, 8th edition, Cengage Learning, 2017. 4. Engineering Mathematics, K.A.Stroud and Dexter J. Booth, 7th Edition, Palgrave Macmillan (2013)			
Mode of Evaluation			
Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test			

List of Challenging Experiments (Indicative)		**CO: 6**
1.	Introduction to MATLAB through matrices, and general Syntax	2 hours
2	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB	2 hours
3.	Evaluating Extremum of a single variable function	2 hours
4.	Understanding integration as Area under the curve	2 hours
5.	Evaluation of Volume by Integrals (Solids of Revolution)	2 hours
6.	Evaluating maxima and minima of functions of several variables	2 hours
7.	Applying Lagrange multiplier optimization method	2 hours
8.	Evaluating Volume under surfaces	2 hours
9.	Evaluating triple integrals	2 hours
10.	Evaluating gradient, curl and divergence	2 hours
11.	Evaluating line integrals in vectors	2 hours
12.	Applying Green's theorem to real world problems	2 hours
	Total Laboratory Hours	**24 hours**

Mode of Evaluation:			
Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course Code	Statistics for Engineers	L	T	P	J	C
MAT2001		3	0	2	0	4
Prerequisites	MAT1011 – Calculus for Engineers	Syllabus Version: v.1.0				

Course Objectives:

1. To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations.
2. To analyse distributions and relationship of real-time data.
3. To apply estimation and testing methods to make inference and modelling techniques for decision making.

Course Outcome:

At the end of the course the student should be able to:

1. Compute and interpret descriptive statistics using numerical and graphical techniques.
2. Understand the basic concepts of random variables and find an appropriate distribution for analysing data specific to an experiment.
3. Apply statistical methods like correlation, regression analysis in analysing, interpreting experimental data.
4. Make appropriate decisions using statistical inference that is the central to experimental research.
5. Use statistical methodology and tools in reliability engineering problems.
6. demonstrate R programming for statistical data

	Topics	Lecture Hrs	
Module: 1	**Introduction to Statistics**		**6 hours**
Introduction to statistics and data analysis-Measures of central tendency –Measures of variability-[Moments-Skewness-Kurtosis (Concepts only)].			
Module: 2	**Random variables**		**8 hours**
Introduction -random variables-Probability mass Function, distribution and density functions - joint Probability distribution and joint density functions- Marginal, conditional distribution and density functions- Mathematical expectation, and its properties Covariance , moment generating function – characteristic function.			
Module: 3	**Correlation and regression**		**4 hours**
Correlation and Regression – Rank Correlation- Partial and Multiple correlation- Multiple regression.			
Module: 4	**Probability Distributions**		**7 hours**
Binomial and Poisson distributions – Normal distribution – Gamma distribution – Exponential distribution – Weibull distribution.			
Module: 5	**Hypothesis Testing I**		**4 hours**
Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis-Large sample tests- Z test for Single Proportion, Difference of Proportion, mean and difference of means.			
Module: 6	**Hypothesis Testing II**		**9 hours**
Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – one and two way classifications -			

CRD-RBD- LSD.			
Module: 7	**Reliability**		5 hours
Basic concepts- Hazard function-Reliabilities of series and parallel systems- System Reliability - Maintainability-Preventive and repair maintenance- Availability.			
Module: 8	**Contemporary Issues**		2 hours
Industry Expert Lecture			
	Total Lecture hours	45 hours	

Text book(s)

- Probability and Statistics for engineers and scientists, R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
- Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th Edition, John Wiley & Sons (2016).

Reference books

- Reliability Engineering, E.Balagurusamy, Tata McGraw Hill, Tenth reprint 2017.
- Probability and Statistics, J.L.Devore, 8th Edition, Brooks/Cole, Cengage Learning (2012).
- Probability and Statistics for Engineers, R.A.Johnson, Miller Freund's, 8th edition, Prentice Hall India (2011).
- Probability, Statistics and Reliability for Engineers and Scientists, Bilal M. Ayyub and Richard H. McCuen, 3rd edition, CRC press (2011).

Mode of Evaluation

Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test.

List of Experiments (Indicative)			
•	Introduction: Understanding Data types; importing/exporting data.	2 hours	
•	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations.	2 hours	
•	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination.	2 hours	
•	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficient of determination.	2 hours	
•	Fitting the following probability distributions: Binomial distribution	2 hours	
•	Normal distribution, Poisson distribution	2 hours	
•	Testing of hypothesis for One sample mean and proportion from real-time problems.	2 hours	
•	Testing of hypothesis for Two sample means and proportion from real-time problems	2 hours	
•	Applying the t test for independent and dependent samples	2 hours	
•	Applying Chi-square test for goodness of fit test and Contingency test to real dataset	2 hours	
•	Performing ANOVA for real dataset for Completely	2 hours	

	randomized design, Randomized Block design ,Latin square Design		
	Total laboratory hours	22 hours	
Mode of Evaluation			
Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course code	Engineering Physics	L	T	P	J	C
PHY1701		3	0	2	0	4
Pre-requisite	Physics of 12th standard or equivalent	Syllabus version				
		v.2.1				

Course Objectives:

To enable the students to understand the basics of the latest advancements in Physics viz., Quantum Mechanics, Nanotechnology, Lasers, Electro Magnetic Theory and Fiber Optics.

Expected Course Outcome:

1. To understand the dual nature of radiation and matter.
2. To apply Schrodinger's equations to solve finite and infinite potential problems.
3. To apply quantum ideas at the nanoscale.
4. To apply quantum ideas for understanding the operation and working principle of optoelectronic devices.
5. To analyze the Maxwell's equations in differential and integral form.
6. To classify the optical fiber for different Engineering applications.
7. To apply concept of Lorentz Transformation for Engineering applications.
8. To demonstrate the quantum mechanical ideas – LAB

Module:1	Introduction to Modern Physics		6 hours

Planck's concept (hypothesis), Compton Effect, Particle properties of wave: Matter Waves, Davisson Germer Experiment, Heisenberg Uncertainty Principle, Wave function, and Schrodinger equation (time dependent & independent).

Module:2	Applications of Quantum Physics		5 hours

Particle in a 1-D box (Eigen Value and Eigen Function), 3-D Analysis (Qualitative), Tunneling Effect (Qualitative) (AB 205), Scanning Tunneling Microscope (STM).

Module:3	Nanophysics		5 hours

Introduction to Nano-materials, Moore's law, Properties of Nano-materials, Quantum confinement, Quantum well, wire & dot, Carbon Nano-tubes (CNT), Applications of nanotechnology in industry.

Module:4	Laser Principles and Engineering Application		6 hours

Laser Characteristics, Spatial and Temporal Coherence, Einstein Coefficient & its significance, Population inversion, Two, three & four level systems, Pumping schemes, Threshold gain coefficient, Components of laser, Nd-YAG, He-Ne, CO2 and Dye laser and their engineering applications.

Module:5	Electromagnetic Theory and its application		6 hours

Physics of Divergence, Gradient and Curl, Qualitative understanding of surface and volume integral, Maxwell Equations (Qualitative), Wave Equation (Derivation), EM Waves, Phase velocity, Group velocity, Group index , Wave guide (Qualitative)

Module:6	**Propagation of EM waves in Optical fibers and Optoelectronic Devices**		**10 hours**
Light propagation through fibers, Acceptance angle, Numerical Aperture, Types of fibers - step index, graded index, single mode & multimode, Attenuation, Dispersion-intermodal and intramodal. Sources-LED & Laser Diode, Detectors-Photodetectors- PN & PIN - Applications of fiber optics in communication- Endoscopy.			
Module:7	**Special Theory of Relativity**		**5 hours**
Frame of reference, Galilean relativity, Postulate of special theory of relativity, Simultaneity, length contraction and time dilation.			
Module:8	**Contemporary issues:**		**2 hours**
Lecture by Industry Experts			
	Total Lecture hours:	**45 hours**	

Text Book(s)

1. Arthur Beiser et al., Concepts of Modern Physics, 2013, Sixth Edition, Tata McGraw Hill.
2. William Silfvast, Laser Fundamentals, 2008, Cambridge University Press.
3. D. J. Griffith, Introduction to Electrodynamics, 2014, 4th Edition, Pearson.
4. Djafar K. Mynbaev and Lowell L.Scheiner, Fiber Optic Communication Technology, 2011, Pearson

Reference Books

1. Raymond A. Serway, Clement J. Mosses, Curt A. Moyer Modern Physics, 2010, 3rd Indian Edition Cengage learning.
2. John R. Taylor, Chris D. Zafiratos and Michael A. Dubson, Modern Physics for Scientists and Engineers, 2011, PHI Learning Private Ltd.
3. Kenneth Krane Modern Physics, 2010, Wiley Indian Edition.
4. Nityanand Choudhary and Richa Verma, Laser Systems and Applications, 2011, PHI Learning Private Ltd.
5. S. Nagabhushana and B. Sathyanarayana, Lasers and Optical Instrumentation, 2010, I.K. International Publishing House Pvt. Ltd.,
6. R. Shevgaonkar, Electromagnetic Waves, 2005, 1st Edition, Tata McGraw Hill
7. Principles of Electromagnetics, Matthew N.O. Sadiku, 2010, Fourth Edition, Oxford.
8. Ajoy Ghatak and K. Thyagarajan, Introduction to Fiber Optics, 2010, Cambridge University Press.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Experiments

1.	Determination of Planck's constant using electroluminescence process	2 hrs
2.	Electron diffraction	2 hrs
3.	Determination of wavelength of laser source (He -Ne laser and diode lasers of different wavelengths) using diffraction technique	2 hrs
4.	Determination of size of fine particle using laser diffraction	2 hrs

5.	Determination of the track width (periodicity) in a written CD	2 hrs
6.	Optical Fiber communication (source + optical fiber + detector)	2 hrs
7.	Analysis of crystallite size and strain in a nano -crystalline film using X-ray diffraction	2 hrs
8.	Numerical solutions of Schrödinger equation (e.g. particle in a box problem) (can be given as an assignment)	2 hrs
9.	Laser coherence length measurement	2 hrs
10.	Proof for transverse nature of E.M. waves	2 hrs
11.	Quantum confinement and Heisenberg's uncertainty principle	2 hrs
12.	Determination of angle of prism and refractive index for various colour – Spectrometer	2 hrs
13.	Determination of divergence of a laser beam	2 hrs
14.	Determination of crystalline size for nanomaterial (Computer simulation)	2 hrs
15.	Demonstration of phase velocity and group velocity (Computer simulation)	2 hrs
	Total Laboratory Hours	**30 hrs**

Mode of evaluation: CAT / FAT			
Recommended by Board of Studies	04-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course code	Engineering Chemistry	L	T	P	J	C
CHY1701		3	0	2	0	4
Pre-requisite	Chemistry of 12th standard or equivalent	Syllabus version				
		1.1				

Course Objectives:

1. To impart technological aspects of applied chemistry
2. To lay foundation for practical application of chemistry in engineering aspects

Expected Course Outcomes (CO):

Students will be able to

1. Recall and analyze the issues related to impurities in water and their removal methods and apply recent methodologies in water treatment for domestic and industrial usage
2. Evaluate the causes of metallic corrosion and apply the methods for corrosion protection of metals
3. Evaluate the electrochemical energy storage systems such as lithium batteries, fuel cells and solar cells, and design for usage in electrical and electronic applications
4. Assess the quality of different fossil fuels and create an awareness to develop the alternative fuels
5. Analyze the properties of different polymers and distinguish the polymers which can be degraded and demonstrate their usefulness
6. Apply the theoretical aspects: (a) in assessing the water quality; (b) understanding the construction and working of electrochemical cells; (c) analyzing metals, alloys and soil using instrumental methods; (d) evaluating the viscosity and water absorbing properties of polymeric materials

Module:1	Water Technology		5 hours

Characteristics of hard water - hardness, DO, TDS in water and their determination – numerical problems in hardness determination by EDTA; Modern techniques of water analysis for industrial use - Disadvantages of hard water in industries.

Module:2	Water Treatment		8 hours

Water softening methods: - Lime-soda, Zeolite and ion exchange processes and their applications. Specifications of water for domestic use (ICMR and WHO); Unit processes involved in water treatment for municipal supply - Sedimentation with coagulant- Sand Filtration - chlorination; Domestic water purification – Candle filtration- activated carbon filtration; Disinfection methods- Ultrafiltration, UV treatment, Ozonolysis, Reverse Osmosis; Electro dialysis.

Module:3	Corrosion		6 hours

Dry and wet corrosion - detrimental effects to buildings, machines, devices & decorative art forms, emphasizing Differential aeration, Pitting, Galvanic and Stress corrosion cracking; Factors that enhance corrosion and choice of parameters to mitigate corrosion.

Module:4	Corrosion Control		4 hours

Corrosion protection - cathodic protection – sacrificial anodic and impressed current protection

methods; Advanced protective coatings: electroplating and electroless plating, PVD and CVD.
Alloying for corrosion protection – Basic concepts of Eutectic composition and Eutectic mixtures - Selected examples – Ferrous and non-ferrous alloys.

Module:5	**Electrochemical Energy Systems**		**6 hours**

Brief introduction to conventional primary and secondary batteries; High energy electrochemical energy systems: Lithium batteries – Primary and secondary, its Chemistry, advantages and applications.
Fuel cells – Polymer membrane fuel cells, Solid-oxide fuel cells- working principles, advantages, applications.
Solar cells – Types – Importance of silicon single crystal, polycrystalline and amorphous silicon solar cells, dye sensitized solar cells - working principles, characteristics and applications.

Module:6	**Fuels and Combustion**		**8 hours**

Calorific value - Definition of LCV, HCV. Measurement of calorific value using bomb calorimeter and Boy's calorimeter including numerical problems.
Controlled combustion of fuels - Air fuel ratio – minimum quantity of air by volume and by weight-Numerical problems-three way catalytic converter- selective catalytic reduction of NO_X; Knocking in IC engines-Octane and Cetane number - Antiknocking agents.

Module:7	**Polymers**		**6 hours**

Difference between thermoplastics and thermosetting plastics; Engineering application of plastics - ABS, PVC, PTFE and Bakelite; Compounding of plastics: moulding of plastics for Car parts, bottle caps (Injection moulding), Pipes, Hoses (Extrusion moulding), Mobile Phone Cases, Battery Trays, (Compression moulding), Fibre reinforced polymers, Composites (Transfer moulding), PET bottles (blow moulding);

Conducting polymers- Polyacetylene- Mechanism of conduction – applications (polymers in sensors, self-cleaning windows)

Module:8	**Contemporary issues:**		**2 hours**
Lecture by Industry Experts			
	Total Lecture hours:	**45 hours**	

Text Book(s)

1. Sashi Chawla, A Text book of Engineering Chemistry, Dhanpat Rai Publishing Co., Pvt. Ltd., Educational and Technical Publishers, New Delhi, 3rd Edition, 2015.
2. O.G. Palanna, McGraw Hill Education (India) Private Limited, 9th Reprint, 2015.
3. B. Sivasankar, Engineering Chemistry 1st Edition, Mc Graw Hill Education (India), 2008
4. "Photovoltaic solar energy : From fundamentals to Applications", AngÃ¨le Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Wiley publishers, 2017.

Reference Books

1. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.
2. S. S. Dara, A Text book of Engineering Chemistry, S. Chand & Co Ltd., New Delhi, 20th Edition, 2013.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT

List of Experiments		
1.	Water Purification: Estimation of water hardness by EDTA method and its	1 h 30 min

	removal by ion-exchange resin	
2. 3.	Water Quality Monitoring: Assessment of total dissolved oxygen in different water samples by Winkler's method Estimation of sulphate / chloride in drinking water by conductivity method	3 h
4/5	Material Analysis: Quantitative colorimetric determination of divalent metal ions of Ni/Fe/Cu using conventional and smart phone digital-imaging methods	**3h**
6.	Analysis of Iron in carbon steel by potentiometry	1 h 30 min
7.	Construction and working of an Zn-Cu electrochemical cell	1 h 30 min
8.	Determination of viscosity-average molecular weight of different natural/ synthetic polymers	1 h 30 min
9.	Arduino microcontroller based sensor for monitoring temperature / conductivity in samples.	1 h 30 min
	Total Laboratory Hours	**17 hours**
Mode of Evaluation: Viva-voce and Lab performance & FAT		
Recommended by Board of Studies	31-05-2019	
Approved by Academic Council	55 Date 13-06-2019	

Course code	Ethics and Values	L	T	P	J	C
HUM1021		2	0	0	0	2
Pre-requisite	Nil	Syllabus version				
		v.1.1				

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity
2. To understand the negative health impacts of certain unhealthy behaviors
3. To appreciate the need and importance of physical, emotional health and social health

Expected Course Outcome:

Students will be able to:

1. Follow sound morals and ethical values scrupulously to prove as good citizens
2. Understand various social problems and learn to act ethically
3. Understand the concept of addiction and how it will affect the physical and mental health
4. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
5. Identify the main typologies, characteristics, activities, actors and forms of cybercrime

Module:1	Being Good and Responsible	5 hours

Gandhian values such as truth and non-violence – Comparative analysis on leaders of past and present – Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society

Module:2	Social Issues 1	4 hours

Harassment – Types - Prevention of harassment, Violence and Terrorism

Module:3	Social Issues 2	4 hours

Corruption: Ethical values, causes, impact, laws, prevention – Electoral malpractices;
White collar crimes - Tax evasions – Unfair trade practices

Module:4	Addiction and Health	5 hours

Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides;
Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases

Module:5	Drug Abuse	3 hours

Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention

Module:6	Personal and Professional Ethics	4 hours

Dishonesty - Stealing - Malpractices in Examinations – Plagiarism			
Module:7	**Abuse of Technologies**		**3 hours**
Hacking and other cybercrimes, Addiction to mobile phone usage, Video games and Social networking websites			
Module:8	**Contemporary issues:**		**2 hours**
Guest lectures by Experts			
	Total Lecture hours:	**30 hours**	

Reference Books

1. Dhaliwal, K.K , "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts,2016, Writers Choice, New Delhi, India.
2. Vittal, N, "Ending Corruption? - How to Clean up India?", 2012, Penguin Publishers, UK.
3. Pagliaro, L.A. and Pagliaro, A.M, "Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological , Developmental and Clinical Considerations", 2012Wiley Publishers, U.S.A.
4. Pandey, P. K (2012), "Sexual Harassment and Law in India", 2012, Lambert Publishers, Germany.

Mode of Evaluation: CAT, Assignment, Quiz, FAT and Seminar			
Recommended by Board of Studies	26-07-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Lean Start-Up Management	L	T	P	J	C
MGT1022		1	0	0	4	2
Pre-requisite	Nil	Syllabus version				
		v. 2.2				

Course Objectives:

The objective of the course is to make a student to create and commercialize the product

Expected Course Outcome:

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

1. Understand developing business models and growth drivers
2. Use the business model canvas to map out key components of enterprise
3. Analyze market size, cost structure, revenue streams, and value chain
4. Understand build-measure-learn principles
5. Foreseeing and quantifying business and financial risks

Module:1		**2 hours**

Creativity and Design Thinking (identify the vertical for business opportunity, understand your customers, accurately assess market opportunity)

Module:2		**3 hours**

Minimum Viable Product (Value Proposition, Customer Segments, Build-measure-learn process)

Module:3		**3 hours**

Business Model Development(Channels and Partners, Revenue Model and streams, Key Resources, Activities and Costs, Customer Relationships and Customer Development Processes, Business model canvas –the lean model-templates)

Module:4		**3 hours**

Business Plan and Access to Funding(visioning your venture, taking the product/ service to market, Market plan including Digital & Viral Marketing, start-up finance - Costs/Profits & Losses/cash flow, Angel/VC,/Bank Loans and Key elements of raising money)

Module:5		**2 hours**

Legal, Regulatory, CSR, Standards, Taxes

Module:6	**Contemporary discussion**	**2 hours**

	Total Lecture hours:	**15 hours**

Text Book(s)	
1.	Steve Blank, K & S Ranch (2012)The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, 1st edition
2.	Steve Blank (2013)The Four Steps to the Epiphany, K&S Ranch; 2nd edition
3.	Eric Ries (2011) The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Crown Business
Reference Books	
1.	Steve Blank (2014) Holding a Cat by the Tail, , K&S Ranch Publishing LLC
2.	Karal T Ulrich, Product Design and Development, SDEppinger, McGraw Hill
3.	Peter Thiel, (2014) Zero to One: Notes on Startups, or How to Build the Future, Crown Business;
4.	Lean Analytics: Use Data to Build a Better Startup Faster(Lean Series), Alistair Croll & Benjamin Yoskovitz,O'Reilly Media; 1stEdition
5.	Marty Cagan, (2008) Inspired: How To Create Products Customers Love, SVPG Press; 1stedition

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Introduction to Innovative Projects	L	T	P	J	C
PHY1999		1	0	0	4	2
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

This course is offered to the students in the 1st Year of B.Tech. in order to orient them towards independent, systemic thinking and be innovative.

1. To make students confident enough to handle the day to day issues.
2. To develop the "Thinking Skill" of the students, especially Creative Thinking Skills
3. To train the students to be innovative in all their activities
4. To prepare a project report on a socially relevant theme as a solution to the existing issues

Expected Course Outcome:

1. Apply concept of Lorentz Transformation for Engineering applications.
2. Demonstrate the quantum mechanical ideas
3. Find out a suitable solution for socially relevant issues

Module:1 A	Self Confidence	1 hour

Understanding self – Johari Window –SWOT Analysis – Self Esteem – Being a contributor – Case Study

Project : Exploring self, understanding surrounding, thinking about how s(he) can be a contributor for the society, Creating a big picture of being an innovator – writing a 1000 words imaginary autobiography of self – Topic "Mr X – the great innovator of 2015" and upload. **(4 non- contact hours)**

Module:1 B	Thinking Skill	1 hour

Thinking and Behaviour – Types of thinking– Concrete – Abstract, Convergent, Divergent, Creative, Analytical, Sequential and Holistic thinking – Chunking Triangle – Context Grid – Examples – Case Study.

Project : Meeting at least 50 people belonging to various strata of life and talk to them / make field visits to identify a min of100 society related issues, problems for which they need solutions and categories them and upload along with details of people met and lessons learnt. **(4 non-contact hours)**

Module:1 C	Lateral Thinking Skill	1 hour

Blooms Taxonomy – HOTS – Outof the box thinking – deBono lateral thinking model – Examples

Project : Last weeks - incomplete portion to be done and uploaded

Module:2 A	Creativity	1 hour

Creativity Models – Walla – Barrons – Koberg & Begnall – Examples

Project : Selecting 5 out of 100 issues identified for future work. Criteria based approach for prioritisation, use of statistical tools & upload . **(4 non- contact hours)**

Module:2 B	Brainstorming	1 hour

25 brainstorming techniques and examples **Project :** Brainstorm and come out with as many solutions as possible for the top 5 issues identified & upload . **(4 non- contact hours)**		
Module:3	**Mind Mapping**	**1 hour**
Mind Mapping techniques and guidelines. Drawing a mind map **Project :** Using Mind Maps get another set of solutions forthe next 5 issues (issue 6 – 10) . **(4 non- contact hours)**		
Module:4 A	**Systems thinking**	**1 hour**
Systems Thinking essentials – examples – Counter Intuitive condemns **Project :** Select 1 issue / problem for which the possible solutions are available with you. Apply Systems Thinking process and pick up one solution [explanation should be given why the other possible solutions have been left out]. Go back to the customer and assess the acceptability and upload. . **(4 non- contact hours)**		
Module:4 B	**Design Thinking**	**1 hour**
Design thinking process – Human element of design thinking – case study **Project :** Apply design thinking to the selected solution, apply the engineering & scientific tinge to it. Participate in "design week" celebrations upload the weeks learning out come.		
Module:5 A	**Innovation**	**1 hour**
Difference between Creativity and Innovation – Examples of innovation –Being innovative. **Project:** A literature searches on prototyping of your solution finalized. Prepare a prototype model or process and upload. . **(4 non- contact hours)**		
Module:5 B	**Blocks for Innovation**	**1 hour**
Identify Blocks for creativity and innovation – overcoming obstacles – Case Study **Project :** Project presentation on problem identification, solution, innovations-expected results – Interim review with PPT presentation. . **(4 non- contact hours)**		
Module:5 C	**Innovation Process**	**1 hour**
Steps for Innovation – right climate for innovation **Project:** Refining the project, based on the review report and uploading the text. . **(4 non-contact hours)**		
Module:6 A	**Innovation in India**	**1 hour**
Stories of 10 Indian innovations **Project:** Making the project better with add ons. . **(4 non- contact hours)**		
Module:6 B	**JUGAAD Innovation**	**1 hour**
Frugal and flexible approach to innovation - doing more with less Indian Examples **Project:** Fine tuning the innovation project with JUGAAD principles and uploading (Credit for JUGAAD implementation) . **(4 non- contact hours)**		
Module:7 A	**Innovation Project Proposal Presentation**	**1 hour**
Project proposal contents, economic input, ROI – Template **Project:** Presentation of the innovative project proposal and upload . **(4 non- contact hours)**		
Module:8 A	Contemporary issue in Innovation	**1 hour**
Contemporary issue in Innovation **Project:** Final project Presentation , Viva voce Exam (**4 non- contact hours)**		
	Total Lecture hours:	**15 hours**

Text Book(s)			
1.	How to have Creative Ideas, Edward debone, Vermilon publication, UK, 2007		
2.	The Art of Innovation, Tom Kelley & Jonathan Littman, Profile Books Ltd, UK, 2008		
Reference Books			
1.	Creating Confidence, Meribeth Bonct, Kogan Page India Ltd, New Delhi, 2000		
2.	Lateral Thinking Skills, Paul Sloane, Keogan Page India Ltd, New Delhi, 2008		
3.	Indian Innovators, Akhat Agrawal, Jaico Books, Mumbai, 2015		
4.	JUGAAD Innovation, Navi Radjou, Jaideep Prabhu, Simone Ahuja Random house India, Noida, 2012.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar Three reviews with weightage of 25 : 25 : 50 along with reports			
Recommended by Board of Studies	15-12-2015		
Approved by Academic Council	38th	Date	17-12-2015

Course code	Environmental Sciences	L	T	P	J	C
CHY1002		3	0	0	0	3
Pre-requisite	Chemistry of 12th standard or equivalent	Syllabus version				
		v.1.1				

Course Objectives:

1. To make students understand and appreciate the unity of life in all its forms, the implications of life style on the environment.
2. To understand the various causes for environmental degradation.
3. To understand individuals contribution in the environmental pollution.
4. To understand the impact of pollution at the global level and also in the local environment.

Expected Course Outcome:

Students will be able to

1. Recognize the environmental issues in a problem oriented interdisciplinary perspectives
2. Understand the key environmental issues, the science behind those problems and potential solutions.
3. Demonstrate the significance of biodiversity and its preservation
4. Identify various environmental hazards
5. Design various methods for the conservation of resources
6. Formulate action plans for sustainable alternatives that incorporate science, humanity, and social aspects
7. Students will have foundational knowledge enabling them to make sound life decisions as well as enter a career in an environmental profession or higher education.

Module:1	Environment and Ecosystem		7 hours

Key environmental problems, their basic causes and sustainable solutions. IPAT equation. Ecosystem, earth – life support system and ecosystem components; Food chain, food web, Energy flow in ecosystem; Ecological succession- stages involved, Primary and secondary succession, Hydrarch, mesarch, xerarch; Nutrient, water, carbon, nitrogen, cycles; Effect of human activities on these cycles.

Module:2	Biodiversity		6 hours

Importance, types, mega-biodiversity; Species interaction - Extinct, endemic, endangered and rare species; Hot-spots; GM crops- Advantages and disadvantages; Terrestrial biodiversity and Aquatic biodiversity – Significance, Threats due to natural and anthropogenic activities and Conservation methods.

Module:3	Sustaining Natural Resources and Environmental Quality		7 hours

Environmental hazards – causes and solutions. Biological hazards – AIDS, Malaria, Chemical hazards- BPA, PCB, Phthalates, Mercury, Nuclear hazards- Risk and evaluation of hazards. Water footprint; virtual water, blue revolution. Water quality management and its conservation. Solid and hazardous waste – types and waste management methods.			
Module:4	**Energy Resources**		**6 hours**
Renewable - Non renewable energy resources- Advantages and disadvantages - oil, Natural gas, Coal, Nuclear energy. Energy efficiency and renewable energy. Solar energy, Hydroelectric power, Ocean thermal energy, Wind and geothermal energy. Energy from biomass, solar- Hydrogen revolution.			
Module:5	**Environmental Impact Assessment**		**6 hours**
Introduction to environmental impact analysis. EIA guidelines, Notification of Government of India (Environmental Protection Act – Air, water, forest and wild life). Impact assessment methodologies. Public awareness. Environmental priorities in India.			
Module:6	**Human Population Change and Environment**		**6 hours**
Urban environmental problems; Consumerism and waste products; Promotion of economic development – Impact of population age structure – Women and child welfare, Women empowerment. Sustaining human societies: Economics, environment, policies and education.			
Module:7	**Global Climatic Change and Mitigation**		**5 hours**
Climate disruption, Green house effect, Ozone layer depletion and Acid rain. Kyoto protocol, Carbon credits, Carbon sequestration methods and Montreal Protocol. Role of Information technology in environment-Case Studies.			
Module:8	**Contemporary issues**		**2 hours**
Lecture by Industry Experts			
	Total Lecture hours:	**45 hours**	
Text Books			
1.	G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15th Edition, Cengage learning.		
2.	George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17th Edition, Brooks/Cole, USA.		
Reference Books			
1.	David M.Hassenzahl, Mary Catherine Hager, Linda R.Berg (2011), Visualizing Environmental Science, 4thEdition, John Wiley & Sons, USA.		
Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT			
Recommended by Board of Studies	12.08.2017		
Approved by Academic Council	No. 46	Date	24.08.2017

Course code	Technical Answers for Real World Problems (TARP)	L	T	P	J	C
MEE3999		1	0	0	8	3
Pre-requisite	PHY1999 and 115 Credits Earned	Syllabus version				
		v. 2.2				

Course Objectives:

1. To help students to identify the need for developing newer technologies for industrial / societal needs
2. To train students to propose and implement relevant technology for the development of the prototypes / products
3. To make the students learn to the use the methodologies available for analysing the developed prototypes / products

Expected Course Outcome:

1. Identify real life problems related to society
2. Apply appropriate technology (ies) to address the identified problems using engineering principles and arrive at innovative solutions

Module:1		2 hours

Steps involved:

1. Strategies to identify the societal and industrial problems that need to be solved
2. SWOC analysis of the available technologies to overcome the problem
3. Possible technology revolution in the next 5 – 10 years
4. Analysis of the problems of present and future
5. Challenges in sustainable prototype / product development
6. Design of specific workflow in developing the prototype / product
7. Validation of the developed prototype / product
8. Analysis of the prototype/product with respect to social, economical, environmental relevance

(The proposed contact hours are for discussion on the projects)
(Projects to be done by a group of 6 – 10 students)

Mode of Evaluation: (No FAT) Continuous Assessment the project done – Mark weightage of 20:30:50 – project report to be submitted.

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

MEE3099	Industrial Internship	L	T	P	J	C
		0	0	0	0	2
Pre-requisite	Completion of minimum of Two semesters					

Course Objectives:

The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns.

Expected Course Outcome:

1. Correlate engineering concepts and their application in industry
2. Extrapolate selected techniques for appropriate innovative applications
3. Document the industrial practices in relevant e-platforms

Contents	**4**	**Weeks**

Four weeks of work at industry site.
Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 37	Date	16-06-2015

Course code	Comprehensive Examination	L	T	P	J	C
MEE4098		0	0	0	0	2
Pre-requisite	As per the academic regulations	Syllabus version				
		2.2				

Course Objectives:

1. To evaluate the overall understanding of the students in the core areas of B.Tech Mechanical Engineering Programme.

Course Outcome:

1. Define, explain, evaluate, and interpret the fundamental knowledge pertaining to the field of Mechanical Engineering and apply those essential knowledge to the field of Energy Engineering.

Module:1	Engineering Thermodynamics		

Thermodynamic systems and processes - properties of pure substances, behaviour of ideal and real gases - zeroth and first laws of thermodynamics, calculation of work and heat in various processes - second law of thermodynamics - thermodynamic property charts and tables, availability and irreversibility - thermodynamic relations.

Module:2	Mechanics of Solids And Fluids		

Stress and strain, elastic constants, Poisson's ratio - Mohr’s circle for plane stress and plane strain - thin shells - bending and shear stresses - torsion of circular shafts - testing of materials with universal testing machine - Fluid properties - fluid statics, kinematics - Euler and Bernoulli's equations and their applications - viscous flow of incompressible fluids, flow through pipes - boundary layer concepts.

Module:3	Materials Engineering and Technology		

Metal and alloys-Properties and Applications – crystal structure – crystalline imperfections – Solidification – Phase diagrams – Binary alloy - Cu-Ni alloy; Cu-Zn alloy and Pb-Sn alloy; Iron-Iron carbide phase diagram -TTT and CCT diagram. Steels and Cast Irons – Types and properties, Effect of alloying elements on structure and properties of steels - Heat Treatment and Surface Heat treatments - Mechanical Properties of Materials -Strengthening mechanisms – Hardness measurements – Tensile properties of the materials – Fracture of metals –Fatigue – Endurance limit of ferrous and non-ferrous metals , S-N curves, factors affecting fatigue, Creep and stress rupture.

Module:4	Manufacturing Process		

Casting Processes - Defects - Runner and riser design; Joining Processes - Consumable and Non-consumable welding processes; Metal Forming processes - Cold and Hot working ; Processing of Powder Metals, Ceramics, Glass and Plastics			
Module:5	**Thermal Engineering Systems**		
I.C. Engines - Air-standard Otto, Diesel and dual cycles-Types- working principles- Valve and port timing diagrams- combustion- knocking- Factors- Testing of IC engines- Frictional power measurement; Air compressors- Types- volumetric efficiency- Steam nozzles- critical pressure ratio - Nozzle efficiency; Refrigeration systems – Types – COP – Refrigerating capacity; Air conditioning types – properties of moist air, psychrometric chart, basic psychrometric processes – cooling load calculations.			
Module:6	**Engineering Mechanics**		
Resultant of system of forces-Equivalent force couple system-Principle of statics-Concept of free body diagram-Application problem on beams, trusses and frames. Theory of dry friction- wedge ladder friction. Concept of first moment of area and second moment of area, Principal moment of inertia, Kinematics of particles and rigid bodies - Types of motion - Rectilinear and curvilinear translations, General plane motion, ICR method and Relative velocity method for kinematics of rigid bodies, Kinetics of particles and rigid bodies - D'Alembert's principle- Work and energy methods, Linear Impulse and momentum principle, Elastic impact problems.			
Module:7	**Power Plant Engineering**		
Steam power plant - Site, components and layout - vapor power cycle - Steam Generators - Fire tube and Water tube boilers - Coal handling and preparation - Combustion equipment and firing methods - Nuclear Power Plants - Principles of nuclear energy - Energy from nuclear reactions - Decay rates and Half lives - Radiation shielding - Gas turbine power plants - Open and closed cycles - Reheating and Regenerating.			
Module:8	**Renewable Energy Sources**		
Introduction to Solar Energy - Energy from sun-Spectral distribution of Solar radiation-Instruments for measurement of solar radiation -Thermal applications - Principle of operation of different collectors; Physics of solar cells- Characteristics of cells and module - Performance parameters - BoS; Gasification - various types of gasifiers -Bio energy through digestion - Types of Digesters- Factors affecting the yield of products; Wind power regulation - various methods of control - wind farms - site selection; Power generation through OTEC systems - various types - Energy through waves and tides			
Module:9	**Turbomachines**		
- Classification of Turbomachines: Cascading, efficiencies, blade parameters and design, velocity triangles; Centrifugal fans, blowers and compressors: Stage pressure rise, slip factor, degree of reaction, stage losses, backward, forward and radial tip blades; Axial fans, blowers and compressors: Stage pressure rise, blade loading factor, flow coefficient, UGV and DGV, stalling and surging, transient flow phenomena; Steam and Gas Turbines: Work, power calculations, Impulse and Reaction stages, Velocity, Pressure and P-V compounding, Degree of reaction. Zero, Fifty, hundred			

percent and negative degree of reaction; IFR turbines; Layout and Hydraulic pumps and turbines: Centrifugal and axial flow pumps, operating head and manometric efficiency, cavitation, Starting and specific speeds, Priming and self-priming pumps, Pelton, Francis, Kaplan and Propeller turbines, Draft tube and design.			
Module:10	**Heat Transfer**		
Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Free and forced convection heat transfer, heat exchanger performance, LMTD and NTU methods; radiative heat transfer, black and grey surfaces, Shape factors, radiation network analysis, radiation shield, dimensionless numbers involved in all the modes of heat transfer.			
Mode of Evaluation: Online Exam			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Capstone Project	L	T	P	J	C
MEE4099		-	-	-	-	20
Pre-requisite	As per the academic regulations	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide a definite context, to apply the leanings from various courses of the program and solve unstructured and ill-defined problems
2. To develop an integrated approach for problem solving
3. To provide an exposure to take up a real life research problem / product development / industrial problem and arrive at meaningful conclusions / product design / solution

Expected Course Outcome:

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints
2. Perform literature search and / or patent search in the area of interest
3. Develop a suitable solution methodology for the problem
4. Conduct experiments / Design & Analysis / solution iterations and document the results
5. Perform error analysis / benchmarking / costing
6. Synthesise the results and arrive at scientific conclusions / products / solution
7. Document the results in the form of technical report / presentation

Topics

Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, etc. or a combination of these.
Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.

Criteria

1. Can be individual work or a group project, with a maximum of 3 students.
2. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage
5. Plagiarism checking by Turnitin is compulsory part of UG Project Report. Plagiarism level should not exceed more than 13%.

Mode of Evaluation: Mid reviews, Final Viva-Voce, Thesis and Poster Submission

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

EEE1001	Basic Electrical and Electronics Engineering	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**Nil**	**Syllabus version**				
Anti-requisite		v. 1.0				

Course Objectives:

[1] To understand the various laws and theorems applied to solve electric circuits and networks
[2] To provide the students with an overview of the most important concepts in Electrical and Electronics Engineering which is the basic need for every engineer

Expected Course Outcome:

On the completion of this course the student will be able to:

[1] Solve basic electrical circuit problems using various laws and theorems.
[2] Analyze AC power circuits and networks, its measurement and safety concerns
[3] Classify and compare various types of electrical machines
[4] Design and implement various digital circuits
[5] Analyze the characteristics of semiconductor devices and comprehend the various modulation techniques in communication engineering
[6] Design and conduct experiments to analyze and interpret data

Module:1	**DC circuits**	**Hours:5**

Basic circuit elements and sources, Ohms law, Kirchhoff's laws, series and parallel connection of circuit elements, Node voltage analysis, Mesh current analysis, Thevenin's and Maximum power transfer theorem.

Module:2	**AC circuits**	**Hours:6**

Alternating voltages and currents, AC values, Single Phase RL, RC, RLC Series circuits, Power in AC circuits-Power Factor- Three Phase Systems – Star and Delta Connection- Three Phase Power Measurement – Electrical Safety –Fuses and Earthing, Residential wiring

Module:3	**Electrical Machines**	**Hours:7**

Construction, Working Principle and applications of DC Machines, Transformers, Single phase and Three-phase Induction motors, Special Machines-Stepper motor, Servo Motor and BLDC motor

Module:4	**Digital Systems**	**Hours:5**

Basic logic circuit concepts, Representation of Numerical Data in Binary Form- Combinational logic circuits, Synthesis of logic circuits.

Module:5	**Semiconductor devices and Circuits**	**Hours:7**

Conduction in Semiconductor materials, PN junction diodes, Zener diodes, BJTs, MOSFETs, Rectifiers, Feedback Amplifiers using transistors. **Communication Engineering:** Modulation and Demodulation - Amplitude and Frequency Modulation

	Total Lecture hours:	**30 Hours**	

Mode: Flipped Class Room, Use of physical and computer models to lecture, visit to industries. Minimum of 2 lectures by industry experts.

Proposed Laboratory Experiments: (Hardware and Simulation)		
1. Thevenin's and Maximum Power Transfer Theorems – Impedance matching of source and load.		

2. Sinusoidal steady state Response of RLC circuits. 3. Three phase power measurement for ac loads. 4. Staircase wiring circuit layout for multi storey building. 5. Fabricate and test a PCB layout for a rectifier circuit. 6. Half and full adder circuits. 7. Full wave Rectifier circuits used in DC power supplies. Study the characteristics of the semiconductor device used. 8. Regulated power supply using zener diode. Study the characteristics of the Zener diode used. 9. Lamp dimmer circuit (Darlington pair circuit using transistors) used in cars. Study the characteristics of the transistor used. 10. Characteristics of MOSFET.		

Text Book(s)

1.	1. John Bird, 'Electrical circuit theory and technology ', Newnes publications, 4 t h Edition, 2010.

Reference Books

1.	Allan R. Hambley, 'Electrical Engineering -Principles & Applications' Pearson Education, First Impression, 6/e, 2013.
2.	Simon Haykin, 'Communication Systems', John Wiley & Sons, 5 t h Edition, 2009.
3.	Charles K Alexander, Mathew N O Sadiku, 'Fundamentals of Electric Circuits', Tata McGraw Hill, 2012.
4.	Batarseh, 'Power Electronics Circuits', Wiley, 2003.
5.	W. H. Hayt, J.E. Kemmerly and S. M. Durbin, 'Engineering Circuit Analysis', 6/e, Tata McGraw Hill, New Delhi, 2011.
6.	Fitzgerald, Higgabogan, Grabel, 'Basic Electrical Engineering', 5t h edn, McGraw Hill, 2009.
7.	S.L.Uppal, 'Electrical Wiring Estimating and Costing ', Khanna publishers, NewDelhi, 2008.

Recommended by Board of Studies	29/05/2015		
Approved by Academic Council	37th AC	Date	16/06/2015

MAT2002	Applications of Differential and Difference Equations	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	MAT1011 - Calculus for Engineers	Syllabus Version				
		v.1.0				

Course Objectives (CoB):

The course is aimed at

[1] Presenting the elementary notions of Fourier series, which is vital in practical harmonic analysis

[2] Imparting the knowledge of eigenvalues and eigen vectors of matrices and the transform techniques to solve linear systems, that arise in sciences and engineering [3] Enriching the skills in solving initial and boundary value problems

[4] Impart the knowledge and application of difference equations and the Z-transform in discrete systems, that are inherent in natural and physical processes

Course Outcome (CO):

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

[1] Employ the tools of Fourier series to find harmonics of periodic functions from the tabulated values

[2] Apply the concepts of eigenvalues, eigen vectors and diagonalisation in linear systems

[3] Know the techniques of solving differential equations

[4] Understand the series solution of differential equations and finding eigen values, eigen functions of Strum-Liouville's problem

[5] Know the Z-transform and its application in population dynamics and digital signal processing

[6] Demonstrate MATLAB programming for engineering problems

Module:1	Fourier series:		6 hours

Fourier series - Euler's formulae - Dirichlet's conditions - Change of interval - Half range series – RMS value – Parseval's identity – Computation of harmonics

Module:2	Matrices:		6 hours

Eigenvalues and Eigen vectors - Properties of eigenvalues and eigen vectors – Cayley-Hamilton theorem - Similarity of transformation - Orthogonal transformation and nature of quadratic form

Module:3	Solution of ordinary differential equations:		6 hours

Linear second order ordinary differential equation with constant coefficients – Solutions of homogenous and non-homogenous equations - Method of undetermined coefficients – method of variation of parameters – Solutions of Cauchy-Euler and Cauchy-Legendre

differential equations			
Module:4	**Solution of differential equations through Laplace transform and matrix method**		**8 hours**
Solution of ODE's - Nonhomogeneous terms involving Heaviside function, Impulse function - Solving nonhomogeneous system using Laplace transform – Reduction of *n*th order differential equation to first order system - Solving nonhomogeneous system of first order differential equations $(X' = AX + G)$ and $X'' = AX$			
Module:5	**Strum Liouville's problems and power series Solutions:**		**6 hours**
The Strum-Liouville's Problem - Orthogonality of Eigen functions - Series solutions of differential equations about ordinary and regular singular points - Legendre differential equation - Bessel's differential equation			
Module:6	**Z-Transform:**		**6 hours**
Z-transform -transforms of standard functions - Inverse Z-transform: by partial fractions and convolution method			
Module:7	**Difference equations:**		**5 hours**
Difference equation - First and second order difference equations with constant coefficients - Fibonacci sequence - Solution of difference equations - Complementary function - Particular integral by the method of undetermined coefficients - Solution of simple difference equations using Z-transform			
Module:8	**Contemporary Issues**		**2 hours**
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, John Wiley India, 2015
Reference Books	
1.	Higher Engineering Mathematics, B. S. Grewal, 43rd Edition, Khanna Publishers, India, 2015
2.	Advanced Engineering Mathematics by Michael D. Greenberg, 2nd Edition, Pearson Education, Indian edition, 2006

Mode of Evaluation		
Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test		
1.	Solving Homogeneous differential equations arising in engineering problems	2 hours
2.	Solving non-homogeneous differential equations and Cauchy,	2 hours

	Legendre equations	
3.	Applying the technique of Laplace transform to solve differential equations	2 hours
4.	Applications of Second order differential equations to Mass spring system (damped, undamped, Forced oscillations), LCR circuits etc.	2 hours
5.	Visualizing Eigen value and Eigen vectors	4 hours
6.	Solving system of differential equations arising in engineering applications	2 hours
7.	Applying the Power series method to solve differential equations arising in engineering applications	4 hours
8.	Applying the Frobenius method to solve differential equations arising in engineering applications	2 hours
9.	Visualising Bessel and Legendre polynomials	2 hours
10.	Evaluating Fourier series-Harmonic series	2 hours
11.	Applying Z-Transforms to functions encountered in engineering	2 hours
12.	Solving Difference equations arising in engineering applications	4 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	55	Date	13-06-2019

MAT-3003	Complex Variables and Partial Differential Equation	L	T	P	J	C
		3	2	0	0	4
Pre-requisite	MAT2002 Applications of Differential and Difference Equations	Syllabus version				
		v.1.0				

Course Objectives (CoB):

The aim of this course is to present a comprehensive, compact and integrated treatment of two most important branches of applied mathematics for engineers and scientists namely the functions of complex variable and Partial differential equations in finite and infinite domains

Course Outcome (CO):1,2,3

1. At the end of the course the student should be able to
2. Construct analytic functions and find complex potential of fluid flow and electric fields
3. Find the image of straight lines by elementary transformations and
4. Able to express analytic functions in power series
5. Evaluate real integrals using techniques of contour integration
6. Analyze partial differential equations, and its applications, design the boundary value problems (one dimensional heat and wave equations) and find Fourier series, Fourier transform techniques in their respective engineering problems.

Module:1	Analytic Functions		6 hours

Complex variable-Analytic functions and Cauchy – Riemann equations - Laplace equation and Harmonic functions - Construction of Harmonic conjugate and analytic functions - Applications of analytic functions to fluid-flow and Field problems.

Module:2	Conformal and Bilinear transformations		5 hours

Conformal mapping - Elementary transformations-translation, magnification, rotation, inversion. Exponential and Square transformations ($w = e^z$, z^2) - Bilinear transformation - Cross-ratio-Images of the regions bounded by straight lines under the above transformations.

Module:3	Power series		4 hours

Functions given by Power Series - Taylor and Laurent series -singularities - poles – Residues.

Module:4	Complex Integration		5 hours

Integration of a complex function along a contour - Cauchy-Goursat theorem- Cauchy's integral formula -Cauchy's residue theorem - Evaluation of real integrals - Indented contour integral.

Module:5	Partial Differential equations of first order		6 hours

Formation and solution of partial differential equation - General, Particular, Complete and Singular integrals - Partial Differential equations of first order of the forms: F(p,q)=0,

F(z,p,q)=0, F(x,p)=G(y,q) and Clairaut's form - Lagrange's equation: Pp+Qq = R.			
Module:6	**Applications of Partial Differential Equations**		**10 hours**
Linear partial differential equations of higher order with constant coefficients. Solution of a partial differential equation by separation of variables - Boundary Value Problems-one dimensional wave and heat equations- Fourier series solution.			
Module:7	**Fourier transforms**		**7 hours**
Complex Fourier transform and properties - Relation between Fourier and Laplace transforms - Fourier sine and cosine transforms – Convolution Theorem and Parseval's identity.			
Module:8	**Contemporary issues:**		**2 hours**
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	
Tutorial	• A minimum of 10 problems to be worked out by students inventory Tutorial Class • Another 5 problems per Tutorial Class to be given as home work**.**	**30 hours**	

Text Book(s)	
1.	Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, John Wiley & Sons (Wiley student Edison) (2015)
Reference Books	
1	Higher Engineering Mathematics, B. S. Grewal, 43rd Edition (2019), Khanna Publishers, New Delhi
2	A first course in complex analysis with applications, G.Dennis Zill, Patrick D. Shanahan, 3rd Edition, 2013, Jones and Bartlett Publishers Series in Mathematics:
3	Advanced Engineering Mathematics, Michael, D. Greenberg, 2nd Edition, Pearson Education (2006)
4	Advanced Engineering Mathematics, Peter V. O' Neil, 7th Edition, Cengage Learning (2012)
5	Complex Analysis for Mathematics and Engineers, JH Mathews, R. W. Howell, 5th Edition, Narosa Publishers (2013)

Mode of Evaluation:			
Digital Assignments(Solutions by using soft skill),Quiz, Continuous Assessments, Final Assessment Test.			
Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	55	Date	13-06-2019

MAT-3005	Applied Numerical Methods	L	T	P	J	C
		3	2	0	0	4
Pre-requisite	MAT2002 – Applications of Differential and Difference Equations	Syllabus Version				
		1.0				

Course Objectives (CoB):

The aim of this course

[1] is to cover certain basic, important computer oriented numerical methods for analyzing problems that arise in engineering and physical sciences.

[2] is to use MATLAB as the primary computer language to obtain solutions to a few problems that arise in their respective engineering courses.

[3] is to impart skills to analyse problems connected with data analysis,

[4] is to solve ordinary and partial differential equations numerically

Course Outcome (CO): 1,2,3,4,5

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

[1] Observe the difference between exact solution and approximate solution.

[2] Use the numerical techniques (algorithms) to find the solution (approximate) algebraic equations and system of equations.

[3] Fit the data using interpolation technique and spline methods.

[4] Find the solution of ordinary differential equations, Heat and Wave equation numerically.

[5] Apply calculus of variation techniques to extremize the functional and also find approximate series solution to ordinary differential equations

Module:1	Algebraic and Transcendental Equations	5 hours	

General iterative method- rates of convergence- Secant method - Newton – Raphson method- System of non-linear equations by Newton's method.

Module:2	System of Linear Equations and Eigen Value Problems	6 hours	

Gauss –Seidel iteration method. Convergence analysis of iterative methods-LU Decomposition -Tri diagonal system of equations-Thomas algorithm- Eigen values of a matrix by Power and Jacobi methods.

Module:3	Interpolation	6 hours	

Finite difference operators- Newton's forward-Newton's Backward- Central differences- Stirling's interpolation - Lagrange's interpolation - Inverse Interpolation-Newton's divided difference-Interpolation with cubic splines.

Module:4	Numerical Differentiation and Integration	6 hours	

Numerical differentiation with interpolation polynomials-maxima and minima for tabulated values-Trapezoidal rule, Simpsons $1/3^{rd}$ and $3/8^{th}$ rules. –Romberg's method. Two and Three point Gaussian quadrature formula.

Module:5	**Numerical Solution of Ordinary Differential Equations**	**8 hours**	
First and second order differential equations - Fourth order Runge – Kutta method. Adams-Bashforth-Moulton predictor-corrector methods. Finite difference solution for the second order ordinary differential equations.			
Module:6	**Numerical Solution of Partial Differential Equations**	**6 hours**	
Classification of second order linear partial differential equations-Laplace equation –Gauss-Seidal method-One dimensional heat equation- Schmidt explicit method-Crank-Nicolson implicit method.-One dimensional wave equation–Explicit method.			
Module:7	**Variational Methods**	**6 hours**	
Introduction - functional –variational problems- extremals of functional of a single dependent variable and its first derivative- functional involving higher order derivatives- Isoperimetric problems- Galerkins- Rayleigh Ritz methods.			
Module:8	**Contemporary Issues**	**2 hours**	
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	
Tutorial	• A minimum of 10 problems to be worked out by students in every Tutorial Class. • Another 5 problems per Tutorial Class to be given for practise.	**30 hours**	

Text Book(s)

1. Numerical Methods for Scientific and Engineering, M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age International Ltd., 6th Edition, 2012.
2. Applied Numerical Analysis, C. F. Gerald and P.V. Wheatley, Addition-Wesley, 7th Edition, 2004.

Reference Books

1. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Pvt. Ltd., 5th Edition, New Delhi, 2009.
2. Applied Numerical Methods Using MATLAB, W.Y. Yang, W. Cao, T.S. Chung and J. Morris, Wiley India Edn., 2007.
3. Numerical Methods for Engineers with Programming and Software Applications, Steven C. Chapra and Ra P. Canale, 7th Edition, Tata McGraw Hill, 2014.
4. Numerical Analysis, R.L. Burden and J. D. Faires, 4th Edition, Brooks Cole, 2012.
5. Numerical Methods: Principles, Analysis and Algorithms, Srimanta Pal, Oxford University Press India; 978-0195693751, 2009.

Mode of Evaluation

Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Final Assessment Test

Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course Code	Engineering Drawing	L	T	P	J	C
MEE1001		1	0	4	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. Understand and escalate the importance of basic concepts and principles of Engineering Drawing (components, sections, views, and graphical representation).
2. Enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
3. Develop the ability to communicate with others through the language of technical drawing and sketching.
4. Ability to read and interpret engineering drawings created by others.
5. Ability to draw orthographic projections and sections.
6. Develop an understanding for size specification procedures and use of SI and traditional units of linear measure.

Expected Course Outcome:

1. Apply BIS and ISO Standards in Engineering Drafting.
2. Graphically construct mathematical curves in engineering applications.
3. Visualize geometrical solids in 3D space through Orthographic Projections
4. Construct isometric scale, isometric projections and views.
5. Draw sections of solids including cylinders, cones, prisms and pyramids.
6. Draw projections of lines, planes, solids, isometric projections and sections of solids including cylinders, cones, prisms and pyramids using Mini-Dafter and CAD.
7. Construct orthographic projections from pictorial views.

Module:1	Lettering and Dimensioning	1 hours

Introduction, lettering practice, Elements of dimensioning - systems of dimensioning.

Module:2	Geometric Constructions	2 hours

Free hand sketching, Conic sections, Special curves.

Module:3	Projection of Points and Projection of Lines	2 hours

Projection of Points: First and Third Angle Projections; Projection of points.
Projection of Lines: Projection of straight lines (First angle projection only); Projection of lines inclined to one plane and both planes, true length and true inclinations.

Module:4	Projection of Solids and Section of Solids	3 hours

Projection of solids: Classification of solids, Projection of solids in simple position, Projection of solids inclined to one plane.

Sections of Solids: Right regular solids and auxiliary views for the true shape of the sections.		
Module:5	**Development of Surfaces**	**2 hours**
Development of surfaces for various regular solids.		
Module:6	**Isometric Projection and Perspective Projection**	**2 hours**
Isometric Projection: Isometric scales, Isometric projections of simple and combination of solids; **Perspective Projection:** Orthographic representation of a perspective views – Plane figures and simple solids - Visual ray method.		
Module:7	**Orthographic Projection**	**2 hours**
Conversion of pictorial view into orthographic Projection.		
Module:8	**Contemporary issues**	**1 hours**
	Total Lecture hours:	**15 hours**

Text Book(s)	
1.	Venugopal K and Prabhu Raja V, "Engineering Graphics", New AGE International Publishers, 2015.
Reference Books	
1.	N. D. Bhatt, Engineering Drawing, Charotar publishing House, 2012.
2	Natarajan, K. V., A Text book of Engineering Graphics, Dhanalakshmi Publishers, 2012.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	Identifying the incorrect dimensioning and correct it as per BIS standards for Engineering Components.	4 hours
2.	Tutorials on free hand sketching of the plan view of stadium, garden, etc.,	4 hours
3.	Tutorials on geometric constructions like conics and special curves for projection of cricket ball, missile projection, etc.,	4 hours
4.	Representation of orthographic projection of points	4 hours
5.	Representation of orthographic projection of lines (First angle projection only) inclined to one plane and projection of lines inclined to both the planes- solving problems like electrical bulbs hanging from the roof, finding the shortest distance between fan to electrical switch board, etc.,	8 hours
6.	Sketching orthographic projection of solids in simple position and projection of solids inclined to one plane for household accessories and objects.	8 hours
7.	Drawing the auxiliary views, orthographic views and true shape of sectioned regular solids for household accessories and objects.	4 hours
8.	Development of lateral surfaces of the regular shapes and sectioned shapes for water cans, refrigerator, cylinder container, funnel, etc.,	4 hours
9.	Conversion of orthographic views to isometric views for engineering components.	8 hours
10.	Tutorial problems on perspective projection of plane figures and simple	4 hours

	solids for train with track, landscape, etc.,	
11.	Conversion of pictorial drawing into orthographic projection for engineering components, architectural structures, etc.,	8 hours
	Total Laboratory Hours	**60 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Engineering Mechanics	L	T	P	J	C
MEE1002		2	2	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To enable students to apply fundamental laws and basic concepts of rigid body mechanics to solve problems of bodies under rest or in motion.
2. To enable the students to apply conditions of static equilibrium to analyse physical systems.
3. To compute the properties of areas and bodies.

Expected Course Outcome:

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

1. Compute the resultant of system of forces in plane and space acting on bodies.
2. Predict the support-reactions and the internal forces of the members of various trusses and frames.
3. Analyse equilibrium problems with friction.
4. Apply transfer theorems to determine properties of various sections.
5. Analyse equilibrium of connected bodies virtual work method.
6. Predict motion parameters of bodies under rectilinear, curvilinear and general plane motion.

Module:1	Basics of Statics	5 hours

Fundamental Principles – Coplanar forces – Resolution and Composition of forces and equilibrium of particles – Forces of a particle in space – Equivalent system of forces – Principle of transmissibility – Single equivalent force – Free body diagram – Equilibrium of rigid bodies in two dimensions and three dimensions.

Module:2	Analysis of Structures	4 hours

Types of supports and their reactions – Plane trusses and frames - Analysis of forces by method of joints and method of sections.

Module:3	Friction	3 hours

Characteristics of dry friction – simple contact friction – Wedges and Ladder friction.

Module:4	Properties of Surfaces and Solids	4 hours

Centroid - First moment of area – Second moment of area – Moment and product of inertia of plane areas – Transfer Theorems - Polar moment of inertia – Principal axes – Mass moment of inertia.

Module:5	Virtual Work	4 hours

Virtual work – Principle of virtual work – System of connected rigid bodies – Degrees of freedom

– Conservative forces – Potential energy – Potential energy criteria for equilibrium.		
Module:6	**Kinematics**	**4 hours**
Displacements, Velocity and Acceleration – Rectilinear motion – Curvilinear motion – Tangential and Normal components – Radial and Transverse components.		
Module:7	**Energy and Momentum Methods**	**4 hours**
Principle of work and energy for a particle and a rigid body in plane motion – Conservation of energy - Principle of impulse and momentum for a particle and a rigid bodies in plane motion – Conservation of momentum.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Beer, Johnston, Cornwell and Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, 10th Edition, McGraw-Companies, Inc., New York, 2013.
Reference Books	
1.	Russell C Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics (11th Edition), Pearson Education Inc., Prentice Hall, 2010.
2.	Meriam J.L and Kraige L.G., Engineering Mechanics, Volume I - Statics, Volume II - Dynamics, 7th Edition, John Wiley & Sons, New York, 2012.
3.	Rajasekaran S and Sankarasubramanian G, Fundamentals of Engineering Mechanics, 3rd Edition, Vikas Publishing House Pvt Ltd., India, 2013.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Engineering Thermodynamics	L	T	P	J	C
MEE1003		2	2	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. Familiarize with the concepts of 1st and 2nd Laws of Thermodynamics.
2. Evaluate the properties of pure substances and mixtures.
3. Understand and analyze power and refrigeration cycles.

Expected Course Outcome:

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

1. Identify thermodynamics systems, point functions and path functions.
2. Solve engineering problems using zeroth and first laws of thermodynamics.
3. Analyse the heat and work interactions by applying the concepts of entropy principles and exergy.
4. Analyse thermodynamic systems involving pure substances and mixtures.
5. Calculate thermodynamics properties based on thermodynamics relations.
6. Analyse basic thermodynamic cycles of various systems.

Module:1	Basic Concepts in Thermodynamics	3 hours

Basic concepts of Thermodynamics - Thermodynamics and Energy - Closed and open systems - Properties of a system - State and equilibrium - Processes and cycles - Forms of energy - Work and heat transfer - Temperature and Zeroth law of thermodynamics.

Module:2	First law of thermodynamics	3 hours

Energy balance for closed systems - First law applied to steady – flow engineering devices

Module:3	Second Law of Thermodynamics and Exergy	6 hours

Limitations of the first law of Thermodynamics - Kelvin-Planck and Clausius statements and its equivalence- Refrigerators, Heat Pump–COP - Perpetual Motion Machines - Reversible and Irreversible process Carnot's Theorem - Entropy - The Clausius inequality - Availability and irreversibility - Second law efficiency-Quality of Energy

Module:4	Properties of Pure Substance and Mixtures	5 hours

Property diagram for water-phase change processes-refrigerants-real gases-Compressibility factor-Composition of gas mixtures - Mass and mole fractions - Dalton's law of additive pressures - Amagat's law of additive volumes - Evaluating properties of gas mixtures

Module:5	Thermodynamic relations	2 hours

Gibbs and Helmholtz function-Maxwell's relations-Clapeyron equations-general relations of properties		
Module:6	**Gas power cycles**	**4 hours**
Air standard assumptions - Otto cycle - Diesel and Dual cycles - Brayton cycle		
Module:7	**Vapor and Refrigeration Cycles**	**5 hours**
Rankine cycle-reheat-regeneration- Vapor compression refrigeration cycle		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Yunus A. Cengel, Thermodynamics: An Engineering Approach, 8th Edition, McGraw - Hill Education, 2017.
Reference Books	
1.	P. K. Nag, Engineering Thermodynamics, 6th Edition, McGraw - Hill Education, 2017.
2.	Michael Moran and Howard Shapiro, Principles of Engineering Thermodynamics, 8th Edition, Wiley, 2015.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Mechanics of Solids and Fluids	L	T	P	J	C
MEE1032		3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To enable students to understand the concept of stress and strain of deformable bodies of different material properties.
2. To enable the students to understand what are principal stresses and strains to follow various failure theories.
3. To prepare the students to understand fluid properties in order to solve problems of liquids under static and flowing conditions.
4. To demonstrate about flow measurement devices and procedures for various flow network design and multi reservoir problems.

Expected Course Outcome:

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

1. Solve problems of axially loaded members either for stress calculation or load calculation with or without accounting temperature effect.
2. Calculate stress planes in other than the cross section for different loading conditions
3. Analyse the members subjected to bending, torsion, combined bending and torsion and able to solve problems of thin shell vessels.
4. Understand the application of manometry during flow measurements.
5. Determine the hydrostatic forces on inclined and curved surfaces and able to find centre of buoyancy and metacentre
6. Apply the fundamental equations to predict fluid flow and solve problems of fluid kinematics and fluid dynamics.
7. Calculate major and minor losses for flow through pipes and able to solve multi reservoir problems
8. Experimentally determine the mechanical properties of materials and important hydraulic coefficients.

Module:1	Introduction	6 hours

Introduction - Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress-strain diagram- Elastic constants – Poisson's ratio – relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Uniaxial deformation.

Module:2	**Fundamentals of Elasticity and Theories of Failure**	**6 hours**
Stress - Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress, Theories of failure - Fundamentals of theory of elasticity – Yield criteria and plasticity		
Module:3	**Thin Shells**	**6 hours**
Solid Mechanics applications – Thin shells, torsion, bending, buckling		
Module:4	**Fluid Pressure**	**5 hours**
Pressure, Pressure head, Pressure Measurement- Simple Manometers, Differential Manometers		
Module:5	**Hydrostatic Forces**	**6 hours**
Fluid properties – Hydrostatic forces on plane – inclined and curved surfaces – buoyancy – centre of buoyancy – metacentre.		
Module:6	**Fluid Kinematics**	**7 hours**
Types of fluid flows - Streamline and Velocity potential lines- Euler and Bernoulli's equations and their applications – moment of momentum – Momentum and Energy correction factors – Impulse – Momentum equation-Navier-Stokes Equations-Applications.		
Module:7	**Flow through Pipes**	**7 hours**
Flow through pipes – Open Channels and Measurement pipe flow: Darcy's law – Minor losses – Multi reservoir problems – pipe network design – Moodys diagram – Hagen Poiseuille equation – Turbulent flow.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

List of Challenging Experiments		
1.	Evaluation of Engineering Stress / Strain Diagram on Steel rod, Thin and Twisted Bars under tension.	3 hours
2.	Compression test on Bricks, Concrete blocks.	3 hours
3.	Deflection test – Verification of Maxwell theorem.	3 hours
4.	Comparison of hardness values of Steel, Copper and Aluminium using Brinell and Rockwell hardness measuring machines.	3 hours
5.	Estimation of Spring Constant under Tension and Compression.	3 hours

6.	Flow through Orifice	3 hours
7.	Flow through Mouth Piece	3 hours
8.	Flow through Triangular Notch	3 hours
9.	Flow through Venturimeter	3 hours
10.	Flow through Pipe	3 hours
	Total Laboratory Hours	**30 hours**

Text Book(s)

1.	P.N.Modi and S.M.Seth, (2011), Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House

Reference Books

1.	Timoshenko, S.P. and Young, D.H., (2011), Strength of Materials, East West Press Ltd.
2.	R.K. Bansal, (2017), Strength of Materials, Laxmi Publications
3.	D.S. Kumar, (2013) Fluid Mechanics and Fluid Power Engineering, Katson Publishing House, Delhi
4.	Rowland Richards, (2000) Principles of Solid Mechanics, CRC Press

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Materials Engineering and Technology	L	T	P	J	C
MEE1005		3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To develop the knowledge on structure of materials including crystallography, microstructure, defects and phase diagrams
2. To provide an understanding to students on the correlation between structure, processing, mechanical properties and performance of materials
3. To develop the knowledge on mechanical properties of materials and strengthening mechanism
4. To give insight in to advanced materials such as polymers, ceramics and composite and their applications

Expected Course Outcome:

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

1. Suggest suitable engineering materials for different application
2. Identify various phases of metals and alloys through appropriate phase diagrams
3. Apply suitable heat treatment process based on material properties
4. Evaluate the effect of alloying elements, properties and application of ferrous and non-ferrous metals
5. Evaluate the mechanical behavior of materials for different applications
6. Apply advanced materials such as polymers, ceramics and composites in product design
7. Correlate the structure-property relationship in metals/alloys in as-received and heat treated conditions

Module:1	Structure of Materials	8 hours

Introduction to engineering materials – significance of structure property correlations in all classes of engineering materials, Unit Cells, Metallic Crystal Structures, Density Computations, Crystal Systems, Crystallographic Points, Crystallographic Directions, Crystallographic Planes, Linear and Planar Densities, Close-Packed Crystal Structures, Crystalline and Non-crystalline Materials, Single Crystals, Polycrystalline Materials, Imperfection in solids – Point, Line, Surface and Volume defects - Polymorphism and Allotropy.

Module:2	Constitution of Alloys	7 hours

Mechanism of Crystallization- Nucleation-Homogeneous and Heterogeneous Nucleation- Growth of crystals- Planar growth – dendritic growth – Cooling curves - Diffusion - Construction of Phase diagram -Binary alloy phase diagram – Cu-Ni alloy; Cu-Zn alloy and Pb-Sn alloy; Iron-Iron carbide phase diagram – Invariant reactions – microstructural changes of hypo and hyper-eutectoid steel-TTT and CCT diagram.

Module:3	**Heat Treatment and Surface Heat treatment**	**5 hours**
Heat treatment – Overview – Objectives – Annealing and types, normalizing, quenching, austempering and martempering – microstructure changes –Surface hardening processes - Carburizing – nitriding – cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam hardening– principles and case depths.		
Module:4	**Ferrous Metals**	**6 hours**
Steels – Types of Steels - HSLA – TRIP - White, Grey, Malleable and Nodular - Properties and application of cast irons, Effect of alloying elements on structure and properties of steels - Properties and uses of Silicon and Hadfield Manganese steels, High speed steels - Stainless steel and Types.		
Module:5	**Non Ferrous metals**	**6 hours**
Properties and Applications of Aluminum, Magnesium, Copper, Nickel, Titanium and their alloys.		
Module:6	**Mechanical behavior of Materials**	**7 hours**
Strengthening mechanisms – Hardness measurements – Hardenability - Tensile properties of the materials – Fracture of metals – Ductile Fracture, Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT) –Fatigue – Endurance limit of ferrous and non-ferrous metals -Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue; Creep and stress rupture– mechanism of creep – stages of creep and creep test.		
Module:7	**Introduction to Advanced Materials**	**4 hours**
Properties and Applications of Engineering polymers- Ceramics – properties and applications of various ceramics – Composites – and their types; properties and processing of composites – Manufacture of fibers.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	W.D. Callister, David G. Rethwisch, Materials Science and Engineering: An Introduction, 9th ed., Wiley & Sons, 2013.

Reference Books

1.	Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright, The Science and Engineering of Materials 6th Edition, Cenage Publications, 2010.
2.	G. F. Carter, Giles F. Carter and Donald E. Paul, Materials Science and Engineering, Digital Printing Edition, ASM International, 2011.
3.	William D. Callister, Jr., David G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition International Student Version, Wiley & Sons, 2016.
4.	W Bolton, Materials for Engineering, 2nd Edition, Routledge Publishers, USA, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1.	Overview of Materials Characterization – Optical Microscopy, Scanning Electron Microscopy, X-Ray Diffraction and Energy Dispersive X-ray analysis.	2 hours
2.	Perform the metallographic studies and identify the given ferrous/non-ferrous samples.	7 hours
3.	Use metallographic analysis software to establish the phases and average grain size of the given samples.	2 hours
4.	Design the heat treatments that result in the following microstructures (a) Coarse pearlite (b) Medium/Fine pearlite (c) 100% Martensite (d) Martensite and retained austenite.	2 hours
5.	Compare the microstructures of the given steel sample before and after heat treatment. Also measure the hardness of the samples.	3 hours
6.	Perform the hardness examination on the given samples using Rockwell Hardness Tester and find out the equivalent Vickers hardness in HV.	2 hours
7.	Perform the phase analysis using XRD.	2 hours
8.	Conduct the tensile studies on the given sample and infer whether the given sample is ductile or brittle. Evaluate the elastic and plastic properties of the given sample.	2 hours
9.	A fractured sample is given for assessment to interpret the reasons for fracture. What are the various metallurgical tests to be carried out to infer the same?	2 hours
10.	Conduct the corrosion studies on the given sample using electrochemical cell. What is the inference drawn from the polarization curves?	3 hours
11.	Perform high temperature corrosion studies on the given sample at 500°C in air oxidation and analyze the microstructure before and after corrosion.	3 hours
	Total laboratory hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Manufacturing Processes	L	T	P	J	C
MEE1007		2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To identify and explain manufacturing concepts.
To impart students, knowledge on fundamentals concepts in metal casting, welding, and forming processes.
To enable students understand basics of digital printing, powder metallurgy process and fabrication methods for polymer products and glass products.

Expected Course Outcome:

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

1. Develop suitable casting processes for various materials and components
2. Identify a suitable welding process & Process Parameters for an application
3. Design a suitable metal forming system for making an industrial product
4. Analyse the influence of Process Parameters on the powder metallurgy process
5. Select fabrication method for glass and polymer products
6. Identify suitable manufacturing process for product realisation
7. Fabricate simple components by various manufacturing processes

Module:1	Manufacturing	3 hours

Manufacturing – Role of Manufacturing in the development of a country – classification of manufacturing processes.

Module:2	Casting Processes	3 hours

Casting: Fundamentals of metal casting – Types of patterns – sand mold making –different casting techniques – types of furnaces – Defects in castings – Testing and inspection of castings.

Module:3	Joining processes	6 hours

Fusion welding processes – solid state welding processes – other welding techniques – Welding defects – Testing of welded joints.

Module:4	Metal forming processes	6 hours

Cold and hot working of metals – Bulk metal forming- Sheet metal forming- High Energy Rate Forming processes: Explosive forming- Electro hydraulic forming – Electromagnetic forming.

Module:5	Processing parts made of metal powders, ceramics and glass	3 hours

Powder metallurgy-production of metal powders-stages in powder metallurgy – production of ceramic parts-production of glass parts.

Module:6	**Shaping methods for polymer parts**	**3 hours**
Injection molding-Blow molding – compression molding-transfer molding-thermoforming.		
Module:7	**Process selection**	**4 hours**
Systematic process selection for given parameters – Process selection charts-economic quantity selection.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Serope Kalpakjian; Steven R. Schmid, Manufacturing Engineering and Technology, 6th Edition, Publisher: Prentice Hall, ISBN-10 0-13-608168-1, ISBN- 13 978-0-13-608168-5, 2013.

Reference Books

1.	P. N. Rao, Manufacturing Technology (Volume 1) – Foundry, Forging and Welding, 4th Edition, Tata McGraw Hill Education, New Delhi, 2013.
2.	Mikell P. Groover, Fundamentals of Modern Manufacturing Materials, Processes and Systems, Publishers: Wiley India, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Estimation of molding sand properties.	4 hours
2.	Fabrication of Pattern for sand moulding-through conventional, digital manufacturing method.	2 hours
3.	Evaluation of 3D printed pattern over conventional pattern for complex profiles	3 hours
4.	Investigation of casting properties of 3D printed pattern	3 hours
5.	Preparation of sand mould for the given engineering part and investigating the mould properties	2 hours
6.	Comparison of 3D printed pattern and wax pattern for Investment Casting	2 hours
7.	Edge preparation for Butt joint (V, J) & Welding practice by SMAW process and heat input basic calculations.	2 hours
8.	Welding practice on T/Butt joint using MIG/GTAW welding through manual and automation	2 hours
9.	Evaluation of welded joint using NDT and DT	3 hours
10.	Deformation behavior during Rolling	2 hours
11.	Recovery, recrystallization, grain growth & grain size measurement by Quantitative metallography.	2 hours
12.	Ericson cupping test to measure the ductility	3 hours
	Total laboratory hours	**30 hours**

Mode of assessment:

Recommended by Board of Studies	17-08-2017

Approved by Academic Council	47	Date	05-10-2017

Course code	Renewable Energy Sources	L	T	P	J	C
MEE1011		2	2	2	0	4
Pre-requisite	nil	Syllabus version				
		v.1.1				

Course Objectives:

1.To help students gain essential knowledge on the importance of various renewable energy sources
2.To familiarize the students with principles of energy conversion for various renewable energy sources
3.To do practical experiments for energy resource performance under different operating conditions
4. To understand the method for assessment of various input energy resources for meeting the specific requirements.
5.To know the limitations in renewable energy conversion techniques

Expected Course Outcome:

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

1.Explain the current energy scenario and requirement of migration to renewable energy sources
2.Demonstrate the knowledge of various solar thermal energy applications
3.Design solar PV systems under stand-alone mode and analyze the performance of solar cells
4.Design a bio-gas digester
5.Analyze the performance of wind mills
6.Assess the power potential of a given site and choose adequate hydro turbine
7.Explain various methods for harvesting the ocean energy
8.Experimentally determine performance of various renewable energy conversion devices working under different operating conditions

Module:1	Classification of Energy	5 hours

Energy chain and common forms of usable energy - Present energy scenario - World energy status - Energy scenario in India - Introduction to renewable energy resources - Introduction to Solar Energy - Energy from Sun - Spectral distribution of Solar radiation - Instruments for measurement of solar radiation - Solar radiation data analysis

Module:2	Applications of Solar Energy	6 hours

Thermal applications - Introduction to Solar thermal collectors - Types - Principle of operation of different collectors - Flat plate - Evacuated tube collectors - Compound parabolic collectors - Solar air heaters - Solar dryers -solar cookers - solar stills - Solar ponds - concentrating collectors - line type - point type - Methods of Solar power generation - Power towers

Module:3	Introduction to Solar Photovoltaics	5 hours

Physics of solar cells - Cell and module.
Manufacturing Process– Characteristics of cells and module - Performance parameters -BoS- PV

System applications - Stand alone- Grid connected systems.		
Module:4	**Bio Energy Sources**	**4 hours**
Energy through various processes - Energy through fermentation - Gasification - various types of gasifiers -Pyrolysis - Fixed bed and fast Pyrolysis - Bio energy through digestion - Types of Digesters- Factors affecting the yield of products.		
Module:5	**Wind Energy**	**4 hours**
resource assessment - types of wind turbines - selection of components - blade materials - power regulation - various methods of control - wind farms - site selection - off shore wind farms - Solar Wind Hybrid energy systems.		
Module:6	**Small Hydro Power Systems**	**2 hours**
Introduction - types - system components, discharge curve and estimation of power potential - Turbines for SHP.		
Module:7	**Ocean Energy**	**2 hours**
Power generation through OTEC systems - various types - Energy through waves and tides - Energy generation through geothermal systems – types.		
Module:8	**Contemporary issues:**	**2 hours**
Discussion on Recent developments in the area of renewable energy systems and their integration		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	John Andrews, Nick Jelley (2013), Energy Science: Principles, technologies and impacts, Oxford Universities press.
Reference Books	
1.	Fang Lin You, Hong ye (2012), Renewable Energy Systems, Advanced conversion technologies and applications, CRC Press
2	John.A.Duffie, William A.Beckman (2013), Solar Engineering of Thermal processes, Wiley
3	A.R.Jha (2010), Wind Turbine technology, CRC Press.
4	Godfrey Boyle (2012), Renewable Energy, power for a sustainable future, Oxford University Press..
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
List of Challenging Experiments (Indicative)	
1.	1.Estimation of Solar radiation :Pyranometer, pyrheliometer. 2.Testing the yield of a Solar still in outdoor conditions (Multiple sessions). 3.Wind Energy Experimental Set up – I.

	4.Wind Energy Experimental Set up – II. 5.Testing of Solar PV system in PV training Kit. 6.Fuel Cell Experiment. 7.Performance of Biomass stove. 8.Production of Bio-diesel by Transesterification process. 9.Flash Point and Fire point comparison for conventional fuels and alternate fuels. 10.Production of Hydrogen from Electrolysis with PV system. 11.Estimation of Figures of Merit in a Solar cooker. 12.Performance characteristics of a Solar thermal collector. 13.Exergy analysis of a Solar cabinet dryer.	
		Total Laboratory Hours 17 hours
Mode of assessment:		
Recommended by Board of Studies	17-08-2017	
Approved by Academic Council	No. 47	Date 05-10-2017

Course code	Sustainable Energy	L	T	P	J	C
MEE2052		2	0	0	4	3
Pre-requisite	MEE1011	Syllabus version				
		1.2				

Course Objectives:

1. To provide the students with sufficient background to model and understand the mathematical representation of the Sustainable Index
2. To apply concepts of sustainable measures to reduce use of conventional fuel resources
3. To understand the related outcomes of practicing and implementing sustainability in the respective application
4. To train the students with practical experience about the conventional grid and smart grid
5. To induce the students with the knowledge of hybrid vehicle
6. To introduce the students with industries and their practical problems

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to

1. Explain various solutions for implementing sustainability concept to reduce the use of conventional fuel resources
2. Estimate the indices for Energy, Environmental and Economic aspects of sustainability
3. Apply the knowledge of various energy storage method and also transmission of energy.
4. Explore strategies for the improvement of conventional grid transmission and implement the modifications in smart grid.
5. Design the hybrid vehicle using hydrogen and fuel cells.
6. Perform various case studies associated with industries based on life cycle assessment.

Module:1	Sustainable Energy	5 hours

Defining Energy and its classification - Scientific and Engineering Foundations - Environmental Effects with use of fossil fuels to derive Energy - Gaining Understanding - Mathematical Representations of Sustainability related choices.

Module:2	Energy conversion and efficiency	7 hours

Factors Influencing Energy and its Efficiency - Related Choices for energy efficiency - Obstacles to Efficiency and Conservation. Economic, technical and sustainability issues in integrating renewable energy systems.

Module:3	Energy storage and Transmission	6 hours

Energy Storage – Mechanical and thermal energy storage – Electric and magnetic storage - Energy Transmission-Alternating current distribution and transmission – skin effect - Direct current distribution –problems with the conventional grid transmission and distribution– goals for smart grid

Module:4	**Sustainable transportation**	**4 hours**
Electric power vehicles – hybrid vehicles – hydrogen and fuel cells for transportation – associated problems and challenges		
Module:5	**Industrial Energy Usage**	**6 hours**
Introduction to Life cycle analysis and design for sustainability – Case studies on a metal – chemical / process – cement and lime industries – waste management		
Module:6	**Contemporary issues:**	**2 hours**
Group Discussions – Guest lectures		
	Total Lecture hours:	**30 hours**
	Sample Projects 1. Design of an Integrated PV-Thermal system 2. Design of a Thermoelectric Generator 3. Applications – Thermoelectric Refrigerators and Heat Pumps 4. Design and Analysis of Organic Rankine Cycle 5. Heat recovery in a Steel Plant, Cement Plant 6. Design of a Cogeneration plant in a Sugar Industry	

Text Book(s)

1.	Wengenmayr, R. and Bührke, T. (2011), Renewable energy: Sustainable energy concepts for the future, John Wiley & Sons.
2	Frank Kreith (2014), Principles of Sustainable Energy Systems, CRC Press, Second

Reference Books

1.	Tester, J.W., Drake, E.M., Driscoll, M.J., Golay, M.W. and Peters, W.A. (2012), Sustainable energy: choosing among options, MIT press.
2	Ehrlich, R. (2013), Renewable Energy: A first course. CRC Press.
3	Doty, S. and Turner, W.C. (2010), Energy management handbook. 7th Edition, CRC Press.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

MEE2003	Thermal Engineering Systems	L	T	P	J	C
		2	2	2	0	4
Pre-requisite	**MEE1003**	**Syllabus version**				
		v. 2.2				

Course Objectives:

1. To guide the students to apply the laws of thermodynamics in applications of thermal systems.
2. To help students gain essential and basic knowledge of various types of internal and external combustion engines, so as to equip them with knowledge required for the design of engines and power plants.
3. To train the students with the procedures for the testing of engines and fuels.
4. To equip the students to analyse various components of thermal power plant.
5. To impart knowledge in the design of refrigeration and air –conditioning systems.

Expected Course Outcome:

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

1. Apply the laws of thermodynamics to the working of I.C engines.
2. Conduct engine tests and analyze different performance parameters.
3. Design a steam nozzles for thermal power plant
4. Analyze different subsystems of thermal power plants and performance of reciprocating compressors.
5. Analyze various refrigeration systems and suggest for better modifications.
6. Evaluate the cooling load requirements for conditioned space.
7. Experimentally determine the performance indicators of IC Engines, R&AC systems and compressors

Module:1	**IC Engines**	**4 hours**

Working principle of 2 stroke and 4 stroke SI and CI engines with PV and Valve Timing Diagrams, Combustion process - Knocking and detonation, Cetane number and Octane number, Comparison of fuel system of diesel and petrol engines, Cooling system, Lubrication system, Ignition system - Battery, Magneto and Electronic systems.

Module:2	**IC Engines Performance**	**4 hours**

Performance test - Measurement of Brake power, Indicated power, Fuel consumption, Air consumption; Heat balance test, Morse test and Retardation test on IC engine.

Module:3	**Steam Boilers**	**4 hours**

Types of boilers, Reheating - Regeneration - Modern features of high-pressure boilers - Heat Recovery Boilers - Mountings and Accessories. Steam Nozzles – One-dimensional steady flow of steam through a convergent and divergent nozzle.

Module:4	**Steam Turbine and Gas Turbine**	**4 hours**

Steam Turbine – Impulse and Reaction principle.

Gas Turbine – Open and Closed cycle gas turbine, Reheating, Regeneration and Intercooling.		
Module:5	**Positive Displacement Compressors**	**4 hours**
Reciprocating compressors - Construction - Working - Effect of clearance volume – Multi-staging - Volumetric efficiency - Isothermal efficiency.		
Module:6	**Refrigeration and Cryogenic Engineering**	**4 hours**
Refrigeration: Vapour compression system - Components - Working - P-H and T-S diagrams - Calculation of COP - Effect of sub-cooling and super-heating - Vapour absorption system - NH_3 - water system, Vapour adsorption system. **Cryogenic engineering:** Introduction, Application, Cryo-coolers.		
Module:7	**Air-conditioning**	**4 hours**
Types, Working Principles - Psychrometry, Psychrometric chart, cooling load calculations.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Rajput R.K, Thermal Engineering, 10th Edition, Laxmi Publications (P) Ltd, 2017.
Reference Books	
1.	Ganesan V, Internal Combustion Engines, 4th Edition, McGraw Hill Education, 2012.
2.	Manohar Prasad, Refrigeration and Air Conditioning, 3rd Edition, New Age International, 2015.
3.	Soman.K, Thermal Engineering, PHI Learning Private Ltd, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Compare the performance of a single cylinder CI engine connected with different dynamometers and suggest a suitable dynamometer for better accuracy of the results.	2 hours
2.	Compare the energy distribution of a single cylinder CI engine connected with different dynamometers and suggest a suitable dynamometer for better accuracy of the results.	2 hours
3.	Do the performance test on a single cylinder SI engine and compare your results with the engine specifications. Suggest a suitable method to improve the accuracy of your results.	2 hours
4.	Determine the friction power of a given four cylinder petrol engine by performing Morse test and compare the results with Willian's line	2 hours

	method.	
5.	Determine the friction power of a given single cylinder diesel engine by performing retardation test and compare the results with Willian's line method.	2 hours
6.	Compare the properties of different fuels by performing flash point, fire point, viscosity and calorific value tests and find out which is suitable for the better performance of the given engine.	2 hours
7.	Determine the actual index of compression and compare with the isentropic compression for a given reciprocating air compressor.	2 hours
8.	Compare the performance of air blower with different vane profiles.	2 hours
9.	Calculate the COP of the given vapor compression refrigeration system and compare with the theoretical calculation.	2 hours
10.	Calculate the COP of the given air-conditioning test rig and compare with the theoretical calculation.	2 hours
11.	Compare the boiler efficiency for different load levels for the given boiler.	3 hours
12.	Compare the power output for the steam turbine at different load conditions.	3 hours
13.	Draw the valve timing and port timing diagrams for the given engines, compare with the theoretical value and give your comments.	4 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Heat Transfer	L	T	P	J	C
MEE2005		2	2	2	0	4
Pre-requisite	MEE1003	Syllabus version				
		v. 2.2				

Course Objectives:

1. To impart a comprehensive knowledge of various modes of heat transfer.
2. To empower the students for solving heat transfer problems in the industry.
3. To equip the student in the design of heat exchangers.

Expected Course Outcome:

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

1. Apply the basic laws of heat transfer.
2. Solve problems of steady and unsteady state heat conduction for simple geometries.
3. Analyse natural and forced convective heat transfer process.
4. Solve radiation heat transfer problems.
5. Design of heat exchangers by LMTD and NTU methods.
6. Conduct experiments, interpret the data and analyse the heat transfer problems.

Module:1	Fundamental Concepts	2 hours

Basic principles of heat conduction, convection and thermal radiation; Fundamental laws; Identification of significant modes of heat transfer in practical applications.

Module:2	Conduction I	6 hours

General equation of heat conduction in Cartesian, cylindrical and spherical coordinates; One dimensional steady state conduction in simple geometries - plane wall, cylindrical and spherical shells; Electrical analogy; Conduction in composite walls and shells; Critical thickness of insulation; Thermal contact resistance; Overall heat transfer coefficient; One dimensional steady conduction heat transfer with internal heat generation in plane walls, cylinders and spheres.

Module:3	Conduction II	6 hours

Steady state heat conduction in 2D systems - graphical and numerical methods of solution; Conduction shape factor; Unsteady state heat transfer – Systems with negligible internal resistance - lumped heat capacity analysis; Infinite bodies – flat plate, cylinder and sphere; Semi-infinite bodies – chart solutions.

Module:4	Convection I	5 hours

Review of fluid mechanics concepts; Equations of conservation of mass, momentum and energy. Forced convection: External flow over flat plate, cylinder, sphere and bank of tubes; Internal flow through circular pipes; Boundary layers for flow over a flat plate, curved objects and flow through circular pipes.		
Module:5	**Convection II**	**4 hours**
Natural convection: Steady one dimensional flow over vertical, horizontal and inclined plates; Steady one dimensional flow over cylinders and spheres; Combined free and forced convection; Introductory concepts of boiling and condensation.		
Module:6	**Radiation**	**3 hours**
Terminology and laws; Black body; Radiation from real surfaces; Effect of orientation - view factor; Electrical analogy - surface and space resistances.		
Module:7	**Practical applications**	**2 hours**
Extended surfaces (fins); Heat exchangers; Radiation shields.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Yunus A Cengel and Afshin J Ghajar,Heat and Mass Transfer: Fundamentals and Applications, 5th edition, McGraw-Hill, 2015.
2.	R C Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, 5th edition, New Age International, 2017.
Reference Books	
1.	Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, Fundamentals of Heat and Mass Transfer, 7th edition, Wiley, 2011.
2.	J P Holman and Souvik Bhattacharyya, Heat Transfer, 10th edition, McGraw-Hill, 2016.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
	Introduction to laboratory, experiments, evaluation plan etc.	2 hours
1.	Determination of the thermal conductivity of a given metal sample and comparison with tabulated values.	2 hours
2.	Determination of the thermal conductivity of a given liquid and comparison with tabulated values.	2 hours

3.	Heat conduction in spherical coordinate system.	2 hours
4.	Study of heat conduction by electrical analogy: experiment on a composite wall.	2 hours
5.	Determination of rate of heat transfer in natural convection from a cylinder and comparison with theoretical calculations.	2 hours
6.	Determination of rate of heat transfer in forced convection from a heated pipe and comparison with theoretical calculations.	2 hours
7.	Prediction of temperature distribution and efficiency of a pin fin under forced and free convection and comparison with theoretical calculations.	4 hours
8.	Study of the regimes of pool boiling and determination of critical heat flux.	2 hours
9.	Determination of emissivity of a given surface.	2 hours
10.	Determination of Stefan-Boltzmann constant and comparison with reference value.	2 hours
11.	Demonstration of condenser, heat pipe and mass transfer apparatus.	2 hours
	Laboratory examinations (model and final)	4 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course Code	Power Plant Engineering	L	T	P	J	C
MEE2022		3	0	0	0	3
Pre-requisite	MEE1003/ MEE1033/ CHE1003	Syllabus version				
		v. 2.2				

Course Objectives:

1. To equip students about the working of various power generation units and steam cycles.
2. To educate the students to understand the steam generators, combustion and firing methods in order to make the fullest use of thermal power potentialities.
3. Enable the students to understand in detail about nuclear, gas turbine, hydro and diesel power plants which play an important role in power generation.

Expected Course Outcome:

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

1. Analyse different kinds of steam generators and their subsystems
2. Explain different combustion mechanisms, coal, ash and flue gas handling systems
3. Explain the functioning of various types of Nuclear power plants
4. Select the suitable conventional power plant by taking into account all the technical constraints.
5. Evaluate the economic aspects of power plant installation and operation

Module:1	Steam Power Plant	9 hours

Site selection, Components and Layout of steam power plant, vapor power cycles. Steam Generators – Classification and Types of Boilers - Fire tube and Water tube boilers - High pressure and Supercritical boilers - Positive circulation boilers - Fluidized bed boiler - Waste heat recovery boiler, Heat Exchangers - Feed water heaters - Super heaters - Reheaters -Economiser - Condenser-Cooling tower.

Module:2	Combustion and Firing Methods	6 hours

Coal handling and preparation -Combustion equipment and firing methods - Mechanical stokers - Pulverized coal firing systems - Cyclone furnace - Ash handling systems - Electrostatic precipator - Fabric filter and Bag house -Forced draft and Induced draft fans.

Module:3	Nuclear Power Plants	7 hours

Site selection, Components and Layout Principles of nuclear energy - Energy from nuclear reactions - Energy from fission and fuel Burnup - Decay rates and Half - Lives.

Boiling water reactor - Pressurized water reactor Pressurized Heavy Water Reactor - Gas cooled reactor - High temperature gas cooled reactor - Fast breeder reactor - Liquid metal fast breeder

reactor-reactor materials - Radiation shielding.		
Module:4	**Gas Turbine Power Plants**	**6 hours**
Site selection, Components and Layout, Open and closed cycles - Intercooling - Reheating and Regenerating - Combined cycle power plant types.		
Module:5	**Hydro Electric Power Plants**	**5 hours**
Site selection, Components and Layout, Classification of Hydro - electric power plants and their applications - Selection of prime movers - Governing of turbine.		
Module:6	**Diesel Engine Power Plant**	**5 hours**
Site selection, Components and Layout, Subsystems - Starting and stopping - Heat balance - Lubricating and Cooling startegies - Constraints in operating range.		
Module:7	**Economics of Power Plants**	**5 hours**
Cost of electric Energy - Fixed and operating costs - Energy rates - Types tariffs Economics of load sharing - Load Curves.		
Module:8	**Contemporary issues**	**2 hours**
Total lecture hours		**45 hours**

Text Book(s)

1.	P. K. Nag, Power Plant Engineering: Steam and Nuclear, Tata McGraw-Hill Publishing Company Ltd., Fourth Edition. New Delhi, 2014.

Reference Books

1.	R.K.Hegde, Power Plant Engineering Pearson India Education services Pvt. Limited Noida, India, 2015.
2.	R. K. Rajput, A Text Book of Power Plant Engineering, Laxmi Publications (P) Ltd. New Delhi, 2015.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Turbomachines	L	T	P	J	C
MEE2026		2	2	2	0	4
Pre-requisite	MEE1003,MEE1032/MEE1004/CHE1003,CHE1005	Syllabus version				
		v. 2.2				

Course Objectives:

1. To enable the students understand the operation of Turbomachines for compressible fluids
2. To enable the students understand the operation of Turbomachines for incompressible fluids
3. To equip students to apply velocity triangles, thermodynamic plots in turbo-machinery
4. To facilitate the students to contrast various types of Turbomachines
5. To infer the characteristics various Turbomachines under variable operating conditions

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1.Define Euler's equation for Turbomachines from second law of motion
2.Apply Euler's equation of motion to various types turbo machines
3.Demonstrate the knowledge of working and stages of Turbomachines
4.Analyze stage parameters and performance characteristics of various Turbomachines
5.Suggest suitable compounding technique for muti-stage operation of Turbines
6.Identify governing and selection of turbomachinery
7.Solve analytical problems in turbo-machines for both compressible and incompressible fluid flows.
8.Experimentally determine the performance characteristics of both power absorbing and power generating Turbomachines.

Module:1	Energy Transfer	4 hours

Definition and classification of Turbomachines, Specific work - T-s and H-s diagram - Equation of energy transfer - Losses - Various efficiencies - Effect of reheat – Preheat

Module:2	Cascading	5 hours

Aero–Foil section - Cascading of compressor and Turbine blades - Energy Transfer in terms of lift and drag co-efficient for compressor and turbine blades - Variation of lift - Deflection and stagnation pressure loss with incidence.

Module:3	Centrifugal Compressors	5 hours

Centrifugal fans - Blowers and Compressors - construction details - Inducers - Backward and Radial blades - Diffuser - volute casing stage work - Stage pressure rise - Stage pressure co-efficient - Stage efficiency - Degree of reaction - Various slip factors H-S diagram for centrifugal compressor.

Module:4	**Axial Compressors**	**5 hours**
Axial flow Fans and Compressors – Stage velocity triangles - Blade loading and flow co-efficient – Static pressure rise - H-S diagram - Degree of reaction - Work done factors - Free and Forced Vortex flow performance - Stalling and Surging		
Module:5	**Radial Turbines**	**6 hours**
Inward flow radial turbine stages - IFR Turbine - T-s diagram - and degree of reaction - Steam turbine governing – Features of Steam turbine and Gas turbine		
Module:6	**Axial Turbines**	**6 hours**
Axial turbine stages - Stage velocity triangle – Work - Single stage Impulse Turbine - Speed ratio maximum utilization factor - Multistage velocity compounded impulse - Multi stage pressure compounded impulse - reaction stages - Degree of reaction - Zero reaction stages - Fifty percent reaction stages – Hundred percent reaction - Negative reaction - Free and Forced vortex flow		
Module:7	**Hydraulic Machines**	**7 hours**
Centrifugal pumps – Work done – Head developed - Pump output and Efficiencies - priming – minimum starting speed - performance of multistage pumps - Cavitation - methods of prevention - Pump characteristics - Classification of hydraulic turbines - Pelton wheel - Francis turbine - Kaplan and Propeller turbines - Velocity triangles - Specific speed - Theory of draft tube - Governing - Performance characteristics - Selection of turbines, P model and prototype , unit quantities.		
Module:8	**Contemporary issues:**	**4 hours**
Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min of 2 lectures by industry experts		
	Total Lecture hours:	**42 hours**

Text Book(s)	
1.	. S.M. Yahya (2002), Turbine, Fans and Compressors, TMH
Reference Books	
1.	1. Dixon, S.L. (2014), Fluid Mechanics and Thermodynamics of Turbomachinery, 7th edition, Elsevier
2	Kadambi and Prasad (2011), Energy conversion Vol. III – Turbomachines, New Age
3	A.H. Church and Jagadish Lal (2000), Centrifugal Pumps and Blowers; Metropolitan Book Co,
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	To study the performance of Gear Pump at different discharge pressures.	
2.	To study the performance of Reciprocating Pump at different discharge Pressures	
3.	To study the performance of Constant Speed Centrifugal Pump at different discharge pressures.	
4.	To study the performance characteristics of Variable Speed Centrifugal Pump at different speeds and different discharge pressures.	
5.	To study the performance of Jet Pump at different discharge pressures	
6	To study the performance of Submersible Pump at different discharge pressures.	
7	To study the performance of Kaplan Turbine at constant speed, constant load and different vane and blade positions.	
8	To study the performance of Francis Turbine at constant speed, constant load and different vane positions	
9	To study the performance of Pelton Turbine at constant speed and constant load conditions.	
10	To study the impact of jet on vanes.	
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Computational Fluid Dynamics	L	T	P	J	C
MEE4006		2	2	2	0	4
Pre-requisite	MEE1004, MEE2005, MAT3005 (or) MEE1032, MEE1033/MEE2005, MAT3005	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide the students with sufficient background to understand the mathematical representation of the governing equations for fluid flow and heat transfer problems.
2. To equip the students to address complex fluid flow and heat transfer problems by approximating the governing differential equations with boundary conditions through Finite difference and finite volume discretization methods.
3. To enable students to understand different types of grid and its attributes and their suitability for different engineering applications
4. Develop the students to use appropriate turbulence model for solving engineering problems.

Expected Course Outcome:

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

1. Apply mathematics and engineering fundamentals to recognize the type of fluid flow and heat transfer that occur in a particular physical system and to use the appropriate model equations to investigate the problem.
2. Solve governing equations using finite difference discretization technique
3. Solve governing equations using finite volume method
4. Generate appropriate type of grids required for solving engineering problems accurately.
5. Apply suitable turbulence model for the chosen real world engineering problems.
6. Solve fluid flow and heat transfer problems using commercial CFD tools

Module:1	Introduction	1 hour

CFD overview - Applications of CFD.

Module:2	Governing Equations of Fluid Dynamics and Heat Transfer:	6 hours

Models of Flow – Conservation and Non-conservation form - Continuity, Momentum and Energy Equation in conservation and non-conservation form (differential equations only) - Characteristics of PDE's - elliptic, parabolic and hyperbolic.

Module:3	Discretization and Finite Difference method	7 hours

Discretization: Basic aspects of Discretization – Comparison of finite difference, finite volume and finite element techniques.

Finite Difference method: Forward, Backward and Central difference schemes, Transient one and two dimensional conduction - Explicit, implicit, semi-implicit and ADI methods - Stability analysis and error estimation.		
Module:4	**Grid Generation**	**3 hours**
Grid Generation: Choice of grid, grid oriented velocity components, Cartesian velocity components, staggered and collocated arrangements.		
Module:5	**Convection and Diffusion**	**7 hours**
Convection and Diffusion: Steady one-dimensional convection and diffusion - Central difference, upwind, quick, exponential, hybrid and power law schemes- False diffusion, SIMPLE – Algorithm.		
Module:6	**Turbulence Modeling**	**4 hours**
Turbulence Modeling : Introduction – Types of Turbulence modeling – Reynolds Time Averaging – Reynolds Time Averaged conservation equations – Boussinesq approach – One equation k - ε model.		
Module:7	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30hours**

Text Book(s)	
1.	John D Anderson, Computational Fluid Dynamics – The Basics with Applications, 1st Edition, McGraw Hill, 2012.
Reference Books	
1.	Chung T.J, Computational Fluid Dynamics, Cambridge University Press, 2014.
2.	Muralidhar K and Sundararajan T, Computational Fluid Flow and Heat Transfer, Narosa Publications, New Delhi, 2014.
3.	Versteeg H.K and Malalasekara W, An Introduction to Computational Fluid Dynamics - The Finite Volume Method, 2nd Edition, Pearson, 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Modeling of simple and complex geometries.	3 hours
2.	Hexahedral meshing for simple geometries like square duct, circular pipe.	3 hours
3.	O-grid hexa meshing for circular pipe.	3 hours
4.	Tetrahedral meshing for simple geometries including fluid and solid	3 hours

	domains.	
5.	Preprocessing in FLUENT – Case setup and analyzing for already mesh generated model.	3 hours
6.	Steady state temperature distribution in a rectangular plate (ANSYS Fluent and FDM).	3 hours
7.	Diffuser for a hydropower turbine.	3 hours
8.	Flow over an airfoil - Laminar and turbulent flow.	3 hours
9.	Supersonic flow past a wedge in a channel.	3 hours
10.	Exercise (for each student – different exercise) from FLUENT tutorial (case setup, analyzing, and post-processing).	3 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Design of Mechanical Components	L	T	P	J	C
MEE2051		2	2	0	0	3
Pre-requisite		Syllabus version				
		v. 1.1				

Course Objectives:

1.To understand the design methodology for machine elements.
2.To analyse the forces acting on a machine element and apply the suitable design methodology.
3. To understand the various standards and methods of standardisation.
4. To apply the concept of parametric design and validation by strength analysis

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to

1. Design Mechanical components as per IS codes
2. Explain fatigue failure using S-N diagram
3. Design Shafts and couplings used for different mechanical systems
4. Design helical and leaf springs
5. Design different fasteners such as riveted, welded and bolted joints
6. Perform design of keys, cotters and knuckle joints
7. Design different components of engines

Module:1	Introduction to Design Process	4 hours

Introduction to Design Process: Introduction to Design process – Factors – Materials selection, IS coding of steels and Cast Irons.Direct, Bending and Torsional stress equation - Impact and Shock loading - Stress concentration factor - Size factor - Surface limits factor - Factor of safety - Design stress - Theories of failures – Problems.

Module:2	Design against Fluctuating Loads:	4 hours

Design Against Fluctuating Loads: Stress Concentration, Endurance limit and Fatigue failure, Factors affecting endurance limit, S-N Diagram, Design for reversed stresses and cumulative damage, Fluctuating stresses: Soderberg, Gerber, Goodman and Modified Goodman criteria, Combined stresses.

Module:3	Design of Shafts and Couplings	4 hours

Design of Shafts and Couplings: Design of solid and hollow shafts for strength and rigidity – design of shafts for combined bending and axial loads– shaft sizes.
Design of Shaft Couplings: Requirements of a Good Shaft Coupling, Types of Shaft Couplings, Sleeve or Muff Coupling, Clamp or Compression Coupling, Flange Coupling, Design of Flange Coupling, Flexible Coupling, Bushed Pin Flexible Coupling, Oldham Coupling, Universal Coupling.

Module:4	Design of Mechanical Springs	4 hours

classification of springs: Stresses and deflections of helical springs – extension -compression. Helical Spring: stresses, Correction Factors, and Deflection, Design against static and fluctuating loads, shot peening of springs. Energy storage capacity – helical torsion springs – Flat Spiral Springs Multi-Leaf Spring: Terminology, Nipping, and Design of multi-leaf spring.		
Module:5	**Design of Riveted, Welded and Bolted Joints:**	**3 hours**
Design of Riveted Joint: Methods of Riveting, Material of Rivets, Essential Qualities of a Rivet, Manufacture of Rivets, Types of Rivet Heads, Types of Riveted Joints, Lap Joint, Butt Joint. Failures of a Riveted Joint, Strength of a Riveted Joint, Efficiency of a Riveted Joint, Design of Boiler Joints. Eccentric Loaded Riveted Joint. Problems.		
Module:6	**Design of Keys, cotters and knuckle joints:**	**4 hours**
Design of keys- Types of Keys, Sunk Keys, Saddle Keys, Tangent Keys, Round Keys, Splines, Forces acting on a Sunk Key, Strength of a Sunk Key, Effect of Keyways.stresses in keys. Design of Joints: Cotter Joint-Spigot and socket, sleeve and cotter, jib and cotter joints- knuckle joints.		
Module:7	**Design of Engine Components:**	**5 hours**
Design of Flywheel: Coefficient of Fluctuation of Speed, Fluctuation of Energy, Maximum Fluctuation of Energy, Coefficient of Fluctuation of Energy, Energy Stored in a Flywheel, Stresses in a Flywheel Rim, Stresses in Flywheel Arms, Design of Flywheel Arms, Design of Shaft, Hub and Key, Construction of Flywheels.Design of Piston: Design Considerations for a Piston, Material for Pistons, Problems – Connecting rod: Forces Acting on the Connecting Rod, Design of Connecting Rod, Design of Crankshaft.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Joseph Edward Shigley and Charles, R. Mischke, (2008), Mechanical Engineering Design, McGraw – Hill International Editions, 8th edition.
2	Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2003.
3	
Reference Books	
1.	V.B. Bhandari (2010) Design of Machine elements, Tata Mc Graw Hill, 3rd Edition.

2	P.C.Sharma&D.K.Aggarwal(2012), A Text Book of Machine Design, S.K.Kataria& Sons, New Delhi,12th edition,.		
3	. Jack A.Collins, Henry Busby, George Staab (2011) Mechanical Design of Machine Elements and Machines, 2nd Edition, Wiley India Pvt. Limited.		
4	B.J. Hamrock, and S.R. Schmid, Fundamentals of Machine Elements, Tata McGraw Hill, New Delhi, 2005,		
5	Juvinal, R.C and Kurt M.Marshek.,(2012), Machine component design, John Wiley.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No.47	Date	05-10-2017

Course code	Machine Drawing	L	T	P	J	C
MEE2001		1	0	4	0	3
Pre-requisite	MEE1001	Syllabus version				
		v. 1.1				

Course Objectives:

1. To understand and apply national and international standards while drawing machine component.
2. To understand the concept of various tolerances and fits used for component design
3. To familiarize in drawing assembly, orthographic and sectional views of various machine components.

Expected Course Outcome:

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

1. Apply the national and international standards in machine drawing.
2. Apply limits and tolerances to assemblies and choose appropriate fits.
3. Prepare production drawings with geometrical dimensioning and tolerances
4. Assign machining and surface finish symbols.
5. Prepare production drawings with geometrical dimensioning and tolerances
6. Illustrate various machine components through drawings.

Module:1	Basics of Machine Drawing	4 hours

Introduction – Projections - Classifications of machine drawing- BIS specifications - Sectioning – Dimensioning methods: Counter Sink, Counter Bores, Spot Faces, Chamfers, Screw Threads, Tapered Features, Title block of Industrial drawing and Bill of Materials.

Module:2	Limits and Fits	2 hours

Classifications and of Fits, Selection of Fits, Representation on Drawings, Tolerance Grade, Computations of Tolerance, Positions of Tolerance, Fundamental of Deviations, Shaft and Hole Terminology, Method of placing limit dimensions.

Module:3	Geometrical Tolerances	2 hours

Need of Geometrical Tolerance, Geometrical Characteristics of Symbols, Indication of MMC, LMC, Interpretation and Indication of Geometrical Tolerance and Dimensioning.

Module:4	Conventional Representations	2 hours

Materials - Interrupted views and Braking of Shaft, Pipe, Bar - Surface finishing & Machining Symbols.

Module:5	**Screwed Fastenings and Joints**	**3 hours**
Screwed Fastenings - Screw Thread Nomenclature and types, Joints: Bolts and Nuts, Key, Cotter, Riveted, Pin, Welded joints. Pulleys and Couplings.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**15 hours**

Text Book(s)	
1.	Bhatt, N.D., Machine Drawing, 50th edition, Charotar Publishing House Pvt. Ltd., India, 2014.
Reference Books	
1.	Ajeet Singh, Machine drawing, 2nd edition, Tata McGraw Hill, India, 2012.
2.	K.L. Narayana, Machine Drawing, 4th edition, New Age International publisher, India, 2014.
3.	K.C. John, Text book on Machine Drawing, 2nd edition, PHI Learning Pvt, Ltd, India, 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Introduction to CAD Packages and demonstration of part modeling, assembly and detailed with simple examples to familiarize CAD Packages. Sketcher constraints, basic 3D commands to be used for drawing machine components.	4 hours
2.	Visualization of machine components and its assemblies.	2 hours
3.	CAD modeling of shaft, bearings, fasteners, couplings, gears, keys, rivets, springs and pulleys –user defined, customization using catalogues.	4 hours
4.	Part modeling, assembling and detailed drawing of Shaft joints: Cotter joint and Knuckle joint.	8 hours
5.	Part modeling, assembling and detailed drawing of Keys and Shaft coupling: Flanged and Universal coupling.	8 hours
6.	Part modeling, assembling and detailed drawing of Shaft Bearing: Plummer block and Footstep bearing.	8 hours
7.	Part modeling, assembling and detailed drawing of Pulleys: Belt pulley, V belt pulley, Fast and loose pulley and Speed cone pulley.	8 hours
8.	Part modeling, assembling and detailing of machine components: Tailstock and Bench Vice.	8 hours
9.	Part modeling, assembling and detailing of I.C engine connecting rods.	6 hours
10.	Part modeling, assembling and detailing of Real time machine components.	4 hours
	Total Laboratory Hours	**60 hours**

Mode of assessment:

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	CAD/CAM	L	T	P	J	C
MEE2007		2	0	4	0	4
Pre-requisite	MEE1007	Syllabus version				
		v. 1.1				

Course Objectives:

1. Demonstrate basics of CAD/CAM concepts.
2. Explain computer graphics and solid modelling techniques.
3. Demonstrate part programs and group technology techniques.
4. Discuss latest advances in the manufacturing perspectives.

Expected Course Outcome:

1. Apply design concepts.
2. Utilise CAD standards for geometrical modelling.
3. Demonstrate Solid modelling techniques.
4. Develop part programs for solid models.
5. Apply group technology concept in manufacturing product.
6. Make use of FEA concept for analysis.
7. Explain FMS and CIM wheel for manufacturing industry
8. Develop the model for analysing and manufacturing structural member.

Module:1	Introduction	4 hours

Definition and scope of CAD/CAM- Computers in industrial manufacturing, design process- Computer Aided Design (CAD)-Computer Aided Manufacturing (CAM)-Computer Integrated Manufacturing (CIM) - Introduction to Computer graphics -Raster scan graphics-Co-ordinate systems.

Module:2	Graphics and computing standards	4 hours

Data base for graphic modeling-transformation geometry-3D transformations –Clipping-hidden line removal-Colour-shading-Standardization in graphics- Open GL Data Exchange standards – IGES, STEP - Graphic Kernal system (GKS).

Module:3	Geometric modelling	4 hours

Geometric construction methods-Constraint based modeling- Wireframe, Surface and Solid – Parametric representation of curves, solids & surfaces.

Module:4	CNC Machine Tools	4 hours

Introduction to NC, CNC, DNC - Manual part Programming – Computer Assisted Part Programming – Examples using NC codes- Adaptive Control – Canned cycles and subroutines – CAD/ CAM approach to NC part programming – APT language, machining from 3D models.

Module:5	Role of information systems in manufacturing	4 hours
Discrete part manufacture-information requirements of a production organization-manufacturing strategies-Integration requirement - Group technology-coding-Production flow analysis-computer part programming-CAPP implementation techniques.		
Module:6	**Introduction to FEA concepts**	**4 hours**
Nodes -Meshing – Pre and Post processing – Modal analysis – Stress analysis – Steady state and Transient analysis.		
Module:7	**Automated manufacturing systems**	**4 hours**
Flexible Manufacturing systems (FMS) – the FMS concepts – transfer systems – head changing FMS – Introduction to Rapid prototyping, Knowledge Based Engineering, Virtual Reality, Augmented Reality –automated guided vehicle-Robots-automated storage and retrieval systems - computer aided quality control-CMM-Non contact inspection methods.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	P.N.Rao, CAD/CAM: Principles and Applications-3rd Edition, Tata McGraw Hill, India, 2010.

Reference Books

1.	Mikell P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education, 2005.
2	James A. Rehg, Henry W. Kraebber, Computer Integrated Manufacturing, Pearson Education, 2002.
3	Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw Hill International Edition,2005.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	2D Geometry –Splines.	2 hours
2.	Surface Modelling –NURBS.	2 hours
3.	Solid Modelling-CSG, Brep.	2 hours
4.	Preparing solid models for analysis-Neutral files.	2 hours
5.	Real time component analysis-STRESS, STRAIN Analysis.	2 hours
6	Model analysis of different structures.	2 hours
7	Tolerance analysis of any mechanical component.	2 hours
8	CNC Milling program involving linear motion and circular interpolation.	2 hours
9	CNC Milling program involving contour motion and canned cycles.	2 hours
10	CNC Milling program involving Pocket milling.	2hours
11	Diagnosis and trouble shooting in CNC machine.	2 hours
12	Route sheet generation using CAM software.	2 hours

13	Generation of CNC programming using DXF file format using Wire EDM.			2 hours
14	Generation of CNC programming and machining using Master Cam.			2 hours
15	Generation of STL file format for the given component.			2 hours
			Total Laboratory Hours	**30 hours**
Mode of assessment:				
Recommended by Board of Studies	17-08-2017			
Approved by Academic Council	47	Date	05-10-2017	

Course code	Internal Combustion Engines	L	T	P	J	C
MEE3004		3	0	0	0	3
Pre-requisite	MEE2003	Syllabus version				
		v. 2.2				

Course Objectives:

1. To introduce students to the working of spark ignition and compression ignition engines and their systems.
2. To teach students about the usage of alternate fuels for IC engines.
3. To enhance the understanding of students in engine emissions, pollution and their control.
4. To introduce students to the recent trends in IC Engines like stratification, multi point injection, plasma ignition etc.

Expected Course Outcome:

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

1. Explain the concept of fuel injection systems and properties of mixture
2. Determine performance and combustion characteristics of SI and CI engines.
3. Propose techniques to enhance the efficiency and performance of IC engines
4. Analyze the emissions from IC engines and its effects on human beings and environment
5. Critically evaluate properties of different alternate fuels for their use in automobile engines
6. Provide guidelines for incorporating latest IC engine technologies into conventional engine Design

Module:1	Mixture preparation	11 hours

Mixture preparation in Spark Ignition Engines: Spark ignition Engine mixture requirements - Feedback Control Carburetors –Properties of Fuel - Injection systems -Monopoint and Multipoint injection – Gasoline Direct Injection – Airmotion.

Mixture preparation in Compression Ignition Engines: Direct and indirect injection systems – Combustion chambers - Properties of Fuel -Fuel spray behavior - spray structure - spray penetration and evaporation – Air motion- Injectors and nozzles.

Module:2	Combustion in CI and SI Engines	5 hours

Stages of combustion in SI and CI engines – Combustion phasing - heat release rate based on cylinder pressure measurement-Knock in CI and SI engines- Measurement and control of Knock.

Module:3	Power Boosting Systems	5 hours

Supercharging – Turbocharging - Variable area turbochargers, twin entry turbochargers - waste gate in turbocharger - different arrangements of turbochargers and super chargers - Effect on

power and emission - basics of intake manifold tuning.		
Module:4	**Engine Emission and Control**	**6 hours**
Pollutant - Sources and types – Effect on environment and human health - formation of NOx - Hydrocarbon Emission Mechanism - Carbon Monoxide Formation - Particulate emissions - Methods of controlling Emissions - Catalytic converters and Particulate Traps - Selective Catalytic Reduction(SCR) - Diesel Oxidation Catalyst (DOC).		
Module:5	**Emission Measurement and Emission Norms**	**6 hours**
Methods of measurements – Chemiluminescence - Non-Dispersive Infrared - Flame Ionisation Technique - Emission Norms and Driving cycles - Indian and Euro norms.		
Module:6	**Alternative Fuels**	**6 hours**
Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas – Biodiesel- Biogas - Properties - Suitability - Engine Modifications - Merits and Demerits as fuels.		
Module:7	**Recent Trends in IC Engines**	**4 hours**
LHR Engines - Learn Burn Engines - Stratified charge spark ignition engine – Homogeneous charge compression Ignition –Reactivity Controlled Compression Ignition-Rotary engine-Six stroke engine concept.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	V Ganesan, Internal Combustion Engine, 4th edition, Tata Mc-Graw Hill, 2012.
2.	Mathur.M.L & Sharma R.P, Internal Combustion Engine, Dhanpat Rai Publications, 2010.

Reference Books

1.	Richard Stone, Introduction to Internal Combustion Engines, 4thedition, Palgrave Macmillan, 2012.
2.	John B.Heywood, Internal Combustion Engine Fundamentals, 2nd Edition, Tata McGraw Hill, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	10-06-2015		
Approved by Academic Council	37	Date	16-06-2015

CHE 2006	Fuels and Combustion	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		1.2				

Course Objectives:

1.Develop the understanding levels of fuels and combustion fundamentals
2. Classify and introduce different types of fuel and fuel analysis techniques that assists the students to choose most convenient fuel for a process involving combustion`
3. Engage the students in designing various control techniques for handling various environmental issues resulting from combustion of fuels

Expected Course Outcome:

1. Understand the various types of fuels like liquid, solid and gaseous fuels are available for firing in boilers and furnaces
2. Select the right type of fuel depends on various factors such as availability, storage, handling, pollution and cost of fuel
3. Understand the fuel properties and efficient use of the fuel
4. Know various analyses of exhaust and flue gases
5. Understand various combustion Equipment

Module:1	Classification and Properties of Fuels	5 hours

Fuels-Types and characteristics of fuels-Determination of properties of fuels-Fuel analysis-Proximate and ultimate analysis-Calorific value (CV)-Gross and net calorific values (GCV,NCV)-Bomb Calorimetry-empirical equations for CV estimation

Module:2	Solid Fuels	6 hours

Origin of coal-Ranking of coal-Washing, cleaning and storage of coal-Renewable Solid Fuelscomparative
study of Solid, liquid and gaseous fuels-selection of coal for different industrial applications-carbonization of coal

Module:3	Liquid fuels	6 hours

Origin of crude oil-composition of crude petroleum-classification of crude petroleum-Removal of salt from crude oil-processing of crude petroleum-Fractionation distillation-ADU and VDUCracking-
Hydrotreatment and Reforming

Module:4	Gaseous fuels	6 hours

Rich and lean gas-Wobbe index-Natural gas-Dry and wet natural gas-Foul and sweet NG-

LPGLNG- CNG-Methane-Producer Gas-Water gas-Coal Gasification-Gasification Efficiency		
Module:5	**Combustion**	**7 hours**
General principles of combustion-types of combustion processes-Combustion chemistry-Combustion equations-Kinetics of combustion-combustion of solid fuels-Combustion calculations-air fuel ratio-Excess air calculations		
Module:6	Combustion Equipment	**7 hours**
Analysis of flue gases by Orsat apparatus-Combustion of solid fuels-grate firing and pulverized fuel firing system-Fluidized bed combustion-Circulating fluidized bed boiler-Burners-Factors affecting burners and combustion		
Module:7	**Air Pollution**	**6 hours**
Types of pollution-Combustion generated air pollution-Effects of air pollution-Pollution of fossil fuels and its control-Pollution from automobiles and its control		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Kenneth K.K., Principles of Combustion, 2nd ed., Wiley Publications, USA, 2012
	Phillips H.J., Fuels-solid, liquid and gases–Their analysis and valuation, 1st ed., Foster
1.	Speight J.G., The Chemistry and Technology of Coal, 3rd ed., Taylor and Francis Ltd., USA,2016
2.	Sarkar S., Fuels and combustion, 3rd ed., Universities Press, India, 2009

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	15-04-2019		
Approved by Academic Council	No. 55th	Date	13-06-2019

Course code	Automobile Engineering	L	T	P	J	C
MEE3006		2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To broaden the understanding of students in the structure of vehicle chassis and engines.
2. To introduce students to steering, suspension, braking and transmission systems.
3. To introduce students to engine auxiliary systems like heating, ventilation and air-conditioning.
4. To teach students about the importance of alternate fuels and modifying the engine suitably.

Expected Course Outcome:

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

1. Choose and suggest a suitable engine chassis layout for different applications
2. Analyse various types of steering systems, Discuss various types of braking and suspension system
3. Select a suitable conventional and automatic transmission system
4. Troubleshoot the electrical and instrumentation system in the automobiles
5. Propose advance technologies to improve vehicle performance characteristics.

Module:1	Vehicle Structure and Performance:	4 hours

Automotive components, subsystems and their positions- Chassis, frame and body, front, rear and four wheel drives, Operation and performance, Traction force and traction resistance, Power required for automobile - Rolling, air and gradient resistance.

Module:2	Transmission Systems	4 hours

Clutch - Types- diaphragm type clutch, single and multi-plate clutches - Gear box: Types-constant mesh, sliding mesh and synchromesh gear box, layout of gear box, gear selector and shifting mechanism, overdrive, automatic transmission, Propeller shaft, universal joint, slip joint, differential and real axle arrangement, hydraulic coupling.

Module:3	Steering System	4 hours

Types of steering systems, Ackermann principle, Davis steering gear, steering gear boxes, steering linkages, power steering, wheel geometry-caster, camber toe-in, toe out etc., wheel Alignment and balancing.

Module:4	Suspension System	4 hours

Types - front and rear suspension, conventional and independent type suspension, leaf springs,

coil springs, dampers, torsion bars, stabilizer bars, arms, air suspension systems.		
Module:5	**Braking System**	**4 hours**
Forces on vehicles, tyre grip, load transfer, braking distribution between axles, stopping distance, Types of brakes, Mechanical, Hydraulic, Air brakes, Disc & Drum brakes, Engine brakes anti-lock braking system.		
Module:6	**Automobile Electrical System and Instrumentation**	**4 hours**
General electrical circuits. Battery, Starting motor, DC generator, Alternator, Ignition circuit, Dash board instrumentation, Lighting system.		
Module:7	**Advances in Automobile Engineering**	**4 hours**
Passenger comfort - Safety and security - HVAC - Seat belts - Air bags - Automotive Electronics - Electronic Control Unit (ECU) - Variable Valve Timing (VVT) - Active Suspension System (ASS) - Electronic Brake Distribution (EBD) – Electronic Stability Program (ESP) Traction Control System (TCS) - Global Positioning System (GPS) - Electric - Hybrid vehicle.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	William. H. Crouse, Donald L Anglin, Automotive Mechanics, 10th Edition, McGraw-Hill, 2017.
Reference Books	
1.	Bosch Automotive Hand Book, 8th Edition, Bentley Publishers, 2011.
2	Kirpal Singh, Automobile Engineering, Vol.1, Standard Publishers, 2012.
3	Kirpal Singh, Automobile Engineering, Vol.2, Standard Publishers, 2011.
4	N. K. Giri, Automobile Mechanics, 5th Edition, Khanna Publishers, 2014.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Study of chassis and body (different types).	3 hours
2.	Assembling and disassembling of gear box (different types).	3 hours
3.	Study of transfer case, propeller shaft, slip joint and universal joint.	3 hours
4.	Assembling and disassembling of steering box (different types).	3 hours
5	Assembling and disassembling of differential and rear axle	3 hours

6	Assembling and disassembling of clutch.			3 hours
7	Determination of camber, caster, toe-in/toe-out.			3 hours
8	Assembling and disassembling of components of hydraulic brake system.			3 hours
9	Assembling and disassembling of components of air brake system.			3 hours
10.	Study on advanced technologies (ABS, EBD, VVT, Hybrid).			3 hours
			Total Laboratory Hours	**30 hours**
Mode of assessment:				
Recommended by Board of Studies	17-08-2017			
Approved by Academic Council	47	Date	05-10-2017	

Course code	Alternative Fuels	L	T	P	J	C
MEE1012		3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide the students with sufficient background to understand the need for alternative fuels.
2. To enable the students to understand different sources of alternative fuels, production and storage methods.
3. To teach students how to use alternative fuels in internal combustion engines and their performance and emission characteristics.
4. To provide the knowledge of zero emission vehicles using clean technologies.

Expected Course Outcome:

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

1. Explicate the importance of alternative fuels and reserve status of fossil fuels.
2. Comprehend the important properties, production and storage of hydrogen and other gaseous fuels and address the implications during their use in IC engines.
3. Comprehend the important properties, production and storage of liquid fuels and solid and address the implications during their use in IC engines.
4. Evaluate the performance of clean propulsion technologies.
5. Predict the behavior of engines during the usage of alternative fuels.
6. Identify the optimal alternative fuels for local usage based on the availability of raw materials.

Module:1	Introduction	2 hours

Status of petroleum reserves, economics; Need for alternative fuels; Review of fuel properties.

Module:2	Hydrogen – Production and Storage	6 hours

Properties; Production and storage methods; Safety aspects; Use in SI and CI engines; Engine modifications required; Performance and emissions.

Module:3	Organic gaseous fuels	10 hours

Natural Gas, LPG, biogas, producer gas, syngas etc.; Properties; Production and storage methods - CNG and LNG, gasification, digesters; Use in SI and CI engines; Performance and emission characteristics; Modes of operation in internal combustion engines.

Module:4	Alcohols and ethers	10 hours

Methanol and ethanol; DME and DEE; Properties; Production methods; Use in SI and CI engines –Fuel and engine modifications required; Performance and emissions.

Module:5	**Vegetable oils**	**10 hours**
Types, composition and properties; Challenges of use in CI engines, solutions - preheating, blending; Transesterification; Pyrolysis; Performance and emissions; Oils from waste - cooking oil, wood, rubber, plastic etc.		
Module:6	**Solid fuels**	**2 hours**
Biomass - processing and usage, forms - municipal solid waste, wood.		
Module:7	**Clean technology**	**3 hours**
Fuel cells - types, working; Hybrid and electric vehicles; Solar power; Challenges; Engine modifications; Performance.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Thipse S. S., Alternative Fuels: Concepts, Technologies and Developments, Jaico Publishing House, 2010.

Reference Books

1.	Ganesan V, Internal Combustion Engines, McGraw-Hill Education India Pvt. Ltd, 2012.
2.	Michael F. Hordeski, Alternative Fuels: The Future of Hydrogen, The Fairmont Press, Inc, 2013.
3.	Sunggyu Lee, James G. Speight, Sudarshan K. Loyalka, Handbook of Alternative Fuel Technologies, 2nd edition, CRC Press, 2014.
4.	James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd edition, John Wiley & Sons, Ltd, 2012.
5.	Richard L.Bechtold, Alternative Fuels Guidebook, Society of Automotive Engineers (SAE), 2014.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of assessment:

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Energy Systems Analysis and Design	L	T	P	J	C
MEE2030		3	0	0	0	3
Pre-requisite	MEE1003	Syllabus version				
		v.1.1				

Course Objectives:

1. To help students gain essential knowledge on the importance of various energy sources and their related conversion techniques for power generation
2. To identify parameters for the design of a system
3. To evaluate system(s) under various operating conditions and optimize energy generation
4. Deriving and solving system equations for optimizing a process or power cycle

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to

1. Explain the techniques for energy conversion and corresponding limitations
2. Demonstrate the knowledge of mathematical modelling of systems and need of optimization
3. Model thermal systems under various conditions and optimize their performance
4. Devise information flow diagram for various systems simulation
5. Analyze the performance of energy systems by optimization techniques
6. Apply dynamic programming techniques for assessing energy systems potential
7. Identify properties of working fluids by using numerical modeling
8. Apply the design optimization concepts for solving practical industrial case studies under different operating conditions

Module:1	Introduction:	5 hours

Overview of various technologies and conventional methods of energy conversion - Power cycles Designing a workable system - Workable and optimum systems - Steps in arriving at a workable system Creativity in concept selection - Workable Vs optimum system – life cycle design

Module:2	Equation fitting	8 hours

- Mathematical modeling – Polynomial representation - Functions of two variables - Exponential forms – Best fit method of least squares Thermodynamic properties - Internal energy and enthalpy – Pressure temperature relationship at saturated conditions - Specific heat - P-V-T equations - Mathematical modeling - Need for mathematical modeling - Criteria for fidelity of representation - Linear regression analysis

Module:3	Modeling of thermal equipment	5 hours

- Counter flow heat exchanger - Evaporators and condensers -Heat exchanger effectiveness - Effectiveness of a counter flow heat exchanger – NTU -Pressure drop and pumping power

Module:4	System simulation -	5 hours

Classes of simulation - Information flow diagrams - Sequential and simultaneous calculations –

Successive substitution - Newton- Raphson method		
Module:5	**Optimization**	**8 hours**
- Mathematical representation of optimization problems - Optimization procedure - Setting up the mathematical statement of the optimization problem - Lagrange multipliers - Lagrange multiplier equations - Unconstrained optimization - Constrained optimization - Sensitivity coefficients - Search methods - Single variable - Exhaustive- Dichotomous and Fibonacci - Multivariable unconstrained – Latticeunivariable and steepest ascent		
Module:6	**Dynamic programming**	**6 hours**
- Characteristic of the dynamic programming solution -Apparently constrained problem - Application of dynamic programming to energy system problems		
Module:7	**Geometric programming**	**6 hours**
One independent variable unconstrained - Multivariable optimization - Constrained optimization with zero degree of difficulty - Linear programming - Simplex method - Big-M method - Application of LP to thermal systems – Genetic algorithm		
Module:8	**Contemporary issues:**	**2 hours**
Contemporary Discussion - Optimization of centralized air condition system – modeling and simulation of advanced thermal power plant using genetic algorithm – pre design post design and analysis of a typical thermal system.		
Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry and study the metallurgical equipment, Min of 2 lectures by industry experts		

	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	
Reference Books	
1.	I.J. Nagrath and M. Gopal, Systems Modeling and Analysis, Tata McGraw-Hill.
2	Y. Jaluria, Design and Optimization of Thermal Systems, McGraw-Hill.
3	B.K. Hodge and Robert P. Taylor, Analysis and Design of Thermal Systems, Prentice-Hall Inc.
4	D.J. Wide, Globally Optimal Design, Wiley Interscience

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Nuclear Power Engineering	L	T	P	J	C
MEE2027		3	0	0	0	3
Pre-requisite	MEE1003	Syllabus Version				
		1.1				

Course Objectives:

- To enable the students understand the basic physics of nuclear reactions
- To facilitate the students to understand nuclear decay
- To enable the students to list and know the operation of nuclear reactors

To equip students about the safety and environmental aspects

Expected Course Outcome:

Upon Successful Completion of this course, Students will be able to

1. Define Einstein's equation related to nuclear reaction and understand the nuclear physics
2. Understand and classify the nuclear cross-sections
3. Differentiate the terminologies related to nuclear fission and fusion process
4. Demonstrate the knowledge of nuclear reactor theory and design parameters of reactor
5. Understand the types of nuclear reactors and its working principle
6. Understand and demonstrate reprocessing and safety aspects

Module:1	Energy Transfer	5 hours

Introduction to Nuclear Physics:
The constituents of nuclei, nucleons, Einstein's theory, particle wavelengths, nuclear dimensions, nuclear units, nuclear mass, mass defect, Nuclear energetic-binding energy, belt of stability, excited states in nuclei, Radioactivity, Radioactive decay, ionizing radiations, decay laws, decay of excited states, decay series, chain reactions and branched decay.

Module:2	Neutron Nucleus Interactions:	5 hours

Binary nuclear reactions, Q values, neutron scattering and capture, microscopic and macroscopic cross-Sections, neutron flux, differential scattering cross-Sections

Module:3	Nuclear Fission and fusion:	5 hours

Mechanisms of fission, fission fuels, cross sections of fissionable nuclei, the products of fission, delayed and non-delayed neutrons, energy release from fission, fuel burn up and fuel Consumption; critical mass, nuclear chain-reacting systems, nuclear fusion reactions, thermonuclear reaction, energy produced in stars and Sun, nuclegenesis

Module:4	Nuclear Reactor Theory:	6 hours

Introduction to nuclear reactors, critical mass and size, multiplication factor, rate equations, four and six factor

Formulas, neutron balance and conditions of criticality, conversion and breeding, breeder ratio and conversion ratio, neutron sources, intrinsic and external sources, sub critical multiplication, burnable poisons, fission products poisoning (xenon and samarium), Nuclear reactor materials		
Module:5	**Nuclear Reactor:**	**7 hours**
Basic Design and components of a nuclear reactor, fuel core, reflectors, moderators, coolants, types of coolants, Reactor control elements, safety rods, shim rods, regulating rods, Radiation shields, materials, General considerations of reactor design, Types of Nuclear Reactors; Gen.1 Research reactors, homogeneous and heterogeneous reactors, graphite moderated reactors, Gen. II-PWR, BWR, heavy water (CANDU) reactors, breeder and fast Breeder Reactors, Comparisons materials, cost and operations. Gen III reactors (ABWR, AGR), Future power (Gen IV)–HTGR and MSR reactors, nuclear fusion (thermonuclear) reactors, layout of nuclear power plant		
Module:6	**Reprocessing:**	**7 hours**
Nuclear fuel cycles, spent fuel characteristics, role of solvent extraction in reprocessing-solvent extraction equipment.		
Module:7	**Safety and Environmental Aspects:**	**8 hours**
Introduction to reactor reliability and safety analysis, spent fuel storage, types of radioactive waste and its disposal. Biological effects of radiation, radiation protection, regulatory aspects, radiation biology, operational radiation protection, radiation monitoring; radiation measuring instruments		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Nuclear Reactor Engineering (3rd Edition), S.Glasstone and A.Sesonske, Von Nostrand, 1981.
2.	Nuclear Reactor Engineering-Concepts & Principles, G.Vaidyanathan, S.Chand co., Delhi, 2013

Reference Books	
1.	Rudy J.M. Konings, Comprehensive Nuclear Materials, vol. 1-5, Elsevier Ltd, 2012
2	M. Yastrebenetsky, V. Kharchenko, Nuclear Power Plant Instrumentation and Control Systems for Safety and Security, February 2014.
3	Fast Breeder Reactor, A. E. Walter and A. B. Reynolds, Pergamon Press, 1981
4	E. Lewis, "Fundamentals of Nuclear Reactor Physics," Academic Press, 2008
5	James Doyle, Nuclear Safeguards, Security and Non-proliferation, Butterworth-Heinemann, 2008.

6	Murray, R. L.; Nuclear Energy, An introduction to the concepts, systems, and Applications of Nuclear Processes, 6 th Ed., Elsevier, 2009.		
7	Radioactive Waste - Politics, Technology and Risk, R. D. Lipschutz, Ballingor, 1980.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Wind Energy Engineering	L	T	P	J	C
MEE1067		2	0	0	4	3
Pre-requisite	PHY1001	Syllabus version				
		v.1.1				

Course Objectives:

To enable students understand

1. how wind is generated, what is its potential and how energy can be extracted from it
2. how to estimate the resource potential of a given area
3. the principle behind wind electric turbines
4. the operation of a wind electric generator and wind farms

Expected Course Outcome:

Upon Successful Completion of thiscourse, Students will be able to

1. Identify global and Indian wind energy potential and installed capacity
2. Understand the techniques used in Wind Resource Assessment and its influence in wind farm planning
3. Apply the concept of aerodynamics to design wind turbine rotor
4. Understand the operation of a wind farm and electrical & safety aspect of power generation
5. Identify the application of small wind turbines, water pumping wind mills for energy generation in remote areas
6. Prepare and evaluate detailed project reports for establishing a wind farm

Module:1	Introduction	2 hours

Historical Perspectives on Wind Turbines, Indian Energy Scenario, Global Energy Scenario, Introduction to Indian Wind Industry, Wind Energy potential of India and Global Wind Installations

Module:2	Basics of Wind Resource Assessment :	5 hours

Power in the wind, Wind Characteristics, Measurement of wind using anemometers (cup anemometer, propeller anemometer, pressure plate anemometer, pressure tube anemometer, sonic anemometer and other remote wind speed sensing techniques), Turbulence, Wind Power Density. Average wind speed calculation, Statistical models for wind data analysis (Weibull and Rayleigh distribution), Energy estimation of wind regimes, Wind Rose, Wind Monitoring Station Siting and Instrumentation.

Module:3	Aerodynamics :	4 hours

Introduction to Aerofoil design, NACA profiles, Lift and drag principle, Lift and drag co-efficient, Axial Momentum theory, Momentum theory for rotating Wake, Blade element theory, Strip theory, Tip losses.

Module:4	Rotor Design and Performance :	4 hours

Design of rotor, Wind Machine parameters (swept area, power co-efficient, torque co-efficient,

thrust, solidity, tip-speed ratio, angle of attack etc.), Power Curve, Energy Estimation, Capacity Factor		
Module:5	**Wind Energy Conversion Systems:**	**5 hours**
Types, Components of Modern Wind Turbine (HAWT and VAWT), Fixed and Variable Speed operations, Power Control (Passive stall, Active pitch, Passive pitch and Active stall), Electrical aspects of wind turbine, Safety of wind turbines		
Module:6	**Wind Farm Design and Health (Conditon) Monitoring:**	**4 hours**
Planning of wind farm, Site selection, Micrositing, Grid Integration, Power evacuation, Wind Farm Feasibility Studies, Preparation of DPR, Environmental Benefits and Impacts.		
Module:7	**Small Wind Turbines:**	**4 hours**
Water pumping wind mills, offshore wind energy, Wind turbine testing, future developments.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**
	Sample Projects • Design of wind farm integrated with hydrogen production • Design of small wind turbines • Design of hybrid wind energy systems • Wind farm micrositing • Annual energy estimation using the raw data from metrological station • Data analysis from metrological station • Testing of wind turbines	**60 (non Contact hrs)**

Text Book(s)

1.	Wind Energy Fundamentals, Resource Analysis and Economics, Sathyajith Mathew, Springer Publications, ISBN 978-3-540-30906-2, 2006 edition
1.	A Guide to Small Wind Energy Conversion Systems, John Twidell, CAMBRIDGE UNIVERSITY PRESS, 2011, ISBN 10: 0521281628
2	Wind Power, Revised Edition: Renewable Energy for Home, Farm, and Business, Paul Gipe, 2004, Chelsea Green Publishing, ISBN-10: 1931498148
3	Offshore Wind Power, Edited by John Twidell and Gaetano Gaudiosi, 2009 Edition, ISBN 978-0906522-639

4	Robert Gasch and Jochen Twele, Wind Power Plants. Fundamentals, Design, Construction and Operation. 2012		
5	Wind Power Generation and Wind Turbine Design, Wei Tong, WIT Press, 2010,ISBN1845642058, 9781845642051		
6	Wind Turbine Technology, A. R. Jha, Ph.D., 2010 by CRC Press, ISBN 9781439815069 - CAT# K10772		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17/08/2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Small Hydro Power Systems	L	T	P	J	C
MEE2058		3	0	0	4	4
Pre-requisite	MEE1032	Syllabus version				

Course Objectives:

1. To provide the students with sufficient background to know about energy outline in our country
2. To apply concepts of small hydro power plant
3. To understand the related outcomes of practicing and implementing hydro turbine used in small hydro power plant
4. To train the students with practical experience about the economics of small hydro power plants

Expected Course Outcome:

Upon Successful Completion of this course, Students will be able to

1. Analyze the energy scenario of our country
2. Describe the working principles of small hydropower plant and its component.
3. Estimate the performance parameters of Hydro turbine
4. Develop clear understanding about functioning of Small hydropower plants
5. Design structural & electro-mechanical subsystems of Small hydropower plant.
6. Evaluate the cost of generation and economics of Small hydropower plants

Module:1		**6 hours**

Overview of Hydropower systems - Case studies- Preliminary Investigation –Determination of Requirements – preparation of Reports and Estimates –Review of World resources – Cost of Hydroelectric Power-Basic Economic Factors.

Module:2	**Hydro projects**	**6 hours**

Types of hydro projects – Site identification and evaluation– Hydrological analysis – Discharge curve – Estimation of power potential – Preparation of DPR

Module:3	Hydraulics and structural designs	**8 hours**

Hydraulics and structural designs related to SHP – Codes and practices – Diversion and intake structures – Power channel, desilting tank and tail race channel – Balancing reservoir, spillway and forebay tank – Penstock – Power house building –Machinery foundations

Module:4	**Types of Turbines**	**5 hours**

Types of turbines: Impulse, reaction and axial flow – Non- conventional types: Propeller, bulb and cross flow – Pumps as turbines – Mechanical governors

Module:5	**Characteristics of turbines**	**4 hours**
Characteristic of turbines – Selection of gates and valves –Installation, operation and maintenance of SHP systems.		
Module:6	**Grid connected systems**	**8 hours**
Stand-alone and grid connected systems - Electrical equipment planning - Sizing of single and three phase generators – Synchronous and induction generators - Power factor and its correction methods – Generator characteristics – Excitation systems – Transformers and circuit breakers – Governor systems – Protection and control – Auxiliary systems – Grounding – Switchyard equipment Instrumentation and control- Synchronization		
Module:7	**Evaluation of DPR**	**6 hours**
DPR evaluation– Detailed technical feasibility report preparation– Project planning –Schedules – Plant and machinery– Operation and maintenance – Policy – Financing – Economics of power		
Module:8	**Contemporary issues:**	**2 hours**
Environmental impact assessment for small hydro power systems.		
	Total Lecture hours:	**45 hours**
	Sample Projects 1.Analyzing the flash flood conditions. 2.Learning about the interpretation of rainfall data. 3.Calculation the friction loss of penstock, surge pressure and safety factor. 4.Computing the speed, specific speed and diameter of runner for 5.Turbines(Pelton, Kaplan, Francis and cross flow).	**60 non – contact hrs**

Text Book(s)

1.	Bryan Leyland "Small Hydroelectric Engineering Practice"CRC Press, 2014.

Reference Books

1.	Carlos Martins, Ajoy Karki, Ulrich Frings, Renewable Energy Guidelines, November 2013.
2	Scott Davis, "Microhydro: Clean Power from Water", New Society Publishers, 2003.
3	Jeremy Thake, "The Micro-Hydro Pelton Turbine Manual: Design, Manufacture and Installation for Small-scale Hydropower", ITDG Publishing, 2000.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of assessment:

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Fuel Cells	L	T	P	J	C
MEE1013		3	0	0	0	3
Pre-requisite	PHY1001	Syllabus version				
		v. 2.2				

Course Objectives:

1. To help students gain essential and basic knowledge of various types of Fuel cells, so as to equip them with knowledge required for the design of component of Fuel cells.
2. To train the students with the performance evaluation of alternative energy systems.
3. To equip the students to analyse various components of Fuel cells.
4. To impart knowledge of environmental issues related to Fuel cells.
5. To understand the working of Standalone Fuel cells and hydrogen storage devices.

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Analyse the energy scenario of our country
2. Describe the working principles of Fuel cells and its component.
3. Estimate the performance parameters of Fuel cells
4. Develop clear understanding about functioning and types of Fuel cells
5. Design structural & thermo-chemical subsystems of Fuel cells.
6. Evaluate the cost of generation and economics of Fuel cells
7. Assess environmental impact of Fuel cells

Module:1	Introduction	5 hours

Basic structure, critical functions of components –fuel cell stacking- fuel cell systems types- advantages and disadvantages – applications and status

Module:2	Fuel Cell Performance	7 hours

Thermodynamic aspects of Electrochemical Energy conversion- Cell efficiency – Factors affecting the efficiency of Electrochemical Energy conversion

Module:3	Alkaline Fuel cells (AFC)	6 hours

Principle of operation – modules- fuel cell stacks-general performance characteristics- Attempts towards advancements-Ammonia as AFC fuel System issues Electrodes: materials and manufacturing- Stacks and systems- Factors affecting the performance of PAFC

Module:4	Solid Oxide Fuel Cells (SOFC) and Molten Carbonate Fuel Cells	6 hours

Cell components- Anode and Cathode materials- Interconnectsseals- Configurations and performance- Environmental impacts - General principle- Cell components- Mechanisms of Electrode
Reactions

Module:5	**Direct Methanol Fuel cells and Proton Exchange and Membrane Fuel Cells (PEM)**	**6 hours**
Catalyst and Non catalyst aspects- Methanol cross over- Catalyst aspects and scale up- Engineering aspects - Scientific aspects and challenges- Modelling- Milestones in technology development- Approaches and challenges to high temperature operations.		
Module:6	**Fuel Processing and Hydrogen storage**	**6 hours**
Processing hydrogen from alcohols- producing hydrogen from hydrocarbons- Hydrogen from other sources- Gas clean up- Hydrogen storage- Methods of Hydrogen storage- Hydrogen as Engine storage		
Module:7	**Fuel Cell systems**	**7 hours**
Introduction to fuel cell power conditioning systems- Various options- Fuel cell systems fuelled by Natural gas (PEFC, PAFC, MCFC systems)- Coal fuelled fuel cell system-Combined fuel cell and Gas turbine system- Hybrid fuel cell systems-Hybrid electric vehicles		
Module:8	**Contemporary Discussions**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Viswanathan.B and Aulice Scibion (2008), Fuel Cells: Principles and applications, CRC Press
2.	Ryan O'Hayre, Suk-Won Cha, Whitney Colella, Fritz B. Prinz (2016), Fuel Cell Fundamentals, John Wiley & Sons. Print ISBN:9781119113805

Reference Books

1.	Bent Sorensen (2011) Hydrogen and Fuel cells, Academic Press
2.	Noriko Hikosaka Behling (2012), Fuel cells, Elsevier Publishers

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	17/08/2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Solar Photovoltaic System Design	L	T	P	J	C
MEE1038		2	0	0	4	3
Pre-requisite	Nil	Syllabus version				
		v. 2.1				

Course Objectives:

1. Understanding the basic concepts of photovoltaic cells, modules and array.
2. Understanding the performance and operating characteristics of PV systems and components.
3. To design a PV system suitable to a given location and end-use requirements.

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to

1. Explain the physics of photovoltaic energy conversion from light
2. Design PV systems to meet economic and functional requirements of any application
3. Analyze the performance of PV systems
4. Prepare a commercial quality Detailed Project Report (DPR)
5. Plan and execute PV projects

Module:1	Solar Radiation	4 hours

Estimation of Solar Radiation: Sun-earth angles; Estimation of solar radiation using Page-Angstrom method; Measurement of Solar radiation.

Module:2	Basics of photovoltaic cells and modules	4 hours

PV physics: Creating p-n junction; PV voltage and currents; IV curve; Performance parameters; STC and NOCT; Estimating module output at field conditions; Module selection; Cell and Module manufacture.

Module:3	Electrical concepts of Solar Cells	2 hours

Equivalent circuit: Cell equivalent circuit; Estimating VOC and ISC; Effect of shading; Use of diodes.

Module:4	System components	4 hours

Battery: Principle, types, operating parameters, performance analysis; Charge controller; Inverter; MPPT; System configurations.

Module:5	System sizing	6 hours

Sizing a stand-alone PV system: Load estimation; Array sizing; Battery sizing; Matching module and battery rating iteratively; Wire sizing; Sizing charge controller and Inverter; MPPT. Sizing a grid connected PV system: Array sizing; Sizing sub- arrays. Central Vs string inverters; Grid interfacing.

Module:6	System installation	4 hours

Site identification; Module orientation; Ground and roof installation of modules; Standard practices in system installation; Module row spacing; Electric codes and practices; Islanding, grounding, and other safety practices.			
Module:7	**Economics, Policy and DPR**		**4 hours**
PV economics and project payback; Calculating cost of electricity; National and State PV policies; Renewable Portfolio Standard (RPS); Renewable Energy Certificate (REC); Preparing a Detailed Project Report (DPR).			
Module:8	**Contemporary issues:**		**2 hours**
Recent developments in the area of photovoltaic power generation by an industry expert			
	Total Lecture hours:	**30 hours**	
	Projects: Students will conceive a solar photovoltaics project of their choice (project type, load and location). Project will help students to progressively design the entire PV system they have chosen based on the concepts taught in the theory. They will estimate the system load and propose a sizing. All components used in the project should be commercially available, with actual company specifications and actual climatic data of the chosen location. Pricing and policies applicable to the specific location shall be incorporated into the project. All industry standard codes and practices shall be adopted in the design. Students will use a standard software package to validate their sizing and estimate unit cost of electricity. There will be periodic presentations by each project on their design. Improvements discussed shall be carried out so that the design will reach a technically and economically acceptable standard. A DPR is expected as the project report. Student design will be		

	evaluated continuously and progressively by the teacher and peers.		

Text Book(s)				
1.	Gilbert M. Masters (2013), Renewable and Efficient Electric Power Systems, 2nd Edition, Wiley-IEEE Press, Inc.			
Reference Books				
1.	Heinrich Haberlin(2012), Photovoltaics - System Design and Practice, John Wiley & Sons, Ltd.			
2	G.N.Tiwari and Swapnil Dubey (2010), Fundamentals of Photovoltaic Modules and their Applications, The Royal Society of Chemistry Publishing, UK.			
3	Roger A. Messenger and, Amir Abtahi (2013), Photovoltaic Systems Engineering, 3rd Edition, CRC Press, USA.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
Recommended by Board of Studies		17-08-2017		
Approved by Academic Council		No. 47	Date	05-10-2017

Course code	Bio-Energy Technology	L	T	P	J	C
MEE1071		3	0	0	4	4
Pre-requisite	Nil	Syllabus version				
		v.1.1				

Course Objectives:

1. To provide the students with sufficient background to know about energy conversion from biomass
2. To apply concepts of energy conversion systems
3. To understand the related outcomes of practicing and implementing Fluidized bed combustion systems
4. To train the students with practical experience about the conventional waste management technology

Expected Course Outcome:

1. Analyse a suitable biomass to energy conversion route for the available biomass
2. Develop an efficient conversion system for the thermal and electric power needs
3. Estimate the performance of Fluidized bed combustion systems
4. Explain about pyrolysis, biomass gasification and fluidised gasification
5. Design the waste management and waste conversion systems
6. Evaluate the cost of generation of Energy from industrial waste and sewage treatment

Module:1	Bio-Energy	4 hours

Introduction: Bio-energy overview - Applications of Bio-energy

Module:2	Photosynthesis	6 hours

Photosynthesis – Biomass composition - Ultimate and proximate analyses-Heating value – Biomass resources - Modes of biomass utilization for Energy - Biomass conversion processes - Characteristics of biomass fuels.

Module:3	Biogas production	8 hours

Biogas production - Types of substrates – Process parameters - Digester design - Operational problems –Biogas kinetics – Gas cleaning – Thermal and electrical conversion – High rate anaerobic digestion systems – Sludge utilization.
Chemical kinetics and mathematical modeling of bio-methanation process;Economics of biogas plant with their Environmental and social impacts.

Module:4	Ethanol and Methanol Production	8 hours

Ethanol and Methanol production using chemical and biological processes: Bioconversion of

substrates into alcohol: Methanol & ethanol production, organic acids, solvents, amino acids, etc. Chemical Conversion: Hydrolysis and hydrogenation; Solvent extraction of hydrocarbons; Solvolysis of wood; Bio-crude and biodiesel, Distillation– Biodiesel: Preparation, characteristics and applications, Chemicals from biomass.		
Module:5	**Biomass combustion**	**6 hours**
Biomass combustion reactions – Combustion systems – Wood stoves and industrial combustion systems – Fluidized bed combustion systems – Phase theory - Densification – Types of devices – Performance parameters – Feed preparation – Properties of densified fuels –Applications - Charcoal production –Dendrothermal power generation.		
Module:6	**Pyrolysis**	**6 hours**
Pyrolysis - Slow and fast pyrolysis – Biomass gasification –Types of gasifiers - Fluidized bed gasification -Equilibrium and kinetic considerations – Gas cleaning – Thermal applications – Decentralised power generation.		
Module:7	**Waste Management**	**5 hours**
Waste and its characteristics – Waste generation, collection, separation, treatment and storage – Waste management – Waste conversion technologies: Landfill, incineration, gasification – Energy from sewage -Treatment – Energy from industrial wastes.		
Module:8	**Contemporary issues:**	**2 hours**
Environmental impacts – Policy and economics		
	Total Lecture hours:	**45 hours**
	Sample Projects 1. Biogas production from agricultural wastes 2. Biodiesel production from waste vegetable oil 3. Ethanol production from biomass 4. Design of Bio gas gasifier by paralysis 5. Energy Recovery from incineration of bio waste. 6. Case studies on energy balance and life cycle assessment	**60 [Non-contact Hrs]**

Text Book(s)	
1.	Lijun Wang, Sustainable bioenergy Production, 2014, CRC Press.
2.	Sunggyu Lee, Y.T. Shah , Bio fuels and bio energy ; processes and technologies, 2012, CRC Press
Reference Books	
1.	Anju Dahiya, Bio energy; bio mass to bio fuels, 2014 Academic press

2.	Hang Bailiang, Bio energy technology and Engineering 2013, Alpha Science Int. ltd.		
3.	Gerhard Knothe, Jon Van Gerpen and Jurgen Krahl (2005), The Biodiesel Handbook, ISBN: 1893997790.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Exergy Analysis of Energy Systems	L	T	P	J	C
MEE2061		3	0	0	0	3
Pre-requisite	MEE1003, MEE1032	Syllabus version				
		v. 1.1				

Course Objectives:

1. To enable the students to understand the exergy method of energy systems.
2. To equip the student with knowledge required for the assessment of thermodynamic properties of a given substance.
3. To develop the knowledge in applying the exergy approach to solve the problems of thermal power plants.
4. To enable the students to understand the thermo economic optimization of energy systems.

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to

1.Explain different types of exergy and its significance.
2.Perform design and analysis of energy systems with irreversibility concept.
3.Formulate thermodynamic relations and properties
4.Perform parametric evaluation of energy systems using second law of thermodynamics.
5.Account the exergetic destruction in various components of process plants.
6.Apply numerical techniques for the thermo economic optimization of various energy systems

Module:1	Concept of Exergy	5 hours

Concept of exergy – Available work – Exergy loss, Reversibility and irreversibility – exergy for control region – physical exergy and chemical exergy – closed system analysis – Exergy evaluation of solid, liquid and gaseous fuels – tables and charts.

Module:2	Thermodynamic Properties	6 hours

combined first and second law equation-Maxwell relations - Clapeyron equation – internal energy, enthalpy, entropy, exergy – specific heats as a function of temperature and pressure.

Module:3	Thermodynamic Equilibrium	8 hours

Combustion – Combustion reactions - Enthalpy of formation - Entropy of formation - Reference levels for tables - Heat of reaction - Adiabatic flame temperature – General product – Enthalpies – Equilibrium – Chemical equilibrium of ideal gases – Effects of Non-reacting gases– Equilibrium in multiple reactions – The vont Hoff Equation – The chemical potential and phase equilibrium – The Gibbs Phase Rule.

Module:4	Numerical methods	5 hours

Use of numerical methods to solve the exergy problems with iterations.

Module:5	Exergy Analysis – Methodology	6 hours

Control mass analysis – control region analysis – pictorial representation of exergy balance – exergy based property diagrams – thermodynamic feasibility of new thermal plants– applications

of exergy method – Exergy analysis of renewable energy systems.		
Module:6	**Exergy Applied to Processes**	**7 hours**
Expansion process - compression process – heat transfer processes – mixing and separation processes – chemical process and combustion – Linde air liquefaction plant – CHP plant – GT-ST combined cycle plant – refrigeration plant – heat pump systems – fuel cell systems.		
Module:7	**Thermoeconomic Applications of Exergy**	**6 hours**
Structural coefficients exergy losses – optimization of component geometry – Thermo economic optimization of thermal systems – thermoeconomic optimization of heat exchanger in a CHP plant – exergy costing in multi product plant.		
Module:8	**Contemporary issues:**	**2 hours**
Exergy applied to heat recovery, cogeneration-trigeneration -polygeneration.		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Dinçer, Marc A. Rosen, 2007, Exergy: Energy, Environment, and Sustainable Development, Elsevier.
2	Lucien Borel, Daniel Favrat, Thermodynamics and Energy Systems Analysis: From Energy to Exergy (Engineering Sciences-Mechanical Engineering), 2010 EPFL Press.
Reference Books	
1.	Valero A., C. C., 2009, "Thermoeconomic Analysis," Encyclopedia of Life Support Systems,
2	Vol. Exergy, Energy System Analysis, and Optimization, Oxford, United Kingdom: EOLSS Publishers.
3	Kalyan Annamalai, Ishwar K. Puri, Milind A. Jog, 2011, Advanced Thermodynamics Engineering, Second Edition (Computational Mechanics and Applied Analysis), CRC Press.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Design and Selection of Heat Transfer Equipment	L	T	P	J	C
MEE2063		3	0	0	4	4
Pre-requisite	MEE2005, MEE1032	Syllabus version				
		v.2.2				

Course Objectives:

1. To teach the basics of heat exchanger design.
2. To gain exposure over different phase change materials.
3. To learn about the Regenerators and condensers.
4. To teach cooling tower design and heat pipes

Expected Course Outcome:

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

1. Design double pipe heat exchanger by Kern and Bell's method.
2. Explain suitability of phase change materials in the heat exchange process.
3. Design Regenerators
4. Design condensers for industrial application.
5. Execute sizing and design of cooling towers
6. Analyze different types of evaporators
7. Explain the working of heat pipes

Module:1	Heat Exchanger Design	**7 hours**

Types of heat exchangers – classificationof heat exchangers - selection criteria – Design of double pipe heat exchangers by Kern and Bell's method.

Module:2	Design of Phase Change Equipments	**7 hours**

condensers, reboilers and evaporators, Design of condensers, evaporators, and reboilers.

Module:3	Regenerators Design	**7 hours**

working of regenerators – Design of regenerators, plate type, compact heat exchanger and cross flow heat exchangers.

Module:4	Condenser Design	**6 hours**

Shell and tube and compact and air cooled and direct contact condensers – design and analysis

Module:5	Cooling Tower Design	**5 hours**

Concepts of psychrometery, Overall energy balance, Wet cooling design and analysis.

Module:6	Evaporator Design	**6 hours**

Raw water evaporator, multi effect process evaporator, salt water evaporator functions and design and analysis

Module:7	Heat Pipes	**5 hours**

Working and construct ion features, limitations, Design of heat pipe heat ex changers.			
Module:8	**Contemporary issues:**		**2 hours**
	Total Lecture hours:	**45 hours**	
	Project • Generally a team project [3 to 5 members] • Concepts studied in Thermodynamics and Heat Transfer to be applied. • Report in digital format with all drawings and analyses performed using software. • Assessment on a continuous basis with a maximum of 3 reviews. Sample project topics 1. Design and analysis of various types of Heat Exchangers for industrial applications. 2. Design and simulation of Regenerators for Compact and Cross flow heat exchangers 1. Heat transfer and two phase flow distribution of evaporators, condensers and heat pipes for industrial requirements	**60 Noncontact Hrs**	

Text Book(s)	
1.	Sarit K.Das – Process Heat Transfer, Narosa Publications, 2013.
	D.Q.Kern – Process heat transfer – McGraw Hill, 2005.
Reference Books	
1.	J.P.Holman, - Heat transfer – 9th edition, The Mc.Graw Hill – 2008
2	Sadik Kakac and Hongton Liu – Heat exchangers-selection, rating and thermal design- CRC press – 2005
3.	John. J.Mc.ketta – Heat transfer design methods – M.Dekkar – 2002.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Conventional and Solar Refrigeration and Air-Conditioning	L	T	P	J	C
MEE2064		3	0	0	0	3
Pre-requisite	MEE1003, MEE1032	Syllabus version				
		v. 2.2				

Course Objectives:

1. To guide the students to apply the laws of thermodynamics in applications of refrigeration and air-conditioning.
2. To equip the students to analyse thermal and thermo-physical properties of various refrigerants.
3. To benefit students gain essential and basic knowledge of various types of refrigeration and air-conditioning systems, so as to prepare them with knowledge required for the design of refrigeration and air-conditioning components.
4. To train the students with the procedure of cooling/heating load calculations of residential and commercial buildings.
5. To impart knowledge in the design of solar refrigeration and air –conditioning systems.

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to

1. Describe the working principles of various single and multi-stage vapour compression Refrigeration systems.
2. Analyze performance of various vapour compression refrigeration systems and various refrigerants.
3. Design various components of vapour compression refrigeration systems.
4. Evaluate the cooling load requirements for conditioned space.
5. Develop clear understanding about functioning of solar refrigeration and air-conditioning systems.
6. Apply concepts of conventional and solar refrigeration and air-conditioning to the various applications.

Module:1	Refrigeration systems	6 hours

Vapor compression refrigeration systems – types – p-h charts – Multi stage compression –Multi evaporator system-cascade system – Vapor absorption systems

Module:2	Refrigerants	5 hours

Refrigerants – properties – classification – Refrigerant mixtures – zeotropic and azeotropic mixtures.

Module:3	System Components	5 hours

Refrigerant compressors – types – condensers – types – design – evaporators – types – design – expansion devices – types.

Module:4	**Psychrometry and Air-conditioning**	**7 hours**
Moist air properties – Psychrometric chart – Psychrometric processes – Air conditioning systems – types – RSHF – GSHF – ERSHF – Cooling load estimation – Air distribution patterns – Ducts – Fans		
Module:5	**Thermodynamic properties and processes**	**7 hours**
Ammonia-water mixture properties - LiBr-water mixture properties – steady flow processes with binary mixtures – separation – adiabatic mixing – diabatic mixing –throttling – dephlegmator.		
Module:6	**Solar absorption, desiccant cooling and Nocturnal cooling**	**7 hours**
Solar absorption air conditioning system – pump less vapor absorption systems – single/double effect convertible absorption chiller of water– LiBr type – Desiccant cooling – open cycle absorption system – solar heating and liquid desiccant cooling system – Nocturnal cooling – evaporative – roof pond – intermittent solar cooling system– thermo electric refrigerator.		
Module:7	**Photovoltaic refrigeration, Ice making and Thermal energy storage**	**6 hours**
Solar powered photovoltaic refrigerator – Ice making – solar refrigerator – scheme – Thermal storage – solar space heating systems – liquid and air – solar cooling system**.**		
Module:8	**Contemporary issues:**	**2 hours**
solar PV based cooling plant – solar thermal based cooling plant – VAR-VCR integrated cooling plant – cooling role in a trigeneration.		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	WF Stocker and J W Jones, (1999), Refrigeration and Air conditioning, McGraw Hill Book Company.
2	A.A.M. Sayieh and J.C. McVeigh (2012), Solar air-conditioning and Refrigeration, Pergamon Press.

Reference Books

1.	İbrahim Dinçer, Mehmet Kanoğlu, 2010, Refrigeration Systems and Applications, Second Edition, john Wiley & Sons, Ltd.
2	Arora, C. P., (2007), Refrigeration and Air Conditioning, Tata McGraw-Hill Publishing Company Ltd.
3	ASHRAE Handbook – Refrigeration (SI Edition), 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
Recommended by Board of Studies	17-08-2017

Approved by Academic Council	No. 47	Date	05-10-2017

EEE2003	Electromechanical Energy Conversion	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**EEE1002/EEE1001**	**Syllabus version**				
Anti-requisite		v. 1.0				

Course Objectives:

1. To analyze the basic principles of DC Machines
2. To derive the various relations of electrical and mechanical parameters in AC Machines
3. Evaluate the characteristics and testing of AC Machines

Expected Course Outcome:

On the completion of this course the student will be able to:

1. Illustrate the basic principles of electromechanical energy conversion
2. Infer the basic operation & characteristics of DC generator
3. Infer the various starting technologies and performance characteristics of DC Motor
4. Apply and analyze performance of transformers
5. Solve the various torque equations and analyze the starting methods of Induction Motor
6. Design the equivalent circuit and circle diagram of Induction Motor
7. Analyze the effect of change in electrical and mechanical parameters of Alternator
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	Principle of Electromechanical Energy Conversion :	**Hours: 4**

Magnetic circuits - Singly excited systems - doubly excited systems - Force and Torque.

Module:2	**D.C. Generator:**	**Hours: 6**

Construction –Windings- Armature Reaction –Commutation-EMF Equation – Types of Generators-Magnetization and load characteristics - Voltage Regulation - Parallel operation - Applications.

Module:3	**D.C. Motor:**	**Hours: 5**

Methods of excitation - Equivalent circuit - Torque equation - Performance characteristics - Losses and efficiency - Speed control and starting techniques - Applications

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Module:4	**Transformers :**	**Hours: 7**

Construction – types-EMF Equation-Transformer on No load and load-phasor diagram – Efficiency and Voltage Regulation –Transformer testing- Equivalent Circuit – predetermination of Efficiency and Voltage Regulation-Parallel Operation –3 Phase Transformers Applications.

Module:5	**Induction Motor:**	**Hours: 6**

3 phase induction motor: Construction Rotating Magnetic Field -Working principle-Power Transferred across air gap, Torque and Power output-Starting methods - Single phase induction motors - Applications.

Module:6	**Testing of Induction Machines :**	**Hours: 6**

Determination of Equivalent Circuit parameters – performance characteristics Circle Diagram – Speed Control –Induction Generator Applications.			
Module:7	**Synchronous Machines :**		**Hours: 9**
Synchronous Generator (Alternator): Construction-Induced EMF - Synchronous reactance - Phasor Diagram and Voltage regulation - Parallel operation- - Synchronizing of alternator Effects of change in excitation and mechanical input. Synchronous Motor: Three-phase synchronous motor - Types - Principle of operation - Methods of starting - Hunting and Damper windings - synchronous condenser – Applications.			
Module:8	**Lecture by industry experts.**		**2 hours**
	Total Lecture hours:	**Hours: 45**	
List of Challenging Experiments (Indicative)			
1.	Speed control of DC shunt motor and predetermination of performance characteristics of DC shunt machine.		2 hours
2.	Performance characteristics of DC traction motor. 10. Voltage Regulation of a three phase induction generator.		2 hours
3.	Performance characteristics of DC motor used for rolling mills.		2 hours
4.	Magnetization and Load characteristics of DC shunt generator.		2 hours
5.	Performance test and connection assessment of a 3 phase transformer.		2 hours
6.	Open circuit and short circuit test on a 3 phase transformer.		2 hours
7.	Parallel operation of transformers.		2 hours
8.	Equivalent circuit and Performance evaluation of 3 phase industrial pump motor.		2 hours
9.	Load test on 3 phase motor used for lift applications.		2 hours
10.	Load test on single phase fan motor.		2 hours
11.	Voltage Regulation of a three phase induction generator.		2 hours
12.	Predetermination of Voltage Regulation in 3 phase alternator by EMF and MMF method.		2 hours
13.	Synchronization of a 3 phase alternator to the busbar.		2 hours
14.	V and inverted V curves of 3 phase synchronous motor.		2 hours
		Total Laboratory Hours	**30 hours**
Text Book(s)			
1.	I. J. Nagrath and D. P. Kothari, "Electric Machines" (Sigma Series), III edition, Tata McGraw Hill 2010.		
Reference Books			

	P. S. Bimbhra, "Electrical machinery", Seventh Edition , Khanna Publications, 2014.		
2.	P.C.Sen, "Principles of Electric Machines and Power Electronics", Wiley, 2013.		
3.	Stephen J.Chapman, "Electric Machinery Fundamentals', "McGraw Hill Intl. Edition, New Delhi, 6th Edition, 2012.		
4.	Arthur Egune Fitzgerald; Charles Kingsley; Stephen D Umans, "Electric machinery", New York : McGraw-Hill, 7th Edition, 2014.		
Recommended by Board of Studies	30/11/2015		
Approved by Academic Council		39th AC	Date	17/12/2015

Course code	Remote Sensing and GIS in Resource Management	L	T	P	J	C
MEE1068		3	0	0	0	3
Pre-requisite	nil	Syllabus version				
		v. 2.2				

Course Objectives:

1. To understand the basic concepts of remote sensing.
2. To learn basic concepts of Geo-graphical Information Systems (GIS).
3. To know various applications of Remote Sensing and GIS applications
4. To understand the importance of Remote Sensing and GIS in resource management

Expected Course Outcome:

Upon Successful Completion of this course, Students will be able to
1.Explain basics of remote sensing and importance of remote sensing in Indian context
2.Identify the Indian remote sensing satellites and their platforms
3.Posses the knowledge of digital image processing
4.Apply the concepts of concepts of Geo-graphical Information Systems
5.interpret and analyse satellite data using different techniques
6. Perform Terrain Modelling
7.Effectively use remote sensing and GIS for resource management

Module:1	6 hours
Basic concepts of Remote Sensing, Introduction to Remote Sensing,Electromagnetic Spectram and radiation, Remote Sensing Platforms,Satellite Sensors, Orbits in Remote Sensing	

Module:2	6 hours
Sensorsand Scanning Systems in Remote Sensing, Indian RemoteSatellites (IRS), Spectral characteristics earth surface features i.e,vegetation, water and soil	

Module:3	7 hours
Digital Image processing of satellite data, Elements of photo / imageinterpretation, Concepts of digital image processing, Filters, Imageregistration, Image classification.	

Module:4	6 hours
Basic concepts of GIS, Introduction to GIS, History of developmentof GIS, Elements of GIS - Computer hardware and software, Mapreading, various maps in GIS	

Module:5	6 hours
Map overlay and Overlay operations, Vector and Raster data model, Data storage and database management, Spatial data analysis techniques.	

Module:6	7 hours

Spatial Data Policy, Spatial / Remote Sensing data collection, OpenSource GIS, Web-GIS. Topographic Mapping , Digital Elevations/Terrain Modelling, Terrain Parameters i.e, Slope, Aspect, Hillshadanalysis			
Module:7			**5 hours**
Applications of remote sensing and GIS in Resource Management i.e,Forest / Agriculture Biomass etc., Case studies and EnergyApplications i.e, Solar, Biomass and hydro-power etc.,			
Module:8	**Contemporary issues:**		**2 hours**
	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	Basudeb Bhatta (2012), Remote Sensing and GIS, Oxford University Press, New Delhi, Second Edition, Fourth Impression 2012
Reference Books	
1.	TemilolaFatoyinbo (2012), Remote Sensing of Biomass – Principles and Applications, Publisher: InTech.
2	Islam Atazadeh (2011), Biomass and Remote Sensing of Biomass, Publisher: InTech
3	Peter A. Burrough, Rachael A. McDonnell and Christopher D. Lloyd (2015), Principle of Geographical Information Systems, Oxford University Press, 3rd Edition
4	G S Srivastava (2014), An Introduction to Geoinformatics, McGraw Hill Education (India) Private Limited.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Solar Thermal Power Engineering	L	T	P	J	C
MEE3011		2	0	2	0	3
Pre-requisite	MEE2005	Syllabus version				
		v. 2.2				

Course Objectives:

1. Estimate solar radiation received on a surface
2. To predict the performance of solar devices and analyze its performance
3. To Identify and integrate solar thermal devices in various applications

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to
At the end of the course the student will be able to
1.Use instrument to measure sun radiation energy.
2.Estimate the sun earth relationship & the solar angles and trace the sun path diagram.
3.Apply the basics of solar thermal engineering and heat transfer for the design of novel solar water and air heater.
4.Design high temperature solar energy concentrating devices.
5.Demonstrate the knowledge of active and passive mode solar thermal devices.
6.Ascertain the principles and methods of solar thermal energy storage systems.
7.Conduct experiments for testing the performance of solar thermal devices.

Module:1	Introduction to solar radiation	3 hours

Solar Radiation: Source of radiation – Electromagnetic wave spectrum-Solar constant - Spectral distribution - Extra-terrestrial and Terrestrial radiation- Beam, diffuse and global radiation - Pyranometer, Pyrheliometer, Sunshine recorder.

Module:2	Sun Earth angles	3 hours

Local Apparent Time-Equations for predicting availability of solar radiation. F- Chart, optimization techniques of incidence angle.

Module:3	Flat type solar thermal collectors	4 hours

Liquid flat plate collector parts –Parameters affecting performance, Efficiency factor, heat removal factor, Overall heat loss coefficient, Performance evaluation–Testing, Novel designs, and system configurations.

Module:4	Concentrating collectors	5 hours

Evacuated tube collector with and without heat pipe, Concentrated Collectors-Fixed mirror collector- parabolic trough collector - compound parabolic collector - Fresnel lens reflector - parabolic dish collector - Central Tower receiver - Chroma sun micro concentrator collector.

Module:5	**Solar air heaters and its applications**	**5 hours**
Conventional solar air heater, Two pass solar air heater, Types of absorber-Finned-V type, Cabinet dryer- thermal performance analysis, and Transpired solar air heater.		
Module:6	**Active and Passive Solar Thermal Collectors**	**4 hours**
Solar still, Solar pond, Solar cooker, Solar cooling, Solar electric power generation, Solar house, solar buildings, Solar ventilations.		
Module:7	**Solar Thermal Energy Storage system**	**4 hours**
Classification, Sensible heat storage – Liquid media storage-Solid media storage-Dual media storage. Latent heat storage-Encapsulation of PCM – Use of nanoparticles, Chemical Storage.		
Module:8	**Contemporary issues:**	**2 hours**
Recent developments in the area of Structural Power engineering systems & it is implications.		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	G.N.Tiwari (2013), Solar Energy- Fundamentals, Design, Modelling and Applications, Narosa publishing house.
2	S P Sukhatme & J K Nayak, (2013), Solar Energy-Principles of Thermal Collection and Storage, 3rd Edition, McGraw Hill Education.
3	Domkundwar, (2014), Solar Energy and Non-conventional Energy Sources, Dhanpat Rai & Co, (P) Ltd., Second Revised edition.

Reference Books

1.	D.Yogi Goswami, Frank Krieth and Jan F. Kreider (2000), Principles of Solar Engineering, 2ndEdition, Taylor and Francis, USA.
2	John A. Duffie and William A. Beckman (2006), Solar Engineering of Thermal Process, 3rdEdition, John Wiley & Sons.
3	J.Gordon (ed.) (2001) State of Art Papers on Solar Energy, International Solar Energy Society.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments

1. Determination of global radiation at a particular location.
2. Charging and discharging characteristics of a thermal energy storage system.
3. Performance evaluation of Solar water heater.
4. Performance test on Solar dryer.
5. Performance test in a solar cooker.

6. Performance test on Multi reflector compound parabolic collector 7. Performance test on Fresnel lense solar collector. 8. Performance test on Water lense solar collector 9. Performance test on solar vapour absorption refrigeration system 10. Testing performance of solar incinerator.			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Energy in Built Environment	L	T	P	J	C
MEE2065		3	0	0	4	4
Pre-requisite	Nil	Syllabus version				
		1.1				

Course Objectives:

1. To provide the students with sufficient background to understand the mathematical representation of the sun-earth relationships.
2. To enable the students to understand steady and unsteady thermal response characteristics of building envelopes.
3. To help the students to understand energy requirements of buildings and estimation of energy in buildings
4. To teach students how to apply mathematical and simulation tools to understand building heat transfer and daylight models using Mat-lab, Design Builder and Energy Plus simulation tools.

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to

1. Possess the knowledge of solar passive architecture methods to have visual and thermal comfort in buildings with reduced energy demand.
2. Explain fundamentals of solar radiation and day light
3. Design and analyze building models for thermal performance using simulation tools.
4. Evaluate building energy requirements
5. Model energy efficient and eco-friendly buildings

Module:1	Fundamentals	8 hours

Indoor activities and environmental control - Internal and external factors on energy use - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications - Thermal comfort - Ventilation and air quality - Air- conditioning requirement - Visual perception - Illumination requirement - Auditory requirement

Module:2	Solar Radiation and Daylight	7 hours

The sun-earth relationship - Climate, wind, solar radiation and temperature - Sun shading and solar radiation on surfaces – Energy impact on the shape and orientation of buildings – Lighting and day lighting: Characteristics and estimation, methods of day-lighting - Architectural considerations for day-lighting

Module:3	Heat Transfer Through Building Envelopes	3 hours

Steady and unsteady heat transfer through wall and glazed window- Admittance method- Use of software and tools

Module:4	**Building Thermal Performance Standards and Evaluation**	**5 hours**
Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer		
Module:5	**Building Energy requirements and Estimation**	**6 hours**
Thermal gain and net heat gain - End-use energy requirements - Status of energy use in buildings - Estimation of energy use in a building		
Module:6	**Energy Audit and Indoor Air Quality**	**7 hours**
Energy audit and energy targeting - Technological options for energy management - Natural and forced ventilation – Indoor environment and air quality - Airflow and air pressure on buildings - Flow due to stack effect		
Module:7	**Solar Passive Building Architecture**	**7 hours**
Passive building architecture – Radiative cooling - Solar cooling techniques - Solar desiccant dehumidification for ventilation - Natural and active cooling with adaptive comfort – Evaporative cooling – Zero energy building concept		
Module:8	**Contemporary issues:**	**2 hours**
Contemporary Issues : Application of information technology and artificial intelligence in intelligent buildings		
	Total Lecture hours:	**45 hours**
	Project # Generally a team project of Five # Concepts studied in Modules should have been used # Down to earth application and innovative idea should have been attempted Sample projects such as 1. A Nuanced Thermal Analysis of a Proposed Living Space on Desert Resort in Rajasthan 2. A Lighting and Thermal Analysis in a High Speed Train Interior along Mumbai Ahmedabad route 3. Development paradigms in cyclone resistant housing	

	4. Thermal, Lighting and Ventilation re-visited in a proposed sea-life centre in Chennai		

Text Book(s)	
1.	Heating and Cooling of Buildings: Principles and Practice of Energy Efficient Design, Third Edition (2016) CRC Press USA
Reference Books	
1.	Intelligent Buildings: Design, Management and Operations (2010) by Derek Clements-Croome. Thomas Telford, U.K.
2.	Green Building: Principles and Practices in Residential Construction (Go Green with Renewable Energy Resources) by Abe Kruger (Author), Carl Seville (Author), Jim Devoe (Editor) Hardcover – Import, 21 Apr 2011 (Kindle Edition)
3	Davies M. G (2004), Building Heat Transfer, John-Wiley & sons Ltd. U.K
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
Mode of assessment:	

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Energy, Environment and Impact Assessment	L	T	P	J	C
MEE1074		2	0	0	4	3
Pre-requisite	Nil	Syllabus version				
		v. 2.2				

Course Objectives:

To enable a comprehensive understanding of:

1. The Earth's Energy Budget, the Environment, and the processes leading to Climate Change.
2. The perturbing effects of anthropogenic activities on this system
3. The use of Environmental Impact Assessment (EIA) procedures to promote sustainable development and
4. To promote effective use of Environmental Management Systems

Expected Course Outcome:

Upon Successful Completion of this Course, Students will be able to

1.Acquire a basic understanding of the terrestrial eco-system comprising of 3 principal components: Energy, Environment and Climate Change
2.Acquire the requisite professional skills to undertake policy decisions on the use and efficient management of the Earth's resources, vis-à-vis the possible environmental impacts on a local, regional and global scale.
3.Apply the main procedures and methods used at different stages in an EIA process during Project Appraisal, Decision making and Implementation

Module:1	Earth and Energy Balance	5 hours

Overview on the Earth's energy requirement vis-à-vis Climate Change.
Energy Balance: Earth –Atmosphere System. Solar and Terrestrial Radiation. Absorption of Radiation by gases. Energy balance. Solar variability and the Earth's Energy Balance –Basic concepts only

Module:2	Environmental Variability	4 hours

Environmental Variability: Natural and Anthropogenic. Effects of urbanization, Landscape changes, Influence of Irrigation, Desertification and Deforestation. Carbon footprint of the Built Environment

Module:3	Safeguarding the Future	4 hours

The Energy Crisis. The needs of the Developing countries. The role of International Bodies. Kyoto and Montreal Protocol. Intergovernmental Panel on Climate Change (IPCC 2014).The Stern Report. Carbon Credits. Indian Context Predicting Future Climate Change: Global Climate Models and their role in the EIA process.

Module:4	Overview of Environmental Impact Assessment	4 hours

Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS) – Objectives – EIA capability and limitations – Legal provisions on EIA. Socio Economic Impact
Use the mathematical models in EIA – Water quality, air quality and noise; assumptions and limitations. Development of Leopold Matrices and quantifying impacts in the Built Environment

Module:5	**EIA and Infrastructure Development Projects and Impacts**	**4 hours**
Case studies – highway, airport, dams, power plans, etc, Plan for mitigation of adverse impact on environment – options for mitigation of impact on water, air and land, flora and fauna; Addressing the issues related to the project affected people, climate impacts and EIA		
Module:6		**4 hours**
Water quality, air quality and noise; assumptions and limitations. Development of Leopold Matrices and quantifying impacts in the Built Environment		
Module:7		**3 hours**
Addressing the issues related to the project affected people, climate impacts and EIA		
Module:8		**2 hours**
Contemporary Discussions – Energy Requirements in India's Upcoming Smart cities, India's Commitment to the Paris climate		

	Total Lecture hours:	**30 hours**	
	Projects 1. Quantifying the Environmental Impact of Chennai International Airport 2. Quantifying Energy Budgeting in the Built Environment in an upcoming smart city in India 3. Predicting long term temperature rise over Tamil Nadu using Global Climate Model during vis-à-vis infrastructure development 4. Quantifying the Environmental Impact of a wind farm in Tamil **Nadu**	**60**	

Text Book(s)

1.	Peter Hodgson (2010) *Energy, Environment and Climate Change*. Oxford University Press
2	Alan Gilpin (2012) Environmental Impact Assessment: Cutting Edge for the 21st Century. Cambridge University Press

Reference Books

1.	W.R. Cotton and R.A. Pielke (2007) Human Impacts on Weather and Climate. Cambridge University Press
2.	Anjaneyalu Y. (2002) Environmental Impact Assessment Methodologies. B. S. Publications, Hyderabad

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Integrated Energy Systems	L	T	P	J	C
MEE2060		3	0	0	0	3
Pre-requisite	MEE1003, MEE1032	Syllabus version				
		v.1.1				

Course Objectives:

1. To understand the various thermal systems, thermodynamic cycles and options for integration.
2. To learn the design of waste heat recovery system and performance evaluation of integrated systems.
3. To understand the design procedure of different heat exchangers and exergy evaluation of integrated systems.
4. To get an overview of integrated systems with case studies on different industries.
5. To get knowledge of evaluating financial feasibility of integrated systems.

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to

1. Analyze different energy systems for possible integration.
2. Able to design a cogeneration, waste heat recovery systems.
3. Able to design various heat exchangers for integrated systems.
4. Evaluate thermodynamic performance of integrated systems and exergy evaluation.
5. Identify various options specific to industry for possibility of integrated systems.
6. Able to evaluate the financial feasibility of integrated systems.

Module:1	Integrated Systems	7 hours

Topping cycle: Prime Movers - Gas turbine, steam turbine, Reciprocating engines; Industrial Examples: Process heating in sugar plants, paper and other industries. Bottoming cycle: Waste Heat Boilers, Metal industries, cement plants. Desalination- basics, and potential in power plants Vapor absorption refrigeration system – concept - working – types. Case studies on trigeneration system - Performance calculations

Module:2	Performance	6 hours

Comparative thermodynamic performance of integrated energy systems – Performance evaluation – Numeircal examples – Calculations of typical heat to power ratios and performance parameters – Effect of irreversibility.

Module:3	Waste heat recovery	6 hours

Pinch Technology, Selection of pinch temperature, Stream splitting, Process retrofit, Insulation, fins, Effective use of heat pumps and heat engines, heat pipes

Module:4	Design of heat exchangers	6 hours

Effectiveness, Types of Heat Exchangers - Recuperative, Regenerative, run-around coils.		
Module:5	**Exergy evaluation**	**6 hours**
Modelling – Plotting of Sankey and Grasmann diagrams – Exergy analysis – Organic Rankine cycle – Kalina cycle system.		
Module:6	**Applications**	**6 hours**
Applications of integrated energy systems – Diesel generators - Case studies in sugar mills, rice mills, textile factories and other process and engineering industries.		
Module:7	**Economics**	**6 hours**
- Full load and part-load performance, Capital and Running costs, ROI and Payback,		
Module:8	**Contemporary issues**	**2 hours**
Environmental and air quality considerations - power augmentation techniques		
	Total Lecture hours:	**45 hours**

Text Book(s)	
Reference Books	
1.	Boyce M.P. Cogeneration and Combined Cycle Power Plants, ASME Press, 2nd Ed., 2010.
2	J.H. Horlock, Cogeneration: Heat and Power, Thermodynamics and Economics, Pergamon
3	Goodwin, G. C., Graebe, S. F., & Salgado, M. E. (2001). Control system design. Upper Saddle River, 13.
4	Yahya, S. M. (1987). Turbines compressors and fans. Tata McGraw-Hill Education.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Operations Research	L	T	P	J	C
MEE1024		2	2	0	0	3
Pre-requisite	MAT2001	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide students the knowledge of optimization techniques and approaches.
2. To enable the students apply mathematical, computational and communication skills needed for the practical utility of Operations Research.
3. To teach students about networking, inventory, queuing, decision and replacement models.

Expected Course Outcome:

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

1. Apply operations research techniques like L.P.P, scheduling and sequencing in industrial optimization problems.
2. Evaluate transportation problems using various OR techniques.
3. Explain various OR models like Inventory, Queuing, Replacement, Simulation, Decision etc. and apply them for optimization.
4. Use OR tools in a wide range of applications in industries.
5. Identify current topics and advanced techniques of Operations Research for industrial solutions.
6. Identify best techniques to solve a specific problem.
7. Analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problems with intellectual independence.

Module:1	Linear Programming Problem	4 hours

Introduction to Operations Research – Linear Programming - Mathematical Formulation – Graphical method – Simplex method – Penalty methods: M-method, Two Phase method- Duality.

Module:2	Transportation Problem	4 hours

Introduction - Formulation - Solution of the transportation problem (Min and Max): Northwest Corner rule, row minima method, column minima method, Least cost method, Vogel's approximation method – Optimality test: MODI method.

Module:3	Assignment and Sequencing Models:	3 hours

Assignment problems – Applications - Minimization and Maximization; Sequencing - Problem with N jobs and 2 machines – n jobs and 3 machines problem - n jobs and m machines problem.

Module:4	Project Management	4 hours

Introduction - Phases of project management-Construction of Network diagrams- Critical path method (CPM) and Project evaluation and review technique (PERT) - Crashing of project network.		
Module:5	**Inventory Control**	**4 hours**
Necessity for maintaining inventory - Inventory costs -Inventory models with deterministic demand - inventory models with probabilistic demand - Inventory models with price breaks - Buffer stock.		
Module:6	**Queuing Models**	**4 hours**
Poisson arrivals and Exponential service times – Single channel models and Multi-channel models - Simulation: Basic concepts, Advantages and disadvantages - Random number generation - Monte Carlo Simulation applied to queuing problems.		
Module:7	**Game theory and Replacement Models**	**5 hours**
Game theory: Competitive games - Useful terminology - Rules for game theory - Two person zero sum game – Property of dominance - Graphic solution – Algebraic method. **Replacement models:** Replacement of items that deteriorate with time: No changes in the value of money, changes in the value of money - Items that fail completely: Individual replacement and group replacement policies.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Hamdy A Taha, Operations Research: An Introduction, 9th edition, Pearson Education, Inc., 2014.
Reference Books	
1.	Hira D S and Gupta P K, Operations Research, S. Chand & Sons, 2014.
2.	Kanti Swarup, Gupta P.K., and Man Mohan, Operations Research, 18th edition, S. Chand &Sons, 2015.
3.	Manohar Mahajan, Operations Research, Dhanpat Rai & Co, 2013.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Energy Conservation, Audit and Management	L	T	P	J	C
MEE2029		2	0	0	4	3
Pre-requisite	MEE1003	Syllabus version				
		v.2.2				

Course Objectives:

1. To help students gain essential and basic knowledge of various energy forms, its availability and the challenges faced by current way of energy exploitation.
2. To familiarize the students with the procedures of energy auditing and the equipments used for the same.
3. To make students understand the common energy using systems or equipments in commercial and industrial premises
4. To enable the students to apply the knowledge of engineering thermodynamics, energy conversions etc to come up with energy saving potentials in industrial systems\
5. To gain knowledge of applying financial appraisal techniques to energy saving projects.

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Possess the knowledge various energy forms, different energy consuming systems.
2. Perform professional energy audit for any organization.
3. Do analysis of energy conversion in various systems to evaluate its operating efficiency and arrive at energy saving opportunities.
4. Identify the possible energy saving options in electrical utilities.
5. Evaluate the financial viability of the energy conservation projects.

Module:1	Energy Scenario	4 hours

Indian Energy Scenario – Types & Forms of Energy – An overview of energy consumption and its effects – Reasons to save energy (financial and environmental) – Energy Conservation Acts and related policies – Schemes of Bureau of Energy Efficiency (BEE), Recent policies of Government of India in energy sector.

Module:2	Energy auditing and management	6 hours

Definition & objective of Energy management – Energy Audit – Types & Methodology– Energy audit report format – Instruments used and purpose – Organizational background desired for energy management – Case studies of energy audit in different industries

Module:3	Energy Efficiency in Thermal Utilities - I	6 hours

Fuels and combustion– Stoichiometry – Combustion Principles – Boilers (classification, types, working principle of important types) – Boiler Heat Loss Estimation – Furnaces – Insulation & Refractories

Module:4	Energy Efficiency in Thermal Utilities - II	6 hours

Steam systems – Steam Traps – Cogeneration – Principles & Operation – Waste Heat Recovery – Sources & Grades – Types (Heat Wheel, Recuperators, Regenerators ,Heat Pipe etc) – Economics of WHR Systems

Module:5	**Electrical energy usage**	**6 hours**
Basics of electrica energy, Electricity Billing – Components & Costs – Determination of kVA demand & Consumption – Time of Day Tariff – Power Factor – Electrical systems – Electric motors.		
Module:6	**Energy Efficiency in Electrical Utilities**	**6 hours**
Fans & blowers – Compressed air systems – Refrigeration and air conditioning systems - Pumps & pumping systems – Lighting systems – Energy efficient technologies in electrical systems, General energy saving measures		
Module:7	**Energy costs and Financial analysis:**	**7 hours**
Understanding Energy Costs– Benchmarking and Energy Performance – Fuel and Energy Substitution – Material Balances – Energy Balances – Financial techniques for assessing energy conservation measures – Fixed and variable cost – Interest charges – Simple payback period – Net Present Value - Discounted cash flow method		
Module:8	**Contemporary issues:**	**4 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	K.V Sharma, P Venkatasheshaiah (2011) Energy management and Conservation, I.K International publishing house New Delhi.
Reference Books	
1.	Y.P abhi, Shashank Jain (2012), Hand book of energy audit and environmet management, TERI Presss
2	William J Kennedy (2013), Guide to energy management, Lulu.com
3	Giude books(2016), National certification Examination for energy managers and auditors, BEE,www.em-ea.org

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Industrial Engineering And Management	L	T	P	J	C
MEE1014		3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To analyze different planning activities needed during the operations stage of a manufacturing or a service industry.
2. To apply productivity techniques for achieving continuous improvement.

Expected Course Outcome:

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

1. Analyze the way price of a product affects the demand for a product for consequent actions and predict demand for a product by making use of different demand forecasting techniques.
2. Explain Break even analysis to determine safe production levels and costing of industrial products.
3. Apply productivity techniques for continuous improvement in different functionalities of an industry.
4. Analyze the existing operations that happen in factories for establishing time standards for different activities.
5. Demonstrate the knowledge of selection of location for the new plant & optimizing the layout within the plant for smooth production.
6. Apply cellular manufacturing concepts in industry.
7. Compute material requirement needed to satisfy the Master Production Schedule of a factory by having thorough understanding of MRP logic.

Module:1	Introduction to macro and micro economics	6 hours

Macro-economic measures – micro economics – Demand and supply – Determinants of demand and supply – Elasticity of demand – Demand forecasting techniques (short term & long term) – Problems.

Module:2	Elements of cost	6 hours

Determination of Material cost - Labour cost – Expenses - Types of cost – Cost of production – Over-head expenses–break even analysis - Problems.

Module:3	Productivity	6 hours

Definition – Factors affecting- Increasing productivity of resources - Kinds of productivity measures - Case study.

Module:4	Introduction to work study	6 hours

Method study – Time study – stopwatch time study – Work measurement - performance rating-allowances – Ergonomics.		
Module:5	**Plant location and Plant layout**	**7 hours**
Plant location –need - Factors – comparison – quantitative methods for evaluation Plant layout: objectives-principles – factors influencing – tools and techniques including computer based layout design – CRAFT, ALDEP, CORELAP.		
Module:6	**Cellular Manufacturing**	**6 hours**
Group Technology – Cellular layout – Machine-Part Cell Formation (MPCF) – Heuristic approaches – Hierarchical clustering for MPCF.		
Module:7	**Material requirement Planning (MRP)**	**6 hours**
Objectives – functions – MRP system – MRP logic – Management information from MRP – lot sizing consideration – Manufacturing resource planning – capacity requirement planning (CRP) – Bill of material.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	R Dan Reid, and Nada R. Sanders, Operations Management, John wiley& Sons, 5th Edition, 2012.
Reference Books	
1.	William J Stevenson, Operations Management, McGrawHill, 12th Edition, India, 2017.
2.	R Panneerselavam, Production and Operations Management, PHI publications 3rd Edition, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Robotics	L	T	P	J	C
MEE1030		2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To outline the basic concepts of Industrial Robots and drive system.
2. To plan and to analyze the design concepts and applications of end effectors.
3. To solve kinematics and trajectory related problems.
4. To identify the appropriate sensors for various robotics applications.

Expected Course Outcome:

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

1. Specify various types of Robots for industrial applications
2. Design appropriate end effectors for various applications.
3. Analyze kinematics of various manipulator configurations
4. Compute required trajectory planning for the given task.
5. Select the suitable sensors for real time working of robotic arm.
6. Prepare Robot program for various industrial applications.

Module:1	Introduction to Industrial robot	4 hours

History of Robotics –Basics components of Robotics system – DOF and types of joints – Work space – Robot precession - Types of robotics configurations – Types of robotics drives – Basic motion of robot manipulator – Harmonics drives – Economics aspects of robotics system in industrial automations.

Module:2	Effectors and Grippers	4 hours

Types of end effector - Mechanical gripper – types of mechanical grippers – magnetic gripper – Vacuum gripper – Adhesive gripper – other special grippers – RCC –Tools – painting gun – welding torch –design of mechanical gripper.

Module:3	Robot control system and Robot kinematics	4 hours

Basic control system concepts – Control system analysis – Robot actuation and feedback -Manipulators - Position analysis and finite rotation and translation – Homogeneous matrices – forward and inverse kinematics – DH representation.

Module:4	Manipulator Trajectory planning	4 hours

Point-to-point and continuous path planning – trajectory planning – Cartesian space – joint space – bending path – problems in trajectory planning.

Module:5	**Sensor in robotics**	**4 hours**
Range sensing, Triangulation, structured light approach, Light-of-flight range finder – Proximity sensing: Inductive, Hall-effect, capacitive and ultrasonic sensor –Touch sensing – Force and Torque sensing		
Module:6	**Machine vision system**	**4 hours**
Introduction to Machine vision – functional block diagram of machine vision system - Sensing and Digitizing – Image processing and analysis		
Module:7	**Robot programming**	**4 hours**
Classification of robotics language – instruction set in Vel language - simple robot in palletizing and de-palletizing – simple robot program in robot arc welding.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Mikell P. Groover, Mitchell Weiss, Industrial Robotics Technology – Programming and Applications, 2nd edition, McGraw Hill, 2013.
Reference Books	
1.	S. R. Deb, Sankha Deb, Robotics Technology And Flexible Automation, 2nd edition, McGraw Hill Education, 2017.
2.	Niku, Saeed. B, Introduction to Robotics: Analysis, Systems, Applications, Prentice Hall of India Pvt. Ltd , New Delhi, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Experiment on Tool Centre Point (TCP).	3 hours
2.	Developing a robot program with point to point control method.	3 hours
3.	Developing a robot program with Continuous path control method.	3 hours
4.	Developing a robot program on given straight line profile.	3 hours
5.	Developing a robot program on given Curved profile.	3 hours
6.	Pick and place with digital signal interpret.	3 hours
7.	Forward kinematics for two link planner using Sim-Mechanics.	3 hours
8.	Inverse kinematics for two link planner using Sim-Mechanics.	3 hours
9.	Trajectory Planning using third order polynomial.	3 hours
10.	Programming two link planner with given profile.	3 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	Instrumentation and Control Engineering	L	T	P	J	C
MEE1027		3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To learn the type of the system, dynamics of physical systems, classification of control system, analysis and design objective
2. To provide good knowledge of Instrumentation systems and their applications
3. To provide knowledge of advanced control theory and its applications to engineering problems

Expected Course Outcome:

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

1. Describe the basic principle of typical measurement systems and error characteristics
2. Understand transduction, working principles of typical sensors used in industrial applications.
3. Demonstrate the applications and role of signal conditioning circuits, data acquisition in measurement systems.
4. Formulate mathematical model for physical systems and simplify representation of complex systems using reduction techniques.
5. Describe the basic concepts in control system design and the role of feedback.
6. Analyse the stability performance of the control system design.

Module:1	Introduction to Measurement systems	6 hours

Sensors, Transducers, classification, static and dynamics characteristics, errors, transduction principles.

Module:2	Measurement of Motion, Force and Torque	6 hours

Displacement and speed measurement for translational and rotation systems using potentiometers, LVDT and RVDT, Encoders, accelerometers and gyroscopes. Force and Torque measurements using strain gauges and piezoelectric pickups.

Module:3	Measurement of temperature, pressure and flow	6 hours

Temperature measurement using Thermistors, RTD, Thermocouple and semiconductor sensors. Pressure measurement using gage, manometers, bellows, diaphragm, differential pressure transmitter. Flow measurement using Venturi-tubes, Rotameters and anemometers.

Module:4	Signal conditioning and data acquisition	6 hours

Basic signal conditioning – bridges, amplifiers, filters, monitoring and indicating systems and data acquisition systems.		
Module:5	**Modelling and representation of systems -**	**6 hours**
Model of a system, Concept of transfer function, block diagram and state space, Modelling of basic physical systems.		
Module:6	**Control concepts**	**6 hours**
Open loop and closed loop systems with examples, controller design, and performance measurements-Design of P, PI, PD and PID controllers.		
Module:7	**Stability analysis**	**7 hours**
Concept of poles and zeros, Stability analysis of system using root locus, Routh Hurwitz criterion and Phase and gain margins.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	W. Bolton, Instrumentation and Control Systems, Newnes-Elsevier publication, 2nd edition**,** 2015.

Reference Books

1.	Ernest O. Doeblin, Measurement Systems: Application and Design, 5th Edition, Tata McGraw- Hill, 2012.
2.	Katsuhiko Ogata, Modern Control Engineering, 5th Edition, Prentice Hall of India Pvt. Ltd, 2010.
3.	Patranabis D, Instrumentation and Control, PHI Learning Pvt. Ltd, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Study, development and calibration of measuring instruments for displacement, speed, torque, force, temperature, pressure, flow, fluid level etc.	3 hours
2.	Control of DC motor, stepper motor and servomotor.	3 hours
3.	Demonstration of PID control system.	3 hours

4.	Use of MATLAB for control system simulation (Control Systems Toolbox) - Modeling of physical systems using Simulink.	3 hours
5.	Signal Conditioning Circuit for specific application.	3 hours
6.	Determination of Dynamic Performance Characteristics of First Order System.	3 hours
7.	Determination of Dynamic Performance Characteristics of Second Order System.	3 hours
8.	Determination of Dynamic Performance Characteristics of Higher Order Systems.	3 hours
9.	Analog to Digital and Digital to Analog Conversion.	3 hours
10.	Grounding Practices.	3 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017