DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH. (MECHANICAL ENGINEERING)

SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY
Ichchhanath, Surat-395007, Gujarat, India
www.svnit.ac.in

Vision and Mission of Institute

Vision statement

To be one of the leading technical institutes disseminating globally acceptable education, effective industrial training and relevant research output.

Mission statement

To be a globally accepted center of excellence in technical education catalyzing absorption, innovation, diffusion and transfer of high technologies resulting in enhanced quality for all the stakeholders.

Vision and Mission of the Department

Vision statement

Perceives to be a globally accepted centre of quality technical education based on innovation and academic excellence.

Mission statement

Strives to disseminate technical knowledge to its undergraduate, post graduate and research scholars to meet intellectual, ethical and career challenges for sustainable growth of humanity, nation and global community.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

The overall educational objective for **Master of Technology in Mechanical Engineering** is to educate students with excellent technical capabilities in the mechanical engineering discipline, who will be responsible citizens and continue their professional advancement through life-long learning.

As mechanical engineers with expertise in **Mechanical Engineering**, postgraduates are prepared with following educational objectives:

PEO1	**Knowledge:** Impart broad technical knowledge in mechanical engineering discipline with research attitude, problem solving techniques and hands-on skill.
PEO2	**Career:** Provide successful career with professional ethics and responsibilities as a leading or participating role in mechanical engineering, R & D organization, academia and other fields or to pursue Ph.D./higher studies.
PEO3	**Communication:** Communicate verbally, in writing or audio-visually with others.
PEO4	**Learning**: Encourage the importance of life-long learning skill and ware of contemporary global issues for the successful professional career through self-study, participation and professional development courses.

PROGRAM OUTCOMES (PO)

PO1	An ability to independently carry out research /investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PSO1	Design, analyse and develop thermal, fluid and manufacturing systems using innovative research, modern tools and techniques.
PSO2	Demonstrate technical and professional skills to solve mechanical engineering problems for the benefits of industry and society.

COURSESTRUCTUREFOR
M.TECH.(MECHANICAL ENGINEERING)

SEMESTER –I

Code No	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
MEME101	**Core 1** Numerical Methods and Computations	3	1	0	3	100	25	-	125	4
MEME102	**Core 2** Computer Aided Engineering	3	0	2	3	100	-	50	150	4
MEME103	**Core 3** Advanced Thermal and Fluid Engineering	3	0	2	3	100	-	50	150	4
MEME110 MEME111 MEME112 MEME113 MEME114	**Elective 1** 1. Electric Vehicles and Advanced I C Engines 2. Additive Manufacturing 3. Advanced Mechanical Vibrations 4. Industrial Tribology 5. Power Plant Engg	3	0	0	3	100	-	-	100	3
MEME120 MEME121 MEME122 MEME123 MEME124 MEME125	**Elective 2** 1. Optimization Techniques 2. Industrial Robotics 3. Concurrent Engineering 4. Computational Fluid Dynamics 5. Design of Refrigeration and Air Conditioning Systems 6. Operation Planning and Control	3	0	0	3	100	-	-	100	3
MEME104	**Software Practice I**	0	0	4	0	-	-	100	100	2
MEME105	**Laboratory Practice**	0	0	4	0	-	-	50	50	2
Total Credits										**22**
Total Contact Hrs Per Week 28Hrs										

SEMESTER –II

Code No.	Subject	L	T	P	Exam Scheme Theory Hrs.	Theory Marks	Tuto. Marks	Pract. Marks	Total	Credits
MEME201	**Core 4** Computer Integrated Manufacturing	3	0	2	3	100	-	50	150	4
MEME202	**Core 5** Mechanical Design Analysis	3	1	0	3	100	25	-	125	4
MEME230 MEME231 MEME232 MEME233 MEME234	**Elective 3** 1. Renewable Energy Systems 2. Design of Pressure Vessels& Piping 3. Theory and Design of Cryogenic Systems 4. Quality Engineering and Management 5. Advanced Welding Technology	3	0	0	3	100	-	00	100	3
MEME240 MEME241 MEME242 MEME243 MEME244	**Elective 4** 1. Design of Experiments 2. Mechanics of Composite Laminates 3. Combustion 4. Design of Heat Exchangers 5. Non Destructive Techniques	3	0	0	3	100	-	-	100	3
MEME210 MEME211 MEME212 MEME213 MEME214	**Institute Elective** 1. Industrial Safety 2. Intelligent Manufacturing Systems 3. Energy Conservation, Management and Audit 4. Energy and Buildings 5. Instrumentation and Experimental Methods	3	0	0	3	100	-	-	100	3
MEME203	**Communication Skills**	0	0	2	0	-	00	50	50	1
MEME204	**Mini Project**	0	0	4	2	-	-	50	50	2
Total Credits										**20**
Total Contact Hrs per Week 24Hrs										

SEMESTER –III

CodeNo.	Subject	L	T	P	ExamScheme					Total	Credits
					Theory		Tuto.	Pract.			
					Hrs.	Marks	Marks	Marks			
MEME301	Dissertation Preliminaries	0	0	12	-	-	-	300		300	6
MEME302	Seminar	0	0	4	-	-	-	100		100	2
Total Credits											**8**

SEMESTER -IV

CodeNo.	Subject	L	T	P	ExamScheme					Total	Credits
					Theory		Tuto.	Pract.			
					Hrs.	Marks	Marks	Marks			
MEME401	Dissertation	0	0	24	-	-	-	600		600	12
Total Credits											**12**

Total Credits: 22+20+8+12 = 62

<u>CREDIT MATRIX</u>

Category	Credits to be earned				
	Sem- I	Sem - II	Sem- III	Sem - IV	Total
Core Courses	12	08	-	-	20
Elective Courses	06	09	-	-	15
Software/ Laboratory	02+02	--	-	-	04
Communication Skills	--	01	--	--	01
Mini Project	--	02	--	--	02
Seminar	-	-	02	-	02
Dissertation	-	-	06	12	18
Total Credits	22	20	08	12	**62**

DEPARTMENT OF MECHANICAL ENGINEERING

POOL OF ELECTIVES FOR ALL P.G. PROGRAMS

SEMESTER-I	
CORE ELECTIVE-1	**CORE ELECTIVE-2**
1. Additive Manufacturing	1. Advanced Metrology and Computer Aided Inspection
2. Advanced Mechanical Vibrations	2. Analysis and Design of Thermal Turbo Machines
3. Advanced Mechanics of Solids	3. Computational Fluid Dynamics
4. Advanced Welding Technology	4. Computer Aided Production Planning
5. Atomization and Sprays	5. Concurrent Engineering
6. Bio-Mass Conversion Systems	6. Design of Pressure Vessels
7. CAD for Manufacturing	7. Design of Refrigeration and Air Conditioning Systems
8. Combustion	8. Electrical Vehicles and Advanced IC Engines
9. Concurrent Engineering: Tools, Techniques & Applications	9. Energy and Exergy Analysis of Turbomachines
10. Condition Monitoring and Fault Diagnosis of Rotating Machinery	10. Failure Analysis & NDE
11. Design of Reacting Systems	11. Finite Element Method in Thermal Engineering
12. Electrical Vehicles and Advanced IC Engines	12. Fracture Mechanics
13. Electro-Chemical Engineering Storage	13. Gas Dynamics and Compressible Fluid Flow
14. Environmental Pollution and Control	14. Hydrogen Energy Applications to Propulsion and Future Modes of Transport
15. Industrial Tribology	15. Industrial Robotics
16. Measurement and Data Analysis	16. Jet and Rocket Propulsion
17. Manufacturing Metallurgy	17. Measurements and Data Analysis in Thermal Engineering
18. Material Characterization and Testing	18. Operations Planning and Control
19. Metal Cutting and Tool Design	19. Optimization Techniques
20. Nonlinear Dynamics and Chaos	20. Rotor Dynamics, Vibration and Stress Analysis
21. Power Plant Engineering	21. Sensors in Manufacturing Systems
22. Product Design & Development	22. Unconventional Turbomachines
23. Theory of Plasticity	

DEPARTMENT OF MECHANICAL ENGINEERING

POOL OF ELECTIVES FOR ALL P.G. PROGRAMS

SEMESTER-II	
CORE ELECTIVE-3	**CORE ELECTIVE-4**
1. Advanced Welding Technology 2. Automation in Manufacturing 3. Bio fluidic and Bio Heat Transfer 4. Cascade Aerodynamics 5. Combustion 6. Composite Design and Manufacturing 7. Computational Fluid Dynamics 8. Computer Aided Tool Design 9. Condition Monitoring and Fault Diagnosis of Rotating Machinery 10. Design of Heat Exchangers 11. Design of Pressure Vessel & Piping 12. Finite Elements Methods 13. Industrial Tribology 14. Instrumentation and Experimental Methods 15. Laser Based Micro Manufacturing 16. Lifecycle Analysis of Turbomachines 17. Metal Cutting 18. Micro Hydro Turbine 19. Quality Engineering and Management 20. Renewable Energy Systems 21. Smart Materials & Manufacturing 22. Theory and Design of Cryogenic Systems 23. Turbulence and Turbulent Flows	1. Combustion 2. Concurrent Engineering 3. Design of Heat Exchangers 4. Flow & Flame Diagnostics 5. Fundamentals of Solid Propellant and Multi-Phase Combustion 6. Hydrodynamic Stability 7. Industrial Refrigeration 8. Industrial Tribology 9. Mechanics of Composite Laminates 10. Mechanics of Composite Materials 11. Nano fluid and its Applications in Thermal Systems 12. Non Destructive Techniques 13. Numerical Methods in Manufacturing 14. Operations Research 15. Optimization Techniques 16. Quality Engineering and Management 17. Surface Engineering 18. Theory of Elasticity and Plasticity 19. Thermo-Acoustic Instabilities 20. Transport in Porous Media 21. Turbulent Combustion

MEME101	:	NUMERICAL METHODS AND COMPUTATIONS	L	T	P	Credits
			3	1	0	04

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1 Understand the fundamental of numerical methods and applications in engineering problems
CO2 implement solution procedures for solving linear and non-linear algebraic equations
CO3 learn how to solve definite integrals by using cubic spline, Romberg and initial value problems and boundary value problems numerically
CO4 solve ordinary differential equations (ODEs), and partial differential equations (PDEs) on a computer
CO5 acquire working knowledge of computational complexity, accuracy, stability, and errors in solution procedures
CO6 Solve one-dimensional optimization problems using optimization algorithm

1. Syllabus:

1. **Introduction** **(03 Hours)**
Introduction to Computer Aided Engineering Analysis, Measuring Errors, Sources of Error, Binary Representation of numbers, Floating Point Representation, Propagation of Errors, Taylor Theorem Revisit

2. **Differentiation** **(04 Hours)**
Primer on Differential Calculus, Differentiation of Continuous Functions, Differentiation of Discrete Functions

3. **Nonlinear Equations** **(04 Hours)**
Solving Quadratic Equations Exactly, Solving Cubic Equations Exactly, Bisection Method, Newton-Raphson Method, Secant Method, False-Position Method

4. **Simultaneous Linear Equations** **(05 Hours)**
Introduction to Matrix Algebra, Systems of Equations, Gaussian Elimination, Gauss-Seidel Method, LU Decomposition, Gauss-Seidel Method, Adequacy of Solutions, Eigenvalues and Eigenvectors, Cholesky and LDLT Method

5. **Interpolation** **(04 Hours)**
Background of Interpolation, Direct Method, Newton’s Divided Difference Method, Lagrange Method, Spline Method

6. Regression **(04 Hours)**

Primer on Statistical Terminology, Introduction to Regression, Linear Regression, Nonlinear Regression, Adequacy of Regression Models

7. Integration **(04 Hours)**

Primer on Integral Calculus, Trapezoidal Rule, Simpson's 1/3rd Rule, Romberg Integration, Gauss-Quadrature Rule, Discrete Data Integration, Improper Integration, Simpson's 3/8 Rule

8. Ordinary Differential Equations **(05 Hours)**

Primer on Ordinary Differential Equations, Initial Value Problems, Euler's Methods, Runge-Kutta methods, Predictor - Corrector Method, Higher Order/Coupled ODEs, Boundary Value Problems, Shooting Method, Finite Difference Method

9. Partial Differential Equations **(05 Hours)**

Introduction to Partial Differential Equations, Parabolic Partial Differential Equations, Elliptic Partial Differential Equations

10. Optimization **(04 Hours)**

Golden Section Search Method, Newton's Method, Multidimensional Direct Search Method, Multidimensional Gradient Method, Simplex Method

Total Lectures (42 Hours)

2. Books Recommended:

1. Chapra, S.C., Canale, R.P., "Numerical Methods for Engineers", 7th edition, Mcgraw hill, 2015.
2. Grewal, B.S., "Numerical Methods in Engineering & Science", 11th edition, Khanna Publication, 2013.
3. Cheney, W., Kincaid, D., "Numerical Mathematics and Computing", 7th edition, Cengage, 2013
4. Gerald, C., Wheatley, P., "Applied Numerical Analysis", 7th edition, Pearson Education India, 2007.
5. Isaacson, E., H. B. Keller, H.B., "Analysis of Numerical Methods", Dover Publications, 1994

MEME102	:	COMPUTER AIDED ENGINEERING	L	T	P	Credits
			3	0	2	05

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Understand the concept of computer graphics, drafting, and modelling using different commands and graphical user interface
CO2	Apply the concept of transformation for generating different positions of given problem with defined geometry
CO3	Create 3D models assemblies and generative drawings of a given engineering part or product
CO4	Apply the knowledge of programming for complex shape required in engineering for drafting or modelling
CO5	Determine the coordinates of space curves and parametric curves required for generating features in CAD models
CO6	Apply the knowledge of approximate methods (FDM/FEM) to solve engineering problems and to analyze status of variable in domain through various interpolation approaches.

1 Syllabus

Computer Graphics:

Basics of Computer Aided Design, Introduction to Computer graphics, CAD/CAM hardware, 2D & 3D Transformations. **[10Hours]**

Plane Curves and Space Curves:

Parametric non parametric curves – cubic splines – Bezier curves, d – spline curves. **[10Hours]**

3-D Modelling:

Solid modeling, modeling approaches-coordinate system-basic features-viewing/visualization-hidden line removal. Introduction to Computer Aided Drafting and modeling using software approach. Programming techniques in drafting/ modeling **[10Hours]**

Numerical Analysis:

Finite Difference Method and Finite Element Method-direct approach, variational approach and weighted residual approach, isoparametric elements, interpolation functions elemental matrix, assembly and boundary conditions, condensation, solution algorithms. Application of FEM in elastic plane stress, plane strain and anisymmetric problem. Application of FEM to thermal problems **[12 Hours]**

2.Books Recommended

1. I. Zeid, Mastering CAD/CAM, Tata Mcgraw-Hill Education Private Limited, 2005.
2. A.D. Belegundu and T.R. Chandrupatla, Finite Elements in Engineering, Prentice Hall of India Private Ltd., 1997.
3. J.N. Reddy, An Introduction to the Finite Element Method, Tata Mcgraw-Hill Education Private Limited, 2005.
4. D. Rogers, J.A. Adams , Mathematical Elements for Computer Graphics, Tata Mcgraw Hill Education Private Limited, 2002.
5. C. S. Krishnamoorthy, S. Rajeev, A. Rajaraman, Computer Aided Design: Software and Analytical Tools, Second Edition Narosa Publishing House, 2009.

3 List of Practicals

1. Sketching of conceptual design through Drafting of a given engineering component
2. Programming In drafting for a given sketch or mechanical component
3. Creating a 3d model of mechanical components exploring various features of CAD tools.
4. Developing relational sketches and model for designing mechanical components.
5. Creating communication drawing using generative approach for manufacturing requirement of given engineering part or product.
6. Creating assemblies for designing digital product through CAD software.
7. Creating a digital models and surfaces of non-geometric nature through parametric curves.
8. Creating presentation animation for digital communication of engineering products.
9. Solving linear problem for a given engineering problems using 1D approach using FEM software
10. Solving linear problem for a given engineering problems using, 2D approach using FEM software
11. Solving linear problem for a given engineering problems using 3D approach using FEM software
12. Demonstrating FEM software for Nonlinear problems using FEM software
13. Solving given engineering problem using FDM by computation approach.

MEME103	:	ADVANCED THERMAL AND FLUID ENGINEERING	L	T	P	Credits
			3	0	2	04

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Explain the concepts of availability and irreversibility and conduct exergy analysis of thermodynamic systems
CO2	Evaluate the performance of vapor power cycles, gas power cycles, combined vapor and gas power cycles, and refrigeration cycles
CO3	Solve complex heat transfer problems of conduction / convection / radiation
CO4	Solve complex heat transfer problems of boiling and condensation
CO5	Apply governing equations to solve different fluid flow problems
CO6	Explain fluid flow measurements and flow visualization techniques

1. Syllabus:

Thermodynamics: **(14 hours)**

Fundamental laws of thermodynamics, availability and irreversibility, second-law efficiency, exergy change of a system, exergy transfer by heat, work, and mass flow, exergy balance for closed systems and control volumes.

Power cycles, Rankine cycle with reheating and regeneration, super-critical Rankine cycle, ultra-super-critical technology, Kalina cycle, Brayton cycle with intercooling, reheating, and regeneration, Otto, diesel, and dual cycles for internal combustion engines, Stirling cycle, Ericsson cycle, second law analysis of power cycles, Combined gas and vapor power cycles; Refrigeration cycles, Innovative vapor compression refrigeration systems.

Heat Transfer: **(14 hours)**

Modes of heat transfer; general heat conduction equation in Cartesian, cylindrical, and spherical coordinates, steady-state heat conduction considering multiple dimensions, numerical methods of analysis, unsteady state heat conduction, heat flow in a semi-infinite solid; empirical and practical relations for forced convection heat transfer, natural convection in internal and external configurations, combined free and forced convection; radiation heat transfer, black and gray body radiation, intensity of radiation and Lambert's cosine law, radiative transport equation for bulk radiation; boiling and condensation heat transfer, heat pipe; methods to improve the performance of heat exchangers.

Fluid Flow: **(14 hours)**

Reynolds transport theorem, Navier-Stokes equation, analytical solutions to simple flows, Couette flow, Poiseuille flow, concepts of lift and drag, flow separation and drag, boundary layer theory, boundary layer flow over a flat plate and with non-zero pressure gradient, free shear flow, characteristics of turbulent flows, Reynolds Averaged Navier Stokes (RANS) equations, compressible flow through convergent and Laval nozzles, normal and oblique shock waves, micro-flows, fluid flow measurements and flow visualization techniques.

Total Lectures 42 Hours

2. Books Recommended:

1. Y. A. Cengel, M. A. Boles, and M. Kanoglu. Thermodynamics - An Engineering Approach, 9th Edition, McGraw Hill, 2019.
2. R. K. Rajput. Thermal Engineering, 11th Edition, Laxmi Publications, 2020.
3. J. P. Holman and S. Bhattacharya. Heat Transfer, 10th Edition, McGraw Hill, 2017.
4. Y. A. Cengel and J. M. Cimbala. Fluid Mechanics: Fundamentals and Applications, 4th Edition, McGraw Hill, 2018.
5. F. M. White and H. Xue. Fluid Mechanics, 9th Edition, McGraw Hill, 2021.

3. List of Practicals (Any 08)

1. Experiments to characterize the pyrolysis behavior of selected biomass fuels.
2. To determine the yield from gasification of different biomass.
3. Preparation and performance analysis of biofuels on IC engines.
4. Experimental investigation of thermal performance of tube finned heat exchanger
5. Calculation of effectiveness and efficiency of the fin for different heat fluxes.
6. Flow & heat transfer simulation for various engineering applications.
7. Two-phase flow experiments.
8. Comparison of flow measuring instruments - measurement of static and dynamic characteristics of instruments.
9. Performance Test on Cascade Refrigeration System
10. Performance Tests on Internal Combustion Engines
11. Wind Tunnel Test
12. Pump Testing for determination of losses
13. Heat pipe experiment

MEME110	:	ELECTRIC VEHICLES AND ADVANCED I C ENGINES	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Compare the general specifications of various commercially available vehicle
CO2	Apply material and design considerations for various engine components
CO3	Evaluate effects of various parameters including use of alternate fuels on normal and abnormal combustion, emission and performance in CI and SI Engines
CO4	Compare basic layout and structure of EV and I C Engines
CO5	Work out battery and motor sizing for various applications in two, three and four wheeler segment
CO6	Analyze Bus Rapid Transit Systems

1. Syllabus

Introduction to I C Engines: 03 hours

Historical Perspective, General Specifications of Engines used in various Two, Three and Four Wheelers. Air Standard Thermodynamic Cycles for I C Engines and its comparison with Fuel Air and Actual Cycle, Thermodynamic properties of working fluid.

Material and Design Consideration for Engine Components 04 hours

Piston, Cylinder, Piston Rings, Connecting Rod, Cam Shafts, Crank Shafts etc.

Gas Exchange Process: 04 hours

Flow through valves, Analysis of suction and Exhaust Processes

Combustion in SI and CI Engines: 06 hours

Combustion Phenomenon in SI and CI Engines, Normal and Abnormal combustion in SI and CI Engines, modelling combustion process in SI engines, Advanced mode combustion like HCCI, PCCI, AFCI, RCCI etc.

Alternate Fuelled Engines : 03 hours

Producer Gas, Biogas and Biodiesel Fuelled Engines

Engine Emission: 06 hours

Introduction to air pollution from SI and CI Engines, Photochemical smog, primary and secondary pollutants, Formation of NO and NO2 in SI and CI Engines, Mechanism of Particulate Matter formation, Composition of Particulates, soot structure, soot formation, Measurement of emission, instrumentation for HC, CO, NOx and PM, EGR and Diesel Particulate Filter.

Introduction to Electric Vehicles : **02 hours**
Limitations of Internal Combustion Engines as Prime Mover, History of EV and EV Systems, Structure of Electric Vehicle covering basic Components, General Layout, Govt. policies on EV and its impact on automotive sector

EV Power Train: **12 hours**
Basic components like Battery, DC-AC Converters, Electric Motors, DC-DC Converters, Transmissions and ECUs. Battery and Motor Selection, Calculations for Motor and battery sizing for EV for Two, Three and Four Wheeler Applications, Thermal Management of Battery, Initial acceleration, rated vehicle velocity, maximum velocity and maximum gradeability of EV, Basic architecture of EV Drive Train.

Urban Transport : **02 hours**
Urban Bus Specifications, Bus Rapid Transit Systems

Total Lectures 42 Hours

2. Books Recommended:

1. Hiroshi Yamagata, The Science and Technology of Materials in Automotive Engine, CRC Press Inc.,2005.
2. John B Heywood, Internal Combustion Engines Fundamentals. McGraw Hill (Indian Edition) 2017.
3. V Ganesan, Internal Combustion Engines. 4^{th} Edition. Tata Mc Graw Hill Edition
4. Mehrdad Ehsani, Yimin Gao, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles., 2^{nd} edition, 2009.
5. Joseph Kent, Handbook of Electric Vehicles, Clanrye International. (2015)

MEME111	:	ADDITIVE MANUFACTURING	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1 Classify additive manufacturing processes and explain generic steps in additive manufacturing.

CO2 Explain principle, and mechanism of solid based, liquid based and powder based additive manufacturing processes.

CO3 Select a suitable additive manufacturing process for a given material and application.

CO4 Identify software related issues in additive manufacturing; and post processing aspects including defects and part quality.

CO5 Design and optimize a given part following guidelines and rules for part building.

CO6 Elaborate state of art in additive manufacturing.

1. Syllabus

Introduction **(04 Hours)**

Definition, classification, stages of generic additive manufacturing process, benefits, applications, process selection, evaluation, benchmarking, future growth and opportunities

Solid Based Processes **(06hours)**

Basic principle and working of Fused Deposition Modelling process, liquefaction, solidification and bonding, bio extrusion, Laminated Object Manufacturing process, Multi jet process, typical materials and applications

Liquid Based Processes **(06 Hours)**

Photo polymerization, principle and working of stereo lithography apparatus, scanning techniques, curing processes, typical materials and applications

Powder Based Processes **(06 Hours)**

Powder fusion mechanism, powder handling and recycling, Principle and working of SelectiveLaser Sintering, Laser Engineering Net Shaping process, Electron Beam Melting, processparameters, typical materials and applications, safety considerations

Additive Manufacturing Data Formats, Pre-processing & Post processing **(08 Hours)**

Additive manufacturing file formats, Defects and Issues in Data Formats; Pre-processing – Part orientation and support structure generation, Model Slicing, Contour Generation, Tool Path Generation, Build File preparation, Machine Set-up; Post Processing – Product quality evaluation, support structure removal, Improvement of finish, geometry and aesthetics.

Design For Additive Manufacturing **(08 Hours)**

Core concepts and objectives, Principles of design for manufacturing and assembly, Constraint approach to design for additive manufacturing: Guidelines and rules for part building, Topology optimization and generative design, exploring designfreedom, design tools.

Recent Trends in Additive Manufacturing **(04 Hours)**

Composite 3D printing, Bio 3D printing of tissues and organs, Clay and Concrete 3D printing, 3D food printing, 3D printing in space, 4D printing

2. Books Recommended:

1. I. Gibson, D. Rosen, B. Stucker, Additive Manufacturing Technologies, Springer Publisher, 2nd Edition, 2015.
2. C. K. Chua, K. F. Leong, C. S. Lim, Rapid Prototyping – Principles and Applications, World Scientific, 3rd Edition, 2010
3. C. P. Paul, A. N. Anoop, Additive Manufacturing – Principles, Technologies and Applications, Mc Graw Hill Education (I) Pvt. Ltd., 1st edition, 2021
4. A. Bandyopadhyay and S. Bose, Additive Manufacturing, CRC Press, 2nd edition, 2015
5. Diegel, Olaf, Axel Nordin, and Damien Motte. A Practical Guide to Design for Additive Manufacturing. Springer Singapore, 1st edition, 2019.

MEME112	:	ADVANCED MECHANICAL VIBRATIONS	L	T	P	Credits
			3	0	0	03

1. Syllabus:

Introduction **04 hours**

Free and forced vibrations with and without damping, transient vibrations, Laplace transform formulation.

Isolation and Stability Criterion **08 hours**

Vibration isolation and transmissibility, undamped vibration absorbers, self-exited vibrations, criterion of stability, effect of friction on stability.

Nonlinear Vibration **10 hours**

Free vibration with nonlinear spring force or nonlinear damping, phase plane, energy curves, Lienard's graphical construction, methods of isoclines, random vibration, power spectral density, bandwidth in vibration, numerical methods for vibration analysis, vibration of continuous systems, Euler equation for beams, effect of rotary inertia and shear deformation.

Vibration Analysis of Rotors **10 hours**

Transverse vibrations single, two and three rotor systems, critical speeds of shafts, torsional vibrations of rotors: one, two and three disc rotor system, frequency of torsional vibration systems, coupling of torsional and bending vibrations due to pretwist and eccentricity, rotor faults, forward and backward rotor whirl model, variable elasticity effects in rotating systems, flow induced vibration in rotating systems, Newkirk effect, stresses in rotating disc and blade, disc of uniform strength, thermal stresses.

Diagnostic Techniques **10 hours**

Introduction to diagnostic maintenance and instrumentation in machinery vibration, amplitude, frequency and phase characteristics, signature analysis-trend plot, time domain plot, frequency-domain plot, FFT, spectrum plot, fault detection transducers, artificial intelligence techniques applied to vibration analysis.

Total Lecture Hours (42 hrs)

2. Books Recommended:

1. S. S. Rao. Mechanical Vibrations, 4th Edition, Pearson Education, 2007.
2. L. Meirovitch. Fundamentals of Vibrations, McGraw Hill, 1st edition, 2001.
3. E. Krämer. Dynamics of Rotors and Foundations, Springer-Verlag, New York, 1993.
4. R. Subbiah and J. E. Littleton. Rotor and Structural Dynamics of Turbomachinery-A Practical, 1st edition, 2018.
5. P. Luciano Gatti. Advanced Mechanical Vibrations: Physics, Mathematics and Applications. CRC Press; 1s^{t} edition 2020.

MEME113	:	INDUSTRIAL TRIBOLOGY	L	T	P	Credits
			3	0	0	03

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

1. Analyze the lubrication and wear behaviour under different conditions
2. Identify and select suitable type of lubrication system for a given problem
3. Design and evaluate the performance parameters for sliding element bearings.
4. Design and evaluate the performance characteristics of rolling element bearings.
5. Select suitable strategy for instrumentation and inspection of selected feature/part
6. Compute relevant features in given system to ensure proper lubrication

Content

1. Surfaces, Friction and Wear (10 Hours)

Topography of Surfaces, Surface features, Surface interaction, Theory of Friction, Sliding and Rolling Friction, Friction properties of metallic and non -metallic materials, Friction in extreme conditions, Wear, types of wear, Mechanism of wear, wear resistance materials, Surface treatment, Surface modifications, Surface coatings.

2. Lubrication Theory (08 Hours)

Lubricants and their physical properties lubricants standards, Lubrication Regimes in Hydrodynamic lubrication, Reynolds Equation, Thermal, inertia and turbulent effects, Elasto hydrodynamic (EHD) magneto hydrodynamic lubrication, Hydro static lubrication, Gas
Lubrication, Solid lubrication.

3. Design of Fluid Film Bearings (09 Hours)

Design and performance analysis of thrust and journal bearings, Full, Partial, Fixed and pivoted journal bearings design, Lubricant flow and delivery, Power loss, Heat and temperature of steady and dynamically loaded journal bearings, Special bearings, Hydrostatic Bearing design.

4. Rolling Element Bearings (08 Hours)

Geometry and kinematics, Materials and manufacturing processes, Contact stresses, Hertzian stress equation, Load divisions, Stresses and deflection, Axial loads and rotational effects, Bearing life capacity and variable loads , ISO standards, Oil films and their effects, Rolling Bearings Failures.

5. Tribo Measurement and Instrumentation (07 Hours)

Surface Topography measurements, Electron microscope, friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, Bearing vibration measurement.

Books Recommended:

1 Bharat Bhushan, Introduction to Tribology, Johan Wieley& Sons, New York, 2nd edition, 2013

2 Basu S. K., Sengupta S. N. , Ahuja B. B., " Fundamental of Tribology", PHI Learning Pvt, Ltd, New Delhi, 2009

3 G. Stachowiak and A. Batchelor. Engineering Tribology, Elsevier Science, 4th edition, 2014.

4 R. Gohar and H. Rahnejat. Fundamentals of Tribology, World Scientific Publishing Company, 3rd Edition, 2018.

5. Harish Harani, Fundamentals of Engineering Tribology, Cambridge, 1st edition, 2017

MEME114	:	POWER PLANT ENGINEERING	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Describe the mechanism of various types of steam boilers and steam turbines.
CO2	Carry out design and analysis of boiler accessories, condenser, feed water heater, cooling tower.
CO3	Assess combustion mechanism, combustion equipment, heat balance sheet of boiler plant.
CO4	Describe the mechanism of non-conventional power generation and direct energy conversion.
CO5	Analyze the Gas turbine power plant to improve overall performance.
CO6	Evaluate power plant economy and evaluate steam power plant to improve performance.

1. Syllabus

Introduction to Power Plants (03 hours)

Introduction to sources of energy for power generation. Site selection criteria for power plants, Principal types of power plants, Present status of power generation in India, General layouts of various types of power plants

Steam Generators and Accessories (10 hours)

Classification of boilers, Description of boilers – Radiant type natural circulation boiler, High pressure forced circulation boilers, heat absorption in boilers, Circulations of down comers and riser, steam drum and its internals, supercritical steam generators, Fluidized bed combustion boilers – Bubbling and circulatory, Economizers, Air preheaters, Superheaters, De-superheaters, firing methods, Reheaters, fabric filters and bag house collector, electrostatic precipitators, feed water heaters, deaerator, ash handling system, Waste Heat Recovery Steam Generators (WHRSG), Numerical based on above theories

Thermal Power Plants (08 hours)

Fuels and combustion, Review of power cycles, coal fired power plant site selection, boiler, turbine, condensing plant and circulating water system, water treatment, fuel handling and fuel firing, ash handling and dust collection, Principles of co-generation, technical options for cogeneration.

Environmental Aspects of Power Station (05 hours)

Different pollutants due to thermal power plant and their effects on human health. Environment control of various pollutants such as particulate matter, oxides of Sulphur, oxides of nitrogen etc. Effluents from power plants, social and economic issues of power plants

Gas Turbine Power Plant (05 hours)

General features and characteristics and their application power plants, Analysis of different cycles, components of gas turbine power plants, governing system of gas turbine plant, advantages of G. T. plant, Gas and steam turbines, combined cycles – Thermodynamic analysis for optimum design, Numerical based on above theories

Solar and Wind based Power Generation (05 hours)

Energy available from the Sun and wind. General layout of solar thermal and solar photovoltaic power plants, Plant sizing for solar and wind, site selection criteria for wind and solar power plants, State and central Government policies for solar and wind power generation.

Economics of Power Generation (06 hours)

Introduction, Load-Duration curves, Load factor, Capacity factor, Reserve factor, demand factor, Diversity factor, plant use factor, base load plant, peak load plant, power plant economics – electricity cost, fixed costs and depreciation, Present-Worth Concept, Incremental Heat Rate, Effect of Load Factor on Cost per kWh, Numerical based on above theories

Total Lecture Hours (42 hrs)

2. Books Recommended:

1. P.K Nag, Power plant engineering, , McGraw Hill Education, New Delhi, 2014.
2. M.M.Ei-Wakil, Power plant Technology, McGraw Hill Education, New Delhi, 1st edition, 2017.
3. R.K. Hegde, Power plant engineering, Pearson India Education, New Delhi, 2015.
4. Arora & Domkundwar, Power plant engineering, Dhanpat Rai& Sons, New Delhi, 8th edition 2016.
5. P C Sharma', Power Plant Engineering, S.K. Kataria & Sons, New Delhi, 3rd edition, 2010.

MEME120	:	OPTIMIZATION TECHNIQUES	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

1. understand the concept of optimization, related terms and formulate mathematical models for practical problems based on the information provided.
2. use linear programming to solve real life linear programming problems
3. solve transportation and transhipment problems, travelling salesman problem and integer programming
4. determine solutions that will be deployed in real world situations after conducting sensitivity and post optimality analysis
5. apply classical methods to solve nonlinear programming problems
6. use evolutionary algorithms to solve complex engineering problems where classical methods are not suitable.

1. Syllabus

Introduction **[04 hours]**

Introduction to Optimization, Linear Programming – Formulation, Graphical method, simplex method and special cases.

Sensitivity and post optimality analysis **[08 hours]**

Sensitivity Analysis and post optimality analysis of linear programming problems – changes in resources and objective function, changes affect feasibility and optimality, duality, dual simplex algorithm, generalize simplex algorithm.

Special types of linear programming problems **[06 hours]**

Transportation problems, Transshipment problems, Travelling salesman problems, Integer programming.

Introduction to MATLAB and solving linear and nonlinear problems using MATLAB **[06 hours]**

Introduction to MALAB, creating and manipulating vectors and matrix, user defined function, special built-in function to create special vectors and matrices, symbolic math, built-in function to solve linear programming problems.

Nonlinear programming problems **[04 Hours]**

Graphical method, convex function and convex region, necessary and sufficient conditions, Lagrangian method, Karush-Kuhn-Tucker (KKT) conditions, solving nonlinear problems using MATLAB.

Evolutionary Algorithms **[14 hours]**

Introduction to evolutionary algorithm, introduction to multi-objective optimization, genetic algorithms, differential evolution algorithm, Particle swarm optimization, tabu search, simulated Annealing technique, solving real life engineering problems using MATLAB.

Total Teaching Hours–42 hours

2. Books Recommended

1. Hillier, F.S. and Lieberman, G.J. Introduction to operations research: Concepts and *Cases*, Tata McGraw-Hill Education 8th edition, 2008.

2. Taha, H.A. Operations research: an introduction. Pearson Education India, 10th edition, 2016.

3. Rao, S.S. Engineering optimization: theory and practice. John Wiley & Sons, 3rdedition, 2018.

4. Xin- She Yang, Nature-Inspired Optimization Algorithms. Elsevier,1st edition 2014.

5. Goldberg, D.E. Genetic algorithms: in search, optimization and machine learning. Pearson Education India, 1st edition 2008.

MEME121	:	INDUSTRIAL ROBOTICS	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO 1	Explain the basics of robotic systems.
CO 2	Apply the concept of robot arm kinematics.
CO 3	Analyze statics and dynamics of robots.
CO 4	Analyze manipulator trajectories and robot end effectors.
CO 5	Analyze control of robot manipulators.
CO 6	Illustrate robot programming, sensing and vision.

1. Syllabus

Introduction **(04 Hours)**

Introduction to robots, robot manipulators, robot anatomy, coordinate systems, work envelope, types and classification, specifications, actuators and drives

Mathematical Representation of Robots **(05 hours)**

Rotations and translation of vectors, transformations and Euler angle representations, homogenous transformations, representation of position and orientation of a rigid body, homogeneous transformations, Denavit-Hartenberg (D-H) notations and parameters, representation of joints, link representation using D-H parameters

Forward and Inverse Kinematics **(05 Hours)**

Introduction, forward and inverse kinematics problems.

Velocity and Statics Analysis **(05 Hours)**

Linear and angular velocity of links, velocity propagation, Jacobians for robotic manipulators, statics and force transformation of robotic manipulators, singularity analysis

Robot Dynamic Analysis **(05 Hours)**

Introduction, forward and inverse dynamics, mass and inertia of links, Lagrangian formulation for equations of motion for robotic manipulators, Newton-Euler formulation method.

Trajectory Planning and Control **(11 Hours)**

Joint and Cartesian space trajectory planning and generation, classical control concepts using the example of control of a single link, Independent joint PID control, control of a multi-link manipulator, nonlinear model based control schemes.

Force Control of Manipulators **(02 Hours)**

Hybrid position/force control.

Robot Programming, Sensing and Vision **(05 hours)**

Robot Programming, Introduction to sensing and vision in robotics.

Total lecture hours (42 hrs)

2. Books Recommended:

1. A. Ghosal.Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.
2. J. J. Craig. Introduction to Robotics: Mechanics and Control, 4th edition, Pearson, 2018.
3. R. J. Schilling. Fundamentals of Robotics Analysis and Control, Pearson Education India, 2015.
4. K. S. Fu, R. C. Gonzalez, C. S. G. Lee. Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill 1987.
5. S. K. Saha. Introduction to Robotics, McGraw Hill Education India, 2014.

MEME122	:	CONCURRENT ENGINEERING	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Support the multi-disciplinary integrated product development teams and Plan and implement a new product development program.
CO2	Apply appropriate concurrent engineering tools and techniques to design and develop environment-friendly products by leveraging both manufacturing cost and lifecycle cost.
CO3	Determine the customer needs and ensure that the product design is robust and meets the professional standards with better quality.
CO4	Design and develop the products with high reliability, maintainability, and availability.
CO5	Apply the information technology tools for collaborative product design and development.
CO6	Demonstrate the applications of concurrent design of structures, products and components.

1. Syllabus

Introduction **(06 hours)**

Motivation, definition, and philosophy of Concurrent Engineering (CE); sequential and concurrent processes; Principles of CE; Organizing for CE; CE teams and team dynamics; Role of CAD/CAM/CAE/CIM and automation in CE; Managing product development projects; Decomposition of product development stages; Benefits of CE; Implementation issues of CE.

Concurrent Engineering Tools and Techniques **(24 hours)**

Design for manufacturing (DFM), Design for assembly (DFA); Factors influencing form design; Casting and machining considerations; Design for manufacturing and Assembly (DFMA) guidelines and examples; Lifecycle design of products with circular economy concept; Design for environment (DFE) with examples; Design for (-to-)cost; Design for X (DFX); Value engineering. Design for quality; Taguchi's methods for designing robust products; Design of Experiments (DOE) with examples; Design optimization; Quality function deployment (QFD) with examples. Design for reliability, maintainability and availability with examples; Failure modes and effects analysis (FMEA); Fault tree analysis (FTA); Rapid prototyping methods; Design simulation; Virtual and augmented reality environments for CE.

Role of Information Technology in Concurrent Engineering (06 hours)

Information technology (IT) components and functions; Artificial Intelligence for IT operations used for product design; Collaborative product development; Collaborative product commerce, Cloud IoT for CE.

Selected Applications of Concurrent Engineering (06 hours)

Design of aerospace and naval structures made of composite materials; Design of automotive components; Design of medical devices; Design of electronic products; Design of white goods parts.

Total lecture hours (42 hrs)

2. Books Recommended:

1. B. Prasad. Concurrent Engineering Fundamentals I & II, Prentice Hall, New Jersey, 1996.
2. I. Moustapha. Concurrent Engineering in Product Design and Development, New Age International, New Delhi, 2006
3. G. Boothroyd, P. Dewhurst, and W. Knight. Product Design for Manufacture and Assembly, 3rd Edition, Routledge, Boca Raton, 2010.
4. J. R. Hartley. Concurrent Engineering: Shortening Lead Times, Raising Quality, and Lowering Costs, 4th Edition, Routledge, Boca Raton, 2017.
5. K. T. Ulrich, S. D. Eppinger, and M. C. Yang. Product Design and Development, 7th Edition, McGraw Hill Education (India), Noida, 2020.

MEME123	:	COMPUTATIONAL FLUID DYNAMICS	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	develop an understanding for major theories, approaches and methodologies used in CFD
CO2	to build up skills in the actual implementation of CFD methods (e.g. boundary conditions, different numerical schemes etc.)
CO3	acquire working knowledge of computational complexity, accuracy, stability, and errors in solution procedures
CO4	To develop numerical models for fluid flow and heat transfer problems
CO5	get an overview of advanced numerical techniques such as LBM, Meshless techniques.
CO6	to gain experience in the application of CFD analysis to real life engineering designs.

1. Syllabus

Introduction to Computational Fluid Dynamics and Principle of Conservation **(05 Hours)**

Introduction of Computational Fluid Dynamics: What, When, and Why?, CFD Applications, Numerical vs Analytical vs Experimental, Conservation of mass, Newton's second law of motion, Expanded forms of Navier-Stokes equations, Conservation of energy principle, Special forms of the Navier-Stokes equations, Classification of second order partial differential equations, Initial and boundary conditions, Governing equations in generalized coordinates.

Fundamentals of Discretization **(08 Hours)**

Discretization principles: Pre-processing, Solution, Post processing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Higher order schemes to

FDM, Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term.

Finite Volume Method (06 Hours)

Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems: Physical consistency, Overall balance, FV Discretization of a 1-D steady state diffusion type problem, Composite material with position dependent thermal conductivity, Four basic rules for FV Discretization of 1-D steady state diffusion type problem, Source term linearization, Implementation of boundary conditions

Discretization of Unsteady State Problems (04 Hours)

1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme, FVM for 2-D unsteady state diffusion problems

Discretization of Convection-Diffusion Equations (06 Hours)

A Finite Volume Approach: Finite volume discretization of convection-diffusion problem: Central difference scheme, Upwind scheme, Exponential scheme and Hybrid scheme, Power law scheme, Generalized convection-diffusion formulation, Finite volume discretization of two-dimensional convection-diffusion problem, The concept of false diffusion, QUICK scheme

Discretization of Navier Stokes Equations (06 Hours)

Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm

Special Topics (07 Hours)

Unstructured Grid Formulation, An overview of Finite Element Method, boundary element method, Lattice Boltzmann Method, Meshless Technique

Total Lectures 42 Hours

2. Books Recommended:

1. S.V.Patankar, Numerical Heat Transfer and Fluid Flow, CRC Press, Indian Edition, 2017.
2. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2^{nd} edition, 2010.
3. H.K.Versteeg& W. Malalasekera, An Introduction to Computational Fluid Dynamics, Pearson; 2^{nd} edition, 2008.
4. J. H. Ferziger and M.Peric, Computational Methods for Fluid Dynamics, Springer, 4^{th} edition 2020.
5. John C. Tannehill, Dale A.Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor &Francis, CRC Press; 3^{rd} edition, 2012.

MEME124	:	DESIGN OF REFRIGERATION AND AIR CONDITIONING SYSTEMS	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1 Describe the properties of refrigerants and evaluate performance of the actual vapour compression refrigeration systems.

CO2 Evaluate the performance of compound vapour compression refrigeration systems for various applications.

CO3 Describe vapour absorption system for large cooling load application and evaluate its performance.

CO4 Explain working principles of non-conventional refrigeration systems and evaluate the performance of steam jet refrigeration system.

CO5 Compute cooling/heating loads for designing air conditioning systems for residential and commercial building.

CO6 Design the air duct systems for large commercial buildings.

1. Syllabus

VAPOUR COMPRESSION REFRIGERATION SYSTEM (15 Hours)

Alternate Refrigerants – properties, applications, selection, mixed refrigerants, retrofit study, standard rating cycle for domestic refrigerator, refrigeration system components: compressors, condensers, expansion devices, evaporators, Multi stage compression with water intercooler, liquid sub cooler, flash chamber, flash intercoolers and multiple expansion valves, multi evaporator systems, cascade refrigeration system, Design aspects of refrigeration system components, solid CO2 – dry ice cycle.

VAPOUR ABSORPTION SYSTEMS (06 Hours)

Temperature concentration and enthalpy concentration diagrams, enthalpy balance for various components of aqua ammonia systems, Vapour absorption system- Electrolux refrigerator.

NON - CONVENTIONAL REFRIGERATION SYSTEMS (06 Hours)

Steam jet refrigeration system, Performance analysis of steam jet refrigeration system, thermos electric refrigeration system, vortex tube Refrigeration, pulse tube refrigeration, adiabatic demagnetization, vapour adsorption refrigeration system

AIR CONDITIONING (15 Hours)

Review of air conditioning processes, summer and winter load calculations, cooling/heating load calculations, cooling coils, bypass factor, effective sensible heat factor, design consideration for cooling coils, high latent heat load, design of evaporative cooling system, de-humidifiers and air washers, Comfort air conditioning, thermodynamics of human body, comfort charts, effective temperature, central air conditioning system, Air handling unit, room air distributions, fluid flow and pressure losses, air filters, duct design Equal pressure drop method, velocity reduction method, static regain method, refrigeration and air conditioning controls

Total Lectures 42 Hours

2. Books Recommended:

1. Stocker, W. F. and Jones, J. W., "Refrigeration and Air Conditioning", McGraw Hill, N. Y. 2nd edition, 2014.
2. Dossat, R. J., "Principles of Refrigeration", John Wiley and Sons, 5th edition, 2001.
3. C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill,3rd edition, 2017.
4. S. C. Arora and S. Domkundwar, A course in Refrigeration and Air-conditioning, Dhanpat Rai & Sons, 7thedition, 2003.
5. ASHRAE Fundamentals, Applications, Systems and Equipment, Handbook, 2005.

MEME125	:	OPERATIONS PLANNING AND CONTROL	L	T	P	Credits
			3	0	0	03

Operations Planning and Control

Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	:	Apply the different concepts of operations, productivity and forecasting.
CO2	:	Understand and apply the tool related to the design of operations like capacity planning, constraint management, layout and location strategies.
CO3	:	Analyse the operations using the concept of supply chain, Inventory management and Aggregate planning.
CO4	:	Evaluate the operations using the concept of Material requirement planning and short term planning.
CO5	:	Formulate, analyze, design and synthesize open-ended operation planning and control problem using the various operation planning and control techniques.

Content	Hours
Operationsplanning&Control: OperationsandProductivity,OperationsStrategyin a Global Environment	**03**
Forecasting: Elements and steps in forecasting, Types of forecasting, Demand forecasting using qualitative and quantitative methods, Errors in forecasting	**04**
Capacity Planning and Constraint Management: Process Strategies, Definitionandmeasurementofcapacity,Adjustingcapacity,Quantitativemethodsfor capacity planning decision.	**04**
LayoutandLocationStrategy:Typesoflayout.Designoflayout,Factorsaffectingloc ationdecision.Mathematicalmodelforfacilitylocationandlayout.	**04**
SupplyChain: TheSupplyChain’sStrategicImportanceSourcingStrategies, Supply Chain Risk Managing the Integrated Supply Chain Building the Supply Base, Supplier Evaluation, Supplier Development	**04**
Inventory Control and Management: Introduction, EOQ Models with and without shortage, Multi item Deterministic Model, Dynamic and Fluctuating Models, Deterministic Model withpricebreaksandProbabilisticinventorymodels.SelectiveInventorycontrol.	**06**
Aggregate Planning: Purpose, inputs of aggregate plan, Aggregate planning Processes and strategies, Methods for aggregate planning, Aggregate planning in	**05**

services.

Material Requirement Planning and ERP: Just in Time, MRP input andoutput,MRPstructure,MRPmanagement,LotsizingTechniqueandExtension of MRP, JIT and MRP in services, JIT to Die exchange, ERP: Introduction, Implementation, Advantages	**07**
Short Term Scheduling: Introduction to Scheduling and Shop floor planning and control; order sequencing rules and their performance based on different evaluation criteria; changeover costs and job sequence, Mathematical models of job sequencing.	**05**

Total lectures 42 hours

Books Recommended

1. Jay Heizer, Barry Render and Chuck Munson, Amit Sachan, Operations Management, Pearson Education, 2017.
2. Everett E. Adam, Ronald J. Ebert, Production and Operations Management, 5th edition, Prentice Hall of India, New Delhi, 2012.
3. E. S. Buffa and R. K. Sarin, Modern Production / Operations Management, John Wiley & Sons, 1994.
4. Samuel Eilon, Elements of Production Planning and Control. New York: Macmillan; London: Collier-Macmillan, 1962
5. Lee J. Knajei& L. P. Ritzman, Operations Management, Pearson Education, Delhi, 2002.

MEME104	:	SOFTWARE PRACTICE -I	L	T	P	Credits
			0	0	4	02

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	understand data analysis, programming machine learning software's.
CO2	develop numerical solutions for linear and non-linear algebraic equations using computer programs
CO3	derive numerical solutions of initial value problems and boundary value problems.
CO4	solve ordinary differential equations (ODEs), and partial differential equations (PDEs) on a computer
CO5	develop code to solve one-dimensional optimization problems using the Golden Section Search method
CO6	show plotting of the graphs, writing equations and performing data analysis in Microsoft excel.

1. Syllabus

Software: (20 hours)

1. Introduction to Origin software
2. Introduction to Minitab software
3. Introduction to Mathematica
4. Introduction to Mapple
5. Introduction to MATLAB
6. Introduction to functions of Microsoft Excel

Coding (36 hours)

1. Introduction to compiler, scripts, loops, logical statements
2. Finding of roots using Bisection method
3. Finding of roots using Newton-Rapson method
4. Solving ODE using Rung-Kutta method of 2nd order: Heun's method, Mid-point method, and Ralston's method
5. Solving ODE using Rung-Kutta method of 3rd order, and 4th order
6. Development of steady-state solver: (a) TDMA/ Line-by-line TDMA (b) Point-Jacobi (c) Gauss-Seidel Method (d) Gauss-Seidel over-relaxation Method
7. Development of transient solver: (a) Euler or Explicit scheme (b) Pure implicit scheme (c) Crank-Nicolson scheme (d) ADI
8. FDM code to solve PDE: elliptic equation
9. FDM code to solve PDE: parabolic equation
10. FDM code to solve PDE: hyperbolic equation

Total lectures 56 hours

MEME105	:	LABORATORY PRACTICE	L	T	P	Credits
			0	0	4	02

Course Outcomes (COs):

At the end of the course the students will be able to:

CO 1	Understand and demonstrate operation of identified machine/instrument/equipment
CO 2	Perform given practical task independently on machine/instrument
CO 3	Analyse and evaluate the observations and deduce conclusions therein
CO 4	Represent results graphically and deduce conclusions therein
CO 5	Demonstrate practical skills to work on identified problem
CO 6	Develop skills for team effort and coordination through group practical performance

Practicals:

Students will perform any 08 practicals in various laboratories. The indicative list (but not limited to) of practicals is as under:

1. Evaluation of effect of process parameters on micro structure and strength of a part fabricated by given casting process
2. To perform various erosion tests on given part
3. To perform various wear tests on given part
4. To perform various NDT inspection for surface and sub-surface defects on given part
5. Demonstration of various composite manufacturing processes
6. Measurement of various features using microscope/ vision measuring instrument
7. Measurement of surface roughness of a given specimen
8. Integrating CAD /CAM/3D printing – CAE for given Product
9. Characterization and feature measurement on micro structure of given part with microscope
10. To conduct performance test on I C Engines
11. To study the different systems of automobile
12. Practicals pertaining to Welding Laboratory

SEMESTER II

MEME201	:	COMPUTER INTEGRATED MANUFACUTRING	L	T	P	Credits
			3	0	2	04

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Describe the different type of Automation and CIM.
CO2	Develop the CNC Program for the given geometry for Drilling, Milling and Turning machines.
CO3	Develop the part program using APT.
CO4	Analyze the production flow based on part classification, identification and coding.
CO5	Evaluate the different types of flexibilities in manufacturing.
CO6	Explain and evaluate types and steps of computer aided process planning

1. Syllabus

Introduction to CIM **(04 Hours)**

Introduction to automation, Types of automation, Automation principles and strategies, Definition of CIM, CIM wheel, Evolution of CIM, Benefits of CIM, CIM hardware and software, Nature and role of the elements of CIM system, Development of CIM

Computer Aided Manufacturing **(18 Hours)**

Components of NC/CNC system, Specification of CNC system, Classification of CNC machines, Constructional details of CNC machines, Axis designation, CNC control loops. Basic programming terms, Programming formats, Preparatory command, Miscellaneous functions, Machine zero, work zero and tool zero, Work offsets, Tool length offset and setup methods, Cutter radius offset, Machine zero return, Part programming for milling - linear and circular interpolation, subprogram, fixed/canned cycles, mirrors commands, machining large hole pattern, polar coordinates, round and rectangular pocket machining and cycles, subroutines, mirror, Part programming for lathe - lathe cycles, with and without tool nose radius feature, repetitive fixed cycle

Part Programming with Automatically Programmed Tools (APT) **(04 Hours)**

Computer aided part programming, APT: Geometry, motions and auxiliary commands, drill cycle commands, programming for geometry and drill cycle and hole pattern

Group Technology **(08 Hours)**

Definition, implementation considerations, benefits and applications, G.T. methods - visual search method, production flow analysis, Parts classification and coding, Design and manufacturing attributes, Concept of composite component, Rank order clustering, machine cell formation, Cell group tooling, Design rationalization, possibilities of integration with CAD/CAM

Flexible Manufacturing System **(06 Hours)**

Introduction, General Considerations for FMS, types of FMS, Flexibilities, their measurements, Computer control in FMS, Automated material handling systems, AGVs, Automatic storage and retrieval systems, Manufacturing cells, cellular v/s flexible manufacturing

Computer Aided Process Planning **(02 Hours)**

Introduction to CAPP, Route card, Manual and computer aided process planning, steps, and types

Total lectures 42 hours

2. Books Recommended:

1. Krar, S.F. and Gill, A., CNC: Technology and Programming, McGraw-Hill, 1989
2. Groover, M.P., Automation, production systems, and computer-integrated manufacturing. Pearson Education India, 5th Edition, 2019
3. P. Radhakrishnan, S. Subramanyan, and V. Raju, CAD/CAM/CIM, New age International publishers, 3rd edition, 2011
4. P. N. Rao, CAD/CAM Principles and Applications, Tata McGraw Hill, 2nd Edition, 2006.
5. S. Kant Vajpayee, Principles of Computer Integrated Manufacturing, PHI, New Delhi, 1st edition, 1998

3. List of Practicals

1. Demonstration of **CNC Milling** machine with user interface and calculating the Co-ordinates of given geometry in absolute and increment mode for cutter path.
2. Introduction of **G codes** and **M codes** and write the **CNC** part programming for a given geometry using Linear, Circular interpolation. (Using FANUC Controller)

3. Write the **CNC** part programming for a given geometry using **Mirror** and **Subroutine.** (Using FANUC Controller)
4. Write the **CNC** programming for a given geometry using Polar Co -ordinate for **drilling cycles**.
5. Write the **CNC** part programming for a given geometry using Tool Radius Compensation and Repeat loop for **Peck Drilling Cycle.** (Using FANUC Controller)
6. Introduction and programming of all **canned cycle** of Milling machine. (Using FANUC controller)
7. Demonstration and study of **CNC Lathe** machine with sample programming.
8. Write CNC programming for given geometry (Lathe) using **stock removal cycles** (Using FANUC controller)
9. Demonstration of FMS setup. (**AS / RS, AGV, CNC Lathe, CNC Milling, Robot & CMM setup)**
10. Demonstration of Advance manufacturing Machines like AJM **(Abrasive Jet Machine), EDM** (Electro Discharge Machine)**, µ Machine** (Micro Machine)**, VMS** (Vision Measuring System).

MEME202	:	MECHANICAL DESIGN ANALYSIS	L	T	P	Credits
			3	1	0	04

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1 **Utilize** the concept of theories of failure to machine components.
CO2 **Evaluate** the fatigue and creep behavior in machine parts and design against fracture.
CO3 **Analyze** impact, thermal properties and stresses in various machine elements like shafts and springs.
CO4 **Design** of various gear drives and gear boxes.
CO5 **Design** the various types of brakes, clutches and flywheel.
CO6 **Design** the fluid-film bearings, anti-friction bearings and I. C. engine components.

1. Syllabus

Introduction: **(03 Hours)**

Design process, factor of safety and reliability in design, review of failure theories, loading conditions and stress concentration, surface stresses and their failures, lubricant films and their effects, Hertzian contact stresses and their effect on load capacities of machine members, effect of inelastic strains and residual stresses on load capacity of machine components, tolerances, limits and fits in design.

Design for Fatigue Strength:

Stress variation, design for fluctuating stresses, influence of low and high cycle fatigue, design for a limited number of cycles, cumulative damage, acoustical and thermal fatigue, fatigue strength of mechanical joints, shaft design.

Design for Creep and Fracture: **(10 hours)**

Creep and creep rupture, creep data for long-life design, stress relaxation in bolts, creep analysis of thin cylinders, thick walled cylinders and rotating discs, designing against fracture, stress intensity factors, linear elastic fracture mechanics approach, theories of brittle fracture, fundamental aspects of crack growth and fractures, crack analysis for different laminas.

Thermal Properties and Stresses: **(5 hours)**

Effect of temperature on short term and long term properties, elementary thermal stresses in machine elements, stress relaxation in bolts at elevated temperatures, detrimental residual stresses, bolt tightening.

Impact: **(5 hours)**

Energy methods-general and particular cases, longitudinal stress waves in elastic media, impact on bars, torsional impact on shafts and longitudinal impacts on helical springs, striking of two bars.

Design of Brakes and Clutches: **(09 hours)**

Work, torque, and motion in brake and clutch systems, short contacts on the cylindrical surfaces of drums, long shoes on cylindrical surfaces, design of band and block brake, shoe brake, external and internal expanding brakes, drum and disc brakes, types of mechanical clutches, design of single and multiple disc clutches, cone and centrifugal clutch, selection of friction materials for brakes and clutches, temperature rise, railway brakes.

Design of Bearings and Power Transmission Elements:

Selection of hydrodynamic and hydrostatic bearings, selection of anti-friction bearings, classification of gears, design of spur, helical, bevel and worm gear drives, speed reducers and gear boxes.

Design of Internal Combustion Engine Components and Flywheel: **(10 hours)**

Cylinder and cylinder liners, piston, connecting rod, crank-shaft and valve-gear mechanism, construction and torque analysis of solid and rimmed flywheel, stresses in flywheel, design of engine flywheel.

Total lectures 42 hours

Books Recommended:

1. A. H. Burr and J. B. Cheatham, Mechanical Analysis and Design, Prentice-Hall, 1995.
2. R. G. Budynas and J. K. Nisbett, Shigley's Mechanical Engineering Design, McGraw Hill Publications, 2016.
3. J. A. Collins, H. Busby and G. Stabb, Mechanical Design of Machine Elements and Machines: A Failure Prevention Perspective, Wiley India, 2010.
4. R. C. Juvinall and K. M. Marshek, Fundamentals of Machine Component Design, Wiley India, 2020
5. R. L. Norton, Machine Design: An Integrated Approach, Pearson Education, 2020.

MEME230	:	RENEWABLE ENERGY SYSTEMS	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	design solar systems for a given energy utility by applying principles of solar energy conversion
CO2	design bio-energy based systems for a given utility by applying principles of bio-mass to bio-energy conversion
CO3	assess theoretical and practical performance of wind turbines including optimal tip speed ratio requirement
CO4	characterize different types of waste and compare various conversion technologies suitable for industrial applications in line with government approved RDF and MSW policies.
CO5	compare hydrogen production methods and use of hydrogen resource with other energy resources in present context
CO6	compare different types of fuel cells and understand its working

1. Syllabus

Solar radiation **(12 Hours)**

Extra-terrestrial and terrestrial, Solar radiation measuring instruments, Estimation of Solar Radiation, Various earth-sun angles.Solar Energy Conversion Systems: Solar Thermal Systems: Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, selective coating, advanced collectors, Concentrators: optical design of concentrators, solar water heater, solar dryers, solar stills, Solar ponds, solar cooling and refrigeration, Solar thermal power generation. Solar Photovoltaic Systems: Principle of photovoltaic conversion of solar energy, Solar cells, Home lighting systems, Solar lanterns, Solar PV pumps, Govt. policies. Introduction to Solar Photovoltaic Thermal Systems (PV/T): Air based, Water based, Refrigerant based Systems. Solar energy storage options: Electrical and Thermal Energy storage options for Solar Energy.

Biomass & Bioenergy **(12 Hours)**

Biogas System: Anaerobic digestion, biogas production, Types of digesters, installation, operation and maintenance of biogas plants, Biogas plant manure utilisation and manure values, factors affecting biogas production, Biogas utilisation and storage, Compressed Biogas (CBG) production from agro waste; biogas for motive power generation, design calculations for biogas plants, Govt. policies. Liquid Biofuels: Biodiesel – The mechanism of transesterification, fuel characteristics of biodiesel, technical aspects of biodiesel/Ethanol and other liquid fuels utilization in engine. Biomass gasification: Different types of gasifier, power generation and applications

Wind Energy Conversion Systems **(08 Hours)**

History of wind energy, Current status and future prospects, Wind energy in India. Power available in the wind, Components of Wind Energy Conversion Systems, Horizontal and Vertical axis wind turbine, Wind turbine power and torque characteristics, Tip speed ratio, Optimal tip speed ratio, Wind speed prediction and forecasting, Betz limit, Govt. Policies.

Waste to Energy Conversion **(06 Hours)**

Introducing Municipal Solid Waste Management; Waste Generation and characterization, Waste Processing Techniques; Source Reduction, Biological Conversion Products: Compost and Biogas, Incineration pyrolysis and Energy Recovery, waste plastic, RDF/Sewage utilization, Govt. Policies on MSW and RDF, Introduction to Microbial Fuel Cell.

Hydrogen Energy and Fuel Cells **(04 Hours)**

Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Electrolysis, Bio-hydrogen Production, Biogas reformation to Syngas, Basic principle of working of fuel cell.

Total Lectures 42 Hours

2. Books Recommended:

1. J. A. Duffie and W.A. Beckman, Solar Engineering and Thermal Processes, John Wiley and Sons., 2013.
2. H. S. Mukunda, Understanding Clean Energy and fuels from biomass. Wiley India Pvt. Ltd, 2011
3. K. M. Mital, Biogas Systems, Principle and Applications. New Age International Ltd, 1996
4. G. D. Rai, Non-Conventional Energy Sources, Khanna Publication, 1988
5. Prabir Basu, Biomass Gasification And Pyrolysis: Practical Design And Theory, Academic Press, 1st Edition, 2010

MEME231	:	DESIGN OF PRESSURE VESSELS AND PIPING	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1 Illustrate the different types of stresses and their effects in pressure vessel.
CO2 Design various supports of the pressure vessel.
CO3 Design shells, heads and nozzles for pressure vessel.
CO4 Design pressure vessel as per ASME & IS codes.
CO5 Draft and design piping system using codes and regulations and standards
CO6 Analyze forces acting in a piping system during operation

1. Syllabus

Introduction: **(08 hours)**

Overview of various parts of pressure vessels, classification of pressure vessels, applications, factors influencing the design of vessels - material selection, loads & types of failures.

Stresses in pressure vessels: **(08 hours)**

Stresses in circular ring, cylinder & sphere, membrane stresses in vessels under internal pressure, thick cylinders, multi layered cylinders, auto-frottage of thick cylinders and their significance, discontinuity and buckling stresses

Design of pressure vessels as per ASME and IS code: **(12 hours)**

Introduction and importance of codes,Externally and internally pressurized vessels, tall vertical vessels, Supports for vertical & horizontal vessels, nozzles and flanges. shells and heads. Introduction to Indian Boiler Regulations

Pressure vessels with different conditions: **(09 hours)**

Evaluation of pressure vessels for different conditions: hydro-test condition, thermal stresses, FEM analysis, Fatigue of pressure vessels

Piping Engineering: (**09 hours)**

Use of codes, regulations and standards for safety and practical engineering of piping systems in process plants.

Piping terminology and use of codes, regulations and standards used in drafting and design of piping systems. Relevant standards in piping systems. Forces acting on a pipe system in operating conditions.

Standards for Operation and maintenance in piping systems. Commonly used metallic piping materials and their serviceability, Installation challenges and safety issues related to pipe spools

Total Lectures hours 42

2. Books Recommended

1 J. F. Harvey.Theory and Design of Pressure Vessels, Springer US, 2007.
2 S. Chattopadhyay. Pressure Vessels: Design and Practice, CRC Press, 2004.
3 ASME Code Section 8^{th} Div 1, Div2 , ASME, 2021.
4 A. S. Tooth. Pressure Vessel Design: Concepts and Principles, 1^{st} Edition, CRC Press, 2012.
5 D. R. Moss, M. M. Basic. Pressure Vessel Design Manual, 4^{th} Edition, Elsevier Science, 2012.

MEME232	:	THEORY AND DESIGN OF CRYOGENIC SYSTEMS	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Select suitable cryogen and material for development of cryogenic system for different applications.
CO2	Carry out design and analysis of gas liquefaction system and cryogenic refrigeration systems including cryocoolers.
CO3	Select proper cryogenic insulating material and designing of cryogenic insulation.
CO4	Analyze gas purification and separation system using cryogenics.
CO5	Select and design storage, handling, and transfer systems for cryogens.
CO6	Design vacuum system for cryogenic application.

1. Syllabus

INTRODUCTION AND APPLICATIONS **(02 Hours)**

CRYOGENICS FLUIDS **(02 Hours)**

Properties of air, Oxygen, Nitrogen, Hydrogen, Helium and its isotopes

PROPERTIES AND SELECTION OF MATERIALS **(03 Hours)**

Study of material properties & their selection for cryogenic application.

GAS LIQUEFACTION and REFRIGERATION SYSTEMS **(10 Hours)**

Basics of Refrigeration, Ideal system, Linde Hampson system, Precooled Linde Hampson system, Linde dual pressure system, Claude system, Heylandt system, Kapitza system, Collins cycle

CRYOGENIC INSULATION **(07 Hours)**

Vacuum insulation, Multilayer insulation (MLI), Methods of measuring effective thermal conductivity of MLI, Liquid & vapour shield, Evacuated porous insulation, Gas filled powders and fibrous materials, Solid foams, Vacuum technology

CRYOCOOLERS **(06 Hours)**

Ideal Stirling cycle, Design parameters (Schmidt's Analysis), GM cryocoolers, Pulse Tube cryocooler, Phasor Analysis

CRYOGENIC INSTRUMENTATION **(04 Hours)**

Peculiarities of cryogenic strain measurement, Pressure, Flow, Density, Temperature and liquid level measurement for cryogenic application

STORAGE & HANDLING SYSTEMS **(03 Hours)**
Dewar vessel design, Piping, Support systems, Vessel safety devices and storage systems, Industrial storage systems

TRANSFER SYSTEMS **(03 Hours)**
Transfer from storage, Uninsulated transfer lines, Insulated lines, Transfer system components.

GAS SEPARATION **(02 Hours)**
Principles of gas separation, Ideal system

Total Lectures 42 Hours

2. Books Recommended:

1. Hastlden, C., Cryogenic Fundamentals, Academic Press, 2001.
2. Barron R., Cryogenic Systems, Plenum Press, 2001.
3. Walker G., Cryocoolers, Springer, 2014.
4. Mikulin, Y., Theory and Design of Cryogenic systems, MIR Publication, 2002.
5. Barron, R. F., Cryogenics Systems, Oxford Press., USA, 2002

MEME233	:	QUALITY ENGINEERING AND MANAGEMENT	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

CO1	Explain different concepts of quality, system reliability & maintenance and its application to the design and manufacturing activities
CO2	Understand and Apply statistical concepts and techniques for designing of products and process controls
CO3	Describe and apply reliability analysis concepts to selected applications
CO4	Describe and Apply the two level factor factorial design, general factorial design and surface response method for experimental design.
CO5	Formulate, analyze, design and synthesize open-ended quality engineering problems using the various statistical process control tools and quality management tool
CO6	Select and apply newer concepts and initiatives for quality improvement

1. Syllabus

Introduction **(02 Hours)**

Introduction to quality control and the quality system, some philosophies and their impact on quality, Cost of quality, Quality audit.

Statistical Quality Control **(14 Hours)**

Statistical Concepts and Data analysis: Fundamentals of statistical concepts and techniques in quality control and improvement, Data analysis and sampling; Control Charts: Statistical Process Control using control charts, Control charts for attributes and variables. Process capability analysis: Concepts and procedures of Process capability. Acceptance Sampling: Acceptance sampling for attributes and variables.

Reliability Analysis **(03 Hours)**

Reliability: Failure rate analysis, mean failure rate, mean time to failure, mean time between failure, Graphical representation of Fd, Z and R. Generalization in graphical form, integral form, Hazard models, systems reliability, availability, maintenance, overall equipment effectiveness, Total Productive Maintenance (TPM), Failure Mode and Effect Analysis (FMEA).

Experimental Design **(08 Hours)**

Experimental Design: Fundamentals of experimental Design, Single, Multi factor and 2k factor experiments, Two level fractional factorial design, Response surface method. Quality loss function.

Taguchi method: Taguchi method, Design of experiments using orthogonal array, Data analysis from Taguchi and Multi level factor design.

New Quality Concepts and Initiatives **(12 Hours)**

New Quality Concepts and initiatives: Total Quality Management (TQM) and its techniques, New Seven Management Tools, and Industrial Case studies on Costs of Quality, Five S, kaizen, Quality Circles, Quality Function Deployment (QFD), Poka Yoke, Total Productive Maintenance (TPM), Lean Manufacturing, Six Sigma, Lean Six Sigma, etc. Quality Management through Software.

Quality Standards **(02 Hours)**

Quality Standards and Business Excellence Models: Quality System Standards, ISO 9000, ISO 14000, various Quality Awards and case studies.

World Class Manufacturing **(01 Hour)**

Manufacturing Excellence World Class Manufacturing (WCM) – Model and elements of WCM.

Total Lectures 42 Hours

2. Books Recommended:

1. Amitra Amitava, Fundamentals of Quality Control and Improvement, 2nd Ed., Prentice Hall of India, 2011
2. K. Krishnaiah and P. Shahabudeen, Applied Design of Experiments and Taguchi Methods, Prentice Hall of India, 2012.
3. Dale H. Besterfield, Carol Besterfield-Michna, Mary Besterfield-Sacre, Glen H. Besterfield, Hemant Urdhwareshe, Rashmi Urdhwareshe, Total Quality Management, , Pearson Education, 2012.
4. George W. Cobb, Introduction to Design and Analysis of Experiments, John Wiley & Sons, 2015.
5. D.C. Montogomery, Design and Analysis of Experiments, John Wiley & Sons, 8th Edition, 2013.

MEME234	:	ADVANCED WELDING TECHNOLOGY	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Relate the significance of welding in various industrial sectors.
CO2	Explain the characteristics of welding arc and relate it importance during welding process
CO3	Develop the concepts of various advanced welding technologies.
CO4	Analyse the heat flow and metal transfer mechanism in welding.
CO5	Determine the solidification mechanism of weld pool.
CO6	Compile the quality of weldments by monitoring and controlling the process through advanced techniques.

1. **Syllabus**

Introduction **(04 Hours)**

Welding as compared with other fabrication processes, classification, weldability, weld configuration, ASME standards for weldments, scope and applications of welding in various industrial sectors.

Physics of Welding Arc **(08 Hours)**

Structure and characteristics of welding arc, methods of arc initiation and maintenance, arc stability, voltage distribution along the arc, cathode and anode drops, arc column, thermionic and non-thermionic cathode, theories of cathode and anode mechanisms, temperature distribution in the arc, arc efficiency, heat generation at cathode and anode, effect of shielding gas on arc, isotherms of arcs, arc blow, arc welding power sources, heat sources for solid state welding.

Advanced Welding Processes **(12 Hours)**

Overview of arc welding processes, flux cored arc welding, plasma transferred arc welding, electro-gas and electro-slag welding, resistance welding, magnetic pulse welding. Theory and mechanism of solid state welding, technique and scope of - friction welding, fiction stir welding, diffusion welding, cold pressure welding, ultrasonic welding, electron beam welding, laser beam welding. Cladding through welding, automation in welding.

Heat Flow and Metal Transfer in Welding **(08 Hours)**

Calculation of peak temperature, width of heat affected zone, cooling rate and solidification rates, weld thermal cycles. Forces, mechanism and types of metal transfer in various arc welding processes, factors controlling melting rate in various welding processes. Residual stresses and their measurement, weld distortion and its prevention.

Solidification of weld pool **(04 Hours)**

Principle of solidification of weld metal, modes of solidification, effect of welding parameters on weld structure, grain refinement principle of weld metal, method of weld metal refinement: inoculation, arc pulsation, external excitation.

Inspection and Quality Control of Weldments **(06 Hours)**

Overview of post weld characterization, weld related discontinuities, Welding Defects, overview of standard destructive and nondestructive testing applicable for weldments, inspection of weldments, importance of welding procedure and performance qualification, monitoring and control of welding processes, welding simulation.

Total lectures 42 hours

Books Recommended:

1. Houdlecroft P.T., “Welding Process Technology”, Cambridge University Press, 3rd edition, 2004
2. Bowditch, W.A., Bowditch, K. E., “Welding Technology Fundamentals”, Goodheart-Willcox Co. Pub., 1991.
3. Jeffus, L., “Welding: Principles and Applications”, Cengage Learning Pub., 7th edition, 2011
4. Lancaster J F., “Metallurgy of Welding”, Springer publications, 6th edition, 2009.
5. Parmar R. S., “Welding Engineering and Technology”, Khanna Publishers, 5th edition,2013

MEME240	:	DESIGN OF EXPERIMENTS	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Formulate objective(s) and identify key factors in designing experiments for a given problem.
CO2	Develop appropriate experimental design to conduct experiments for a given problem.
CO3	Identify randomization, replication, blocking and degree of freedom based on given parameters and their levels
CO4	Analyze experimental data to derive valid conclusions.
CO5	Optimize process conditions by developing empirical models using experimental data.
CO6	Design robust products and processes using parameter design approach.

1. Syllabus

Fundamentals of Experimentation **(04 Hours)**

Role of experimentation in rapid scientific progress, Historical perspective of experimental approaches, Steps in experimentation, Principles of experimentation

Simple Comparative Experiments **(08 Hours)**

Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA

Experimental Designs **(08 Hours)**

Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data

Response Surface Methodology **(10 Hours)**

Concept, linear model, steepest ascent, second order model, regression

Taguchi's Parameter Design **(12 Hours)**

Concept of robustness, noise factors, objective function & S/N ratios, inner-array and outer-array design, data analysis.

2. Books Recommended:

1. Ross P.J., Taguchi Techniques for Quality Engineering, McGraw-Hill Book Company, New York, 1st edition, 2008.
2. Montgomery D.C, Design and Analysis of Experiments, John Wiley & Sons, New York, 7th Edition, 2008.
3. Jiju Antony, Design of Experiments for Engineers and Scientists, Elsevier, 2nd edition, 2018
4. Colin Hardwick, Practical Design of Experiments, Createspace Independent Publisher, 1st edition, 2013
5. Angela Dean, Max Morris, John Stufken, Derek Bingham. Handbook of Design and Analysis of Experiments. Chapman and Hall/CRC; 1st edition, 2020.

MEME241	:	MECHANICS OF COMPOSITE LAMINATES	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Explain the different types of composite materials.
CO2	Analyse the macro and micro mechanical behaviour of composites.
CO3	Solve bending, buckling and vibration problem.
CO4	Explain the design requirement of composite materials.
CO5	Analyse the nonlinear behaviour of composite materials.

1. Syllabus

Introduction **06 hours**

Classification and characteristics of composite materials, Mechanical behaviour of composite materials, Terminology of laminated composite materials, Manufacture of laminated composite materials, Applications of composite materials

Macro-Mechanical Behaviour of a Lamina **06 hours**

Stress-strain relationship for anisotropic materials, Stiffness, compliances and engineering constants for orthotropic materials, Restrictions on engineering constants, Stress-strain relationship for plane stress in an orthotropic material, Strength of an orthotropic lamina

Micro-Mechanical Behaviour of a Lamina **06 hours**

Mechanics of materials approach to stiffness, Elasticity approach to stiffness, Mechanics of materials approaches to strength.

Macro-Mechanics Behaviour of a Laminate Hours **06 hours**

Classical laminate theory, Special cases of laminate stiffnesses, Theoretical versus measured laminate stiffnesses, Strength of laminates, Interlaminar stresses

Bending, Buckling and Vibration of Laminated Plates **10 hours**

Governing equations for bending, buckling and vibration of laminated plate, Deflection of simply supported laminated plates under distributed transverse load, Buckling of laminated plate, Vibration of laminated plate.

Introduction to Design of Composite Structures and Nonlinear Behaviour **08 hours**

Introduction, Introduction to structural design, Material Selection, Configuration Selection, Laminate joints, Design requirements and design failure criteria, Definition and types of non-linearity, Non-linear analysis of plates for bending, buckling and vibration, Interlaminar stresses of laminate.

Total lectures 42 hours

2. **Books Recommended**

1. K.K. Autar, 2006. Mechanics of composite materials, 2nd Edition, CRC Press.
2. J.N. Reddy, 2003. Mechanics of laminated composite plates and shells theory and analysis, 2nd Edition, CRC press.
3. R.M. Jones, 2018. Mechanics of composite materials, 2nd Edition, Taylor and Fransis.
4. M. Mukhopadhyay, 2004. Mechanics of composite materials and structures, Universities press.
5. M.M. Kaminski, 2005. Computational mechanics of composite materials, Springer.

MEME242	:	COMBUSTION	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Describe different combustion mechanisms and how these can be efficiently used in engineering applications.
CO2	Illustrate elementary chemical and physical processes of combustion phenomena
CO3	Describe combustion characteristics and how these can be measured.
CO4	Illustrate different type of pollutants generated by combustion, their effects on health and on the environment.
CO5	Explain basic concepts about combustion processes for efficient designing of burners for different types of fuels and combustion chambers.

1. Syllabus

INTRODUCTION **(02 Hours)**
Introduction to combustion, Applications of combustion, Types of fuel and oxidizers, Characterization of fuel, Various combustion mode, Scope of combustion.

THERMODYNAMICS OF COMBUSTION **(08 Hours)**
Mixture composition, energy and entropy properties of gaseous mixtures, Thermodynamics properties of reacting mixtures, Laws of thermodynamics, Stoichiometry, Thermochemistry, adiabatic temperature, chemical equilibrium. Conditions of chemical equilibrium, equilibrium constant, challenges in chemical equilibrium.

COMBUSTION KINETICS **(08 Hours)**
Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics reaction rate formula, approximations for construction of global reaction rate, global rates of hydrocarbon fuels

CHEMICAL MECHANISMS **(03 Hours)**
Explosive and oxidative characteristics of fuels, Criteria for explosion, Explosion limits and oxidation of hydrogen, Carbon monoxide and hydrocarbons

PHYSICS OF COMBUSTION **(03 Hours)**

Fundamental laws of transport phenomena, Conservations Equations

PREMIXED FLAME **(07 Hours)**
Laminar premixed flame, laminar flame structure, Stability limits of laminar flames, Laminar flame speed, Flame speed measurements, Flame stabilizations, Ignition and quenching,

Turbulent flames, turbulent flame speed, external aided ignition (spherical propagation, plane propagation), auto ignition, flammability limits

DIFFUSION FLAME **(07 Hours)**
Laminar Diffusion flames, turbulent diffusion flames, Schvab-Zel'dovich formulation, Burke-Schumann problem, Gaseous Jet diffusion flame, Droplet Combustion, Liquid fuel combustion, Atomization, Spray and Solid fuel combustion.

COMBUSTION AND ENVIRONMENT **(04 Hours)**
Atmosphere, Chemical Emission from combustion, Quantification of emission, Emission control methods. mechanisms of pollutant formation during combustion, pollutants reduction in conventional combustors, pollutants reduction by control of flame temperature, dry low-oxides of nitrogen combustors, lean premix per vaporize combustion, rich-burn quick-quench lean burn combustor, catalytic combustion, correlations and modelling of oxides of nitrogen and carbon monoxide emission.

Total Lectures 42 Hours

2. Books Recommended

1. K.K. Kuo, Principles of Combustion, John Wiley and Sons, 2005.
2. S.R. Turns, An introduction to combustion, New York: McGraw-Hill, 2017.
3. C.K. Law, Combustion physics, Cambridge University Press, 2010.
4. D.P. Mishra, Fundamentals of Combustion, Prentice Hall of India, 2010.
5. H. S. Mukunda, Understanding combustion, Universities Press, 2009.

MEME243	:	DESIGN OF HEAT EXCHANGERS	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Identify different types of heat exchangers and understand the basic design methodologies
CO2	Design and analyse the double pipe shell and tube heat exchanger
CO3	Design and perform the thermal performance of tube finned and plate finned heat exchanger
CO4	Estimate thermal performance of Gasketed and Spiral plate heat exchanger
CO5	Estimate the pressure drop in tubular and extended surface heat exchanger
CO6	Estimate furnace outlet temperature using furnace model

1. Syllabus

Introduction **(04 hours)**

Application of heat exchanger, classification of heat exchanger, design and simulation of heat exchanger, Review of heat transfer principles & convection correlation, Basic design methodologies, Net Transferable Units method and Logarithmic Mean Temperature, Examples

Design of Tubular Heat Exchanger **(10 hours)**

Heat transfer coefficient, double pipe heat exchanger design, Shell & tube type heat exchangers, nomenclature, J-factors, conventional design methods, bell, Delaware method

Design of Extended Surface Heat Exchanger **(15 hours)**

Enhancement of heat transfer compact heat exchanger, Compact heat exchangers, J-factors, Design method Extended surface heat exchanger, Rating problem of tube finned heat exchanger, Rating problem of plate finned heat exchanger, Pressure drop calculations and tutorials, Sizing problem

Design of Plate Heat exchangers **(05 hours)**

Introduction, Types of the plate heat exchanger, thermal design of Gasketed plate heat exchanger, thermal design of spiral plate heat exchanger

Heat Exchanger Pressure Drop Analysis **(05 hours)**

Importance of pressure drop, Major contributions to the heat exchanger pressure drop, Tubular heat exchanger pressure drop, Extended surface heat exchanger pressure drop, Plate heat exchanger pressure drop

Furnace design **(03 hours)**
Design development of Stirred Reactor Furnace model, Estimate the furnace outlet temperature

Total lectures 42 hours

2. Books Recommended

1. Shah, R.K. and Sekulic D.P., "Fundamentals of Heat Exchanger Design", John Wiley & Sons, Inc, 2003
2. Kays, V.A. and London, A.L., "Compact Heat Exchangers" , McGraw Hill, 2002.
3. Holger Martin, "Heat Exchangers" Hemisphere Publ. Corp. Washington, 2001.
4. Kuppan, T., "Heat Exchanger Design Handbook", Macel Dekker, Inc., N.Y. , 2000
5. Seikan Ishigai, "Steam Power Engineering , Thermal and Hydraulic Design Principles", Cambridge Univ. Press, 2001.

MEME244	:	NON DESTRUCTIVE TECHNIQUES	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1 Understand the basic concept of NDT and its industrial applications
CO2 Select appropriate NDT technique to identify given defect.
CO3 Identify internal flaw in the part and suggest measures to eliminate it
CO4 Analyse available data using modern tools and softwares
CO5 Introduce environmental friendly solutions to the industrial problem through NDT
CO6 Identify and overcome limitations of NDT technique through alternative techniques

1. Syllabus

1. Introduction to NDT, Liquid Penetrant Test (06 Hours)

Physical Principles, Procedure for penetrant testing, penetrant testing materials, Penetrant testing methods, sensitivity, Applications and limitations, typical examples.

2. Ultrasonic Testing (06 Hours)

Basic properties of sound beam, Ultrasonic transducers, Inspection methods, Techniques for normal beam inspection , Techniques for angle beam inspection, Flaw characterization techniques, Applications of ultrasonic testing , Advantages and limitations.

3. Thermography (06 Hours)

Basic principles, Detectors and equipment, techniques, applications.

4. Radiography (06 Hours)

Basic principle, Electromagnetic radiation sources, radiographic imaging, Inspection techniques, applications, limitations, typical examples.

5. Eddy Current Test (06 Hours)

Principles, instrumentation for ECT, techniques, sensitivity, advanced eddy Current test methods, applications, limitations.

6. Acoustic Emission (06 Hours)

Principle of AET, Technique, instrumentation, sensitivity, applications, Acoustic emission technique for leak detection.

7. Magnetic Particle Inspection **(06 Hours)**

Principle of MPT, Procedure used for testing a component, sensitivity, limitations.

Total lectures 42 hours

2. Books Recommended:

1 Peter J. Shull, Nondestructive Evaluation: Theory, Techniques and Applications, Marcel Dekkar, 1st edition, 2002.

2 Ravi Prakash, Non Destructive Testing Techniques, New Age International Publishers, 1st edition, 2010

3 Sadashiva M, Non Destructive Testing, Notion Press, 1st edition, 2021

4 ASM Metals Hand Book, Non Destructive Testing and Quality Control, Vol. 17, ASM, 1989.

5. Mix Paul, Introduction to NDT: A training guide, John Wiley and Sons, 2nd edition, 2005

MEME210	:	INDUSTRIAL SAFETY	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Understand causes of accidents and their consequences, and applicable safety laws
CO2	Identify hazards and manage risk
CO3	Measure safety performance
CO4	Formulate safety and health policy
CO5	Conduct the accident investigation
CO6	Establish fire control system

1. Syllabus

INTRODUCTION **(04 Hours)**

Accident fatalities across the globe, nature of industry, review of accident statistics in India, types of injuries, causes of accidents, consequences of accidents, responsibilities of stakeholders

Accident causation theories: **(06 Hours)**

Accident proneness theories, Goals- Freedom-Alertness theory, adjustment stress theory, theory of mental stress, dominoes theories, chain of events theory, distraction theory, the human error-causation model, behaviour theory

Hazard identification and risk assessment: **(06 Hours)**

Types of hazards**,** identification of hazards and risk, risk analysis, risk evaluation, risk ranking, risk acceptance, risk control, , and risk transfer, A *priori* risk estimates, ergonomics and cognitive assessment methods, task demand assessment methods

Measurement of safety performance: **(04 Hours)**

Reactive indicators, proactive indicators,

permanent total disabilities, permanent partial disabilities, temporary total disabilities, computations of accident indices, problems

Safety and health management policy: **(04 Hours)**

Safety policy, budget, organization, inspection, audit, education and training, safety health and environment plan, safety manual, committee, incentive programmes

Accident investigation and analysis methods: **(06 Hours)**
Accident investigation, reporting, record keeping, gathering information of accident, root cause analysis, fault tree analysis, failure modes and effect analysis, hazard and operability study review, etc., case study

Safety laws : **(06 Hours)**
History of safety acts in India, the factory Act, 1948, the building and other construction workers Act, 1996, occupational safety health and working condition code,2020, the contract labour Act, 1970, the hazardous wastes rules, 1989, motor vehicle Act,1988, the industrial relations code bill, 2020, the code on social security bill,2020, etc.

Fire Safety Management: **(06 Hours)**
Fire properties of solid, liquid and gases, Sources of ignition, fire triangle, principles of fire extinguishing, active and passive fire protection systems, various classes of fires, types of fire controlling apparatus, industrial fire protection system, explosive protection system

Total Lectures 42 Hours

2. Books Recommended

1. Deshmukh, L. M. (2010). Industrial safety management. New Delhi: Tata McGraw Hill.
2. Dhillon, B. S. (2022). Applied Safety for Engineers: Systems and Products. CRC Press.
3. Goetsch, D. L. (2005). Occupational Safety and Health for Technologists, Engineers and Managers, Pearson Education, Inc., Upper Saddle River, New Jersey.
4. Heinrich, H. W. (1941). Industrial Accident Prevention. A Scientific Approach. Industrial Accident Prevention. A Scientific Approach., (Second Edition).
5. Jha,K.N., Patel, D.A., Singh,A., (2022). Construction safety management, Pearson India Education Services Pvt. Ltd., Noida (India).

MEME211	:	INTELLIGENT MANUFACTURING SYSTEMS	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Explain the need and capability of AI based manufacturing system
CO2	Identify the characteristics and components of knowledge based expert systems
CO3	Apply probability and fuzzy logic for machine thinking
CO4	Apply the ANN modeling to identified manufacturing problem
CO5	Develop the knowledge based GT for selected automation system
CO6	Design an intelligent system for various manufacturing systems

1. Syllabus

Concepts of Artificial Intelligence **(08 Hours)**

Origin of Artificial Intelligence, Human and machine Intelligence, Branches of artificial intelligence, Programming in AI environment, Emergence of expert systems, Applications in Engineering and Manufacturing, Intelligent Manufacturing Systems – System components, System Architecture and Data Flow and System Operation

Knowledge Based Systems/Expert Systems **(12 Hours)**

Expert systems: Expert system process, characteristics and components of expert systems, Knowledge Acquisition: Knowledge acquisition phases, Methods of extracting knowledge from experts, Knowledge acquisition meetings, Group knowledge acquisition, Knowledge Representation: Characteristics of knowledge, Knowledge representation models,
Concepts of knowledge sets and Reasoning models. Expert system justification and future directions for expert systems

(10 Hours)

Machine Learning

Machine Learning – Concept, Artificial Neural Networks, Biological and Artificial Neuron, Types of Neural Networks, Applications in manufacturing, Use of probability and fuzzy logic for machine thinking.

Knowledge Based Group Technology **(08 Hours)**

Group Technology: Models and Algorithms – Visual method, Coding method, Cluster analysis method , Knowledge based group technology – Group technology in automated manufacturing system, Structure of knowledge based system for group technology (KBSGT) – Database, Knowledge base, Clustering algorithm

Industrial Applications of AI **(04 Hours)**
Intelligent system for design, equipment selection, scheduling, material selection, maintenance, facility planning and process control

Total Lectures 42 Hours

2. <u>Books Recommended</u>

1. Michael Negnevitsky, Artificial Intelligence: A guide to Intelligent systems, Pearson, 3rd edition, 2020
2. A. B. Badiru, Expert Systems Applications in Engineering and Manufacturing, Prentice-Hall, New Jersey, 1992.
3. Andrew Kussiak, Intelligent Manufacturing Systems, Prentice Hall, 1990.
4. Kishan Mehrotra, Elements of Artificial Neural Network, Penram International Publishing Pvt Ltd; 2nd edition, 2009
5. Rajendra Akerkar, Knowledge based Systems, Jones & Bartlett, 1st edition, 2009

MEME212	:	ENERGY CONSERVATION MANAGEMENT AND AUDIT	L	T	P	Credits
			3	0	0	03

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1 Apply various energy conservation techniques to estimate energy saving potential in various thermal and electrical utilities

CO2 Compare various appliances/utilities based on their stars and labelling, benchmarking values, PAT Scheme in industries

CO3 Calculate the usage of energy for a given industrial thermal/electrical utility and suggest suitable way to minimize energy bill

CO4 Analyse the saving potential of Cogeneration option for process industry

CO5 Determine Energy conservation potential in various industrial utilities like fans, blowers, compressors, pumps etc.

CO6 Compute various performance parameters of HVAC systems and suggest suitable ways for improving energy efficiency

1. Syllabus

Global and National Energy Scenario (08 Hours)

Energy consumption in various sectors, Energy resources like Coal, Oil and Natural Gas – their demand and supply management, Indian energy scenario, Indian Coal & LPG scenario, Primary and Secondary Sources of Energy, Commercial and Non-Commercial Sources, India's installed energy capacity, per capita energy consumption. General aspects of Energy conservation and management, Roles of energy auditors, Roles of energy manager, Energy policy of industry, Energy Conservation Act and its amendments, PAT Scheme. Star and Labelling

Energy Efficiency in Boiler, Steam And Furnace System Utilities (08 Hours)

Energy conservation opportunities in boiler systems, retrofitting of FBC in conventional boilers, Steam line distribution standard practices including sizing and layouts, selection, operation and maintenance of steam traps, energy saving opportunities in steam systems.

Energy Efficiency in Furnaces and Refractories (06 Hours)

Sankey diagram, Fuel economy measures in furnaces Insulation and Refractories: Types of insulations, Economic thickness of insulation, Typical refractories for industrial applications. Benchmarking in Glass and Steel Industries

Cogeneration (05 Hours)

Principle of cogeneration, Technical options for cogeneration, Factors influencing cogeneration choice, Important technical parameters for cogeneration, case study on savings with and without cogeneration

Energy Conservation in Fans, Blowers, Compressors and Pump Systems (10 Hours)

Energy saving opportunities, performance evaluation and efficient system operation.

Air Systems: Efficient operation of Fans, Blowers and compressed air system, Energy conservation opportunities in Fans, Blowers and Compressors. Compressor Leakage tests.

Pumps and Pumping Systems: Pump curves, factors affecting pump performance, Energy loss in throttling, Effects of impeller diameter change, Flow control strategy, Variable speed drives, Energy conservation opportunities.

Energy Conservation in HVAC and Cooling Towers (05 Hours)

Total Lectures 42 hours

2. Books Recommended:

1. General Aspects of Energy Conservation, Management and Audit: Guide Book for Energy Managers and Energy Auditors; Bureau of Energy Efficiency, Ministry of Power
2. Energy Efficiency in Electrical Utilities: Guide Book for Energy Managers and Energy Auditors; Bureau of Energy Efficiency, Ministry of Power
3. Energy Efficiency in Thermal Utilities: Guide Book for Energy Managers and Energy Auditors; Bureau of Energy Efficiency, Ministry of Power
4. S. A. Roosa, Energy Management Handbook, Fairmont Press,2018
5. Wayne C Turner, Energy Management Handbook. Prentice Hall 3rd Edition, 2000

MEME213	**:**	**ENERGY AND BUILDINGS**	**L**	**T**	**P**	**Credits**
			3	**0**	**0**	**03**

Course Outcomes (COs):

At the end of the course the students will be able to:

CO 1	express the importance of climate, building and energy.
CO 2	illustrate daylight and lightings for energy efficiency perspective.
CO 3	analyze ventilation and air quality in buildings.
CO 4	estimates building load and develop methods to reduce it.
CO 5	evaluate energy efficiency in buildings.
CO 6	distinguish green building rating systems, life cycle and environmental assessments and contribution of renewable energy.

1. Syllabus

Introduction **(04 hours)**

Understanding building energy use, concepts of energy efficiency potential in buildings, effect of climates on building energy usage.

Daylight and lighting in buildings **(04 hours)**

Introduction, Types of technology, design considerations, operation and maintenance, relevant codes and standards.

Ventilation and air quality in buildings **(08 hours)**

Types of ventilation systems, Passive and active methods of heating and cooling with their layouts, performance of room air distribution systems, cooling comfort in hot climates.

Estimation of building loads **(12 hours)**

Steady state method, Network method, Numerical method, Correlations, Computer packages for carrying out thermal design of buildings and predicting performance.

Energy Efficiency in buildings **(06 hours)**

Energy efficient building technologies, energy efficiency policies, Building codes and standards, energy efficient building operation, evaluation of energy efficiency.

Advances in Building: **(08 hours)**

Life cycle perspective and environmental assessment of buildings. Renewable Energy in Buildings; Sustainable Building Rating Systems

Total Lectures 42 Hours

2. Books Recommended

1. David Thorpe, Energy Management in Buildings The Earthscan Expert Guide, , 1st Ed 2014, Routledge
2. Mili Majumdar, Energy-efficient Buildings in India, , The Energy and Resources Institute (TERI), 2001
3. Sofia-Natalia Boemi, OlatzIrulegi, Mattheos Santamouris, Energy Performance of Buildings, Energy Efficiency and Built Environment in Temperate Climates., 2016, Springer Nature
4. Andreas Athienitis, William O'Brien, Modeling, Design, and Optimization of Net-Zero Energy Buildings, First published 2015, Wiley
5. Bruce D. Hunn and Charles B. Fundamentals of Building Energy Dynamics: 4 (Solar Heat Technologies): Volume 4, The MIT Press, 1996

MEME214	:	INSTRUMENTATION AND EXPERIMENTAL METHODS	L	T	P	Credits
			3	0	0	03

Significance of Measurement and Instrumentations Introduction, generalized configuration and functional stages of measuring systems, the transducer and its environment, an overview, sensing process and physical laws, Types of measurement problems. Transducer classification and their modelling, characteristics of instruments, design and selection of components of a measuring system.	**05 hours**
Dynamic Response of Instruments Mathematical model of a measuring system, response of general form of instruments to various test inputs; time domain and frequency domain analysis Elementary transfer functions, Bode plots of general transfer functions.	**05 hours**
Errors in Measurement and Uncertainty in measurements Errors in instruments, Causes and types of experimental errors, Analysis of experimental data and determination of overall uncertainties in experimental investigation, Uncertainties in measurement of measurable parameters like pressure, temperature, flow etc. under various conditions, Estimation for design and selection for alternative test methods.	**06 hours**
Transducers Developments in sensors, detectors and transducer technology, displacement transducers; force, torque and motion sensors, piezoelectric transducers, capacity type transducers, Strain gauge transducers, Accelerometers, pressure transducers based on elastic effect of volume and connecting tubing. Transducers for Position, speed, vibration, sound, humidity, and moisture measurement, Hall effect Transducer.	**08 hours**
Data Acquisition and Signal Processing Systems for data acquisition and processing modules and computerized data system digitization rate, time and frequency domain representation of signals, and Nyquist criterion a brief description of elements of mechatronics modular approach to mechatronics and engineering design.	**05 hours**
Advanced Flow Measurements Basic flow meters, magnetic, ultrasonic flow meters, Flow visualization, shadowgraph, Schlieren and interferometric techniques, Pitot static tubes; hot wire anemometers, flow measuring problems, Laser Doppler velocity meter, flow measurements using coriolis effect.	**07 hours**

Temperature Measurements Modes of heat transfer, laws of conduction, convection and radiation, Temperature scales, classification of Temperature Sensors, Overview of Temperature Sensor Material, Expansion thermometers, filled system thermometers Thermoelectric sensors, electric resistance sensors; thermistors, Electrical temperature instruments, thermocouples, RTD, and thermistors, Pyrometers, IR temperature detectors, radiations pyrometers, Temperature measuring problems in flowing fluids, dynamic compensation	**06 hours**

2.Books Recommended

1. Holman J. P., “Experimental methods for engineers”, McGraw Hill, NY, USA, 2017.
2. Doebelin E.O. and Manik D. N. “Measurement systems: application and design”, McGraw Hill, NY, USA, 2019.
3. Venktesh S. P. “Mechanical measurements”, John Wiley & Sons Ltd, USA, 2021.
4. Goldstein R. “Fluid mechanics measurements,” Taylor & Francis, USA, 2017.
5. Sheldom M. R., “Introduction to probability and statistics for engineers and scientist”, Elsevier, 5th edition, Amsterdam, Netherland, 2014.

MEME203	:	COMMUNICATION SKILLS	L	T	P	Credits
			0	0	2	01

Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	apply their skills in oral and written communication
CO2	write technical report, personal resume effectively
CO3	avoid common errors in writing by using right vocabulary
CO4	follow ethics in publication by avoiding plagiarism
CO5	make effective oral presentation during seminar, dissertation
CO6	build self confidence

1. Syllabus

Technical Writing **(2 Hours)**
Style of Technical Writing, Five Steps of Successful Writing- Preparation, Research, Organization, Writing and Revision. Ethics in Writing.

Written Communication **(4 Hours)**
Summary, Report Writing- Types and Parts, Resume, Email and Job Application, Research Paper- Types and Parts, Executive Summary

Organisation and Development **(4 Hours)**
Note Making, Structuring Paragraphs and Sentences, Paragraph Writing, Summarising and Paraphrasing, Methods of Development.

Style And Language **(4 Hours)**
Common Errors, Right Vocabulary, Avoiding Ambiguity, Removing Redundancy, Avoiding Plagiarism.

Total Lectures (14 Hours)

2. Books Recommended

1. Mike Markel. Practical Strategies for Technical Communication. Bedford/ St. Martin's Second Edition. 2016.
2. Gerald J. Alred, Charles T. Brusaw& Walter E. Oliu. Handbook of Technical Writing. 9th edition. Bedford/St. Martin, 2009.
3. Laura J. Gurak& John M. Lannon. Strategies for Technical Communication in The Workplace. Pearson 2013.
4. Rowena Murray & Sarah Moore. The Handbook of Academic Writing: A Fresh Approach. Open University Press, 2006.
5. Stephen Bailey. Academic Writing: A Practical Guide for International Students. 4th Edition. Routledge, 2014.

MEME204	**:**	**MINI PROJECT**	**L**	**T**	**P**	**Credits**
			0	**0**	**4**	**02**

At the end of the course the students will be able to:

CO 1	get acquainted with latest areas of Mechanical Engineering
CO 2	Get enough exposure on the field problems pertaining to mechanical engineering
CO 3	Get hands on training on augmentation of his/her skill
CO 4	Utilize various software skills to design, develop the product before fabrication
CO 5	Analyze the computation results with experimental results
CO 6	Prepare technical report and make presentation on the chosen area of mini project

Note: The students are expected to identify the prospective faculty for the proposed mini project work. The PG Incharge will float the form and prepare the list of students and prospective faculty for mini project at the beginning of the given semester. The concern faculty will take periodic review of the progress of work. The candidate is supposed to submit the report based on the mini project work assigned by concerned faculty. The faculty will evaluate the same at his/her level and will submit the marks. The report will be kept for record purpose.