M. TECH. (MECHANICAL ENGINEERING) (1st Year)

Total Contact Hours = 24 Total Marks = 600 Total Credits = 22

SEMESTER 1st		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MREM0-101	Research Methodology	4	0	0	40	60	100	4
MMEE2-102	Advanced Heat & Mass Transfer	4	0	0	40	60	100	4
MMEE2-103	Advanced Manufacturing Processes	4	0	0	40	60	100	4
MMEE2-104	Advanced Machine Design	4	0	0	40	60	100	4
MMEE2-105	Lab –I	0	0	4	60	40	100	2
Departmental Elective – I (Select any one)		4	0	0	40	60	100	4
MMEE2-156	Composite Material							
MMEE2-157	Mechatronics							
MMEE2-158	Finite Element Modelling							
Total	**Theory = 5 Lab = 1**	**20**	**0**	**4**	**260**	**340**	**600**	**22**

M. TECH. (MECHANICAL ENGINEERING) (1st Year)

Total Contact Hours = 24 Total Marks = 600 Total Credits = 22

SEMESTER 2nd		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MMEE2-206	Computational Fluid Dynamics	4	0	0	40	60	100	4
MMEE2-207	Advanced CAD/CAM	4	0	0	40	60	100	4
MMEE2-208	Industrial Automation & Robotics	4	0	0	40	60	100	4
MMEE2-209	Advanced Optimization Techniques	4	0	0	40	60	100	4
MMEE2-210	Lab-II	-	-	4	60	40	100	2
Departmental Elective – II (Select any one)		4	0	0	40	60	100	4
MMEE2-259	Modelling & Simulation of Mechanical Systems							
MMEE2-260	Welding Metallurgy							
MMEE2-261	Gas Dynamics							
Total	**Theory = 5 Lab = 1**	**20**	**0**	**4**	**260**	**340**	**600**	**22**

Overall

Semester	Marks	Credits
1st	600	22
2nd	600	22
Total	**1200**	**44**

RESEARCH METHODOLOGY

Subject Code – MREM0-101 **L T P C** **Duration – 45 Hours**
4 0 0 4

UNIT–I (11 Hrs)

Introduction to Research: Meaning, Definition, Objective and Process

Research Design: Meaning, Types - Historical, Descriptive, Exploratory and Experimental

Research Problem: Necessity of Defined Problem, Problem Formulation, Understanding of Problem, Review of Literature

Design of Experiment: Basic Principal of Experimental Design, Randomized Block, Completely Randomized Block, Latin Square, Factorial Design.

Hypothesis: Types, Formulation of Hypothesis, Feasibility, Preparation and Presentation of Research Proposal

UNIT–II (10 Hrs)

Sources of Data: Primary and Secondary, Validation of Data

Data Collection Methods: Questionnaire Designing, Construction

Sampling Design & Techniques – Probability Sampling and Non Probability Sampling

Scaling Techniques: Meaning & Types

Reliability: Test – Retest Reliability, Alternative Form Reliability, Internal Comparison Reliability and Scorer Reliability

Validity: Content Validity, Criterion Related Validity and Construct Validity

UNIT–III (13 Hrs)

Data Process Operations: Editing, Sorting, Coding, Classification and Tabulation

Analysis of Data: Statistical Measure and Their Significance, Central Tendency, Dispersion, Correlation: Linear and Partial, Regression: Simple and Multiple Regression, Skewness, Time series Analysis, Index Number

Testing of Hypothesis: T-test, Z- test, Chi Square, F-test, ANOVA

UNIT – IV (11 Hrs)

Multivariate Analysis: Factor Analysis, Discriminant Analysis, Cluster Analysis, Conjoint Analysis, Multi-Dimensional Scaling

Report Writing: Essentials of Report Writing, Report Format

Statistical Software: Application of Statistical Softwares like SPSS, MS Excel, Mini Tab or MATLAB Software in Data Analysis

**Each Student has to Prepare Mini Research Project on Topic/ Area of their Choice and Make Presentation. The Report Should Consists of Applications of Tests and Techniques Mentioned in The Above UNITs*

Recommended Books

1. R.I. Levin and D.S. Rubin, 'Statistics for Management', 7th Edn., Pearson Education, New Delhi.
2. N.K. Malhotra, 'Marketing Research–An Applied Orientation', 4th Edn., Pearson Education, New Delhi.
3. Donald Cooper, 'Business Research Methods', Tata McGraw Hill, New Delhi.
4. Sadhu Singh, 'Research Methodology in Social Sciences', Himalaya Publishers.
5. Darren George & Paul Mallery, 'SPSS for Windows Step by Step', Pearson Education New Delhi.
6. C.R. Kothari, 'Research Methodology Methods & Techniques', 2nd Edn., New Age International Publishers.

ADVANCE HEAT AND MASS TRANSFER

Subject Code: MMEE2-102 **L T P C** **Duration – 45 Hrs.**

4 0 0 4

Review

Review of the basic laws of conductions, radiation and convection.

UNIT-I (13 Hrs)

Conduction

One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source, local heat source in non-adiabatic plate. Extended surfaces-review, fins of non-uniform cross section, performance of fins (fin efficiency, thermal resistance of a fin, total surface efficiency), design consideration. Two dimensional steady and unsteady state conduction, semi-infinite and finite flat plates; temperature field in finite cylinders and infinite semi-cylinders, numerical method, graphical method. Unsteady state conduction; sudden changes in the surface temperatures of infinite plate, cylinders and spheres; solutions using Groeber's and Heisler's charts for plates, cylinders and spheres suddenly immersed in fluids.

UNIT-II (11 Hrs)

Radiation

Introduction, properties and definitions, review of radiation principles (Planck's law, Kirchoff''s law, Stefan Boltzman law, Lambert's cosine law). Radiation through non-absorbing media; Hottel's method of successive reflections; Radiation through absorbing media; logarithmic decrement of radiation; apparent absorptivity of simple shaped gas bodies; net heat exchange between surfaces separated by absorbing medium; radiation of luminous gas flames.

UNIT-III (12 Hrs)

Convection

Heat transfer in laminar flow; free convection between parallel plates; forced internal flow through circular tubes; fully developed flow; velocity and thermal entry lengths; solutions with constant wall temperature and with constant heat flux; forced external flow over a flat plate; the two dimensional velocity and temperature boundary layer equations; Karman Pohlhousen approximate integral method. Heat transfer in turbulent flow; eddy heat diffusivity; Reynold's analogy between skin friction and heat transfer; Von Karman integral equations, analogy between momentum and heat transfer, flow across cylinders, spheres and other bluff shapes and packed beds.

UNIT-IV (9 Hrs)

Mass Transfer

Introduction, concentration, velocities and fluxes, Fick's law of diffusion, steady state diffusion in common geometries, equimolal counter-diffusion in gases, steady state diffusion in liquids, transient mass diffusion in common geometries, mass transfer coefficient, convective mass transfer

Recommended Books

1. Eckert and Drake, 'Analysis of Heat and Mass Transfer', McGraw Hill.
2. Erk and Grigul, 'Fundamentals of Heat Transfer', Grober, McGraw Hill.
3. J.P. Holman, 'Heat Transfer', McGraw Hill.
4. 'Conduction Heat Transfer', Schneider Addison Wesley.
5. Siegel and Howel, 'Thermal Radiation', McGraw Hill.
6. Rohsenhow and Choi, 'Heat, Mass and Momentum', Prentice Hall.

ADVANCE MANUFACTURING PROCESSES

Subject Code: MMEE2-103 **L T P C** **Duration – 42 Hrs.**

4 0 0 4

UNIT-I (5 Hrs)

Introduction: Overview of general trends in Manufacturing, concept and significance of important properties related to manufacturing processes; Machinability index, Formability, weldabilty, Fluidity, dimensional accuracy, surface integrity, residual stresses, limitations of conventional manufacturing processes need and evolution of advanced manufacturing, selection and economics of manufacturing processes.

UNIT-II (16 Hrs)

Advanced Machining Processes: Classification, Review of conventional machining processes , Principles, process parameters, capabilities and mechanism of material removal of Electro discharge machining, Electrochemical Machining, Laser Beam Machining, and Abrasive Flow

machining, concept and need of Hybrid machining Processes, Advanced Welding Processes Classification, Review of conventional welding processes, Principles, process parameters, capabilities and theoretical considerations for Ultrasonic Welding, friction Welding, Explosion Welding, Underwater Welding, Adhesive Bonding

UNIT-III (11 Hrs)

Advanced Forming Processes: Classification, Review of conventional Forming processes (2hours), concept of High Energy Rate Forming, Principles, process parameters, capabilities and theoretical considerations for Explosive Forming, Electro hydraulic Forming, Electromagnetic Forming, Super plastic forming

UNIT-IV (10 Hrs)

Advanced Casting processes: Classification, Review of conventional casting processes brief review regarding Casting of Ferrous and Non-ferrous metals, Principles, process parameters, capabilities and theoretical considerations for Shell Mould Casting, Vacuum Casting, Lost Foam Casting, Investment Casting, Centrifugal Casting, concept of rapid solidification.

Recommended books

1. Shan and Pandey, 'Modern Machining Processes', Tata Mc Hill, N. Delhi.
2. 'ASTME High Velocity Forming of Metals', PHI, N. Delhi.
3. Serope Kalpakjian and Steven R. Schmid, 'Manufacturing Processes for Engg. Materials', Pearson Education.
4. G.F. Benedict, 'Non Traditional Manufacturing', Marcel Dekker.
5. P.K. Mishra, 'Non-Conventional Machining', Narosa Publishing House, N. Delhi.

ADVANCE MACHINE DESIGN

Subject Code: MMEE2-104 **L T P C** **Duration – 35 Hrs.**

4 0 0 4

UNIT-I (5 Hrs)

Machine Design Review: Review of failure theories; designing against fatigue; cumulative damage theories; design of machine members (bolts, shafts, springs) under fatigue loading.

UNIT-II (6 Hrs)

Contact Stresses: Hertzian contact stresses (cylindrical and spherical surfaces) and their effect on design; theory of limit design; Machinery construction principles.

UNIT-III (9 Hrs)

Fracture and Creep: Fracture Mechanics approach to design. Causes and interpretation of failures; Creep behaviour; rupture theory; creep in high temperature low cycle fatigue; designing against creep.

Reliability: Probabilistic approach to design; reliability prediction; design for reliability.

UNIT-IV (10 Hrs)

Computer Aided Machine Design: Philosophy of Computer Aided Machine Design, Interactive design software, Basic advantages of analysis Software, Design of machine components (springs, gears, temporary fasteners, permanent fasteners, belts and ropes) through interactive programming, Introduction to FEM.

Recommended Books

1. Sharma & Aggarwal, 'Machine Design'.
2. B'ack, 'Machine Design'.
3. Shigle, 'Machine Design',
4. Pandya & Shah, 'Machine Design'.
5. Sadhu Singh, 'Strength of Materials'.

LAB-I

Subject Code: MMEE2-105

One lab /field/industrial oriented project/problem will be allocated to each student related to the subjects related to the subjects taught in 1st semester.

COMPOSITE MATERIALS

Subject Code: MMEE2-156 **L T P C** **4 0 0 4** **Duration - 40 Hrs.**

UNIT-I (12 Hrs)

Basics of Materials: Processing of metal, ceramic, and polymer composites; analysis of residual stresses. Study of micromechanics, additional strength, theory, perforated and notched composites, experimental techniques, fracture, manufacturing and processing, structural mechanics/vibration, nanomaterials, smart structures/systems/materials. Advanced analysis of composite materials; anisotropic elasticity; behavior of composite plates and beams under bending, buckling, and vibration; advanced elasticity solution techniques; hygrothermal behavior of polymer composites; strength prediction theories and failure mechanisms in composites;

UNIT-II (12 Hrs)

Fabrication Methods: Fundamentals of rheology and visco-elasticity of polymer solution and metal; Master curve and its use for design of polymer parts: polymer fabrication by techniques such as compression, molding, extrusion, calendaring, thermoforming, injunction molding, reaction injection molding (RIM), blow molding etc. Compounding of plastics and role of additives in processing.

UNIT-III (4 Hrs)

Laminated Plates: Governing differential equation for a general laminate, angle ply and cross ply laminates. Failure criteria for composites.

UNIT-IV (12 Hrs)

Sandwich Constructions: Basic design concepts of sandwich construction -Materials used for sandwich construction - Failure modes of sandwich panels. Overview of mechanical behavior, Crystals: Miller Indices, Scalars, Tensors, Vectors, Stress and strain, Microscopic basis for elastic modulus, Elastic behavior of materials, Viscoelasticity, Plasticity, deformations, Imperfections, Strengthening mechanisms, Fracture mechanics, High temperature deformation , Creep, Fatigue, embrittlement.

Recommended Books

1. J.M. Whitney, I.M. Daniel and R. Byron Pipes, 'Experimental Mechanics of Fiber Reinforced Composite Materials', **ISBN 0-912053-01-1.**
2. Martinus-Nijhoff, 'The Behavior of Structures Composed of Composite Materials'.
3. L.R. Von – Noastrand Reinhold Company, The Analysis of laminated Composite Structures Calcote, New York, **1998**.

MECHATRONICS

Subject Code: MMEE2-157 **L T P C** **4 0 0 4** **Duration - 40 Hrs**

UNIT-I (6 Hrs)

Control Engineering: Open loop and closed loop control system, system components, hydraulic, thermal, pneumatic processes and their electrical analogies.

UNIT-II (15 Hrs)

Process Control: Concept of measurement of electrical and non-electrical parameters, displacement, force, temperature, pressure etc. and related signal conditioning techniques. Valves, drives and actuators, PID controllers, multivariable and multi-loop processes, basic circuits using pneumatic and PLC's.

UNIT-III (6 Hrs)

Sensors and Signal Conditioners: Transducers for Industrial processes, signal conditioning, output devices and displays.

UNIT-IV (13 Hrs)

Microprocessors and Interfacing: Microprocessors/Microcontroller architecture and programming memory, Input/output operations and interfacing, peripherals, typical applications of Microprocessors, system design concept through case studies.

Recommended Book

1. Koren, 'Computer Control of Manufacturing System', McGraw Hill.
2. Groover, 'Production Systems and CIM', PHI.
3. Maleki, 'Flexible Manufacturing Systems', Prentice Hall.
4. B.C. Kuo, 'Feedback Control Systems', PHI.
5. E.O. Doeblin, 'Measurement Systems', McGraw Hill.

FINITE ELEMENT MODELLING

Subject Code: MMEE2-158 **L T P C** **Duration - 40 Hrs.**
4 0 0 4

UNIT-I (5 Hrs)

Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method.

UNIT-II (15 Hrs)

Variation Methods: Calculus of variation, Rayleigh-Ritz and Galerkin methods;
Finite Element Analysis of 1-D problems: Formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its post processing, Applications in heat transfer, fluid mechanics and solid mechanics: bending of beams analysis of truss and frame

UNIT-III (15 Hrs)

Finite Element Analysis of 2-D problems: Finite element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics; **Axi-symmetric and 3D bodies**

UNIT-IV (5 Hrs)

Numerical Considerations: numerical integration, error analysis, meshes refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and timedependent problems.

Recommended Books

1. K.J. Bathe, 'Finite Element Procedures in Engineering Analysis', Prentice-Hall, Englewood Cliffs, NJ, **1982**.
2. J.N. Reddy, 'Introduction to the Finite Element Method, McGraw-Hill', New York, **1993.**
3. C.S. Krishnamoorthy, 'Finite Element Analysis', Tata McGraw Hill.
4. Chandupatla, 'Finite Element Methods', Pearson Publication.

COMPUTATIONAL FLUID DYNAMICS

Subject Code: MMEE2-206 **L T P C** **Duration - 40 Hrs**
4 0 0 4

UNIT-I (5 Hrs)

Introduction: History of CFD; Comparison of the three basic approaches in engineering problem solving – Analytical, Experimental and Computational Methods. Recent Advances in Computational Techniques

UNIT-II (12 Hrs)

Problem Formulation: The standard procedure for formulating a problem Physical and Mathematical classification of problems; Types of governing Differential equations and Boundary conditions. Methods of Discretization: Basics of Finite Difference Method; Finite Element Method, Finite volume Method and Spectral Method. Treatment of Boundary Condition

UNIT-III (10 Hrs)

Numerical Solution to Heat Conduction Problems: Steady-state Problems: (i) One-dimensional Heat Conduction Transfer through a Pin-fin (ii) Two-dimensional Conduction through a plate Unsteady-state Problem: One dimensional Transient Heat Conduction. Explicit and Implicit Methods, Stability of numerical Methods.

UNIT-IV (13 Hrs)

Numerical Solution to Fluid Flow Problems Types of fluid flow and their governing equations: Viscous Incompressible Flows Calculation of flow field using the stream function-vorticity method; Calculation of boundary layer flow over a flat plate; Numerical algorithms for solving complete Navier Stokes equations- MAC method; SIMPLE algorithm; Project problem.

Recommended Books

1. Suhas V. Patankar, 'Numerical Heat Transfer and Fluid Flow', Taylor & Francis.
2. J. Anderson, 'Computational Fluid Dynamics'.

ADVANCED CAD/CAM

Subject Code: MMEE2-207 **L T P C** **Duration: 40 Hrs**
4 0 0 4

UNIT-I (6 Hrs)

Introduction: Design process in general and using computers, hardware and software in CAD applications

UNIT-II (12 Hrs)

Two Dimensional Transformations: Two dimensional geometric transformations-basic transformations, concatenation, reflection, shear and transformations between coordinate systems.

Two and Three Dimensional Object Representations Parametric representation of synthetic curves, spline representations, cubic spline interpolation methods, Bezier curves and surfaces, B spline curves and surfaces, conversion between spline representations

UNIT-III (10 Hrs)

Representation of Solids: Half spaces, boundary representation (B-rep), sweep representation, constructive solid geometry (CGS), solid manipulations. Three Dimensional Geometric Transformations: Transformations-translation, rotation, scaling, reflections, shears, concatenation transformations

UNIT-IV (12 Hrs)

Basic concepts of visual realization, hidden line removal, hidden surface removal, shading surfaces and solids, CAD Standards, CAD and CAM integration, Introduction to reverse engineering and rapid prototyping**,** Practice on available CAD packages, computer programming for geometric modelling of curves, surfaces & solids, projects involving assembly and kinematics analysis of mechanisms, surface modeling in any available CAD package.

Recommended Books

1. Groover and Zimmer, 'CAD/CAM', Prentice Hall.
2. I. Zeid, 'CAD/CAM: Theory and Practice', McGraw Hill.
3. M.E. M, 'Geometric Modeling'.

INDUSTRIAL AUTOMATION

Subject Code: MMEE2-208 **L T P C** **Duration – 42 Hrs**
4 0 0 4

UNIT-I (8 Hrs)

Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines.

UNIT-II (12 Hrs)

Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods. Automated Manufacturing Systems: Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation, Quality Control Systems: Traditional and Modern Quality Control Methods, SPC Tools,

UNIT-III (13 Hrs)

Control Technologies in Automation: Industrial Control Systems, Process Industries Versus Discrete-Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms. Computer Based Industrial Control**:** Introduction & Automatic Process Control,

Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, SCADA Systems & RTU. Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems

UNIT-IV (9 Hrs)

Modeling and Simulation for Plant Automation: Introduction, need for system Modeling, Building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement, Thermal Water Treatment & Steel Plants.

Recommended Books

1. M.P. Groover, 'Automation, Production Systems and Computer Integrated Manufacturing', Pearson Education, **2009.**

ADVANCE OPTIMIZATION TECHNIQUES

Subject Code: MMEE2-209 **L T P C** **Duration – 42 Hrs**

4 0 0 4

UNIT-I (09 Hrs)

Definition of Optimization: Meaning of Operations Research, Modeling in operation research, principles of modeling, Introduction to linear and non-linear programming problems and formulation of problems.

UNIT-II (11 Hrs)

Linear Programming: Characteristics, Assumptions and Applications, Graphical solutions of two variables LP Problem, Linear programming in standard form, Solution of LP by Simplex (including Big M and Two phase methods) and revised Simplex methods, Special cases of LP, Duality and dual Simple method, Sensitivity analysis of LP problems.

UNIT-III (12 Hrs)

Network Models: Transportation problem, Transshipment problem, Assignment problem, Traveling-salesman problem, Shortest route problem, Minimal spanning tree problem, Maximum flow problem. CPM & PERT: Characteristics & uses, drawing of network, removal of redundancy in network. Computation of EOT, LOT, free slack, total slack in CPM and PERT, crashing, resource allocation Dynamic Programming: Deterministic and Probabilistic Dynamic Programming Game theory: Two-person, Zero-sum games, Games with mixed strategies, Graphical solution, Solution by linear programming.

UNIT-IV (10 Hrs)

Non-linear Programming: Characteristics, Concepts of convexity, maxima and minima of functions of n variables using Lagrange multipliers and Kuhn-Tukker conditions, Quadratic programming, One dimensional search methods, Fibonacci and golden section method, Optimization using gradient methods for unconstrained problems.

Recommended Books

1. S.S. Rao, 'Engineering Optimization Theory and Practice', New Age International.
2. Kalyanmoy Deb, 'Optimization for Engineering Design', Prentice Hall of India.
3. J.S. Arora, 'Optimization Technique', John Wiley.

LAB-II

Subject Code: MMEE2-210 **L T P C**
0 0 4 2

One lab /field/industrial oriented project /problem will be allocated to each student related to the subjects related to the subjects taught in 2nd Semester.

MODELING & SIMULATION OF MECHANICAL SYSTEMS

Subject Code: MMEE2-259 **L T P C** **Duration – 41 Hrs**
4 0 0 4

UNIT-I (10 Hrs)

Modelling in Multi-Energy Domain Through Bond Graphs: Introduction to bond graphs, Power variables of bond graphs and models of simple circuits, Reference power directions, Bond graph elements and their constitutive relations, Causality, Generation of system equations from bond graph models. The Idea of activation.

UNIT-II (10 Hrs)

System Modeling: Modeling of a system of rigid bodies, structural systems, Hydraulic systems, Thermal systems, electronic and mechatronic systems.

Modeling of multi body systems: mechanisms, parallel and hybrid manipulators and vehicles

UNIT-III (10 Hrs)

Advanced Topics in Bond Graph Modeling of Physical Systems: Elements of multiband graphs, Thermo-mechanical bond graphs and continuous systems, bond graph for welding dynamics and plant water dynamics, thermal modeling of twin tube shock absorber and car cabin exposed to sunlight.

Control System: Modeling systems for control strategies and design of control strategies in physical domain. Numerical prototyping as modeling for design and synthesis using computational tools like SYMBOLS, MATLAB etc.

UNIT-IV (11 Hrs)

Research Assignment: The students work in groups to model different dynamic systems through Bond Graph. Project activity include group formation and selection of team leader, preparation of questionnaire, computer usage in Bond Graph modelling and control using SYMBOLS,

conversion of Bond Graph model into Simulink model in MATLAB through signal flow graph, presentation (at least three in a semester), final technical report and daily diary.

Recommended Books

1. Mukherjee, R. Karmakar, A.K. Samantaray, 'Bond Graph in Modeling, Simulation and fault Identification', CRC Press, FL **2006.**
2. D.C. Karnopp, D.L. Margolis, R.C. Rosenberg, 'System Dynamics, Modeling and Simulation of Mechatronic Systems', John Wiley & Sons, **2000.**
3. B. Ould Bouamama, J. Thoma, Jean U. Thom, 'Modelling and Simulation in Thermal and Chemical Engineering: A Bond Graph Approach', Springer, New York, **2000.**
4. Dean Karnopp, 'Vehicle Dynamics, Stability and Control', CRC Press, **2013.**

WELDING METALLURGY

Subject Code: MMEE2-260 **L T P C** **Duration – 41 Hrs**

4 0 0 4

UNIT-I (08 Hrs)

Solidification of pure metals; micro and macro structure, elastic / plastic deformation, recrystallization, work hardening.

UNIT-II (10 Hrs)

Equilibrium diagrams of common binary alloy systems; non, fully and partially mixable components, their construction and use.

UNIT-III (12 Hrs)

Fe-C diagram; diffusion; equilibrium and non-equilibrium transformation in Fe-C system. C-curves, solidification, under cooling, ingot structure and coring. Phase transformation in steel; pearlitic, Bainitic, martensitic reactions and related properties; hardenablity, Heat treatment of steels; austenitising, annealing, normalizing, spherodising, stress relieving; T-T-T & C-C-T diagrams.

UNIT-IV (11 Hrs)

Effect of Micro – alloying elements on structure and mechanical properties of steels
Structure of welds, fusion, Thermal Field, Heat distribution, Heat input, peak temperature, cooling rate, solidification of weld pool, fusion line, HAZ, Single and Multi pass welding

Recommended Books

1. Fundamental of Welding, 'Welding Handbook', Part – I, American Welding Society.
2. J.L. Lancaster, 'Metallurgy of Welding', Woodhead Publishing Ltd.
3. Metals and their Weldability, 'Welding Handbook', Part – 4, American Welding Society.

GAS DYNAMICS

Subject Code: MMEE2-261 **L T P C** **Duration – 47 Hrs**
4 0 0 4

UNIT-I (11 Hrs)

Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves

One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations

UNIT-II (12 Hrs)

Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number;

Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves;

UNIT-III (12Hrs)

Expansion Waves: Prandtl-Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves;

Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers;

Flow with Heat addition or removal: One-dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition, one-dimensional constant area flow with both heat exchanger and friction;

UNIT-IV (12 Hrs)

Generalized Quasi One-Dimensional Flow: Governing equations and influence coefficients, solution procedure for generalized flow with and without sonic point;

Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential, linearized solutions, linearized subsonic flow, linearized supersonic flow, method of characteristics.

Recommended Books

1. L.D. Landau and E.M. Lifshitz, 'Fluid Mechanics'.
2. Dover Pub, 'Elements of Gas Dynamics', **2001.**