COURSE STRUCTURE AND SYLLABUS

for

M.Tech. Programme in Mechanical Engineering

<u>Regular 4 Semester Programme</u>

- **M.Tech. in Mechanical Engineering**
- **M.Tech. in Mechanical Engineering with specialization in Computer Integrated Manufacturing**
- **M.Tech. in Mechanical Engineering with specialization in Computer Aided Design**
- **M.Tech. in Mechanical Engineering with specialization in Advanced Computer Aided Design**
- **M.Tech. in Mechanical Engineering with specialization in Manufacturing Science & Technology**
- **M.Tech. in Mechanical Engineering with specialization in Manufacturing Systems Engineering**
- **M.Tech. in Mechanical Engineering with specialization in Production Engineering**
- **M.Tech. in Mechanical Engineering with specialization in Thermal Engineering**
- **M.Tech. in Mechanical Engg. with specialization in Machine Design**

<u>Part Time 6 Semester Programme</u>

- **M.Tech. in Mechanical Engineering with specialization in Design Engineering**
- **M.Tech. in Mechanical Engineering with specialization in Industrial System Engineering**
- **M.Tech. in Mechanical Engineering**

M.Tech.- Mechanical Engineering (Regular Programme)

Semester I

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Applied Operations Research
Elective-I

Semester 2

Optimization for Engineering Design
Advanced Mechanics of Solids
Production Technology
Elective-II

Semester 3

Advanced Thermal Engineering
Open Elective
Dissertation #
Seminar / Minor Project

Semester 4

Dissertation

M.Tech.- Mechanical Engineering (Regular Programme)

Specialization: COMPUTER INTEGRATED MANUFACTURING

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Advanced Computer Aided Design
Elective-I

Semester 2

Optimization for Engineering Design
Computer Aided Manufacturing
Robotics & Control
Elective-II

Semester 3

Advance Machining Processes
Open Elective
Dissertation #
Seminar / Minor Project

Semester 4

Dissertation

M.Tech.- Mechanical Engineering (Regular Programme)

Specialization: COMPUTER AIDED DESIGN

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Geometric Modelling
Elective-I

Semester 2

Optimization for Engineering Design
Manufacturing Automation
Advanced Mechanics of Solids
Elective-II

Semester 3

Interactive Computer Graphics & Design
Open Elective
Dissertation #
Seminar / Minor Project

Semester 4

Dissertation

M.Tech.- Mechanical Engineering (Regular Programme)

Specialization: ADVANCED COMPUTER AIDED DESIGN

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Geometric Modelling
Elective-I

Semester 2

Optimization for Engineering Design
Advanced Mechanics of Solids
Information System in CAD/CAM
Elective-II

Semester 3

Interactive Computer Graphics & Design
Open Elective

| Dissertation # |
| Seminar / Minor Project |

Semester 4

Dissertation

M.Tech.- Mechanical Engineering (Regular Programme)

Specialization: MANUFACTURING SCIENCE & TECHNOLOGY

Semester 1

| Numerical Methods & Computer Programming |
| Simulation, Modelling and Analysis |
| Applied Operations Research |
| Elective-I |

Semester 2

| Optimization for Engineering Design |
| Computer Aided Manufacturing |
| Production Technology |
| Elective-II |

Semester 3

| Advance Machining Processes |
| Open Elective |
| Dissertation # |
| Seminar / Minor Project |

Semester 4

Dissertation

M.Tech.- Mechanical Engineering (Regular Programme)

Specialization: MANUFACTURING SYSTEMS ENGINEERING

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Computer Aided Design & Product Data Management
Elective-I

Semester 2

Optimization for Engineering Design
Quality Management Systems
Advanced Manufacturing Planning & Control
Elective-II

Semester 3

Design of Production Systems
Open Elective
Dissertation #
Seminar / Minor Project

Semester 4

Dissertation

M.Tech.- Mechanical Engineering (Regular Programme)

Specialization: PRODUCTION ENGINEERING

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Applied Operations Research
Elective-I

Semester 2

Optimization for Engineering Design
Computer Aided Manufacturing
Robotics & Control
Elective-II

Semester 3

Design of Production Systems
Open Elective
Dissertation #
Seminar / Minor Project

Semester 4

Dissertation

M.Tech.- Mechanical Engineering (Regular Programme)

Specialization: THERMAL ENGINEERING

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Advanced Thermal Sciences

Elective-I

Semester 2

Optimization for Engineering Design
Advance Heat Transfer
Design of Thermal Systems
Elective-II

Semester 3

Advance Fluid Mechanics
Open Elective
Dissertation #
Seminar / Minor Project

Semester 4

Dissertation

M.Tech.- Mechanical Engineering (Regular Programme

Specialization: MACHINE DESIGN

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Advanced Design of Mechanical System
Elective-I

Semester 2

Optimization for Engineering Design
Advanced Mechanical Vibrations
Advanced Mechanics of Solids
Elective-II

Semester 3

Experimental Stress Analysis
Open Elective
Dissertation#
Seminar/Minor Project

Semester 4

Dissertation

M.Tech.- Mechanical Engineering (Part Time Programme)

Specialization: DESIGN ENGINEERING

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Geometric Modelling

Semester 2

Optimization for Engineering Design
Manufacturing Automation
Advanced Mechanics of Solids

Semester 3

Interactive Computer Graphics & Design
Elective-I
Seminar / Minor Project

Semester 4

Elective-II
Dissertation #

Semester 5

Open Elective
Dissertation

Semester 6

Dissertation

M.Tech.- Mechanical Engineering (Part Time Programme)

Specialization: INDUSTRIAL SYSTEM ENGINEERING

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Applied Operations Research

Semester 2

Optimization for Engineering Design
Managerial Economics and Accounting
Project Management

Semester3

Design of Production Systems
Elective-I
Seminar / Minor Project

Semester 4

Elective-II
Dissertation #

Semester 5

Open Elective
Dissertation

Semester 6

Dissertation

M.Tech.- Mechanical Engineering (Part Time Programme)

Semester 1

Numerical Methods & Computer Programming
Simulation, Modelling and Analysis
Applied Operations Research

Semester 2

Optimization for Engineering Design
Advanced Mechanics of Solids
Production Technology

Semester 3

Advanced Thermal Engineering
Elective-I
Seminar / Minor Project

Semester 4

Elective-II
Dissertation #

Semester 5

Open Elective
Dissertation

Semester 6

Dissertation

Elective-I

Subject
Product Design and Development
CAD/CAM
Experimental Modal Analysis and Dynamic Design
Computer Aided Design of Thermal Systems
Computer Aided Design of Mechanical Systems
Advanced Mechanism Design
Machine Tool Design
Machining Science
Manufacturing System Analysis
Production, Planning and Control
Modern Manufacturing Processes
Metal Casting
Metal Forming
Computer Aided Process Planning & Control
Design for Manufacture
Rapid Prototyping and Tooling
Concurrent Engineering & Product Lifecycle Management
Quality Assurance
Power Plants Engineering
Computational Fluid Dynamics & Heat Transfer
Gas Turbines and Compressors
Combustion Engineering
Internal Combustion Engines

Elective-II

Finite Element Method
Industrial Automation & Robotics
Advanced Mechanical Vibrations
Theory of Elasticity & Plasticity

Fracture Mechanics
Industrial Tribology
Advanced Materials Technology
Heat Treatment of Metals
Advanced Welding Technology
Advanced Foundry Technology
Flexible Manufacturing Systems
CNC, FMS & CIM
Total Quality Management
Materials Management
Production & Operations Management
Computer Aided Plant Layout and Materials Handling
Metrology & Computer Aided Inspection
Work Science
Advanced Gas Dynamics
Cryogenics Systems
Cold Preservation of Food
Renewable Energy systems
Combustion, Engines and Pollution

Open Elective

Subject
Accounting & Financial Management
Information Systems and Data Management
Industrial Design and Ergonomics
Industrial Policy, Management Research and Development
Quantitative Techniques in Decision Making
Management Information Systems
Energy Management
Reliability, Maintenance Management & Safety
Environmental Pollution & Its Control
Artificial Intelligence in Engineering
Neural Network and Fuzzy Systems
Applied Probability and Statistics

Intelligent Instrumentation
Microprocessor Systems
Machine Vision
Micro-Electro-Mechanical Systems
Electric Drives
Alternative Fuels & Engine Pollution

SYLLABUS

M.Tech. Semester I
Compulsory Subjects -All specializations (Regular & Part Time)

NUMERICAL METHODS AND COMPUTER PROGRAMMING

Solution of Algebraic and Transcendental Equation: Newton-Raphson method including method of complex roots, Graeffe's root square method (Computer based algorithm and programme for these methods)

Interpolation and Approximation: Lagrange's and Newton-divided difference formula, Newton interpolation formula for finite differences, Gauss's forward and backward interpolation formulae, Bessel's and Laplace-Everett's formulae, Cubic spline, least squares approximation using Chebyshev polynomial.

Solution of Linear Simultaneous Equations: Cholesky's (Crout's) method, Gauss-Seidel iteration and relaxation methods, Solution of Eigenvalue problems; Smallest, largest and intermediate Eigen values (Computer based algorithm and programme for these methods)

Numerical Differentiation and Integration: Numerical differentiation using difference operators, Simpson's 1/3 and 3/8 rules, Boole's rule, Weddle's rule.

Solution of Differential Equations: Modified Euler's method, Runge-Kutta method of 2nd, 3rd and 4th orders, Predictor-Corrector method, Stability of Ordinary differential equation, Solution of Laplace's and Poisson's equations by Liebmann's method, Relaxation method.

Books:

1.	Numerical Method for Scientific and Engineering Computation	M.K. Jain, S.R.K. Iyenger and R.K. Jain	Wiley Eastern Ltd.
2.	Numerical Methods for Engineers	S.K. Gupta	Wiley Eastern Ltd.
3.	Numerical Methods	B.S. Grewal	Khanna Publications
4.	Numerical Methods	A.D. Booth	Academic Press, NY

5.	An Introduction to Numerical Analysis	K.E. Atkinson	John Wiley & Sons, NY
6.	Introduction Methods of Numerical Analysis	S.S. Sastry	Prentice Hall of India
7.	Elementary Numerical Analysis	S.D. Conte	McGraw Hill

SIMULATION, MODELLING AND ANALYSIS

Introduction: A review of basic probability and statistics, random variables and their properties, Estimation of means variances and correlation.

Physical Modelling: Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic activities, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation

System Simulation: Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages.

System Dynamics: Growth and Decay models, Logistic curves, System dynamics diagrams.

Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs.

Simulation of Mechanical Systems: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems.

Simulation of Manufacturing Systems: Simulation of waiting line systems, Job shop with material handling and Flexible manufacturing systems, Simulation software for manufacturing, Case studies.

Books:

1.	System Simulation	Geoffrey Gordon	Prentice Hall
2.	System Simulation: The Art and Science	Robert E. Shannon	Prentice Hall
3.	System Modelling and Control	J. Schwarzenbach and K.F. Gill	Edward Arnold
4.	Modelling and Analysis of Dynamic Systems	Charles M Close and Dean K. Frederick	Houghton Mifflin
5.	Simulation of manufacturing	Allan Carrie	John Wiley & Sons

ADVANCED COMPUTER AIDED DESIGN

Introduction and Review of CAD: Introduction, Graphics Hardware input, display and output devices, Software configuration and functions, Graphics standards.

Output Primitives: Bresenham's Circle and Ellipse generating algorithms, problems.

Three Dimensional Transformations: Three Dimensional Geometric Transformations, multiple transformation, Rotation about an arbitrary axis in space, Parallel projections–Matrix equations for Orthographic, Oblique and Axonometric projections, Perspective transformations, equation for one point perspective projections, Stereographic projection.

Curves: Parametric representation of plane curves, space curves, Hermite curves, Bezier curves-generation and properties, B-spline curves-generation and properties, uniform, open uniform and non uniform B-splines, Rational B-spline curves.

Surface Description and Generation: Parametric representation, Surfaces of revolution, Sweep surfaces, Bilinear surface, Ruled and developable surfaces, Coons bicubic surfaces, Bezier and B-spline surfaces.

3D Graphics: Polygon mesh generation, Wire frame and Solid models; Sweep, Boundary and Constructive Solid Geometry of solid modeling, Problems.

Books:

1.	Computer Graphics	D Hearn & M P Baker	Prentice Hall
2.	CAD/CAM Theory and Practice	Ibrahim Zeid & R Sivasubramanian	Tata McGraw-Hill
3.	CAD/CAM Principles and Applications	P N Rao	Tata McGraw-Hill
4.	Computer Aided Engineering Design	A Saxena and B Sahay	Anamya Publications
5.	Mathematical Elements for Comp. Graphics	D F Rogers and J A Adams	McGraw-Hill International
6.	CAD/CAM	H P Groover and E W Zimmers	Prentice Hall

GEOMETRIC MODELLING

Geometric Modelling and Applications: Introduction, wire frame models and entities, curve representations, parametric representation of analytical curves, synthetic curves, Bezier curves, B-spline curves, Rational curves, curve manipulations, design and engineering applications.

Surface Modelling: Introduction, Surface models and entities, surface representation, Parametric representation of analytic and synthetic surfaces, Non-uniform rational B-splines (NURBS), Coon's and Bezier surface patches, Ruled, lofted, revolved and swept surfaces, Surface manipulations, design and engineering applications.

Solid Modelling: Wire frame models, Solid models and entities, Half spaces-basic elements, building operations, B-representation-basic elements and building operations, Constructive Solid geometry-basic elements & basic operations, Sweep representation, Analytical solid modeling,

Solid modeling of components using computer software, Advances in Computer Aided Engineering Design, Failure considerations in designing, Robust design, Reliability, Ergonomic considerations in Design, Feature based design, Design for manufacturing, Design for Automation, CAD of complex Engg. Systems.

Books:

1.	Computer Graphics	D Hearn & M P Baker	Prentice Hall
2.	CAD/CAM Theory and Practice	Ibrahim Zeid & R Sivasubramanian	Tata McGraw-Hill
3.	CAD/CAM Principles and Applications	P N Rao	Tata McGraw-Hill
4.	Computer Aided Engineering Design	A Saxena and B Sahay	Anamya Publications
5.	Mathematical Elements for Comp. Graphics	D F Rogers and J A Adams	McGraw-Hill International
6.	CAD/CAM	H P Groover and E W Zimmers	Prentice Hall

APPLIED OPERATIONS RESEARCH

Introduction: Definition and scope of OR, Techniques and tools, model formulation, general methods for solution, Classification of Optimization problems, Optimization techniques

Linear Optimization Models: Complex and revised Simplex algorithms, Degeneracy and duality, Post optimum and Sensitivity analysis, Assignment, transportation and transshipment models, Traveling salesman problem, Integer and parametric programming.

Game Problems: Minimax criterion and optimal strategy, two persons zero sum game, Games by Simplex dominance rules.

Waiting Line Problems: Classification of queuing problems, M/M/1 & M/M/1/N queuing systems, Steady state analysis of M/M/m queues, Discrete and continuous time Markov models, Chapman-Kolmogorov equation, Birth & death processes in manufacturing, Open and Closed queuing networks.

Inventory Management: ABC analysis, deterministic and Probabilistic models.

Dynamic Programming: Characteristics of dynamic programming problems, Bellman's principle of optimality, Problems with finite number of stages.

Stochastic Programming: Basic concepts of Probability theory, Stochastic linear programming.

Books:
1.	Elements of Queuing Theory	Saaty	Pitam
2.	Nonlinear and Dynamic Programming	Hadley	Addison Wesley
3.	Fundamentals of Operations Research	Ackoff & Sasieni	Wiley eastern
4.	Principles of OR with Applications to Managerial Decisions	Wagner	Prentice Hall
5.	Operations Research	Taha	McMillan
6.	Operations Research	R Panneerselvam	Prentice Hall of India
7.	Operations Research	A P Verma	S.K. Kataria & Sons
8.	Introduction to Operations Research	Hillier and Lieberman	Prentice Hall

COMPUTER AIDED DESIGN & PRODUCT DATA MANAGEMENT

Computer Graphics: Windowing and Clipping algorithms, Bresenham's Circle and ellipse generating algorithms, Three Dimensional geometric transformations, multiple transformation.

Geometric Modelling: Dimensions of models, Types, Wire frame modeling, Solid modeling, Parametric representation of analytic curves-Line, Circle, Ellipse, parabola, hyperbola, conics.

Parametric representation of Synthetic curves-Hermite cubic curves, Bezier curves, B-spline curves, rational curves. Curve manipulations-displaying, evaluating points on curves, Blending, segmentation, Trimming, Intersection.

Surface models, surface entities, Parametric representation of analytic surfaces-planed and ruled surfaces, Surface of revolution, Tabulated cylinder, Parametric representation of synthetic surfaces-Hermite bicubic, Bezier and B-spline surfaces, Coons surface, offset surface, Triangular patches, sculptured surface, Rational parametric surface. Surface manipulations-Displaying, evaluating points & curves on surfaces, segmentation, Trimming, Intersection, Projection.

Assembly and Modelling Software Standards: Introduction, assembly modeling-Parts modeling and representation, Hierarchical relationships, Mating conditions. Inference of position from mating conditions. Representation schemes-Graph structure, Location graph, Virtual link, generation of assembly sequences-Precedence diagram, Liasion-Sequence analysis, Precedence graph, Assembly analysis programs.

Graphics database structure and handling, Operating features, Symbols, micros. Editing facility, Data selection, Graphic transformation, Plotting. Graphic standards-GKS and CORE, GKS-3D and PHIGS, IGES, Other graphic standards.

Introduction to Product Data Management (PDM): Present market constraints-need for collaboration Internet and developments in server-client computing. Components of PDM: Components of a typical PDM setup, hardware and document management, creation and viewing of documents, creating parts version, Control of parts and documents, case studies.

Configuration Management: Base lines, product structure, configuration management, Products configuration, Comparison between sales configuration and products, Generic product modeling. Projects and roles: Creation of projects and roles, life cycle of a product, life cycle management, automation information flow, work flow, creation of work flow. Templates, life cycle, work now integration, Case studies.

Books:
1.	Computer Graphics	D Hearn & M P Baker	Prentice Hall
2.	CAD/CAM Theory and Practice	Ibrahim Zeid & R Sivasubramanian	Tata McGraw-Hill
3.	Principles of Computer Graphics	W.M. Neumann and F Robert	McGraw-Hill Co., Singapore
4.	Principles of CAD	J Rooney &P Steadman	Longman Higher Education
5.	CAD/CAM	H P Groover and E W Zimmers	Prentice Hall
6.	PDM: Product data Management	Rodger Burden	Resource Publishing

INTRODUCTION TO MECHANICAL DESIGN

Concepts of stress, strain and theories of failure, Design principles: Strength, rigidity and wear considerations, Design for strength, static and dynamic loadings, Manufacturing considerations: Limits, fits and standarisation, Design of shafts, Keys, Splines, springs. Design of riveted, bolted, welded and friction joints, Power screws, design of sliding and rolling contact bearings, Material selection and design processes.

Theory and principles of design of – Couplings, Clutches, brakes, belt and chain drives, Spur, Helical, bevel and Worm gear drives, Lubrication systems.

Failure-Quality loss and robust design, Service failure modes, Characterisation and interpretation, Deformation modes-Yielding and creep, Ductile and brittle fracture-Fatigue and fracture mechanics approach to design, Cumulative damage-Life prediction, Wear modes and control, Systematic approach to failure analysis.

Books:
1. Mechanical Engineering Design   J.E. Shigley and L.D. Mitchel   McGraw Hill International
2. Fundamentals of Machine Component Design   R.C. Juvinal   John Wiley and Sons
3. Design of Machine Elements   M.F. Spottes   Prentice Hall India
4. Failure of Materials in Mechanical Design   J.A. Collens   John Wiley & Sons
5. Metal Fatigue in Engineering   H.O. Fuchs   John Wiley & Sons
6. Mechanical Metallurgy   G.E. Dieter   McGraw Hill

INTRODUCTION TO ELECTRONICS AND ELECTRICAL ENGINEERING

Basic Electronics-Diode, Transistor Biasing and Introduction to experimental mode of transistor (Low frequency and high frequency analysis), Operation amplifiers-Application of operational amplifier characteristics and equivalent circuits, Power amplifier: Class A, Class B, Class C, Class AB efficiency calculation and heat sinks, Feed back amplifiers-Advantages, disadvantages, Classification (positive and negative feedback), V & I feedback.

Oscillators-PC phase shift, LC Wein bridge & crystal, Digital- Number system, Boolean algebra, Gates, K-map, sequential circuits, Brief introduction of-Transformer, motors AC/DC, Solid sate devices- SCR, IGBT, Converters & Invertors, Variable speed drives (AC & DC), Transducers.

Books:
1. Integrated Electronics   Millman Halkias   Tata McGraw-Hill
2. Digital Design   M. Morris Mano   McGraw-Hill
3. Operational Amplifier-Linear Integrated Circuits   Gayakwad   Prentice Hall India
4. Power Electronics   Mohammad H. Rasid   Prentice Hall India
5. Electrical and Electronics Measurement & Instrumentation   A.K. Sawhney   Dhanpat Rai & Sons

ADVANCED THERMAL SCIENCES

Recapitulation of Fundamentals: Basic definitions & concepts, Simplified Carathedory's formulation, Equation of state-Calculation of Thermodynamic properties, Generalized compressibility charts, Second law analysis-availability, Thermodynamics of reactive mixtures, Stoichiometry, First and Second law analysis of chemical reactions, Elements of irreversible thermodynamics.

Derivation of 3D generalized conduction equation, steady state conduction, Transient conduction, Numerical methods, Fundamentals of discretization, radiation heat transfer, Surface properties, Configuration factors, Calculation of radiative heat exchange between grey surfaces, Fundamentals of two-phase flow, Condensation & evaporation.

Navier-Stokes equation, Potential flow theory: Flow around bodies, Cylinder and aerofoil, Transformation of circle into aerofoil, Boundary layer theory: Basic equations, Blasius solution, Integral similarity solutions, Fundamentals of turbulent boundary layer, Convective heat transfer in laminar and turbulent flow.

Books:
1. Thermal Spraying for Power Generation Components   Klaus Erich Schneider   -
2. Engineering thermodynamics   Jones & Dugan   -
3. Engineering thermodynamics   Achuthan   -
4. Thermal Engineering   Sarkar   -

Advanced Design of Mechanical System

System Design approach for mechanical engineering, Constraints and creativity, Selection of Material & process in mechanical design, concurrent Mechanical Engineering design and its implementation, Design Methodologies of Total Design, Design for quality and manufacture, design for assembly, Recent advances in content and approaches of mechanical engineering design and new design strategies like design for X.

Review of static strength failure analysis, theories of failure including Von-Misestheory based strength on load carrying capacities of members, effect of small inelastic strains and residual stresses on load carrying capacity, theory of limit design.

High cycle and low cycle fatigue, cumulative damage theories, acoustical and thermal fatigue, corrosion and fretting fatigue, pitting of gears, fatigue strength of joints, components and structures, exercise of fatigue design of shafting and gears, Exercises of surface fatigue design of rolling contact bearings. Creep behavior, an elastic and plastic creep, rupture theory, analysis of tensile creep data, creep in high temperature low cycle fatigue, creep analysis of thick walled cylinders and rotating discs.

Designing against fracture, theories of brittle fracture, Yield Criteria for ductile isotropic materials under multi axial state of stress, fundamental aspects of crack growth and fractures, fatigue crack propagation fracture toughness data, stress corrosion cracking.

Reference :
1. Fatigue design Procedures by Gasner & Shulz, Pergoman Press.
2. Fracture An AdvanceTreatise by H.Liebawitz, Academic Press, Vol 1-6.
3. Fatigue of Metals by P.G. forest, Pergoman Press.
4. Mechanical Engineering Design by Toseph E. Suigley, McGraw Hill.

SYLLABUS
M.Tech. Semester II
Compulsory Subjects -All specializations (Regular & Part Time)

OPTIMIZATION FOR ENGINEERING DESIGN

Introduction: Historical Developments, Engineering applications of Optimization

Classical Optimization Techniques: Introduction, Review of single and multivariable optimization methods with and without constraints, Non-linear one-dimensional minimization problems, Examples.

Constrained Optimization Techniques: Introduction, Direct methods - Cutting plane method and Method of Feasible directions, Indirect methods - Convex programming problems, Exterior penalty function method, Examples and problems

Unconstrained Optimization Techniques: Introduction, Direct search method - Random, Univariate and Pattern search methods, Rosenbrock's method of rotating co-ordinates, Descent methods - Steepest Decent methods-Quasi-Newton's and Variable metric method, Examples.

Geometric Programming: Introduction, Unconstrained minimization problems, solution of unconstrained problem from arithmetic-geometric inequality point of view, Constrained minimization problems, Generalized polynomial optimization, Applications of geometric problems, Introduction to stochastic optimization.

Novel methods for Optimization: Introduction to simulated annealing, selection of simulated annealing parameters, simulated annealing algorithm; Genetic Algorithm (GA), Design of GA, Key concepts of GA, Neural Networks, A frame work for Neural Network models, Construction of Neural Network algorithm, Examples of simulated algorithm, genetic annealing and Neural Network method.

Books:

1.	Engineering Optimization	S. S. Rao	New Age International
2.	Applied Optimal Design	E. J. Haug and J.S. Arora	Wiley, New York
3.	Optimization for Engineering Design	Kalyanmoy Deb	Prentice Hall of India
4.	Optimization	G.V. Reklaites, A. Ravindran and K.M. Rogsdeth	Wiley, New York

COMPUTER AIDED MANUFACTURING

Introduction: Introduction to Automation, Need and future of NC Systems and CAM, Advantages and Disadvantages, Open and Closed loop systems, Historical developments and future trends. Future of NC Machines, Difference between ordinary and NC Machine tools, Methods for improving accuracy and productivity.

Control of NC Systems: Types of CNC Machine Tools systems devices, e.g. encoders and interpolators, Features of CNC Systems, Direct Numerical Control (DNC), Standard Controllers and General Programming features available in CNC Systems, Computer Process monitoring and Control. Adaptive control systems.

NC Part Programming: Manual Programming for simple parts, e.g., turning, milling, drilling, etc., Computer aided NC Programming in APT language, use of canned cycles, Generation of NC Programmes through CAD/CAM systems, Design and implementation of post processors.

Computer Aided Process Planning: Introduction, Manual process planning vs. Computer aided process planning, Basics of variant and generative process planning methods, Examples of automated process planning systems.

Computer Integrated Manufacturing: Introduction, features and applications of CIM, key elements, advantages and disadvantages of CIM.

Artificial Intelligence in Manufacturing: Introduction, Elements of Expert Systems, Introduction to Neural Networks, Expert Systems application in manufacturing, Case studies.

Books:

1.	Computer Control of Manufacturing Systems	Koren	-
2.	CAD/CAM	Groovers	Prentice Hall
3.	NC Machine Tools	S J Martin	-
4.	CAD/CAM	P N Rao	Tata McGraw Hill
5.	CAD/CAM	P Radhakrishnan, S Subramanyam, V Raju	-
6.	Computer Aided Manufacturing	Chang, Wysk & Wang	Prentice Hall of India

ROBOTICS & CONTROL

Introduction: Definition, Classification of Robots, Geometric classification and control classification.

Robot Elements: Drive systems, Control systems, sensors, End effectors, Gripper actuators and gripper design.

Robot Coordinate Systems and Manipulator Kinematics: Robot co-ordinate system representation, Transformation, Homogeneous transforms and its inverse, Relating the robot to its world.

Manipulators Kinematics, Parameters of links and joints, Kinematic chains, Dynamics of kinematic chains, Trajectory planning and control, Advanced techniques of kinematics and dynamics of mechanical systems, Parallel actuated and closed loop manipulators.

Robot Control: Fundamental principles, Classification, Position, path and speed control systems, adaptive control.

Robot Programming: Level of robot programming, Language based programming, task level programming, Robot programming synthesis, robot programming for foundry, press work and heat treatment, welding, machine tools, material handling, warehousing assembly, etc., automatic storage and retrieval system, Robot economics and safety, Robot integration with CAD/CAM/CIM, Collision free motion planning

Books:

1.	Robotic Technology (Vol. I-V)	Phillipe Collet	Prentice Hall
2.	An Introduction to Robot Technology	Coiffet and Chirooza	Kogan Page
3.	Robotics for Engineers	Y. Koren	McGraw Hill
4.	Robotics	K.S. Fu, R.C. Gonzalez & CSG Lee	McGraw Hill International
5.	Robotics	J.J. Craig	Addison-Wesley
6.	Industrial Robots	Groover, Mitchell Weiss, Nagel Octrey	McGraw Hill
7.	Robots & Manufacturing Automation	Asfahl	Wiley Eastern

MANUFACTURING AUTOMATION

Automation strategies, Flow lines, Automated assembly systems, Transfer systems, Vibratory bowl feeders, non vibratory feeders, Part orienting, Feed track, Part placing and part escapement systems.

Programmable Automation: Industrial robots, Robot elements, Robot Control-Fundamental principles, Classification, Position, path and speed control systems, adaptive control, Robot Programming-Level of robot programming, Language based programming, task level programming, Robot programming synthesis, robot programming for foundry, press work and heat treatment, welding, machine tools, material handling, warehousing assembly, etc., automatic storage and retrieval system, Robot integration with CAD/CAM/CIM, Collision free motion planning

Flexible Manufacturing systems: Features of Computer controlled machine tools, NC, DNC, CNC, VNC, automatic tool changers, tool design, group technology, cell design and layout, CAPP, Automatic material handling principles, Materials handling systems, Pallet design, Loading unloading station design

Books:

1.	Automation Production Systems and Computer Integrated Manufacturing	Groover	Pearson Education India
2.	Automation, Production Systems and Computer Integrated Manufacturing	Groover Mikell P	Prentice Hall
3.	Manufacturing, Automation Systems And CIM Factories	Asai K	Chapman and
4.	Manufacturing Automation at the Crossroads, Standardization in CIM Software	Louis-francois Pau	

ADVANCED MECHANICS OF SOLIDS

Analysis of stress and strain, Constitutive relationships, failure theories, Torsion of non-circular sections, Plane stress and plain strain problems, Review of fatigue analysis, Introduction to fracture mechanics, Inelastic behaviour, Viscoelasticity, Structure and behaviour of polymers, Behaviour of unidirectional composites and orthotropic lamina, Failure theories for fibre composites, development of various structures in composites, Computer based analysis and solutions to problems in mechanics of solids.

Books:

1.	Theory of Elasticity (Foundations of Engineering Mechanics)	A I Lurie	-
2.	Fracture Mechanics: Fundamentals and Applications	T.L. Anderson	CRC Press
3.	Mechanical Behaviour of Materials: Engineering Methods for Deformation, fracture and Fatigue	Dowling, Norman E	Prentice Hall
4.	Engineering Mechanics of Solids	E.P. Popov	Prentice Hall of India
5.	Mechanics of Solids	AK Singh	Prentice Hall of India
6.	Advanced Fracture Mechanics	Kanninen, Melvin F, Popelar, Carl H and C.H. Popelar	Oxford University
7.	Engineering Mechanics of Composite Materials	Isaac M. Daniel Ori Ishai	Oxford University

INFORMATION SYSTEM IN CAD/CAM

Brief review of CAD/CAM, Flexible manufacturing systems, needs and elements of information integration approaches.

Fundamentals of Information Technology, Concepts, Information systems, Database systems, data processing, Types and structures, data models (Record base data models and object oriented models), Database linkage, Management Information Systems (MIS) and strategic information systems (SIS), Information networking, Network communication and selection of network communication systems and network topology, Medium access control methods for LAN and signaling methods, Network architectures and protocols, Network interconnections, devices and performances, Information integration paradigms, Data archiving and analysis, Application of IT based approaches in CAD/CAM.

Distributed design environment, Computer supported cooperative work and outsourcing, Computer Aided Process Planning (CAPP), Computerised layout planning, Parts oriented production planning systems, Computerised production scheduling: Group scheduling techniques and interactive group scheduling techniques, Online production control systems.

Web base manufacturing information management, real time responses, problems due to diversity of systems, Case studies and examples.

Books:

.	Principles of Computer Aided Design and Manufacturing	Amirouche Farid M L	Prentice Hall
2.	Microstation J : An Introduction To Computer Aided Design	Andrew L	Anderson Publisher
3.	Computer Aided Design and Synthesis Environment for Analog Integrated Circuits	Van Der Plas Geert	Kluwer Aca

4. Computer Aided Design- Software and Analytical Tools	C S Krishnamoorthy	Narosa Publishing House

PRODUCTION TECHNOLOGY

Welding Technology: Welding comparison with other fabrication processes, Classification, Fusion and pressure welding, Weldability of metals, Metallurgy of welding, Weld design, Stress distribution and temperature fields in the welds, Recent developments in welding viz. Diffusion, Friction, Electron beam and Induction welding, Cladding, Metallizing, Surfacing and Fabrication, Welding defects and inspection of welds, Thermal cutting of metals and its use in fabrication of process machines, Cutting of cast iron, stainless steel and non-ferrous metals.

Metal Forming: Classification of forming process, Stress, strain and strain rules, laws, Yield criterion and flow rules, Friction and lubrication in metal forming processes, Indirect compression processes e.g., Drawing and Extrusion processes, Direct compression processes e.g., forming and rolling, Theory of deep drawing, Load bounding techniques and upper bound estimates of field theory, Bending and forming, High-energy rate forming techniques and their applications, Recent advances in metal forming.

Metal Cutting: Tool geometry and signature, Theory of orthogonal and oblique metal cutting, Tool wear and lubrication, Theoretical evaluation of temperature fields at shear zone and tool-chip interface, Dynamics of metal cutting and machine tool stability, A critical review of theories of dynamic cutting machining at super high speeds, recent advances in cutting tool and science of metal cutting.

Books:
1. Fundamentals of Metal Machining   G. Boothroyd   -
2. Metal Forming Analysis   Avitzur   -
3. Metal Cutting Principle   M.C. Shaw   -
4. Theory of Plastic Deformation and Metal Working   V. Masterov & V. Berkovsky   -
5. Metal Cutting   E.M. Trent   -

QUALITY MANAGEMENT SYSTEMS

Review of Quality Control: Quality assurance, Total Quality Management (TQM), Core concepts, Quality gurus and their contribution, Quality costs and measurement.

Total Quality Control (TQC): TQC concepts, Responsibility, Learning from the west, TQC concepts categorized, Goals, habit of improvement, Perfection, Basics, Process control, Easy to see quality control as facilitator, Small lot sizes, Housekeeping, Less than full capacity scheduling, daily machine checking, Techniques and aids, Problems, Full proof devices, Tools of analysis, QC circles, TQC in Japanese-owned US electronics plant, TQC in Japanese-owned automotive plants.

Taguchi Methods: Review of design of experiments, Quality engineering, System, Parametric and tolerance design, Process optimization and robust product design using orthogonal arrays, Taguchi loss functions quality level, Taguchi online feed back quality control, Manufacturing tolerance design course will include software applications and industry case studies.

Total Quality Management (TQM): philosophy of TQM, Customer focus, Organisation, Top management commitment, Teamwork, Goal setting and bench marking, TQM systems-Quality policy deployment, Quality function deployment, Standarisation, Designing for quality, MANUFACTURING FOR QUALITY, implementation-KAIZEN, POKA YOKE, Six sigma etc.

Quality System and Standards: ISO 9000 system QS 9000, ISO 14000- need, Advantages, Clauses, Implementation, Quality auditing, Case studies,

Books:
1. Total Quality Control   A.V. Feigenbaum   McGraw Hill
2. Total Quality Management-A Practical Approach   H. All   Wiley eastern
3. Quality Engineering Production Systems   G.L. Taguchi and Syed et. al.   McGraw Hill
4. Essence of TQM   John bank   Prentice Hall
5. SPC-Concepts, Methodology and Tools   Zaidi   Prentice Hall
6. ISO 9000   Perry L Johnson   McGraw Hill
7. TQM for Engineers   M. Zairi   Woodhead Publication

ADVANCED MANUFACTURING PLANNING & CONTROL

Introduction to Manufacturing Systems Engineering: Process Planning, Logical design of process planning, Computer Aided Process Planning (CAPP), Computerisation of file management; Variant (Retrieval), Generative and demigenertaive approaches, General remarks on CAPP developments and trends.

Resource Planning & Production Control: Overview of production control, Forecasting, Master production schedule, Materials requirements planning, Evolution from MRP to MRP II, Evaluation of MRP approach, Order release, Shop floor control.

Just in Time (JST) Production: Introduction- The spread of JIT movement, Some definitions of JIT, Core Japanese practices of JIT, Profit through cost reduction, Elimination of over production, Quality control, Quality assurance, Respect for humanity, Flexible work force, JIT production adapting to changing production quantities, Process layout for shortened lead times, Standardization of operation, automation.

Job Sequencing and Operations Scheduling: Introduction- Job sequencing-n jobs, One machine-n jobs, Two machine-n jobs, Three machines-n jobs- two jobs, M machines –n jobs, M machines-sequencing jobs on parallel machines, Minimization of setup costs.

Toyota Production System (TPS): Philosophy of TPS, Basic frame work, Kanbans, Determining number of Kanbans in TPS
(a)   Kanban number under constant quantity withdrawal system
(b)   Constant cycle, Non-constant quantity withdrawal system
(c)   Constant withdrawal cycle system for the supplier Kanban
Supplier Kanban and the sequence schedule for use by suppliers
(a)   Later replenishment system by Kanban
(b)   Sequence withdrawal system
Production smoothing in TPS, Production planning, Production smoothing, Adaptability to demand fluctuations, Sequencing method for the mixed model assembly line to realize smoothed production of goal.

Plant Configurations: Introduction-Ultimate plant configuration, Job shop fabrication, Dedicated production lines, Overlapped production, Daily schedule, Forward linkage by means of Kanban, Physical merger of processes, Adjacency, Mixed models, Automated production lines, Pseudo robots, Robots, CAD and manufacturing, Conveyers and stacker cranes, Automatic Quality monitoring.

Books:

1.	Principles of Process Planning	G. Halevi and R.D. Weill	Chapman and Hall
2.	Toyota production System-An Integrated Approach to Just in Time	Yasuhiro Monden	Engg. and Management Press
3.	Production and Operations Management	S.N. Chary	Tata McGraw Hill
4.	Operations Management	J.G. Monks	McGraw Hill
5.	Facility Layout and Location	Francis and White	Prentice Hall
6.	Just in Time Manufacturing	Kargoanker	-
7.	Lean Thinking	James Womack	-

PNEUMATIC & HYDRAULIC CONTROL

Introduction to control system, Types and utility, Hydraulic power generation and transmission, Valve control pressure flow relationship for hydraulic valves, Valve configurations and constructions, Steady state operating forces, Transient forces and valve stability, Circuit design, Pneumatic valves, Hydraulic and pneumatic drives.

Introduction to fluidic devices and sensors, Lumped and distributed parameter fluid systems, Fluid mechanics of jets, Wall attachment and vortex devices, Pure fluidic analog amplifiers, Analog signal control techniques, Design of pure fluid digital elements.

Physical concepts of pneumatics and electricals, Electro pneumatic components operation and application, Interpretation of electric ladder diagram.

Books:

1.	Fluid Power Control	J.F. Blackburn, G. Rechthof and J.L. Shearer	MIT
2.	The Analysis and Design of Pneumatic Systems	B.W. Anderson	Wiley Eastern
3.	Fluidic Components and Circuits	K. Foster and G. Parker	Wiley Eastern
4.	Fluid Power Systems	A.B. Goodwin	Macmillan
5.	Fluid Power with Applications	Anthony Esposito	Prentice Hall of India

ADVANCED HEAT TRANSFER

Review: Reviews of basic laws of Conduction, Convection and Radiation

Conduction: One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source, Local heat source in non-adiabatic plate, Thermocouple conduction error, Extended Surfaces-Review, Optimum fin of rectangular profile, straight fins of triangular and parabolic profiles, Optimum profile, Circumferential fin of rectangular profile, spines, design considerations. 2D steady state conduction, semi-infinite and finite flat plates, Temperature fields in finite cylinders and in infinite semi-cylinders, spherical shells, Graphical method, relaxation technique. Unsteady state conduction, Sudden changes in the surface temperatures of infinite plates, cylinders and spheres using Groeber's and Heisler charts for plates, cylinders and spheres suddenly immersed in fluids.

Radiation: Review of radiation principles, Diffuse surfaces and the Lambert's cosine law. Radiation through non-absorbing media, Hottel's method of successive reflections, Gebhart's unified method, Poljak's method. Radiation through absorbing media, Logarithmic decrement of radiation, Apparent absorptive of simple shaped gas bodies, Net heat exchange between surfaces separated by absorbing medium, Radiation of luminous gas flames.

Convection: Heat transfer in laminar flow, free convection between parallel plates, Forced internal flow through circular tubes, Fully developed flow, Velocity and thermal entry length, solutions with constant wall temperature and with constant heat flux, Forced external flow over a flat plate, 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, Prandtl-Taylor, Von Karman and Martineli's analogies, Turbulent flow through circular tubes.

Books:

1.	Advances in Heat Transfer	James P Hartnett	Academic Press
2.	Principles of Heat Transfer	Kaviany M	Wiley-International
3.	Heat Transfer: Principles and Applications	B.K. Datta	Prentice Hall of India
4.	Heat Transfer Calculations	Myer Kutz	McGraw-Hill Professional Publishing
5.	Convective Heat Transfer	Burmeister Louis	Wiley-International

DESIGN OF THERMAL SYSTEMS

Design of Refrigeration systems, design of Air-Conditioning equipments and systems, Design of turbo machines comprising of axial flow turbines and compressors, Centrifugal Compressor.
Analysis and Design of Thermal systems using FEM

Books:

1.	Developments In The Design Of Thermal Systems	Robert F Boehm	Cambridge University Press
2.	Design Analysis Of Thermal Systems	Boehm R F	John Wiley

MANAGERIAL ECONOMICS AND ACCOUNTING

Financial Accounting, Conventions, Balance sheet concepts, Profit and loss account, Accounting mechanics, Basic records, Preparing financial statements, Adjustment entries, Inventory valuations financial rations, Sources of funds, Cost of capital, cash flow statements, Simulation of cash flow accounting, Cost classification, Allocation and absorption of costs, Relevant costs, Allocation joint costs, design of historical and standard costing systems, Overhead cost control, Managerial

economics concept, demand theory and demand assessment, cost functions, Effect of plant size on cost, Production functions and their estimation, Market structure and price, Capital budgeting.

Books:

1.	Managerial Economics	G S Gupta	Tata McGraw-Hill
2.	Managerial Economics Concepts And Cases	V L Mote	Tata McGraw-Hill

PROJECT MANAGEMENT

Introduction, Computer Aided Project management, Computer Tools & software, Project Definition Structure, Work break down structure, Project functional organization, Project Budget and Cost control system, Project Planning and schedule control system using CPM and PERT networks, case studies.

Books:

1.	Project Management	K . Nagarajan	New AGE International
2.	Guide to the Project Management Body of Knowledge	Project Management Institute	Project Management Inst
3.	Project Management	Greer Michael	JAICO PUBL
4.	Successful Project Management	Trevor Young	viva

SYLLABUS
Compulsory Subjects -All specializations (Regular & Part Time)

ADVANCE MACHINING PROCESSES

Introduction: Limitations of Conventional machining processes, Need of advanced machining processes and its classification.

Mechanical Type Metal Removal Processes: Ultrasonic machining; Elements of the process; Tool design and economic considerations; Applications and limitations, Abrasive jet and Abrasive water jet machining principles; Mechanics of metal removal; Design of nozzles; applications, Abrasive finishing process, Magnetic abrasive finishing process

Thermal Type Advance Machining Processes: Classification, General principles and applications of Electro discharge, Plasma arc, Ion beam, Laser beam, Electron beam machining, Mechanics of metal removal in EDM, selection of EDM pulse generator dielectric, machining accuracy, surface finish and surface damage in EDM, Generation and control of electron beam for machining applications, advantages and limitations

Chemical and Electro-chemical Type Metal Removal Processes: Principle, working advantages, disadvantages and applications of Electrochemical, Chemical machining, Economy aspects of ECM, Electro-chemical deburring and honning

Hybrid Unconventional Machining Processes: Introduction to ECDM, ECAM, Abrasive EDM etc.

Books:

1.	Advance Machining Processes	V.K. Jain	New Age
2.	Modern Machining Processes	P.C. Pandey	New Age
3.	Manufacturing Processes	Degarmo	-
4.	Manufacturing Processes	Kalpakjian	Tata McGraw-Hill International

INTERACTIVE COPUTER GRAPHICS & DESIGN

Introduction, Developments and Present stage of computer graphics based design and modeling approaches.

Basic graphic standards, GKS, IGES, VDI, VDM etc. Principles of raster scan and vector graphics, Fundamental requirements, Plotting of points, Line drawing, DDA and Bresenham's algorithm, Circle generation algorithms, Ellipse generation algorithm, Scan conversions: Real time conversions, Run length encoding and cell encoding, character display, Polygon filling.

3D geometric transformations, inverse geometric transformations, Viewing in 3D, Representation of 3D shapes, rendering of surfaces and solids, hidden lines, edges and surface removals, Shading models, shadows, Representation scheme for colors, selection and mixing of colors.

Principle of developing animation, morphing etc. 3D industrial imaging and inspection systems, Human computer interaction tools and techniques, development of Virtual reality based environments, Development of industrial, medical and gamming applications.

Books:

1.	Computer Graphics	D Hearn & M P Baker	Prentice Hall
2.	CAD/CAM Theory and Practice	Ibrahim Zeid & R Sivasubramanian	Tata McGraw-Hill
3.	Computer Aided Engineering Design	A Saxena and B Sahay	Anamya Publications
4.	Mathematical Elements for Comp. Graphics	D F Rogers and J A Adams	McGraw-Hill International
5.	CAD/CAM	H P Groover and E W Zimmers	Prentice Hall

DESIGN OF PRODUCTION SYSTEMS

Essential of Manufacturing Systems: Basic system concepts, System design, Manufacturing systems, Structural and transformation aspect of manufacturing systems, Integrated manufacturing systems and its frame work.

Process System for Manufacturing: Modes of production-mass production, Multi-product small batch production, Group Technology based production, Cellular and flexible manufacturing systems, Automation systems for manufacturing, CAM/CIM, Economic evaluation of processes.

Discrete Part Manufacturing Systems: Different types and management decision system models, Basic approach of modeling, Analytical vs Simulation models, Modelling approach, Long run analysis, deterministic models, Binomial approximation, Sample path analysis, Markov models, Examples

High Volume Production System: Automated flow lines, Method of work part transport, Transfer mechanism, Automation for machining operations, Analysis of automated flow lines, Automated flow lines with/without buffer storage, computer simulation of automated flow lines, Automated assembly system, design for automated assembly, Analysis of multi-station assembly machines, Assembly systems and line balancing.

Manufacturing Process Design: Process planning and design, Process design operation design, Optimum routing analysis, Facility location and layout planning, Single and multiple facility placement problem, Continuous facility location, Computer Aided plant layout, Material handling system design, Storage & warehousing, Automated storage and retrieval systems, Simultaneous development of plant layout and material handling.

Management systems for Manufacturing: Managerial information flow in manufacturing systems, Decision problem in managerial information, flow, Production planning and scheduling, Production control, Scope and problems; Quality control & function deployment.

Information Systems for Manufacturing: Fundamentals of Information technology information systems, Information networking, Computerised manufacturing information systems

Books:

1.	Manufacturing	Hitomi	-
2.	Manufacturing Facilities	Sule	-
3.	Automation, Production Systems & Computer Aided Manufacturing	Groover	-

DESIGN OF MECHANISMS AND MANIPULATORS

Design of Mechanisms: Mobility analysis, Degree of freedom, Mixed mobility, Total, partial and fractional DOF, Closed and open chain systems, Structural analysis and synthesis of mechanisms.

Alternative design solutions, Coding, Evaluation and selection of optimum mechanism, Type synthesis, Number synthesis, and design of mechanisms, Indexes of merit, Graphical =, Algebraic and optimization techniques, Matrix method of design and analysis, Design of function path and motion generators, Structural and mechanical error, design and analysis using software like ADAMS.

Design of Manipulators: Classification, Actuation and transmission systems, Co-ordinate transformations, DH notations, Inverse and forward kinematics, Manipulators dynamics from Lagrangian and Newtonian point of view.

Books:

1.	Robot Design Handbook	G.B. Andeen	McGraw Hill
2.	Introduction to Robotics, Mechanics and Control	J.J. Craig	Addison Wesley
3.	Robotic Manipulators: Mathematics, Programming and Control	R.P. Paul	MIT Press
4.	Robot Dynamics and Control	M. Spong and M. Vidyasagar	JohnWiley, NY
5.	Dextrous Robot Hands	S.T. Venkataraman	Springer-Verlag

ADVANCE FLUID MECHANICS

Two-Dimensional Irotational Flow: Two dimensional irotational flow in rectangular and polar coordinates- Continuity equation and the stream function; Irrotationality and the velocity potential function; Voriticity and circulation; Plane potential flow and the complex potential function.

Sources, sinks, doublets and vorities-Superposition of uniform stream with above; Flow around corners; Ranbkine ovals; Flow around circular cylinders with and without circulation; Pressure distribution on the surface of these bodies and D'Alembert's paradox; Blasuis theorem for forces and moments; Method of residues, Conformal transformation of flows with solid boundaries.

Elements of two-dimensional aerofoil theory; Joukowski transformation; Circular are symmetrical aerofoil theory; Joukowski hypothesis, Lift and moment.

Three-Dimensional Irotational Flow: Irrotationality and the velocity potential function; Symmetric flows and the Stokes stream function; Sources, sinks.

Vortex Motion: Definition; Vortex lines; Surfaces and tubes; Vorticity; Kelvin's circulation theorem; Helmholtz's vorticity theorems; Convection and diffusion of vorticity.

Vortex filament, Biot-Savart law for induced velocities; Rectilinear vortex filaments; System of vortex filaments; Horse-shoe vortex filaments; Ring vortices; Vortex sheets; Karman vortex sheet.

Viscous Flow: exact solution; Plane Poiselle and Courtte flows; Hagen-Piselle flow through pipes.

Flow with very small Reynold's number, Stoke's flow around a sphere; Seen's approximations; Elements of hydrodynamic theories of lubrication, Hele-Shaw flow.

Flows with very large Reynold's number; Elements of two-dimensional boundary solutions for boundary layer on a flat plate without pressure gradient; Karman Polhausen integral method for obtaining approximate solutions.

Drag on bodies; Form drag and skin friction drag profile drag and its measurement.

Compressible Fluid Flow: Derivation of basic equations, Fanno flow, Rayleigh flow.

Books:

1.	Fluid Mechanics and Its Applications	Vijay Gupta & S.K. Gupta	New Age International
2.	Fluid Mechanics and Machinery	DR Durgaiah	New Age International
3.	Engineering Fluid Mechanics	J A Roberson And C T Crowe	Jaico Publishing House
4.	Fluid Mechanics: Problems And Solutions	Joseph H Spurk	-
5.	Introduction to Fluid Mechanics	A.F. James	Prentice Hall of India

ADVANCED THERMAL ENGINEERING

Basic Definitions & Concepts, Equation of state, Calculation of thermodynamic properties, Generalized compressibility charts, Second law analysis, Availability, irreversibility, Maxwell equations, Joule-Thomson coefficient, Thermodynamics of reactive mixtures, Stoichiometry.

Generalized conduction equation, Steady and unsteady heat conduction in a slab of finite thickness; Effect of heat generation; Non-zero initial condition, Constant flux and convective boundary conditions, Heat conduction in an inhomogeneous medium; Examples of composite media; Radiation heat transfer, Surface properties, Configuration factor, Radiative heat exchange between gray surfaces.

Navier-Stokes equation, Stream function, Velocity potential, Vorticity and circulation potential flow theory, Boundary layer theory.

Advance Manufacturing Technology

Metal forming – Nature of plastic deformation, fundamental theory of plasticity, Mechanics of forming processes like rolling, forging, drawing, extrusion etc. Various forming operations, Defects in metal forming, local instability & tearing, bending of sheets, hydro forming.

Metal casting – Metal casting processes, pattern & mould, moulding materials, elements of gating system design, riser design, solidification structure, solidification shrinkages structure, defects and properties of finished casting, heat treatment.

Welding Technology & Design – Welding processes, heat flow in welding, metallurgy of fusion weld, welding stresses and distortions, preheat and post weld heat treatment weldability and weldability tests, weld defects, weld inspection and quality control, weld design for static loading, weld design for dynamic loading, residual life assessment & failure analysis of weld structure, Destructive & non-destructive testing of weld structures.

Machining Processes – Mechanics of basic machining operations, various machining process like shaping, turning, boring, drawing, milling, grinding, surface finishing operations, cutting tool materials, tool geometry, optimization of cutting parameters. For minimum cost, for maximum productions and for maximum efficiency, design for machining (DFM)

Unconventional Machining Process-Need for unconventional process, analysis of electric discharge machining, electro chemical machining, ultrasonic machining Chemical machining, laser beam machining etc.

Integrated manufacturing- Selection of manufacturing process, designing for economic production, integrated manufacturing, tool and technology for integration.

References –
Production Process : P.N. Rao
Production Process : Kalpakjain

Experimental Stress-Analysis

Importance of experimental methods and their scope; whole field and point by point methods, Static and dynamic problems.

Photo Elasticity

Photoelastic effect and polarized light, permanent and temporary birefringence, Optics of plane and circular polariscope:Dark & light background; Isoclinic and isochromatics; stress otpics law for two-dimensional problems; secondary principal stresses.

Photoelastic model materials; preparation of model, firing order, compensation techniques : separation of principal stresses using extensometer, oblique incidence, shear difference and mumerical integrations of laplace's equation : Basic elements of three dimensional photoelsticty; photo elastic stress and strain gauges;

Other Optical Methods

Surface stress determination using birefringent coating, reinforcing Thickness effect of photo stress coats; moir's method; Scattered light technique in photoelasticity, advantages and scope, scattered light prlasiscope; elements of holography, preparation and interpretation of holograms.

Brittle Coating method

Characteristics and methods of applying brittle coatings on components, factors affecting accuracy failure analysis of cracks developed in coating; refrigeration techniques; calibration methods, scope of application.

Strain Gauge Technique

Review of strain measuring technique : Strain rosettes; transverse sensitivity; graphical and homographic solutions for determination of principal stresses from strain results, stress gauge.

References
1. Experimental Stress Analysis and Motion Measurements by Dow & Adaws, Prentice Hall.

2. Experimental Stress Analysis by Dally & Riley, McGraw Hill.
3. Applied Stress Analysis by Durelli, Prentice Hall.
4. Photoelasticity Vol. I & II by Forcht, John Wiley.
5. Introduction to Photmechanics by Durelli & Riley McGraw Hill.

SYLLABUS

M.Tech. Semester I

Elective-I Subjects -All specializations (Regular & Part Time)

PRODUCT DESIGN AND DEVELOPMENT

Introduction, Sources of new ideas, Development processes, Product planning, Identification for Customer needs and technology potentials, Innovation and intellectual property rights, Product and process Patents, Patents and patenting processes.

Product specifications, Tolerance specifications, Taguchi loss factor concepts, Quality function deployment, Functional specifications of products, Form and function, Development of alternatives.

Design for manufacture, Design for Assembly and design for economy, Prototyping and analytical prototyping, Stage-gate process of product development.

Holistic product development approaches-Form product concept to decommissioning, Environment requirements, Life cycle design, Product data management and Product life cycle management systems, Dependency and concurrent engineering in development of products. Internet based approach to product development involving users. Democratization of innovation, Connecting products to services, Experience innovation, Robust design, Patents and Intellectual properties, product Developments.

Books:

1.	Production Management	K K Ahuja	CBS Publishers
2.	Production Design and Manufacturing	A.K. Chitale & A.K. Gupta	Prentice Hall of India
3.	Management Development	Alan Mumford	Jaico Publishing House

CAD/CAM

Mathematical Elements, CAD, Solid modeling methods, Database structures for CAD, CSG formulation, B-rep and wire frame methods, Intersection surface generation methods, Boundary file generation methods, Feature based modeling systems, Surface modeling, B- splines, Coons and Bezier surfaces, NURBS and surface patches, fitting surfaces for arbitrary digested points, Offset surfaces, Fillet surfaces, Sewn surfaces.

Features recognition from the databases, IGES, STEP, PDES, and DXF data exchange formats, Graphic standards for CAD/CAM such as GKS, PHIGS and VDI.

Concurrent engineering integration of manufacturing principles and analytical principles in design, Manufacturing information generation from CAD data, Planar sectioning, Penalty functions, cavity milling, Optimization of cutter path, Effect of tool profile geometry, Methods for multi-axis machining, Methods for software design for CAD/CAM system, use of software libraries, Development of software package for a specific problem as part of course using software libraries.

Introduction to automation, CAM/CIM, Part programming, Interpolator & Control.

Books:

1.	Computer Graphics	D Hearn & M P Baker	Prentice Hall
2.	CAD/CAM Theory and Practice	Ibrahim Zeid & R Sivasubramanian	Tata McGraw-Hill
3.	Mathematical Elements for Comp. Graphics	D F Rogers and J A Adams	McGraw-Hill International
4.	Computer Aided Engineering & Design	Jim Browne	New ATC International
5.	The Engineering Database	D.N. Chorafas and S.J. Legg	Butterworths
6.	Principles of CAD	J Rooney &P Steadman	Longman Higher Education

| 7. | CAD/CAM | H P Groover and E W Zimmers | Prentice Hall |
| 8. | Computer Integrated Design and Manufacture | D Bedworth, M Henderson & P Wolfe | MacGraw Hill Inc. |

EXPERIMENTAL MODAL ANALYSIS AND DYNAMIC DESIGN

Introduction to modal testing, Dynamic test data measurement and processing methods, Frequency response function for multi-degree freedom systems, Forced response.

Experimental and Theoretical modal analysis-Algorithms and codes, Application of modal testing in system and force identification, Structural dynamic modification, Sensitivity analysis and frequency response coupling of substructure etc., Introduction to non-linear vibration analysis, Introduction to discrete systems and finite element modeling, Comparison of numerical data with test results, Introduction to model updating, Techniques of correlation of analytical and experimental models.

Dynamic design of mechanical equipment structures via model testing, structural dynamic modification and model testing.

Books:

1.	Modelling, Analysis and Control of Dynamic Systems	J.B. Bird and J.P. William	-
2.	Modelling & Analysis of Dynamic Systems	Charles M. Close, D.K. Fredrick and J.C. Newell	-
3.	Modelling & Analysis of Dynamic Systems	Charles M. Close, D.K. Fredrick	-
4.	System Dynamics Modelling, Analysis Simulation, Design	E.O. Doebelin	-
5.	Introduction to Dynamic Systems: Theory, Models & Applications	D.G. Luenberger	-

COMPUTER AIDED DESIGN OF THERMAL SYSTEMS

Study of the design aspects, fluid flow and heat transfer characteristics and material requirements of heat exchange equipments, Liquid-to-liquid and Liquid –to-gas heat exchange systems, Familiarity with use of design related International/National and other codes.

Design of any of the subsystems using compressor, condenser, evaporator and optimization for minimum cost and maximum performance etc., Development of computer programs for designing the systems.

Environmental considerations in design of thermal systems.

Books:

1.	CAD/CAM , Computer Aided Design and Manufacturing	M P Groover & E W Zimmers Jr	Prentice-Hall of India
2.	Computer Aided Design- Software And Analytical Tools	C S Krishnamoorthy	Narosa Publishing House
3.	Developments In The Design Of Thermal Systems	Robert F Boehm	Cambridge University
4.	Design Analysis Of Thermal Systems	R F Boehm	John Wiley

COMPUTER AIDED DESIGN OF MECHANICAL SYSTEMS

Design of static and Dynamic Components-Use of computer for Eigen value problems, Method of solutions.

Shaft design, calculation of critical speeds and vibration modes at different speeds, Effect of bearing flexibility.

Detailed design of mechanical systems viz, Gear box, Conveyer systems, Pumps, Machine tools such as Lathe, Drilling, Shaper machines etc., Application of CAD software

Books:

1.	Computer Algorithms- Introduction to Design and Analysis	Baase	Pearson Education India
2.	Principles of Computer Aided Design and Manufacturing	Amirouche Farid M L	Prentice Hall
3.	Computer Aided Mechanical Assembly Planning	Homem De Mello Luiz S	Kluwer Aca

ADVANCED MECHANISM DESIGN

Introduction: Concepts related to kinematics and mechanisms, Degrees of freedom, Grubler's Criteria, Transmission and Deviation angles, Mechanical advantage.

Kinematic Synthesis: Type, number and dimensional synthesis, Spacing of accuracy points, Chebyshev polynomials, Motion and function generation, Graphical synthesis with two, three and four prescribed motions and points, The complex number modeling in kinematic synthesis, The Dyad, Standard form, Freudentein's equation for three point function generation coupler curves, Robert's law, Cognates of the slider crank chain.

Path Curvature Theory: Fixed and moving centrode, Inflection points and inflection circle circle, Euler'-savary Equation, Bobillier's and Hartsman construction.

Dynamic Force Analysis: Introduction, Inertia force in linkages, Kineto static analysis by superposition and matrix approach, Time response of mechanisms, Force and moment balancing of linkages.

Spatial Mechanism: Introduction to 3-dimensional mechanisms, Planar Finite, Rigid body and spatial transformation, Analysis of spatial mechanisms.

Books:
1.	Fundamentals of applied Kinematics	D.C. Tao	Addison Wesley
2.	Kinematic Synthesis of Linkages	R. Hartenberg and Denavit	McGraw Hill
3.	Kinematic Analysis and Synthesis of Mechanisms	A.K. Mallik and A. Ghosh	CRC Press
4.	Theory of Mechanisms	A.K. Mallik and A. Ghosh	East west Press
5.	Kinematics and Dynamics of Plane Mechanisms	J. Hirschern	McGraw Hill, NY
6.	Mechanism Synthesis & Analysis	Soni	McGraw Hill

MACHINE TOOL DESIGN

Machine Tool Drive: working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanical transmission, General requirements of machine tool design, Layout of machine tools.

Regulation of Speed and Feed Rates: Aim of speed feed regulation, stepped regulation of speed, design of speed box, Design of feed box, Special cases of gear box design, Set stopped regulation of speed and feed rates.

Design of Machine Tool Structure: Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structure, Static and dynamic stiffness, Design of beds and columns, Design of housing models, Techniques in design of machine tool structure.

Design of Guide-ways and power Screws: Function and type of guide-ways, design of slide-ways, Protecting devices for slide-ways, Design of power screws.

Design of Spindles and Spindle Supports: Materials for spindles, Design of spindles, Antifriction bearings, Sliding bearings.

Dynamics of Machines Tools: General procedure of assessing dynamic stability of EES, Cutting processing, Closed loop system, Dynamic characteristics of cutting process, Stability analysis.

Books:
1.	Machine Tool Design	N.K. Mehta	Tata McGraw Hill
2.	Machine Tool design Handbook	-	CMTI Banglore

MACHINING SCIENCE

Mechanics of metal cutting-Tool geometry, Mechanics of orthogonal and oblique cutting, Shear angle relations in orthogonal cutting, Shear angle and chip flow direction in oblique cutting, Chip control methods, Analysis of cutting process, Machining with rotary tools, Thermodynamics of chip formation, Machining at super high speeds, Theories of tool wear, Basic action of cutting fluids, tool life, Factors governing tool life, Machinability-definition and evaluation.

Economics of metal cutting-Single and multipass machining operations, Criteria, variables, and restrictions for the economical conditions.

Dynamic metal cutting-Comparison of steady and dynamic process, Shear angle and force relationships, Grinding mechanics, Wheel characteristics and theory of wheel wear, Lapping, Honning, High speed grinding theory, Grinding of drills, form cutters etc., Problems associated with machining of plastics, Tools for plastic cutting, Analysis of non-conventional machining processes ECM, EDM, LBM, WJM, USM etc.

Books:
1. Metalwork and Machining Hints and tips (Workshop Practice)   Arnold Throp   -
2. Machining Fundamentals   Walker John R   Goodheart
3. Introduction to Machining Science   GK Lal   New Age International
4. Non-Conventional Machining   P K Mishra   Narosa Publishing House

MANUFACTURING SYSTEM ANALYSIS

Basic concept of manufacturing, manufacturing problems, Systems approach to manufacturing problems, Principle of modeling in mathematical and physical form, Types of model, Simulation in modeling, Sources of system error, Stability of linear and non-linear system, Adaptive control, System optimization techniques, Product design and part configuration project scheduling by PERT, GERT, flow graph, Productive maintenance.

Automation of production, Computer Aided Design, Computerised layout planning, Automated process planning, Automatic operation planning, Automatic and Computer Integrated Manufacturing, Automated assembly and Testing information systems for manufacturing.

Fundamentals of information system, data bank, On-line production management systems, Parts oriented production information system, Production information and management systems.

Books:
1. Manufacturing Process & system   Ostwald   Willey India Pvt. Ltd
2. Materials & Process in Manufacturing   E. Paul Degarmo, JT Black RA Kosher   Prentice Hall of India
3. Manufacturing Systems Design and Analysis   Wu B   Kluwer Aca
4. Queuing Theory in Manufacturing Systems Analysis and Design   Papadopoulos H T   Chapman
5. Performance Analysis of Manufacturing Systems   Altiok Tayfur   Springer-V

PRODUCTION, PLANNING AND CONTROL

Function of production, planning and control, Its importance in an organization, Manufacturing systems, Product development and design, Product analysis, Product characteristics, Break even analysis, Step-wise cost function, Learning cost-profit-volume charts, Economics of new design, Sales forecasting and estimating, Sales trend analysis and activity charts, Production order.

Quantity in batch production, Stock control, Minimum lot batch size, Production range, Maximum profit batch size, Maximum rate of return batch size.

Machine capacity, Machine operation, Multi machine supervision by one operator, Machine interface, Aschroft number, Balancing, Profit maximization.

Scheduling, Different forms, Sequencing, Batch production, Scheduling-maximum profit for whole schedule, Maximum return to whole schedule.

Elements of control procedure, Dispatching, Expediting, Computer aided production control.

Books:
1. Elements of Production, Planning and Control   Samual Eilon   -
2. Production, Planning and Control   SK Mukhopadhaya   Prentice Hall of India
3. Modern Production Management   Buffa   -

MODERN MANUFACTURING PROCESSES

Metal cutting: Need for rational approach to the problem of cutting metals-Observation in metal cutting, Energy considerations in machining, Modern theories in mechanics of cutting, Review of Merchant and Lee Shaffer theories, critical comparison, Measurement of cutting forces-Classification of cutting force dynamometers, Lathe tool dynamometer, Drill, Milling and grinding dynamometer, Heat distribution in machining-Effects of various parameters on temperature, Method of temperature measurement in machining, Hot machining, Cutting fluids.

Tool Materials, Tool Life and Tool Wear & Wear Mechanisms: Essential requirements of tool materials, Developments in tool materials, ISO specifications for inserts and tool holders, Tool life, Conventional and accelerated tool life tests, Concepts of machinability and mach inability index, Economics of machining, Reasons for failure of cutting tools, Forms of wear, Chatter in machining, Chatters types, Mechanism of chatter based on force vs Speed graph, Mechanism of grinding, Various parameters affecting grinding process, Machinability data systems.

Sheet Metal Forming & Special Forming Processes: Review of conventional processes, HERF techniques, Super plastic forming techniques, Principles and Process parameters, Advantages, applications and limitations of HERF techniques, Orbital forging, Isothermal forging, Hot and cold iso-static pressing, High speed extrusion, Rubber pad forming, Water hammer forming, Fine blanking.

Unconventional and special Welding Processes and Automation: Friction welding, Explosive welding, Diffusion bonding, High frequency induction welding, Ultrasonic welding, Electron beam welding, Laser beam welding, Automation in welding, Welding robots, Overview of automation of welding in aerospace, Nuclear, Surface transport vehicles and under water welding.

Special Casting Processes & Recent Advances in Casting: Shell moulding, precision investment casting, CO_2 moulding, Centrifugal casting, Die and continuous casting, Low pressure die casting, Squeeze casting, Full mould casting process, Layout of mechanized foundry, sand reclamation, Material handling in foundry, Pollution control in foundry, recent trends in casting, Computer aided design of casting.

Books:
1. Metal Cutting Principles — M.C. Shaw — Oxford Clarendon Press
2. Metal Cutting Theory and Practice — Bhattacharya — New Central Book Agency
3. Fundamentals of Metal Cutting and Machine Tools — B.L. Juneja and G.S. Sekhon — New Age International
4. Principles of Metal Cutting — G. Kuppuswamy — Universities Press
5. Fundamentals of Machining and Machine Tools — D.G. Boothroy and W.A. Knight — Marcel Dekker, NY
6. Fundamentals of Metal Casting — H. Loper and Rosenthal — Tata McGraw Hill
7. Metal forming-Fundamentals and Applications — T Altan, Soo-Ik-Oh and H.L. Gegel — American Society of Metals, Metal Park, 1983

METAL CASTING

Introduction: Features of Casting problems, Survey and Scope of Foundry Industry, Solidification of pure metals, Nucleation and growth in alloys, Solidification of actual casting, Progressive and directional solidification, Centreline feeding resistance, Rate of solidification, Chvorinov's rule, Electrical analog of solidification problems.

Gating and Risering Systems: Gating systems and their characteristics, Effects of gates on aspiration, Turbulence and dross trap, recent trends, Riser design, Risering curves, NRL method of riser design, Feeding distance, Risering of complex casting, Risering of alloys other than steel, Riser design by geometrical programming.

Moulding and Core Making: Review and critical comparison of various established processes, recent developments e.g. low pressure and ferrous die casting, High pressure moulding, Full mould process, Flaskless moulding, Hot and cold box moulding, Ceramic shell moulding, V-process, Continuous casting, Squeeze and pressed casting, Nishiyama process, Shaw process, Anitoch process, etc.

Melting and Fluidity: Selection and control of melting furnaces; molting, refining and pouring; Coupla design, Measurement of fluidity, Effect of various parameters on fluidity, Methods of elimination and control of gases in casting.

Internal Stress, Defects and Surface Finish: Residual stresses, Hot tears and cracks in casting; Stress relief, defects and their causes and remedies; Parameters affecting surface finish and related defects e.g., Rough casting, bum-on sand bum-in metal penetration, Facing and washes; Mold wall movement; transport zones, Expansion scabbing etc.

Casting of Sand, Design Considerations: Recent developments, e.g., Mulling index; Mouldability index, Compactability; deformability etc.

Foundry Practice: Casting of different Cast Irons, Steel, Aluminum, Zinc, Brass etc., Mechanization in Foundry, Use of Computers in foundry, Inspection and Quality Control-Review of X-ray and gamma ray radiography, Magnetic particle, Penetrant and Ultrasonic inspections, use of statistical quality control.

Books:
1. Bronze Sculpture Casting And Patination: Mud Fire Metal   Steve Hurst   Schiffer Publishing
2. Fine Art Metal Casting   Richard Rome   -
3. Casting Technology and Cast Alloys   Chakraborty   Prentice Hall of India
4. Meta Casting: Principles and Practice   TV Rammana Rao   New Age International

METAL FORMING

Introduction: Stress/strain/strain-rate characteristics of materials, Yield criteria, classification of metal working processes, Formability and theory of sheet metal working, Friction and lubrication in metal working operation, Theories of friction and lubrication, Assessment of friction at interface.

Process Analysis: Various methods of analyzing the metal working processes (slip-line field theory, Upper bound solution, stab methods).

Mechanics of Forming Processes: Rolling-Determination of rolling pressure, roll separating force, driving torque and power, Power loss in bearings, Forging-Forces in strip forging and disc forging, Drawing-determination of force and power, Maximum allowable reduction, Deep drawing force analysis, Analysis of tube drawing process with fixed and moving mandrel, Tandem tube drawing, Bending- Determination of work load and spring back, Extrusion-Determination of work load from stress analysis and energy consideration, Power loss, Hydrostatic extrusion, Punching & Blanking-Mode of metal deformation and failure, 2D deformation model and fracture analysis, Determination of work force.

Hydrostatic Extrusion: Comparison with conventional extrusion, Pressure required to extrude, variables affecting the process.

High Speed Forming: Classification, Comparison of low and high speed forming, operation problems in high speed forming operation, Introduction to high forming process such as explosive forming, Electrical and Mechanical high speed forming techniques.

Books:
1. An Introduction to the Principles of Metal Working   Rowe   Arnold
2. Metal Forming Analysis   Avitzur   McGraw Hill
3. Mathematical Simulation and Computer analysis of Thin   Polukhin   MIR Publications
   Strip Rolling Mill
4. Plasticity for Mechanical Engineers   Johnson & Mellore   Van Nostrand
5. High Velocity Working of Metals   ASTME   EEE
6. Manufacturing Science   Ghosh & Mallik   Affiliated East-West
7. Technology of Metal Forming Processes   S. Kumar   Prentice Hall of India

COMPUTER AIDED PROCESS PLANNING & CONTROL

Introduction to Process Planning: Principles and scope, Manual process planning, Experienced based process planning, Decision table and decision trees, process capability analysis, Tolerance analysis, Variant process planning, Generative approach, Forward and Backward planning.

Computer Aided Process Planning: Logical design of process planning systems, Implementation considerations, Computer based process monitoring and control, Computer and process interfacing, Totally integrated process planning systems, Process planning for rotational and prismatic parts, Machining of curves and surfaces, Five axis machining, Process planning of freedom surfaces, Development of NC codes, Computer aided design of fixtures, Inspection policies and inspection planning, Expert systems and their use in developing process planning systems.

Process Control: Process control concepts; On, Off, Proportional, Integral derivatives; control action and their selection; Pneumatic and electronic controllers, discrete process control using programmable logic controllers (PLCs); Logic control ladders and logic diagrams; Time line diagrams; use of counters and timers etc.

Microcontrollers, microprocessors and digital signal processors, Role of instrumentation buses, DMA and timing interrupts etc., Real time operating systems, scheduling and priority, embedded systems and their requirement.

Books:

1.	Computer Control of Processes	M Chidanbaram	Narosa Publishing House
2.	Computer Aided Process Control	SK Singh	Prentice Hall of India
3.	Computer Processing of Remotely Sensed Images: An Introduction	Mather Paul M	John Wiley

DESIGN FOR MANUFACTURE

Introduction: Introduction, Concept and need of concurrent Engineering, Automation of design and manufacturing functions in CIM, Computer Aided Process Planning, Design for X, Approach to DFM & DFM, Design for automated manufacturing and design for economic manufacturing.

Effect of Materials & manufacturing processes on Design: Major phases in design & Manufacture, Effect of material properties on design, Effect of manufacturing process on design, Material selection process, Cost per unit property & Weighted properties method.

Design Quality: Quality by Design, QFD, Taguchi's concept of Quality Loss function parameter design, comparing alternate designs, tolerance design, system optimization, Robust design.

Design for Reliability: Basic concepts, reliability analysis during design phase, failure mode analysis, reliability analysis of mechanical systems, design guidelines for reliability, reliability tests, quality and reliability assurance during production phase.

Design Knowledge Representation: Design for manufacturing and re-design considerations in automated CAD/CAM systems. Design and manufacturing knowledge representation, Knowledge representation for DFM support, Intelligent evaluation of design for manufacturing cost.

Evaluation for Manufacturability: Evaluation of the manufacturability of a part design, methods for defining manufacturability index, Interpretation of the MI value, Manufacturability evaluation, a multi criteria approach.

Books:

1.	Integrated Product Development	M.M. Anderson and L Hein	IFS Publications
2.	Product Design for Manufacture	G Boothroyd, P Dewhurst and W Knight	Marcel Dekker
3.	Design for Manufacture	Harry Peck	Pitman Publications
4.	Handbook of Product Design for Manufacture: A Practical Guide to Low Cost Production	J.G. Bralla	McGraw Hill
5.	Design for X	G.D. Huang	Chapman & Hall
6.	Concurrent Engineering	Kusiak	Wiley Eastern
7.	Engineering Design A Materials and Processing Approach	G Dieter	McGraw Hill
8.	Competitive Product design for Manufacturability	Barkan and Ishvi	McMillan
9.	Engineering Design Products, Process and Systems	Kusiak	Academic Press

RAPID PROTOTYPING AND TOOLING

Introduction: Historical developments, Fundamentals of RP Systems and its Classification, Rapid prototyping process chains, 3D modeling and mesh generation, Data conversion and transmission.

RP Systems: Liquid polymer based rapid prototyping systems, Teijin Seikis' solid form and other similar commercial RP systems, Solid input materials based rapid prototyping systems, laminated object manufacturing (LOM) and fused deposition modelling systems etc., Power based rapid prototyping systems, selective Laser sintering, Soligen Diren's shell production casting (DSPC), Fraunhofer's multiphase jet solidification (MJS) and MIT's 3D printing (3DP) etc.

RP Database: Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations, Digital inspection, Data warehousing and learning from process data.

RP Applications: Development of dies for moulding, RP applications in developing prototypes of products, application in medical fields, Development of bone replacements and tissues, etc., RP materials and their biological acceptability.

Books:
1. Rapid Prototyping Of Digital Systems: A Tutorial Approach   Hamblen James O   Kluwer Aca
2. Rapid Prototyping: Principles And Applications   Kai Chua Chee   World Scie
3. Rapid System Prototyping With Fpgas: Accelerating The Design Process   R C Cofer   Newnes
4. Rapid Prototyping of Digital Systems   James O Hamblen   Springer

CONCURRENT ENGINEERING AND PRODUCT LIFECYCLE MANAGEMENT

Introduction: Extensive definition of Concurrent Engineering (CE), CE design methodologies, Review of CE techniques like DFM (Design for manufacture), DFA (Design for assembly), QFD (Quality function deployment), RP (Rapid prototyping), TD (Total design), for integrating these technologies, Organizing for CE, CE tool box, Collaborative product development.

Use of Information Technology: IT support, Solid modeling, Product data management, Collaborative product commerce, Artificial Intelligence, expert systems, Software hardware component design.

Design Stage: Lifecycle design of products, Opportunities for manufacturing enterprises, Modality of concurrent engineering design, Automated analysis Idealization control, CE in optimal structural design, Real time constraints.

Need for PLM: Importance of PLM, Implementing PLM, Responsibility for PLM, Benefits to different managers, Components of PLM, Emergence of PLM, Lifecycle problems to resolve, Opportunities to seize.

Components of PLM: Components of PLM, Product lifecycle activities, Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards.

Books:
1. Integrated Product Development   M.M. Anderson and L Hein   IFS Publications
2. Design for Concurrent Engineering   J. Cleetus   CE Research Centre, Morgantown
3. Concurrent Engineering Fundamentals: Integrated Product Development   Prasad   Prentice hall India
4. Concurrent Engineering in Product Design and Development   I Moustapha   New Age International
5. Product Lifecycle Management   John Stark   Springer-Verlag, UK
6. Product Lifecycle Management   Michael Grieves   McGraw Hill
7. Concurrent Engineering: Automation tools and Technology   Andrew Kusiak   Wiley Eastern

QUALITY ASSURANCE

Quality assurance & Total Quality control, Basic statistical concepts, Control of accuracy and precision, Shewhart control charts for process control, X bar, Range, p, np, c, and u charts, CUSUM chart, Subgroup selection, Process capability, Process diagnosis using runs, cause effect and Pareto diagrams, Acceptance sampling plans, IS 25OO, MIL-STD-105E, Continuous sampling plans, Sequential sampling, Effect of inspection, Errors on QA, ISO 9000 / QS 9000, FEMA reliability, Review of design of experiments, Quality Engineering System, Parameters and tolerance design, Process optimization and robust product design, using orthogonal arrays, Taguchi loss function, Manufacturing tolerance design, Software applications and case studies,

Books:
1. Quality Assurance And The Law   Reeves Richard   Butterwort
2. Quality Assurance For Biopharmaceuticals   Huxsoll Jean F   Wiley-International
3. Quality Control and Applications   B.L. Hansen & P.M. Ghare   Prentice Hall of India
4. Software Engineering and Quality Assurance   K Chandrashekar Shet   BPB Publications
5. Design Of Experiments for Process Improvement and Quality Assurance   R F Brewer   Narosa Publishing House

POWER PLANTS ENGINEERING

Introduction: Rankine cycle with reheat & regeneration; Binary vapour cycle and flow through nozzles; Energy resources & development of power in India; Hydro, thermal and nuclear energy; present power position & Future planning of policies in India.

Thermal Power Plants: Introduction, Fossil fuel & its resources; Fuel properties and storage, Classification of coal; Use of high ash coal, Lignite coal, Drying, Storage and handling of liquid fuels, Types of petroleum fuels; Producer gas; Fuel firing; Furnaces construction; Grates; Pulverizes; Oil & gas burners and fluidized bed combustion system, Ash handling and flue gas analysis; High pressure boilers; Super critical boilers; Steam plant accessories; Effect of component characteristics on the plant performance and variable load problem.

Diesel Electric Power Plants: Field of use, Outline of diesel power plant, different systems, Super charging, Diesel plant efficiency & heat balance, Research in diesel power plant.

Gas Turbine Plants: Introduction, Classification; Types of gas turbine plants; Analysis of closed and open cycle, Constant pressure gas turbine plants; Methods to improve the thermal efficiency of a simple open cycle constant pressure gas turbine plant; Auxiliaries & controls. Environmental impact of gas turbine power plants.

Hydro Electric Power Plants: Hydrology-rainfall, Runoff & its measurement, Hydrograph & storage of water; Classification of Hydro units; Design, construction & operation of different components of hydroelectric power stations.

Nuclear Power Plants: Principles of nuclear energy; Classification, Main parts of nuclear reactors; Types of reactors; PWR, BWR, Heavy water reactors, gas cooled reactor, Liquid metal cooled reactors; Organic moderated cooled reactors, Breeder reactors plant operation, safety features & Radioactive waste disposal.

Non-Conventional Power Generation: Introduction; Geo thermal power; Tidal; solar & Wind power plants and direct energy conversion systems.

Economic analysis of Power Plants and its Tariffs: Instrumentation & control in thermal power plants, energy conservation & management.

Environmental aspects of Power Generation: Pollutants from fossils fuels and health hazards, Control of emissions and particulate matter, desulfeorization, Coal gasification & Introduction to greenhouse effect.

Books:
1. Power Plant Engineering   Drbal Larry F   Kluwer Aca
2. Plant Genetic Engineering   Dodds John H   Cambridge
3. Plant Design and Economics for Chemical Engineers   Peters Max Stone   McGraw-Hill
4. Plant Engineering's Fluid Power Handbook, Volume 2: System Applications And Components   Hehn Anton H   Gulf Profe

COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER

Introduction, Conservation equation, Mass Momentum and Energy equations, Convective form of the equation and general description.

Clarification into various types of equation, Parabolic, Elliptic, Boundary and initial conditions, Overview of numerical methods.

Finite difference methods; Different means for formulating finite difference equations, Taylor series expansion, Integration over element, Local function method; Finite volume methods; Central, upwind and hybrid formulations and comparison for convection-diffusion problem, Treatment of boundary conditions; Boundary layer treatment; Variable property, Interface and free surface treatment, Accuracy of F.D. method.

Solution of finite difference equations; Iterative methods; Matrix inversion methods, ADI method, Operator splitting, Fast Fourier Transform applications.

Phase change problems, Rayleigh-Ritz, Galerkin and Least square methods; Interpolation functions, One and two dimensional elements, Applications.

Phase change problems; Different approaches for moving boundary; Variable time step method, Enthalpy method.

Books:
1. Computational Methods for Fluid Dynamics   Ferziger Joel H   Springer-Verlog
2. Principles of Heat Transfer   Kaviany M   Wiley-International
3. Radiative Heat Transfer   Modest Michael   Academic Press
4.   Middleman Stanley   John Wiley

GAS TURBINES & COMPRESSORS

Gas Turbines: Development, Classification and field applications of gas turbines, Ideal and actual cycles; multi-stage compression; Reheating, Regeneration, Combined and Cogeneration, Energy transfer between fluid and rotor; Axis-symmetric flow in compressors and turbines.

Centrifugal Compressor: Principles of operation; Compressor losses; Adiabatic efficiency; Slip factor; Pressure coefficient; Power unit; Design consideration for impeller and diffusion systems; Performance characteristics.

Axial Flow Compressors: Elementary theory; Vortex theory; Degree of reaction; Simple design; Elementary airfoil theory; Isolated airfoil and cascade theory; 3D flow; Stages; stage efficiency and overall efficiency; Performance characteristics.

Turbines: Axial flow and radial flow turbines; Impulse and reaction turbines; Fundamental relations and velocity triangles; Elementary vortex theory; Limiting factors in turbine design application of Airfoil theory to the study of flow through turbine blades; Aerodynamic and thermodynamic design considerations; Blade materials; Blade attachments and blade cooling.

Gas Turbine Power Plants: Fuel feed systems; Combustion systems-design considerations and flame stablization; regenerator types and design; Gas turbine power; Plant performance and matching; Applications

Books:
1. Steam and Gas Turbine   R Yadav   Standard Publishers
2. Gas Turbine Engineering Handbook   Boyce Meherwan P   Gulf Profe
3. Process Centrifugal Compressors : Basics, Function,   Klaus H Ldtke   -
   Operation, Design, Application
4. Compressor Performance, Aerodynamics for the User   Theodore Gresh   -

COMBUSTION ENGINEERING

Introduction: Importance of combustion; Combustion equipments, Hostile fire problems, pollution problems arising from combustion.

Thermodynamics of Combustion: Enthalpy of formation; Enthalpy of reaction; Heating values; First & second laws; Analysis of reaction system, Chemical equilibrium, Equilibrium composition; Adiabatic & equilibrium, Flame temperature.

Kinetics of Combustion: Law of mass action; Reacting rate; Simple and complex reaction; Reaction order & molecularity, Arhenius laws; Activation Energy; Chain reaction; Steady rate & Partial equilibrium approximation; chain explosion; Explosion limit and oxidation characteristics of hydrogen, Carbon monoxide, Hydrocarbons.

Flames: Remixed flame structure & propagation of flames in homogeneous mixtures; Simplified Rankine Hugoniot relation, Properties of Hugoniot curve, analysis of Deflagration & detonation branches, Properties of Chapmen Jouguet wave, Laminar flame structure; Theories of flame propagation & calculation of flame speed measurements.

Stability limits of laminar flames; Flammability limits & quenching distant, Burner design, Mechanism of flame stablization in laminar & turbulent flows, Flame quenching, Diffusion flames; Comparison of diffusion with premixed flame, combustion of gaseous fuel, jets burke & Schumann development.

Burning of Condensed Phase: General mass burning considerations, Combustion of fuels droplet in a quiescent and convective environment, Introduction to combustion of fuel sprays.

Ignition: Concept of ignition, Chain ignition, Thermal spontaneous ignition, Forced ignition.

Combustion Generated Pollution & its Control: Introduction, Nitrogen oxide, Thermal fixation of atmospheric nitrogen prompts, NO, Thermal NOx & control in combustors. Fuel NOx & control, post combustion destruction of NOx, Nitrogen dioxide, carbon monoxide Oxidation-Quenching, Hydrocarbons, Sulphur oxide.

Books:
1. Internal Combustion Engines: Applied Thermo sciences   Ferguson Colin R   John Wiley
2. Engineering Fundamentals of the Internal Combustion Engine   Pulkrabek   Pearson Education India
3. Instrumentation for Combustion and Flow in Engines   Durao D F G   Kluwer Aca
4. Energy From Biomass: A Review of Combustion and   Quaak Peter   -
   Gasification Technologies

INTERNAL COMBUSTION ENGINES

Classification, Construction, Valve arrangements, Fuels, Properties of fuels, Rating of fuels, Alternative fuels, Fuel air cycle, Actual cycles, Combustion in SI engines, Combustion in CI engines, Effect of engine variables, Combustion chambers, Carburation and fuel injection, Knocking, Engine cooling, Friction and lubrication, Supercharging, Turbocharging, Boost control, Testing and performance, Pollution due to engines.

Books:
1. Internal Combustion Engines: Applied Thermo sciences   Ferguson Colin R   John Wiley
2. Fundamentals of Internal Combustion Engines   H.N. Gupta   Prentice Hall
3. Internal Combustion Engines   SK Agrawal   New Age international
4. Engineering Fundamentals of the Internal Combustion Engine   WW Pulkrabek   Prentice Hall of India

SYLLABUS

M.Tech. Semester II

Elective-II Subjects -All specializations (Regular & Part Time)

FINITE ELEMENT METHOD

Introduction to Finite Difference Method and Finite Element Method, Advantages and disadvantages, Mathematical formulation of FEM, Variational and Weighted residual approaches, Shape functions, Natural co-ordinate system, Element and global stiffness matrix, Boundary conditions, Errors, Convergence and patch test, Higher order elements.
Application to plane stress and plane strain problems, Axi-symmetric and 3D bodies, Plate bending problems with isotropic and anisotropic materials, Structural stability, Other applications e.g., Heat conduction and fluid flow problems.
Idealisation of stiffness of beam elements in beam-slab problems, Applications of the method to materially non-linear problems, Organisation of the Finite Element programmes, Data preparation and mesh generation through computer graphics, Numerical techniques, 3D problems, FEM an essential component of CAD, Use of commercial FEM packages, Finite element solution of existing complete designs, Comparison with conventional analysis.

Books:
1. The Finite Element Method   O.C. Zienkiewicz and R.L. Taylor   McGraw Hill
2. An Introduction to Finite Element Method   J. N. Reddy   McGraw Hill
3. Finite Element Procedure in Engineering Analysis   K.J. Bathe   McGraw Hill
4. Finite Element Analysis   C.S. Krishnamoorthy   Tata McGraw Hill
5. Concepts and Application of Finite Element Analysis   R.D. Cook, D.S. Malcus and M.E. Plesha   John Wiley
6. Introduction to Finite Elements in Engineering   T.R Chandragupta and A.D. Belegundu   Prentice Hall India
7. Finite Element and Approximation   O.C. Zenkiewicy & Morgan   -

INDUSTRIAL AUTOMATION AND ROBOTICS

Introduction to Automation: Automation production system, Mechanization and automation, Types of automation, Automation strategies, Mechanical, electrical, hydraulic and Pneumatic automation devices and controls, Economics of automation.
High Volume Manufacturing Automation: Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multimodel and mixed model production lines.

Programmable Manufacturing Automation: CNC machine tools, Machining centers, Programmable robots, Robot time estimation in manufacturing operations.

Flexible Manufacturing Automation: Introduction to Group Technology, Grouping methods, Cell Design, Flexible manufacturing system.

Assembly Automation: Assembly systems, Automatic transfer, feeding and orienting devices, Flexible assembly systems, Performance evaluation and economics of assembly systems

Robotics: Review of robotic technology and applications, Laws of robotics, Robot systems and anatomy, Robot classification, End Effectors, Robot kinematics, Object location, Homogeneous transformation, Direct and inverse kinematics, Manipulator motions, Robot drives, actuators and control, Drive systems, Hydraulic, Pneumatic Electrical DC and AC servo motors and stepped motors, Mechanical transmission method-Rotary-to-rotary motion conversion, Robot motion and path planning control and Controllers, Robot sensing, Range sensing, Proximity sensing, touch sensing, Force and torque sensing etc., Robot vision, Image representation, Image recognition approaches.

Robot Applications: Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference, Economics and social aspects of robotics, Future applications.

Books:

1.	Automation, Production System & Computer Integrated Manufacturing	Groover	Prentice Hall India
2.	Principles of Automation & Automated Production Process	Malov and Ivanov	Mir Publication
3.	Automation in Production Engineering	Oates and Georgy Newness	-
4.	Stochastic Models of Manufacturing Systems	Buzacott & shanty Kumar	Prentice Hall India
5.	Robotics	K.S. Fu, R.C. Gonzalez, C.S.G. Lee	McGraw Hill
6.	Robotics	J.J. Craig	Addison-Wesely
7.	Robot Engineering: An Integrated Approach	R.D. Klafter, t.a. Chmielewski and M. Negin	Prentice Hall India

ADVANCED MECHANICAL VIBRATIONS

Introduction: Characterization of engineering vibration problems, Review of single degree freedom systems with free, damped and forced vibrations

Two-degree of Freedom Systems: Principal modes of vibration, Spring coupled and mass coupled systems, Forced vibration of an undamped close coupled and far coupled systems, Undamped vibration absorbers, Forced damped vibrations, Vibration isolation.

Multi-degree Freedom systems: Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes, Modal analysis for free, damped and forced vibration systems, Approximate methods for fundamental frequency-Rayleigh's, Dunkerely, Stodola and Holzer method, Method of matrix iteration, Finite element method for close coupled and far coupled systems.

Continuous systems: Forced vibration of systems governed by wave equation, Free and forced vibrations of beams/ bars

Transient Vibrations: Response to an impulsive, step and pulse input, Shock spectrum

Non-linear Vibrations: Non-linear systems, Undamped and forced vibration with non-linear spring forces, Self-excited vibrations.

Books:

1.	Theory and practice of Mechanical Vibrations	J.S. Rao and K. Gupta	New Age International
2.	Mechanical Vibrations	G.K. Groover	Nem Chand & Brothers
3.	Mechanical Vibration Practice	V. Ramamurti	Narosa Publications
4.	Mechanical Vibrations	V.P. Singh	Dhanpat Rai & sons
5.	Textbook of Mechanical Vibrations	R.V. Dukkipati & J. Srinivas	Prentice Hall of India

THEORY OF ELASTICITY & PLASTICITY

Theory of Elasticity: Analysis of stress and strain, equilibrium, Compatibility and constitutive equations, Plane stress and plane strain problems, General equation in Polar co-ordinates, Rotating discs and stresses in circular discs, Stress function in terms of harmonic and complex functions, Equation of equilibrium of a deformed body in curvilinear co-ordinates, Principle of superposition and principle of virtual work, Torsion of thin tubes, Bending of cantilevers, Uniformly and continuous loaded beams, Bending of circular, elliptical and rectangular cross-section bars, Axi-symmetric formulation and deformation of solids of revolution.

Theory of Plasticity: Nature of engineering plasticity, Differential equations of equilibrium, 3D stress analysis, infinitesimal deformation, finite deformation, Von Mises', Tresca's and anisotropic yield criteria, halgh-Westergard stress space representation of yield criteria, experimental verification of yield criteria, Subsequent yield surfaces, Elastic and plastic stress-strain relations and stress strain rate equations, Prandtle-Reuaa equations, Generalized plastic stress strain relations, Anisotropy and instability.

Plane plastic flow, Slip-line field theory, Application of slip line field theory to plane strain metal forming processes, Plane plastic stress and pseudo plane stress analysis and its applications, Extremum principle for rigid perfectly plastic material, surfaces of stress and velocity discontinuity, Upper bound and lower bound theorems and applications.

Books:
8.	Theory of Elasticity (Foundations of Engineering Mechanics)	A I Lurie	-
9.	Contact Problems in the Classical Theory of Elasticity	Gladwell G M	Kluwer Aca
10.	Applied Plasticity	Chakrabarty J	Springer-Verlog
11.	The Mathematical Theory of Plasticity	R Hill	Oxford University

FRACTURE MECHANICS

Introduction and overview, Concepts of fracture mechanics and strength of materials, Elements of solid mechanics, Elasticity and plasticity, Incremental plasticity and deformation theory.

Elastic crack-tip fields, Basic concepts of linear elastic fracture mechanics, Griffth's theory, stress intensity factor, Energy release rate, Plastic zone and fracture toughness, path invariant integrals and numerical approach.

Plastic crack-tip fields, Mode-I fields and fracture criterion, Engineering approach to plastic fracture, J-integral approaches and numerical concepts, Tearing modulus, Time dependent fracture, non-linear aspects of fatigue crack growth, Theoretical models, Fatigue cracks in welds, standard tests and testing procedures.

Brittle fracture of welded structures, Notch toughness, weld cracks and joint restrains, Weld defects and service behaviour, Application of fracture mechanics concepts and limitations, Weld cracking tests and elimination of joint restraints, Residual stress and its interaction in fracture behaviour, Numerical approaches for estimation of fracture parameters.

Books:
1.	Fracture Mechanics: Fundamentals and Applications	Anderson, T. L	CRC Press
2.	Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue	Dowling, Norman E Dowling	Prentice Hall
3.	Advanced Fracture Mechanics	Kanninen, Melvin F Popelar, Carl H	Oxford University Press
4.	Analytical Fracture Mechanics	Unger, David J	Dover Publications

INDUSTRIAL TRIBOLOGY

Introduction: Definition and Scope of tribology, Contact of solids, Surface topology, Surface interaction.

Friction: Definitions, Types, Friction laws, Modern theory of dry solid friction, Temperature of sliding surface, Mechanism of rolling friction, Friction instability, Friction of elastomers.

Wear: Definition, Classification, Theories of adhesives, Abrasives, Surface fatigue and corrosive wear, Miscellaneous wear theory such as Erosive, cavitation and Fretting wear, Wear of miscellaneous machine components such as gears, Plane bearings and rolling elements.

Lubrication: Lubrication of bearing, Lubricant, Mineral Oil, Grease, Solid lubricant, Lubrication regime, Viscous flow, Reynolds equation and its limitations, Hydrodynamic lubrication, Hydrostatic lubrication, Elasto-hydrodynamic lubrication, Boundary lubrication, Squeeze films.

Applications: Application of tribology in manufacturing processes, Metal machining, Metal cutting, Tool wear, Action of lubricants, Friction welding, Extrusion process.

Books:

1.	Engineering Tribology	P Sahoo	Prentice Hall of India
2.	Principles and Applications of Tribology	D.F. Moore	Pergamon Press
3.	Fundamentals of Tribology	Basu, Sengupta & Ahuja	Prentice Hall of India
4.	Tribology Handbook	M.J. Neele	-

ADVANCED MATERIALS TECHNOLOGY

Materials and Classification: Solid materials- Classification, Ceramics, composites and metal glasses, selection and application of tool steel, Magnetic alloys, Copper, aluminum and magnesium alloys, Bearing alloys, Super hard materials, Plastics, Alloying techniques-Thermal, mechanical and chemical methods, Power metallurgy techniques, Macro and micro analysis of materials, Macro analysis of ferrous and non ferrous materials, Dendritic structures, Segregation and bonding, Heterogeneity formed thru treatment and mechanical working.

Mechanical Properties: Strengthening mechanism of materials, elements of dislocation theories, Strain hardening, Grain size control, Single crystal growth, Reinforcing fibres for polymers, Composite structure, determination of mechanical properties of materials, Dynamic tests, Fracture and toughness tests, Low temperature and high temperature tests, Creep characteristics, Hot hardness tests, Total intragranular cracking and aggressive media, Ceramics and composites, Insulation, Strength and aging of plastics.

Processing of Materials for Casting and Joining: Plastic working of materials, Strain hardening, Recovery and re-crystallisation, Formability, Forgibility and drawability of materials, Powder processing of materials, Ceramic processing, Composite processing, Features controlling machinability of materials, thermal treatment for better mach inability of metals, Universal mach inability index.

Modern Materials and Alloys: Super alloys-refractory materials, Ceramic and their applications, Low melting alloys, Shape memory alloys, Advanced Composites-Particulate and dispersioned composites, Metal matrix and ceramic matrix composites, Carbon-Carbon composites, Ti and Ni based alloys for gas turbine applications, Managing and cryogenic steels- Newer materials and their treatment for automobile applications, materials for Naval and nuclear systems. Smart and Nano materials.

Polmers and polymerization, Structure and properties of thermoplastics and thermosets, Engineering applications, Property modifications, Mechanical, thermal behaviour of composites with polymer matrix, ceramics glasses.

Books:

1.	Engineering Materials and Applications	P. Flinn and P.K. Trojan	MIR Publications
2.	Engineering Materials: Polymers, Ceramics and Composites	A.K Bhargava	Prentice Hall of India
3.	Manufacturing processes for Engineering Materials	Serope Kalpakjian	Wesley Publishing Co.
4.	An introduction to Physical Metallurgy	S.H. Avner	McGraw Hill
5.	Advances in Materials and Their Applications	P. Rama Rao	Wiley Eastern
6.	Mechanical Metallurgy	Dieter	McGraw Hill

HEAT TREATMENT OF METALS

Introduction: Nature and alloys; Heat treatment process, Requirements, Theory, Advantages, Process variables.

Heat Treatment of Ferrous Metals: Iron Carbon phase diagram; TTT diagram; different microstructures; transformations; Annealing, Stress relieving; Spherodizing; Normalizing; Hardening; Tempering; Austemepring; Martempering; Quenching; Quenchants; Quenching media; Surface hardening; Hardenability; Sub-zero treatment; Thermo-mechanical treatment; Chemical Treatment; Tool steel and their heat treatment; cast Iron and their heat treatment.

Heat Treatment of Non-Ferrous Metals: Aluminium and its alloys; Heat treatable and non heat-treatable aluminum alloys; Classification of heat treatment of aluminum alloys; Heat treatment of Aluminum and its alloys; Heat treatment of Magnesium and its alloys; Heat treatment of Titanium and its alloys; Heat treatment of Copper and its alloys; Heat treatment of Nickel and its alloys,

Energy Economy in heat treatment.

Books:

1.	Principles of Heat Treatment of Steels	R.C. Sharma	New Age International (P)

| 2. | Heat Treatment: Principle and Techniques | T.V. Rajan, C.P. Sharma and Ashok Sharma | Prentice Hall India |

ADVANCED WELDING TECHNOLOGY

Welding Metallurgy: Welding as compared with other fabrication processes, Classification of welding processes; Heat affected zone and its characteristics; Effects of alloying elements on weldability, Weldability of steels, stainless steel, cast iron, and aluminum and titanium alloys, Weld testing standards, Hydrogen embrittlement, Lammellar tearing, residual stresses and its measurement, heat transfer and solidification, Analysis of stresses in welded structures, Pre and post welding heat treatments, Metallurgical aspects of joining, Conditions of soldering, Brazing and welding of materials.

Weld Design & Quality Control: Principles of sound weld design, Welding joint design, Welding defects; Testing of weldament, Material joining characteristics, Welding positions, Allowable strength of welds under steady loads, Weld throat thickness; Weld quality, Discontinuities in welds, their causes and remedies and quality conflicts.

Modern Trends in Welding: Friction welding, Explosive welding, Diffusion bonding, High frequency induction welding, Ultrasonic welding, Electron beam welding, Plasma arc welding, Laser welding.

Mechanisation in Welding: Mechanisation of flat/circular joints, Thin/thick sheets (resistance/arc weld), Mechanisation of I beams (arc weld), Longitudinal circumferential SA welding (roller blocks, column booms, flux supports), Circular/spherical welding joints (rotating tables positioners), Manufacture of welding longitudinal welded pipes by induction, TIG, Plasma and SA welding of spiral welded pipes.

Robotics in Welding: Robot design and applications in welding, Programming of welding robots, tolerances for assemblies for robot welding, New generation of welding robots, Self alignment by current arc variation, Robots for car body welding, Microelectronic welding and soldering, Efficiency of robotics in welding.

Books:
1.	Advanced Welding Processes	Nikodaco & Shansky	MIR Publications
2.	Welding Technology and Design	VM Radhakrishnan	New Age International
3.	Source Book of Innovative welding Processes	M.M. Schwariz	Americal Society of Metals (Ohio)
4.	Advanced Welding Systems, Vol. I, II, III	J. Cornu	Jaico Publishers
5.	Manufacturing Technology (Foundry, Forming and Welding)	P.N. Rao	Tata McGraw Hill

ADVANCED FOUNDRY TECHNOLOGY

Solidification of Casting: Solidification of metals, Homogeneous and heterogeneous nucleation, Growth mechanism, Solidification of Pure metals and alloys, Mechanism of columnar and dendritic growth, Coring or Segregation, Solidification time and Chvorinov's rule, concept of progressive and directional solidifications, Material processing, castable nature of metals and alloys, Problems in casting materials with poor castability, Test for castability, Test for castability, Influence of plastic material properties on moulding, casting of thermosets.

Principles of Gating and Risering: Purpose of the gating system, Components of gating system and its functions, Design of gating system, Types of gates, Gating ratio and its functions, Functions, types and applications of the riser, design of riser and its shape, size and location, Use of insulating material and exothermic compounds in risers.

Design of Casting and Quality Control: Factors to be considered in casting design, design considerations in pattern making, Moulding techniques, Core making and assembly, Cooling stresses and hot spots in casting and modification in casting geometry to overcome them.
Casting quality control-Casting defects and factors responsible for them, different inspection and testing methods to evaluate the casting, Quality control activities in a foundry, Salvaging methods of defective casting,.

Furnace Technology: Study of various furnaces used in foundry, Construction and operation of crucible and hearth furnaces, Arc and induction furnaces- construction, operation and application, Heat treatment furnaces and drying ovens used in foundry, Real time chemical composition determination-'Spectroscopy'

Cast Iron Foundry Practice: Chemical composition and structure of gray CI-Graphite structure in gray CI & graphite distribution, Inoculation of gray CI, Application of gray CI castings, Ductile Cast Iron-Chemical composition and structure of ductile CI, Melting and spherodisation treatment, Inoculation of ductile iron properties and applications of ductilities on casting.

Soft Material foundry Practice: Aluminum casting-Composition, properties and application of common aluminum alloy casting, Melting and casting of aluminum alloys, Gating and risering of Al-alloy casting, Copper alloy foundry practice-

General characteristics of common cast copper alloys, Melting and casting of copper alloys, Gating and risering of copper alloy castings.

Foundry Mechanization and Modernization: Introduction to modernization, Mechanization of foundry and its advantages, Mechanization of sand plant, Moulding and core making mechanization in melting, pouring and shakeout units, Material handling equipments and conveyor systems, Brief sketches and description of layouts of job, Captive and mechanized foundries.

Books:

1.	Principles of Metal Casting	Heine et. al.	Tata McGraw Hill
2.	Text Book of Foundry Technology	M.L. Khanna	Dhanpat rai & Sons
3.	Foundries practice	Titov Stepnov	-
4.	Foundry Technology	P.R. Beelely	Butterworth.

FLEXIBLE MANUFACTURING SYSTEM

Introduction: FMS definition and classification of manufacturing systems, Automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.

FMS Equipment: Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment.

Group Technology: GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part-machine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production.

FMS related problem and Solution Methodology:

- FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system, Communication networks.
- FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems.
- Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control.
- FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns.

Books:

1.	Automation, Production System & Computer Integrated Manufacturing	Groover	Englewood
2.	Design and Operation of SMS	Rankey	IFS
3.	Flexible Manufacturing System	Wernecks	Spring-Verlag
4.	FMS in Practice	Bonctto	Northox Ford
5.	Flexible Manufacturing Cells and systems	W.W. Luggen	Prentice Hall India
6.	Performance Modelling of Automated Manufacturing Systems	Vishwanathan & Narahari	Prentice Hall India

CNC, FMS & CIM

Introduction to CNC Machine Tools: Development of CNC Technology-Principles and classification of CNC machines, Advantages & economic benefits, Types of control, CNC controllers, Characteristics, Interpolators, Applications, DNC concept.

CNC Programming: Co-ordinate System, Fundamentals of APT programming, Manual part programming-structure of part programme, G & M Codes, developing simple part programmes, Parametric programming, CAM packages for CNC machines-IDEAS, Unigraphics, Pro Engineer, CATIA, ESPIRIT, MasterCAM etc., and use of standard controllers-FANUC, Heidenhain and Sinumeric control system.

Tooling for CNC Machines: Cutting tool materials, Carbide inserts classification; Qualified, semi-qualified and preset tooling, Cooling fed tooling system, Quick change tooling system, Tooling system for machining centre and turning center, tool holders, Tool assemblies, Tool magazines, ATC mechanisms, Tool management.

Robotics and Material Handling Systems: Introduction to robotic technology, and applications, Robot anatomy, material handling function, Types of material handling equipment, Conveyer systems, Automated guided vehicle systems, Automated storage/retrieval systems, Work-in-process storage, Interfacing handling and storage with manufacturing.

Group Technology and Flexible Manufacturing System: group Technology-part families, Parts classification and coding, Production flow analysis, Machine Cell Design, Benefits of Group Technology, Flexible manufacturing systems-Introduction, FMS workstations, Computer control system, Planning for FMS, Applications and benefits.

Computer Integrated Manufacturing: Introduction, Evaluation of CIM, CIM hardware and software, Requirements of computer to be used in CIM system, Database requirements, Concurrent engineering-Principles, design and development environment, advance modeling techniques.

Books:

1.	Computer Numerical Control Machines	P. Radahkrishnan	New Central Book Agency
2.	CNC Machines	M.S. Sehrawat and J.S. Narang	Dhanpat Rai and Co.
3.	CNC Programming Handbook	Smid Peter	Industrial Press Inc.
4.	Automation, Production systems and Computer Integrated Manufacturing	M.P. Groover	Prentice Hall of India
5.	Computer Integrated Manufacturing	Paul Ranky	Prentice Hall of India

TOTAL QUALITY MANAGEMENT

Introduction and Components of TQM: Concept and Philosophy of TQM, Value and Quality assurance, Total Quality Control, Quality policy, Team-work and participation, Quality cost measurement, Quality Circle, Customer/Supplier integration, Education and training.

Tools and Techniques of TQM: Statistical method in quality control, Process control chart, Acceptance sampling plan, Statistical Productivity control (SPC)

Reliability: Failure analysis, System reliability and redundomy

TQM implementation: Steps in promoting and implementing TQM in manufacturing industries, Industrial Case studies.

ISO 9000 Quality Systems: Concepts, designation Standards, Quality system documentation, Quality manual, Quality procedures and work inspection.

Books:

1.	Total Quality Control	F. Ammandev	Tata McGraw Hill
2.	Total Quality Management	Besterfield, et. al.	Prentice Hall of India
3.	Total Quality Management: Text and Cases	B. Janakiraman & RK Gopal	Prentice Hall of India
4.	What is Total Quality Control?	K. Ishikawa	Prentice hall
5.	Total Quality Management: The Route to Improving Performance	J.S. Oakland	Butterworth Heineman Oxford
6.	Out of Crisis	W.E Dming	Centre of Advance Engineering Study, Cambridge

MATERIALS MANAGEMENT

Introduction & Materials management functions; Inventory, Inventory types; Tools for materials management; Materials Planning and programming-relevant costs, measurement of costs.

Static Inventory Models: Static inventory models under uncertainty, decision criteria for inventory problems.

Dynamic Inventory Models: Models under certainty; Optimal lot size with constant demand; Dynamic inventory problems under risk and under uncertainty; Multi-stage inventory problems; Procurement policies under inventories supported with some case studies; Value analysis and standarisation in procurement; Materials Requirement Planning (MRP), Inputs, Outputs, MRP computation, EOQ-MRP comparisons; MRP types; Capacity Planning and Control.

Simulation: Simulation categories; Monte-Carlo simulation; perpetual inventory; Periodic simulation problems; Simulation of joint probability distribution.

Inventory Control systems: Types of control systems; Selective inventory control; Inventory system development, Excess materials; Inventory system improvement; Aggregate inventory measurement.

Books:
1. Operations Research   A.P. Verma   S.K. Kataria & Sons
2. Inventory Management   D. Chandra Bose   Prentice Hall of India
3. Materials Management   A.K. Chitale R.C. Gupta Prentice Hall of India
4. Materials Management: An Integrated Approach   P. Gopalakrishnan & M. Prentice Hall of India
                                                        Sundaresan
5. Materials Management: Procedures, text and Cases   A.K. Datta   Prentice Hall of India

PRODUCTION & OPERATIONS MANAGEMENT

Introduction: Operations strategy, Framework for operations strategy in manufacturing, Operations strategy services, Meeting the competitive challenges.

Managing the Supply Chain: Supply chain management, Purchasing, JIT purchasing, Global sourcing, Electronic information flow, Forecasting, Qualitative techniques, Time series analysis, Selection of forecasting method, Focus forecasting, Aggregate planning techniques, Inventory systems for independent demand, Fixed order quantity and fixed time period models, Inventory systems for independent time period models, Inventory systems for dependent demand, MRP type systems, Embedding JIT into MRP, Lot sizing in MRP, Advanced MRP Systems.

Operations Scheduling: Scheduling & control functions, Priority rules and techniques, Single machine scheduling problems, Scheduling in jobs on 'm' machines, Personal scheduling, Simulation methodology, Two assembly simulation.

Design of Facilities & Jobs: Strategic capacity planning concepts, determining capacity requirements, Planning service capacity, JIT production systems, JIT implementation requirements, Facility location, Plant location methods, Facility, Process and Product layout, GT layout, Retail service layout, Computer aided layout techniques.

Job design and work measurement, Considerations in job design, Work measurements and standards, Financial incentive plans, Learning curves and its applications.

Product Design & Process Selection: Product design process, Designing for the customer QFD, Value analysis, designing products for manufacturer & assembly. Process selection, product process matrix, Choosing from alternative processes & equipment, Virtual factory, Waiting line management & models, Quality management, Quality specifications & costs, Tolls and procedures for continuous improvement, Shingo system of fail-safe design, Review of SQC models.

Books:
1. Operations management   Buffa   John Wiley
2. Operations management   Starr   Prentice Hall
3. Production and Operations management   Adam & Ebert   Prentice Hall India

COMPUTER AIDED PLANT LAYOUT AND MATERIALS HANDLING

Facilities planning, Types of layouts, Charts required for facilities planning, Role of templates in plant layout, Quantitative methods in Progress layouts, Computerized layout planning, CRAFT, CORELAP, ALDEP, Single and multi-facilities location and layout models, Min-max location, Location allocation models, Production and assembly line balancing, Various algorithms in assembly line balancing, Job enlargement in line production.

Introduction to materials productivity and role of materials management techniques in improved materials productivity.

Inventory management, ABC-VED analysis, Inventory models, Inventory models with quantity discount, Exchange curve concept and coverage analysis, JIT, Information systems for inventory management, Store management and warehousing, Optimal stocking and issuing policies, Inventory management of perishable commodities, Surplus management, design of inventory distribution systems, Monitoring MM effectiveness, Case studies.

METROLOGY & COMPUTER AIDED INSPECTION

Metrology and Techniques: Standards in metrology-definition, Traceability, Characteristics Length & Angular measurements-Review of standard instruments, GD and tolerance procedure-Review of dimension & form tolerance and methods of measurement, Tolerance analysis, Surface metrology-Instruments, Methods and new approaches.

Laser Applications in Metrology: LASER light source, LASER interferometer, LASER alignment telescope, LASER micrometer, On-line and in-process measurements of diameter, Roundness and surface roughness using LASER, Micro holes and topography measurements, straightness and flatness measurement.

Special Measuring Instruments and Techniques: Optoelectronic devices, contact and non-contact types, Applications in on-line and in-process monitoring systems, Tool wear measurement, Surface measurement, Machine vision, shape identification, Edge detection techniques, Normalisation, gray scale correlation, Template Techniques, Surface roughness using vision system, Interfacing robot and image processing system.

Co-ordinate Measuring Machine: Types of CMM, Probes used, Applications, Non-contact CMM using electro optical sensors for dimensional metrology, Non-contact sensors for surface finish measurements, statistical evaluation of data using computer, Data integration of CMM and data logging in computers.

Sensors in Inspection: Manufacturing applications of photo detectors, deflection methods-beam detection, Reflex detection, & Proximity detection, Applications of Inductive and Capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches. Advanced sensor technology-Bar code systems, Principles and applications of Colour sensors, electro-magnetic identifier, Tactile sensors, Ultrasonic sensors, Odour sensors,

Books:

1.	Fundamentals of dimensional Metrology	T. Busch and R. Harlow	Delmar, 3e
2.	Engineering Metrology	G. Thomas and G. Butter Worth	PUB
3.	Sensors and Control systems in Manufacturing	Sabne Soloman	McGraw Hill Book
4.	Measurement systems: Applications & Design	Doebelin	International Student Edition
5.	Optoelectronics for Technology and Engineering	Robert G. Seippel	Prentice Hall India
6.	Interface Technology for Computer Controlled Manufacturing processes	Ulrich-Rembold, Armbruster and Ulzmann	Marcel Dekker Publications, NY
7.	Optoelectronics	J. Watson	Van Nostrand Rein Hold (UK) Company

WORK SCIENCE

Introduction: Introduction to work science, techniques of work and work organization. Appraisal method study and stop watch time study procedures, formulation and analysis of methods, design problems, Improvements in stop watch time study, Motion and time study training programmes.

Work Measurement: Procedures for work sampling study; Random, systematic, stratified and zone sampling techniques; Practical applications, Evaluation and improvements; Performance sampling.

Standard Data: Derivation, advantages and disadvantages, Applications.

Systems: variables, time units; Arm and hand motions; Eye motions; Leg and foot motions; Motion combinations; Motion pattern used in MTM; MTM data and its installation.

Work Factor: Motion time table; Standard elements of work; Work factor notation; recording and analysis; Modified and abbreviated work factor systems.

Man Machine Systems: Human factors affecting work, energy requirements for men; Effects of noise, light, heat and humidity, Monotony and fatigue on operator performance I, Case studies, MAN MACHINE SYSTEM CHARACTERISTICS; system components and its reliability, Man machine communication, design and arrangements of controls and displays, Man machine relationships and problems.

Books:

1.	Engineering Work Measurement	Karger & Bayha	Industrial Press
2.	Work Sampling	Barnes	John Wiley
3.	Methods Engineering	Krick	John Wiley
4.	Human Factors Engineering	Mc Cormic	McGraw Hill
5.	Ergonomics	Murrel	Chapman & Hall

ADVANCED GAS DYNAMICS

Basic Equation: Application of general differential equation of continuity, momentum & energy to compressible inviscid fluids; Compressible Bernoulli's equation; Irrotational flow; Velocity potential & Stream function.

Shock Wave in Supersonic Flow: A review of normal shock relation; Mach waves; Equation for finite strength shock waves; Rankine-Hugenit relation; Extended Prandtl relation; Hodograph shock polar reflection & interaction of shock, Curved shocks.

Small perturbation Theory: Liberalization; Small perturbation equation; Pressure coefficient, Subsonic flow a wave shaped wall, General solution of supersonic flows; Supersonic flow past a curve-shaped wall; Elements of supersonic thin aerofoil theory.

Similarity Rules: Similarity rules between two-dimensional subsonic compressible flows & incompressible flows; Gothert rule; Prandtl Glauert rule; Application of supersonic flow.

Hodograph method for Subsonic Flows: Hodograph equation for two-dimensional subsonic flow; Chaplygin's equation; the tangent gas approximation of Karman & Tsien for subsonic flows; Karman-Tsien formula for pressure correction; Comparison with Prandtl Glauert rule.

Method of Characteristics for Supersonic Flows: Method of characteristics for two-dimensional supersonics flows; Characteristics curves; equation of hodograph characteristics network; Computational methods.

Books:

1.	Molecular Gas Dynamics and the Direct Simulation of Gas Flows	Bird G A	Oxford University
2.	Kinetic Theory and Gas Dynamics	Carlo Cercignani	Springer Verlog
3.	Gas Dynamics: Multidimensional Flow	Maurice Joseph Zucrow	-
4.	Elements of Gas Dynamics	Liepmann H W	Dover Publication
5.	Gas Dynamics	E Rathakrishnan	Prentice Hall of India

CRYOGENIC SYSTEMS

Introduction & Low Temperature properties of Engineering Materials: Historical background, Present area involving cryogenics, Mechanical properties; Thermal properties; Electrical and Magnetic properties; properties of Cryogenic fluids.

Gas Liquefaction System: Joule Thompson effect; Adiabatic expansion; Simple Linde-Hampson, Precooled Linde-Hampson system; Liquid dual pressure system; Cascaded system; Claude system, Kapitza system, Collins helium liquefaction system.

Critical Component of Liquefaction System: Effect of heat exchanger; Effectiveness of system performance, Effect of compressor and expander efficiency on system performance; effect of heat transfer to the system.

Cryogenic Refrigeration System: Phillips refrigerator, Importance refrigerator, effectiveness for Phillips refrigerator, Gifford-McMohan refrigerator.

Measurement System of Low Temperature: Temperature measurement, Flow rate measurement, Liquid level measurement.

Cryogenic Storage & Transfer System: Cryogenic fluid storage vessels, Insulation, Cryogenic transfer system.

Vacuum Technology: Importance of Vacuum technology in cryogenics, Flow regimes in vacuum systems; Conductance in vacuum systems, Calculation of pump down time for a vacuum system, Components of vacuum systems, Mechanical vacuum pumps, Diffusion pumps, Ion pumps, Cryopumping, Vacuum gauges & valves.

Books:

1.	Cryogenic Systems	Barron Randall F	Oxford University
2.	A Text Book of Cryogenics	Valery V Kostiouk	Discovery Publishing House
3.	Cryogenic Technology and Applications	A R Jha	-
4.	Thermodynamic Properties of Cryogenic Fluids	R T Jacobsen	Plenum Publishing Corpn.

COLD PRESERVATION OF FOOD

Introduction: Necessity of food preservation; general techniques; Cold preservation of food.

Biological Aspects: Live and dead foods; Biology of food products such as fruits, vegetables, milk, meat and fish; Effect of temperature on food ingredients; Respiration rates of food products; Controlled atmospheric storage; Disease and deterioration of foods.

Cold Preservation of Food: Short and long term preservation; Methods of chilling; Freezing and freeze-drying; Heat and mass transfer analysis of cooling and freezing.

Cold Storages: Necessity and present status in the country; Site selection; Building constructional features, Load calculation, Equipment, Selection, safety consideration, Insurance and management of cold storages; Storages of some important food products; Modern trends in cold storage practices.

Refrigerated Food Handling: Preparation for cooling/freezing; Packaging of foods; Modes of transportation- land, sea and air; Their thermal load and equipment; Marketing of refrigerated food.

Books:
1. Food Processing And Preservation   B Sivasankar   Prentice Hall of India
2. Handbook of Vegetable Preservation and Processing   Hui Y H   Marcel Dekker
3. The Technology of Food Preservation   Desrosier   CBS Publishers

RENEWABLE ENERGY SYSTEMS

Introduction: Energy and Development; Energy demand and availability; Energy crisis; Conventional and Non-conventional energy; Renewable and Non-renewable energy resources; Environmental impacts of conventional energy usage; Basic concepts of heat and fluid flow useful for energy systems.

Solar Energy Systems: Solar radiations data; Solar energy collection, Storage and utilization; Solar water heating; air heating; Power generation; Refrigeration and Air-conditioning; Solar Energy system Economics.

Micro and Small Hydro Energy Systems: Resource assessment of micro and small hydro power; Micro, mini and small hydro power systems; Economics; Pump and turbine; Special engines for low heads; Velocity head turbines; Hydrams; Water mill; Tidal power.

Bio mass Energy Systems: Availability of bio mass-agro, forest, animal, municipal and other residues; Bio mass conversion technologies; Cooking fuels; Biogas; producer gas; Power alcohol from biomass; Power generation; Internal engine modifications and performance; system economics.

Wind Energy Systems: Wind data; Horizontal and vertical axis wind mills; Wind farms; Economics of wind energy.

Integrated Energy Systems: Concept of integration of conventional and non-conventional energy resources and systems; Integrated energy system design and economics.

Books:
1. Energy Efficient Buildings in India   Mili Majumdar   Tata Energy Research Institute
2. Understanding Renewable Energy Systems   Volker Quaschning   -
3. Renewable Energy Systems   Simmoes Marcelo Godoy   CRC Press
4. Renewable Energy Resources   John Twidell   Taylor and Francis
5. Renewable Energy Sources and Their   Abbasi & Abbasi   Prentice Hall of India
   Environmental Impact

COMBUSTION, ENGINES AND FUELS

Introduction, Heat of reaction and formation, Adiabatic flame temperature, Chemical equilibrium, Properties of equilibrium, Combustion products of air-fuel mixtures, Chemical kinetics, reaction rates, Law of mass action, Reaction order, Activation energy, Flammability limits, SIT, Features of SI engines combustion processes, Burned and unburned mixture states, Features of CI engine combustion process, Spray structure, atomization, penetration, drop size distribution, evaporation, Ignition delay, Factors affecting delay, Mixing controlled combustion, Engine design variables and heat release rates, Vehicle emissions, Photochemical smog, Formation of NO and NO_2 in SI & CI engines, Formation of CO_2, Unburned HC, Flame quenching, Sources of HC in SI, Oxidation and emission, HC in CI engines, PM composition & Structure, Formation, growth, oxidation, adsorption & condensation.

Emission regulations, regulated/unregulated pollutants, Effects of pollutants on human health, Introduction to EGR, EGR system classification, After treatment technologies, TWC, NO_x, adsorber, selective catalytic reduction, formation of particulate matter, Diesel particulate filters, regeneration

Measurement & test procedures, Exhaust smoke opacity meters, Bosch smoke meter, NDIR, FID, Chemiluminiescence detector, particulate matter measurement, IS codes for engine testing and pollution measurements.

Introduction to MPFI, Gasoline direct injection, Key technical features, HCCI combustion.
Lubricating oils, properties, additives, engine friction & wear, lubricating oil tribology.

Books:
1. Fundamentals of Combustion DP Mishra Prentice Hall of India

SYLLABUS

M.Tech. Semester III

Open Electives-All Specializations (Regular & Part Time)

ACCOUNTING & FINANCIAL MANAGEMENT

Accounting: Balance sheet; profit and Loss concepts; Accounting principles and mechanics; Inventory valuation and depreciation accounting; ratio and Fund flow analysis; Introduction to cost accounting; Various method of cost determination and cost accounting systems such as activity based costing systems and responsibility accounting; use of costing systems in decision making, Case studies.

Financial Management: Fund and cash flow analysis; Working capital management; determination of capital structure of the firm; Cost of capital; Capital asset pricing models; Leverages; Investment analysis; Portfolio management; Debt management; Dividend policy; Concept of financial strategy; Case studies.

Books:
1. Advanced Accounting S.P. Jain & K.L. Narang -
2. Accounting for Management S.K. Bhattacharya & John Dearden -
3. Financial Management I.M. Pandey -
4. Financial Management and Accounting P Mohan Rao Deep and Deep Publications
5. Construction Accounting and Financial Palmer Willman McGraw Hill
   Management
6. Construction Management and Accounting B L Gupta Standard Publishers
7. Fundamentals of Financial Management Chandra Prasun -

INFORMATION SYSTEMS AND DATA MANEGEMNT

Introduction: Role of information system; Function of information system; Determination of information need.

Information Processing Concepts: Historical perspective, Today's status; System approach and analysis; Concepts of data and information, Data collection, Data or information reduction; Data and information storage; Data processing and information generation; Transmission of data and information and the information economics of information.

Information System Analysis: Overview of system; Management and fom lal information system; Hierarchical and system approach to information system design and their applications; Tailoring the information system to meet specific information requirements using filtering monitoring, interrogative and external methods.

Data Base Management System: Introduction to database concepts; difference between a file system and a database system; Goals of DBMS including data independence consistency, data security and integrity; DBMS model hierarchical network and relational; Data description and query language; Physical database design, case studies; System R, Ingress, IDMS etc.; Introduction to distributed database, Concurrency control bases recovery etc.

Books:
1. Information Systems Concepts for Management Henry C. Luces Jr. McGraw Hill
2. Information System theory and Practice Burch and Strater Hamilton Publishing Co.
3. Computer Based Information System D.W. Walker Pergamon Press
4. Data Base Management system A.F. Cardenas -

INDUSTRIAL DESIGN & ERGONOMICS

Introduction to Ergonomics and Industrial Design: An approach to industrial design- elements of design, Structure for industrial design in engineering; Application in modern manufacturing systems; General approach to the man-machine relationship, Work station design, Working position.

Control and Displays: Shapes and sizes of various controls and displays- Multiple displays and control situations; design of major controls in automobiles, machine tools etc.; Design of furniture; Redesign of instruments.

Ergonomics and Production: Ergonomics and product design, ergonomics in automated systems; Expert systems for ergonomic design; Anthropometrics data and its applications in ergonomic design; Limitations of anthropometric data, Use of computerized database; Case study.

Visual Effects of Line and Colour: The mechanics of seeing; Psychology of seeing; General influence of line and form; Colour and light; Colour and objects; Colour and the eye; Colour consistency; Colour terms; Reaction to colour and colour continuation; Colour on engineering equipments.

Aesthetic Concepts: Concept of unity; Concept of order with variety; Concept of purpose style and environment; Aesthetic expressions; Style, Components of style; House style; Observation style in capital goods; Case study.

Industrial Design in Practice: General design; Specifying Design equipments; Rating the importance of industrial design; Industrial design in design process.

Books:

1. Industrial design for Engineers   W.H. Mayall   London Hiffee Books Ltd.
2. Introduction to Ergonomics   R.C. Bridger   McGraw Hill
3. Human Factor Engineering   Sanders & McComlick   -

INDUSTRIAL POLICY, MANAGEMENT RESEARCH AND DEVELOPMENT

Policy-Technology choice, Linkage, National technology policies, technology, policy and industrial structure, Formulating a technology strategy, Technology development and acquisition process, managing technologies, Technology in Indian industries, Strategic R&D management and technological Consortia, Licencing and joint ventures, Managing technology Spillovers.

Types of technological change, their inter-relationships, R&D environment in India, process of innovation, R&D as an element of corporate strategy, Technological forecasting, Technology assessment, project selection and evaluation, Structure of organization for R&D in Indian firms and in Government research laboratories, perception and motivation of R&D employees, Leadership style in R&D, Effect of organizational climate on R&D, Creativity, Locks to creativity, Improving creativity.

Books:

1.	Perspective of Industrial Policy and Development	P.R. Shukla	Anmol Publications
2.	Planning For Change: Industrial Policy And Japanese Economic Development 1945-1990	Vestal James	Oxford University
3.	Encyclopedia of Social Development, Law, Policy and Security (10 Vols. Set)	Prabhas C. Sinha	Anmol Publications
4.	Developmental Assets And Asset-building Communities: Implications For Research, Policy, And Practice	Benson Peter L	Kluwer Aca

QUANTITATIVE TECHNIQUES IN DECISION MAKING

Fundamentals of Statistics, Probability and Probability distributions: Measures of central tendency and location, Measure of dispersion, skewness and kurtosis, Rules of probability, random variables and probability distributions,-Binomial, Poisson, Hyper geometric and Normal, decision making under Uncertainty and Risk-Alternative criteria for decision under uncertainty & risk, Bayesian approach and incremental analysis.

Correlation, Regression and Multivariate Analysis: Bivariate frequency distribution and scatter diagram, correlation analysis and regression analysis, Non-linear regression, Auto correlation and multiple regression analysis, Multivariate analysis, Introduction to experimental design and optimization.

Review of solution of LPP by simplex method, Revised simplex method, Concept of duality and solution of dual problems, Solution of LPP by dual simplex method, Integer programming-Cutting plane method, Bala's algorithm for zero-one programming problems.

Review of transportation, Transshipment and assignment problems, Traveling salesman problem, Techniques of dynamic programming, Goal programming and integer programming, calculus method of solution for dynamic programming problems, Continuous dynamic programming.

Theory of Games: Two person zero sum game, Minimax & Maxmin strategies, Solution of game by dominance rules, Arithmetic & algebraic methods, Solution of game by graphical method and method of matrices, Solution of game by linear programming approach and approximate method to solve game problems.

Stochastic programming: Basic techniques for solving stochastic linear and non-linear programming problems, Examples.

Books:
1.	Quantitative Techniques for Managerial Decisions	U.K. Srivastava	New Age International
2.	Operations Research	H. Taha	Prentice Hall of India
3.	Introduction to Operations Research	Hillier and Liberman	McGraw Hill International
4.	Principles of Operations Research	Ravindran, Phillips and Soldberg	-

MANAGEMENT INFORMATION SYSTEMS

Introduction; Meaning and definition of management information systems (MIS); Systems approach; Role of MIS in facing increasing complexity in business and management.

Conceptual information systems design; defining the problem; setting system objectives; Establishing system constraints; Determining information needs; Determining information sources; Developing alternative conceptual designs; Documenting the conceptual designs.

Detailing information systems design; Informing and involving the organization; Project management of MIS; Identifying dominant and tradeoff criteria; Subsystem definition and sources.

Evaluation of information systems; Basic information systems; Financial information systems; Production and operations information systems; Marketing information systems; Personal information system etc.

Information systems for decision making; Programmed and non-programmed decisions; Components of decision support systems, Strategic and project planning.

Enterprise wise information systems; Integration with ERP systems; Real-time organizations; Integration with external organizations; Virtual organizations; data warehousing; Data mining; OLAP (OnLine Analytical Processing) Systems, Business analytics.

Issues in ethics, crime and security.

Books:
1.	Management Information Systems	O' Brien, J	Tata McGraw Hill
2.	Management Information Systems	W.S. Jawedker	Tata McGraw Hill
3.	Management Information Systems	S Sadagopan	Prentice Hall of India
4.	An Information System for Modern Management	R.G. Mudrick	Pearson
5.	Management Information Systems	M. Jaiswal	Oxford University Press

ENERGY MANAGEMENT

Introduction: Energy sources, energy demand and supply, Energy crisis, future scenario; Energy system efficiency; energy conservation aspects; Instrumentation and measurements.

Principles of Energy Management and Energy Audit: General principles, planning and program; Introduction to energy audit; General methodology; Site surveys; Energy systems survey, energy audit; Instrumentation; Analysis of data and results.

Heating and Cooling Management: General principles of energy managements in HVAC systems; Human comforts and health requirements; HVAC systems; Boiler and heat sources; Chillers, fans, pumps, cooling towers, Energy management opportunities; Modelling of heating and cooling loads in buildings.

Electrical Load and Lighting Management: General principles; Illumination and human comfort; Lighting systems; Equipments; Energy management opportunities; Electrical systems; Electrical load analysis; Peak load controls.

Process Energy Management: Principles; Process heat, Combustion, Automatic fuel controls; Steam generation and distribution, Hot water and pumping, Furnaces and ovens; Process electricity; Compressed air; Manufacturing process; Energy storage for process industries; Process control.

Integrated Building systems: General principles; Environment conformation; Passive design considerations; Building envelope design consideration, Integration of building system, Energy storage-cold storage techniques, Economic analysis.

Economic Aspects of Energy Management: General considerations; Economic analysis methods; Life-cycle costing, Break even analysis, benefit cost analysis, payback period analysis, present worth analysis, equivalent annual cost analysis, Use of computers; Management of energy with environment aspects.

Books:

1.	Rural Energy Management	S Kaushik, T Verma	Deep and Deep Publs.
2.	Energy Management	W R Murphy; G Mckay	B.S. Publications
3.	Renewable Energy and Energy Management	S C Patra; B C Kurse; R Kataki	International Book Co.
4.	Operations and Maintenance Manual for Energy Management	J Piper	Standard Publishers

RELIABILITY, MAINTENANCE MANAGEMENT & SAFETY

Reliability Engineering: System reliability - series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models. Reliability improvement and allocation-Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Optimization, Reliability – Cost trade off, Prediction and analysis, Problems.

Maintainability, Availability & Failure Analysis: Maintainability & Availability – Introduction, formulae, Techniques available to improve maintainability & availability, trade off among reliability, maintainability & availability, simple problems, Defect generation – Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA.

Maintenance Planning and Replacement: Maintenance planning – Overhaul and repair; Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions – Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

Maintenance Systems: Fixed time maintenance, Condition based maintenance, Operate to failure, Opportunity maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of terrotechnology.

Condition Monitoring: Techniques-visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, Crack monitoring, Thickness monitoring, Noise and sound monitoring, Condition monitoring of hydraulic system, Machine diagnostics - Objectives, Monitoring strategies, Examples of monitoring and diagnosis, Control structure for machine diagnosis.

Safety Aspects: Importance of safety, Factors affecting safety, Safety aspects of site and plant, Hazards of commercial chemical reaction and operation, Instruments for safe operation, Safety education and training, Personnel safety, Disaster planning and measuring safety effectiveness, Future trends in industrial safety.

Books:

1.	Concepts in Reliability Engineering	L.S. Srinath	Affiliated East West Press
2.	Maintainability and Reliability Handbook	Editors: Ireson W.A. and C.F. Coombs	McGraw Hill Inc.
3.	Failure Diagnosis and Performance Monitoring	L.F. Pau	Marcel Dekker
4.	Industrial Maintenance Management	S.K. Srivastava	S. Chand & Co Ltd.
5.	Management of Industrial Maintenance	Kelly and M.J. Harris	Butterworth and Co.
6.	Maintenance, Replacement and Reliability	A.K.S. Jardine	Pitman Publishing
7.	Engineering Maintainability: How to Design for Reliability and Easy Maintenance	B.S. Dhillon	Prentice Hall of India

ENVIRONMENTAL POLLUTION & ITS CONTROL

Introduction: Nature and extent of pollution problems; Types of pollution.

Air Pollution: General nature of air pollution; Air pollutants; Sources of air pollutants; Pollination from stationary sources and its control; Pollution from mobile sources and its control.

Thermal Pollution: Introduction; Effects of thermal pollution on ecology; Thermal plume, regions of plume; Parameters relevant to thermal plume and their limits; Mechanics of condenser water discharge from thermal power plants; Modelling of heated water discharge.

Global Atmospheric Change: Introduction; Simple global temperature models; Green House effects, Green house gases; CO_2 and its estimates; Equilibrium temperature increase caused by CO_2, Chloroform carbons and warming and Ozone depletion impacts of CFC's, changes in stratospheric ozone.

Books:

1. Environmental Pollution And Protection — Garg, Bansal, Tiwana — Deep and Deep Publs.
2. Environmental Pollution- Hazards And Control — R D Gupta — Concept Publishing Company
3. Environmental Pollution Compliance — H.C. Sharma — CBS Publishers
4. Global Effects of Environmental Pollution — American Association For The Advancemen — Kluwer Aca

ARTIFICIAL INTELLIGENCE IN ENGINEERING

Introduction: Concept and understanding AI; Representation of facts; predicate and predicate expressions and types; Semantics with and without multiple arguments. Variables and queries; Single and multidirectional queries; matching alternatives; Multi condition queries; Negative predicate expressions, back tracking.

Definition and Inferences: Rules and fact orders; Rules as programmes; Rules in natural language; Rules without right side; Back tracking with rules; Transitive inheritance/inferences.

Control Structure for Rule based systems: Backward and forward chaining; Hybrid control structures; Meta rules decision lattices; Concurrency in control structures; AND-OR NOT lattices; Randomness in control structures; Grammars for interpreting languages; Rule based system implementation-backward chaining; Virtual facts and catching; Implementation, Input/output coding, Intermediate predicates, Probability in rules, Independence assumption and/or combination, search-state operators, search as graphical traversal search strategies; Depth first and breadth first heuristics, cost and evaluation functions, Optimal path search.

Abstraction of Facts: Partitioning of facts; Frames and slots; Frames with components; Frames as forms; Slot inheritance, Past kind inheritances, Extension vs intentions; Procedural attachment; Frames in Prolog; Frames for natural language understanding.

Expert system: Architecture of expert systems, rule based system, Knowledge acquisition, Neural networks, fuzzy logic and genetic algorithm applications

Books:

1. Neural Networks-A Comprehensive Foundation — Siman Haykin — Mc Millan
2. Introduction to Artificial Neural Networks — J.M. Jureda — Jaico
3. Fuzzy sets, uncertainty and Information — J.K. George & Tina A Plogar — -
4. Neural Networks and Fuzzy systems — Baert Kosko — -
5. Introduction to artificial Intelligence and Expert System — Peterson — Prentice Hall of India
6. Introduction to AI Robotics — RR Murphy — Prentice Hall of India
7. Introduction to genetic Algorithm — M. Vidyasagar — Springer

NEURAL NETWORK AND FUZZY SYSTEMS

Introduction to neural network and fuzzy systems; Artificial neural networks and their biological roots; ANN as numerical data/signal processing device, Taxonomy of neural networks, Feed forward and recurrent neural networks; Supervised and unsupervised learning; Various training methods; Importance of back propagation methods; Adoptive resonance theory.

Fundamentals of fuzzy logic systems; Operations on fuzzy sets, Complements, intersections and unions etc., Fuzzy arithmetic, Crisp vs fuzzy relations; Fuzzy equivalence; Compatibility and ordering relations; Fuzzy morphisms; Fuzzy

relation equations and approximate solutions; Fuzzy logic and multi valued logic; Fuzzy propositions; Fuzzy quantifiers; Linguistic hedges; Fuzzy system controllers- an operative and examples; Fuzzy dynamic systems such as pattern recognition systems; Fuzzy databases and information retrieval systems.
Neuro-fuzzy systems; Computational intelligence paradigm and its applications.

Books:

1.	Neural Network Learning: Theoretical Foundations	Anthony Martin M	Cambridge University
2.	Neural Network Perception for Mobile Robot Guidance	Ean A Pomerleau	-
3.	Neural Networks and Fuzzy Systems	Shigeo Abe	-
4.	Fuzzy Systems Engineering: Theory and Practice	Nadia Nedjah	Springer Verlog

APPLIED PROBABILITY AND STATISTICS

Axioms of probability, Conditional probability, discrete and continuous random variables, Functions of random variables, expectation of random variables, Jointly distributed random variables, Descriptive and interferential statistics, Estimation of parameters, Test of hypothesis, Analysis of variance, Regression analysis, Introduction to statistical packages.

Books:

2.	Engineering Reliability	Richard E Barlow	-
3.	Applied Statistics and Probability For Engineers, Student Workbook With Solutions	Montgomery Douglas C	John Wiley
4.	Basic Concepts of Probability and Statistics	L Hodges	-
5.	Probability And Statistics With Reliability, Queuing, And Computer Science Applications	Trivedi Kishor S	Wiley-International

INTELLIGENT INSTRUMENTATION

Transducers: Electro mechanical transducers, Resistance, Inductance, capacitive and Piezoelectric transducers, Thermoelectric and Photoelectric transducers, Analog and digital transducers including semiconductor and optical type, Application to measurement of temperature, Pressure, Flow, Displacement and other non-electrical quantities.
Introduction to data acquisition system, A/D and D/A converters, Sample and hold circuit, MUX and DEMUX, Signal transmission; Introduction to AM, FM, FSK, PSK and PWM modulation and demodulation, Signal to noise ratio and band width considerations

Books:

1.	Intelligent Instrumentation	Barney	Prentice hall India
2.	Modern electronic Instrumentation & Control	Helfrick & Cooper	Prentice hall
3.	Telemetry System	Border & Mayewize	-
4.	Data Communication	Schewher	McGraw Hill
5.	Telemetry Principles	Patranabis	TMS

MICROPROCESSOR SYSTEMS

Evolution of Microprocessors, General architecture of microprocessor, An overview of 8086/88 architecture, Minimum/maximum mode configuration, Assembly language programming in 8086, Interrupt structure
Programmed I/O, Parallel I/O (8255-PP) serial I/O (8251/8250), RS-232, IEEE bus standard, 8157 DMA controller A/O & D/A conversion, 8253/4 PIT Countess.
Introduction to 8087/287, 80386, Pentium & Microcontrollers 8051 Case studies & applications, examples.

Books:

1.	Microprocessor and It's Applications	D.V. Hall	Tata McGraw Hill
2.	The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro processor, Architecture, Programming & Interfacing	B.B. Bray	Prentice Hall India
3.	Microprocessor & Microcomputer Based System Design	Moh. Refiguzzaman	Universal Book Stall
4.	The Pentium Microprocessor	J.L. Antonkos	Pearson Education
5.	The 8051 Microcontrollers and Embedded Systems	Moh Mazidi and J. Mazidi	Prentice Hall

MACHINE VISION

Image capture and digitization; Image transforms; Digital Fourier transform; Fast Fourier transform; Other transforms; Convolution; Image enhancement; Spatial methods; Frequency domain methods; Image restoration.

Geometric transformation; Image compression; error free and lossy compression; Edge detection; Hough transform; Region based segmentation; image feature / region representation and descriptors; Morphological operators.

Feature based matching; Baye's classification; Low level vision; Introduction to stereopsis, Shape from shading; Optical flow; Rule based picture segmentation; tutorial exercise will emphasize development and evaluation of image algorithms.

Books:

1.	Image Processing, Analysis and Machine Vision	Milan Sanka, Vaclav Hlavac and Roger Boyle	Vikas Publishing
2.	Digital Image Processing	Kenneth & Castleman	Prentice Hall India
3.	Digital Image Processing	Conzalez RC & P Wint	Addision Wesley
4.	Digital Image Processing & Analysis	Chandra and Mazumdar	Prentice Hall India

MICRO-ELECTRO-MECHANICAL SYSTEMS

Its Elements – such as mechanics, electronics, microelectronics, power electronics and information technologies.

Mechanical elements with integrated electronics, Suspension systems, Vibration dampers, Clutches, Bearings-Mechanical/magnetic, gears etc. Micro-motors, DC motors, PCB motors, Disc motors, Reluctance motors, PM motors, Brushless motors, Stepper motors, Universal motors, Aerial field motors, Induction motors, and synchronous motors.

Applications to Tele-communication technology equipment, computer printers, Actuators, Consumer products such as cameras, Camcorder, Timers, Clock, VCR, wipers, Fax machines, Recorders.

Books:

1.	Mechatronics	Bolten	-
2.	Stepper Motors Fundamentals, Applications and Design	V. Athani	New Edge International
3.	Switched Reluctance Motors and Their Control	T.J.E. Miller	Oxford
4.	Permanent Magnet Motor Technology	J.F. Gieras and M. Wing	M. Dieker
5.	Brushless Servo motor Fundamentals and applications	Y. Dote & S. Kinoshikha	Clarendon Press Oxford

ELECTRIC DRIVES

Characteristics and operating modes of drive motors, starting, braking and speed control of motors, Four quadrant drives, types of loads, Torque and associated controls used in process industries.

Applications of solid state controllers such as choppers, rectifiers, invertors and cyclo-converters in drive systems and their performance characteristics, Modern trends in industrial drives and control.

Case studies relating to steel mills, paper mills, textile mills, machine tools etc., A.C. motor drives in transportation system and traction, duty cycle, heating/Cooling and insulation in motors, Choice of motors and rating, Electromagnetic control of motors.

Books:

1.	Fundamentals of Electric Drives	M.A. EI- Sharkawi	Brooks/Col.
2.	Power Electronics, Converter, Applications &	N. Mohan, T.N. Udeland & W.T.	John Wiley

	Design	Robbins	
3.	Power Semiconductor Controlled Drives	G.K. Dubey	Prentice Hall India
4.	Electric Drives	N.K. De & P.K. Sen	Prentice Hall
5.	Power Electronics and Variable Frequency Drives	B.K. Bose	Standard Publishers

ALTERNATIVE FUELS AND ENGINE POLLUTION

Alternative fuels, Biodiesel production & specifications, transesterification process, alcohol, emulsified fuels, DME, GTI, Introduction to gaseous alternative fuels, Hydrogen, production, storage, combustive properties of hydrogen, hydrogen induction systems, Compressed natural gas, production, supply, storage, filling systems, LPG. Pollutants due to transportation systems, Nature of pollutants and their formation, Local and global effects of pollutants, Effects of engine pollutants on human health, Photochemical smog, Emission regulations, regulated/unregulated pollutants, technologies to control engine pollution