Kamla Nehru Institute of Technology, Sultanpur

M. Tech. - Mechanical Engineering (Full Time Programme)
Specialization: THERMAL ENGINEERING
[Starting from Session 2017-18]

SEMESTER –I

Sr. No.	Subject Category	Subject Code	Name of Subject	Periods		Evaluation Scheme				Subject Total	Credit
						SESSIONAL			ESE		
				L	T/P	CT	TA/LAB	Total			
1.	DC	RMEC101	Numerical Methods and Computer Programming	3	1/2	30	10	40	60	100	4
2.	DC	RMEC102	Simulation, Modelling & Analysis	3	1/2	30	10	40	60	100	4
3.	DC	RMEC103	Advanced Thermal Sciences	3	1/2	30	10	40	60	100	4
4.	DE	RMEE___	Department Elective 1	3	1/2	30	10	40	60	100	4
			Total							**400**	**16**

SEMESTER –II

Sr. No.	Subject Category	Subject Code	Name of Subject	Periods		Evaluation Scheme				Subject Total	Credit
						SESSIONAL			ESE		
				L	T/P	CT	TA/LAB	Total			
1.	DC	RMEC201	Advance Heat Transfer	3	1/2	30	10	40	60	100	4
2.	DC	RMEC202	Design of Thermal Systems	3	1/2	30	10	40	60	100	4
3.	DE	RMEE___	Department Elective 2	3	1/2	30	10	40	60	100	4
4.	DE	RMEE___	Department Elective 3	3	1/2	30	10	40	60	100	4
			Total							**400**	**16**

Elective-I/III

S.N.	Subject Code (Elective-I)	Subject Code (Elective-III)	Subject
1	RMEE101	RMEE301	Product Design and Development
2	RMEE102	RMEE302	CAD/CAM
3	RMEE103	RMEE303	Computer Aided Design of Thermal Systems
4	RMEE104	RMEE304	Computer Aided Design of Mechanical Systems
5	RMEE105	RMEE305	Concurrent Engineering & Product Lifecycle Management
6	RMEE106	RMEE306	Power Plants Engineering
7	RMEE107	RMEE307	Computational Fluid Dynamics & Heat Transfer
8	RMEE108	RMEE308	Gas Turbines and Compressors
9	RMEE109	RMEE309	Combustion Engineering
10	RMEE110	RMEE310	Internal Combustion Engines
11	RMEE111	RMEE311	Advanced Fluid Mechanics

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

Specialization: INDUSTRIAL SYSTEM ENGINEERING

[Starting from Session 2017-18]

SEMESTER –I

Sr. No.	Subject Category	Subject Code	Name of Subject	Periods		Evaluation Scheme				Subject Total	Credit
						SESSIONAL			ESE		
				L	T/P	CT	TA/LAB	Total			
1.	DC	PMEC101	Numerical Methods and Computer Programming	3	1/2	30	10	40	60	100	4
2.	DC	PMEC102	Simulation, Modeling & Analysis	3	1/2	30	10	40	60	100	4
3.	DC	PMEC103	Applied Operation Research	3	1/2	30	10	40	60	100	4
			Total							**300**	**12**

SEMESTER –II

Sr. No.	Subject Category	Subject Code	Name of Subject	Periods		Evaluation Scheme				Subject Total	Credit
						SESSIONAL			ESE		
				L	T/P	CT	TA/LAB	Total			
1.	DC	PMEC201	Optimization for Engineering Design/ Theory of Optimization	3	1/2	30	10	40	60	100	4
2.	DC	PMEC202	Project Management	3	1/2	30	10	40	60	100	4
3.	DE	PMEE___	Department Elective 1	3	1/2	30	10	40	60	100	4
			Total							**300**	**12**

Department Elective-I/III (PMEE-1?? / PMEE-3??)

S.N.	Subject Code	Subject
1.	PMEE-151 / PMEE-351	Product Design and Development
2.	PMEE-152 / PMEE-352	CAD/CAM
3.	PMEE-153 / PMEE-353	Experimental Modal Analysis and Dynamic Design
4.	PMEE-154 / PMEE-354	Computer Aided Design of Thermal Systems
5.	PMEE-155 / PMEE-355	Computer Aided Design of Mechanical Systems
6.	PMEE-156 / PMEE-356	Advanced Mechanism Design
7.	PMEE-157 / PMEE-357	Machine Tool Design
8.	PMEE-158 / PMEE-358	Machining Science
9.	PMEE-159 / PMEE-359	Manufacturing System Analysis
10.	PMEE-160 / PMEE-360	Production, Planning and Control
11.	PMEE-161 / PMEE-361	Modern Manufacturing Processes
12.	PMEE-162 / PMEE-362	Metal Casting
13.	PMEE-163 / PMEE-363	Metal Forming
14.	PMEE-164 / PMEE-364	Computer Aided Process Planning & Control
15.	PMEE-165 / PMEE-365	Design for Manufacture
16.	PMEE-166 / PMEE-366	Rapid Prototyping and Tooling
17.	PMEE-167 / PMEE-367	Concurrent Engineering & Product Lifecycle Management
18.	PMEE-168 / PMEE-368	Quality Assurance
19.	PMEE-169 / PMEE-369	Power Plants Engineering
20.	PMEE-170 / PMEE-370	Computational Fluid Dynamics & Heat Transfer
21.	PMEE-171 / PMEE-371	Gas Turbines and Compressors
22.	PMEE-172 / PMEE-372	Combustion Engineering
23.	PMEE-173 / PMEE-373	Internal Combustion Engines

SYLLABUS

M.Tech.- Thermal Engineering

Semester I

RMEC101	NUMERICAL METHODS AND COMPUTER PROGRAMMING	L	T	P
		3	1	-

Unit-I

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)

Unit-II

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.

Unit-III

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).

Unit-IV

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

Unit-V

Solution of Differential Equations: Modified Euler's method, Runge-Kutta method of 2^{nd}, 3^{rd} and 4^{th} 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

RMEC102 **SIMULATION, MODELLING AND ANALYSIS** **L T P**

3 1 -

Unit-I

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

Unit-II

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.

Unit-III

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

Unit-IV

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.

Unit-V

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

RMEC103	ADVANCED THERMAL SCIENCES	L	T	P
		3	1	-

Unit-I

Recapitulation of Fundamentals: Basic definitions & concepts, Simplified Carathedory's formulation, Equation of state-Calculation of Thermodynamic properties.

Unit-II

Generalized compressibility charts, Second law analysis-availability, Thermodynamics of reactive mixtures, Stoichiometry, First and Second law analysis of chemical reactions, Elements of irreversible thermodynamics.

Unit-III

Derivation of 3D generalized conduction equation, steady state conduction, Transient conduction, Numerical methods, Fundamentals of discretization, radiation heat transfer, Surface properties.

Unit-IV

Configuration factors, Calculation of radiative heat exchange between grey surfaces, Fundamentals of two-phase flow, Condensation & evaporation.

Unit-V

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

SYLLABUS

M.Tech.- Thermal Engineering

Semester II

RMEC201 **ADVANCED HEAT TRANSFER** **L T P**

3 1 -

Unit-I

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.

Unit-II

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,

Unit-III

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.

Unit-IV

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.

Unit-V

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

RMEC202 **DESIGN OF THERMAL SYSTEMS** **L T P**

3 1 -

Unit-I

Design of Refrigeration systems

Unit-II

Design of Air -Conditioning equipments and systems,

Unit-III

Design of turbo machines comprising of axial flow turbines and compressors

Unit-IV

Centrifugal Compressor.

Unit-V

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

Department Elective Subjects

Elective-I/III

RMEE101/RMEE301 PRODUCT DESIGN AND DEVELOPMENT **L T P**
3 1 -

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

RMEE102/RMEE302 CAD/CAM **L T P**
3 1 -

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.

RMEE103/RMEE303 **COMPUTER AIDED DESIGN OF THERMAL SYSTEMS** **L T P**

3 1 -

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

RMEE104/RMEE304 **COMPUTER AIDED DESIGN OF MECHANICAL SYSTEMS** **L T P**

3 1 -

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

RMEE105/RMEE305 **CONCURRENT ENGINEERING AND PRODUCT LIFECYCLE MANAGEMENT** **L T P**

3 1 -

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

RMEE106/RMEE306	POWER PLANTS ENGINEERING	L	T	P
		3	1	-

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

RMEE107/RMEE307	COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER	L	T	P
		3	1	-

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

RMEE108/RMEE308 **GAS TURBINES & COMPRESSORS**

L	T	P
3	1	-

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, Operation, Design, Application	Klaus H Ldtke	-
4.	Compressor Performance, Aerodynamics for the User	Theodore Gresh	-

RMEE109/RMEE309 **COMBUSTION ENGINEERING**

L	T	P
3	1	-

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 Gasification Technologies	Quaak Peter	-

RMEE110/RMEE310 INTERNAL COMBUSTION ENGINES **L T P**
3 1 -

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

RMEE111/RMEE311 ADVANCE FLUID MECHANICS **L T P**
3 1 -

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

SYLLABUS

M. Tech. (Part Time) Semester I

Compulsory Subjects -Industrial System Engineering

PMEC101 **NUMERICAL METHODS AND COMPUTER PROGRAMMING** **L T P**

3 1 -

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 forfinite 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 relaxationmethods, 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 3/8rules, Boole's rule, Weddle's rule.

Solution of Differential Equations: Modified Euler's method, Runge-Kutta method of 2^{nd}, $3^{rd}$and 4^{th}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

PMEC102 **SIMULATION, MODELING AND ANALYSIS** **L T P**

3 1 -

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

Physical Modelling: Concept of System and environment, Continuous and discrete systems, Linear and non-linearsystems, 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, Numericalcomputation 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, Randomnumbers, 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 mechanicalsystems, Simulation of hydraulic systems.

Simulation of Manufacturing Systems: Simulation of waiting line systems, Job shop with material handling and Flexiblemanufacturing 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

PMEC103 **APPLIED OPERATIONS RESEARCH** **L T P**
3 1 -

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 andSensitivity 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 dominancerules.

Waiting Line Problems: Classification of queuing problems, M/M/1 & M/M/1/N queuing systems, Steady state analysisof 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, Problemswith 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

SYLLABUS

M. Tech. Semester II

Compulsory Subjects -Industrial System Engineering (Part Time)

PMEC201 OPTIMIZATION FOR ENGINEERING DESIGN **L T P**
3 1 -

Introduction: Historical Developments, Engineering applications of Optimization
Classical Optimization Techniques: Introduction, Review of single and multivariable optimization methods with andwithout constraints, Non-linear one-dimensional minimization problems, Examples.
Constrained Optimization Techniques: Introduction, Direct methods - Cutting plane method and Method of Feasibledirections, Indirect methods - Convex programming problems, Exterior penalty function method, Examples and problems **Unconstrained Optimization Techniques:** Introduction, Direct search method - Random, Univariate and Pattern searchmethods, 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 fromarithmetic-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

PMEC202 Project Management **L T P**
3 1 -

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	

SYLLABUS

M. Tech. Semester II

Department Elective Subjects -Industrial System Engineering (Part Time)

Department Elective-I/III

PMEE-151/PMEE-351 PRODUCT DESIGN AND DEVELOPMENT **L T P**
3 1 -

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

PMEE-152/PMEE-352 CAD/CAM **L T P**
3 1 -

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.

PMEE-153/PMEE-353 EXPERIMENTAL MODAL ANALYSIS ANDDYNAMIC DESIGN

L	T	P
3	1	-

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	-

PMEE-154/PMEE-354 COMPUTER AIDED DESIGN OF THERMAL SYSTEMS

L	T	P
3	1	-

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

PMEE-155/PMEE-355 COMPUTER AIDED DESIGN OF MECHANICAL SYSTEMS

L	T	P
3	1	-

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

PMEE-156/PMEE-356 ADVANCED MECHANISM DESIGN **L T P**

3 1 -

Introduction: Concepts related to kinematics and mechanisms, Degrees of freedom, Grubler's Criteria, Transmission andDeviation 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'-savaryEquation, Bobillier's and Hartsman construction.

Dynamic Force Analysis: Introduction, Inertia force in linkages, Kineto static analysis by superposition and matrixapproach, 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

PMEE-157/PMEE-357 MACHINE TOOL DESIGN **L T P**

3 1 -

Machine Tool Drive: working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanicaltransmission, 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 ofmachine 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 forslide-ways, Design of power screws.

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

Dynamics of Machines Tools: General procedure of assessing dynamic stability of EES, Cutting processing, Closed loopsystem, 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

PMEE-158/PMEE-358 **MACHINING SCIENCE**

L	T	P
3	1	-

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

PMEE-159/PMEE-359 **MANUFACTURING SYSTEM ANALYSIS**

L	T	P
3	1	-

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

PMEE-160/PMEE-360 PRODUCTION, PLANNING AND CONTROL

L	T	P
3	1	-

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	-

PMEE-161/PMEE-361 MODERN MANUFACTURING PROCESSES

L	T	P
3	1	-

Metal cutting: Need for rational approach to the problem of cutting metals-Observation in metal cutting, Energyconsiderations 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, Developmentsin 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 plasticforming 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, Diffusionbonding, 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_2moulding,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

PMEE-162/PMEE-362 METAL CASTING

L	T	P
3	1	-

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 anddross 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 andtheir 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 ofComputers 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

PMEE-163/PMEE-363 METAL FORMING

L	T	P
3	1	-

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 boundsolution, stab methods).
Mechanics of Forming Processes: Rolling-Determination of rolling pressure, roll separating force, driving torque andpower, 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 theprocess.
High Speed Forming: Classification, Comparison of low and high speed forming, operation problems in high speedforming 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 Strip Rolling Mill	Polukhin	MIR Publications
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

PMEE-164/PMEE-364 COMPUTER AIDED PROCESS PLANNING & CONTROL

L	T	P
3	1	-

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

PMEE-165/PMEE-365 DESIGN FOR MANUFACTURE

L	T	P
3	1	-

Introduction: Introduction, Concept and need of concurrent Engineering, Automation of design and manufacturingfunctions 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 materialproperties 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, comparingalternate designs, tolerance design, system optimization, Robust design.

Design for Reliability: Basic concepts, reliability analysis during design phase, failure mode analysis, reliability analysisof 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/CAMsystems. 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 definingmanufacturability index, Interpretation of the MI value, Manufacturability evaluation, a multi criteria approach.

Books:

1.	Integrated Product Development	M.M. Anderson and LHein	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

PMEE-166/PMEE-366 RAPID PROTOTYPING AND TOOLING

L	T	P
3	1	-

Introduction: Historical developments, Fundamentals of RP Systems and its Classification, Rapid prototyping processchains, 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 RPsystems, 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 inmedical 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

PMEE-167/PMEE-367 CONCURRENT ENGINEERING AND PRODUCT LIFECYCLE MANAGEMENT

L	T	P
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Introduction: Extensive definition of Concurrent Engineering (CE), CE design methodologies, Review of CE techniqueslike 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 productcommerce, Artificial Intelligence, expert systems, Software hardware component design.

Design Stage: Lifecycle design of products, Opportunities for manufacturing enterprises, Modality of concurrentengineering 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, Humanresources 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

PMEE-168/PMEE-368 QUALITY ASSURANCE

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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

PMEE-169/PMEE-369 POWER PLANTS ENGINEERING

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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; Useof 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 plantefficiency & heat balance, Research in diesel power plant.

Gas Turbine Plants: Introduction, Classification; Types of gas turbine plants; Analysis of closed and open cycle, Constantpressure 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 directenergy conversion systems.

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

Environmental aspects of Power Generation: Pollutants from fossils fuels and health hazards, Control of emissions andparticulate 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

PMEE-170/PMEE-370 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER

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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

PMEE-171/PMEE-371 **GAS TURBINES & COMPRESSORS**

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Gas Turbines: Development, Classification and field applications of gas turbines, Ideal and actual cycles; multi-stagecompression; 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; Pressurecoefficient; Power unit; Design consideration for impeller and diffusion systems; Performance characteristics.
Axial Flow Compressors: Elementary theory; Vortex theory; Degree of reaction; Simple design; Elementary airfoiltheory; 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 velocitytriangles; 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, Operation, Design, Application	Klaus H Ldtke	-
4.	Compressor Performance, Aerodynamics for the User	Theodore Gresh	-

PMEE-172/PMEE-372 **COMBUSTION ENGINEERING**

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Introduction: Importance of combustion; Combustion equipments, Hostile fire problems, pollution problems arising fromcombustion.
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 Hugoniotrelation, 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 andconvective 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 nitrogenprompts, 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 Gasification Technologies	Quaak Peter	-

PMEE-173/PMEE-373 INTERNAL COMBUSTION ENGINES **L T P**

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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