Bundelkhand Institute of Engineering and Technology, Jhansi

Department of Mechanical Engineering

Session: 2019 – 2020

(Even & Odd Semester)

M.Tech (Thermal Engineering)

1st & 2nd Year Syllabus

[Effective from session 2012-13]

BUNDELKHAND INSTITUT OF ENGINEERING & TECHNOLOGY, JHANSI

NEW STUDY & EVALUATION SCHEME

M.Tech. (Thermal Engineering)

[Effective Form session 2009-10]

S N	Course Code	Subject	Periods			Evaluation Scheme					Subject Total
			L	T	P	Sessional				Exam	
						CT	Attd	TA	Total	ESE	
		Semester I									
1	MME-101	Numerical Methods & Computer Programming	3	1	2	30*	10	10	50	100	150
2	MME-102	Simulation, Modelling and Analysis	3	1	-	30	10	10	50	100	150
3	MME-109	Advanced Thermal Sciences	3	1	2	30*	10	10	50	100	150
4	MME-1??	Elective-I	3	1	2	30*	10	10	50	100	150
		Total	**12**	**4**	**6**				**200**	**400**	**600**
		Semester II									
1	MME-201	Optimization for Engineering Design	3	1	2	30*	10	10	50	100	150
2	MME-211	Advance Heat Transfer	3	1	2	30*	10	10	50	100	150
3	MME-212	Design of Thermal Systems	3	1	-	30	10	10	50	100	150
4	MME-2??	Elective-II	3	1	2	30*	10	10	50	100	150
		Total	**12**	**4**	**6**				**200**	**400**	**600**
		Semester III									
1	MME-305	Advance Fluid Mechanics	3	1	2	30*	10	10	50	100	150
2	OEL-3??	Open Elective	3	1	-	30	10	10	50	100	150
3	MME-351	Dissertation #	-	-	8	-	-	-	50	-	50
4	MME-352	Seminar / Minor Project	-	-	2	-	-	-	100	-	100
		Total	**6**	**2**	**12**				**250**	**200**	**450**
		Semester IV									
1	MME-451	Dissertation	-	-	18	-	-	-	150	200	350
		Total	**-**	**-**	**18**				**150**	**200**	**350**
		GRAND TOTAL									**2000**

Note: *15 Marks are for Class Test and 15 Marks are for Lab., if any, Otherwise 30 Marks are for Class Test
Dissertation to be continued in IV Semester

Elective-I

S.No.	Subject code	Subject Name
1	MME-154/MME-354	Computer Aided Design of thermal systems
2	MME-169/MME-369	Power plant engineering
3	MME-170/MME-370	Computational Fluid Dynamics & Heat Transfer
4	MME-171/MME-371	Gas Turbine & Compressors
5	MME-172/MME-372	Combustion Engineering
6	MME-173/MME-373	Internal Combustion Engines

Elective-II

S.No.	Subject code	Subject Name
1	MME-251/MME-451	Finite Element Method
2	MME-257/MME-457	Advanced Materials Technology
3	MME-258/MME-458	Heat Treatments of Metals
4	MME-269/MME-469	Advanced Gas Dynamics
5	MME-270/MME-470	Cryogenics Systems
6	MME-272/MME-472	Renewable Energy Systems
7	MME-273/MME-473	Combustion Engines and Pollution

Open Elective

S.No.	Subject code	Subject Name
1	OEL-308/ OEL- 508	Reliability, Maintenance Management & Safety
2	OEL-309/ OEL- 509	Environmental Pollution & its Control
3	OEL-311/ OEL- 511	Neural Network and Fuzzy Systems
4	OEL-318/ OEL- 518	Alternative fuels & Engine Pollution
5	OEL-313/ OEL- 513	Intelligent Instrumentation

1st SEMESTER

MME-101 NUMERICAL METHODS AND COMPUTER PROGRAMMING **L T P 3 1 2**

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.

MME-102 SIMULATION, MODELLING AND ANALYSIS **L T P 3 1 –**

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.

MME-109 ADVANCED THERMAL SCIENCES **L T P 3 1 2**

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.

MME-169 POWER PLANTS ENGINEERING **L T P3 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.

2nd SEMESTER

MME-201 OPTIMIZATION FOR ENGINEERING DESIGN **L T P3 1 2**

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.

MME-211 ADVANCED HEAT TRANSFER **L T P 3 1 2**

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 nonabsorbing 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.

MME-212 DESIGN OF THERMAL SYSTEM **L T P 3 1 –**

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

MME-258 HEAT TREATMENT OF METALS **L T P 3 1 –**

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.

3rd SEMESTER

MME-305 ADVANCE FLUID MECHANICS **L T P 3 1 2**

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; Horseshoe 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.

OEL-308 RELIABILITY, MAINTENANCE MANAGEMENT & SAFETY **L T P 3 1 –**

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.