Scheme of INSTRUCTION and EVALUATION [Semester wise]

FIRST SEMESTER:

Name of the Subjects	Hrs/Week			Credits	Evaluation (marks)			
	L	T	P		Internal	External		Total
						Theory	Practical	
1. METE1001: Optimization Techniques	**4**	**--**	**--**	**4**	**40**	**60**	**--**	**100**
2. METE1002: Advanced Thermodynamics	**4**	**--**	**--**	**4**	**40**	**60**	**--**	**100**
3. METE1003: Advanced Heat Transfer	**4**	**--**	**--**	**4**	**40**	**60**	**--**	**100**
4. METE1004: Measurements in Thermal Engg.	**4**	**--**	**--**	**4**	**40**	**60**	**--**	**100**
5. METE1005: Elective – I	**4**	**--**	**--**	**4**	**40**	**60**	**--**	**100**
6. METE1006: Elective – II	**4**	**--**	**--**	**4**	**40**	**60**	**--**	**100**
7. METE1051: Advanced Thermal Engineering Lab	**--**	**--**	**3**	**2**	**25**	**--**	**50**	**75**
8. METE1052: Seminar	**--**	**--**	**3**	**2**	**25**	**--**	**50**	**75**
Total	**24**	**--**	**6**	**28**	**290**	**360**	**100**	**750**

ELECTIVE I

METE1005/A: Finite Element Analysis
METE1005/B: Fuels, Combustion and Emission Control
METE1005/C: Nuclear Power Plants

ELECTIVE II

METE1006/A: Advances in I.C. Engines
METE1006/B: Advanced Fluid Mechanics
METE1006/C: Solar Energy Utilization

SECOND SEMESTER:

Name of the Subjects	Hrs/Week			Credits	Evaluation (marks)			
	L	T	P		Internal	External		Total
						Theory	Practical	
1. METE2001: Gas Turbine	**4**	**-**	**-**	**4**	**40**	**60**	**--**	**100**
2. METE2002: Renewable Energy Systems	**4**	**-**	**-**	**4**	**40**	**60**	**--**	**100**
3. METE2003: Advanced Refrigeration and Air Conditioning	**4**	**-**	**-**	**4**	**40**	**60**	**--**	**100**
4. METE2004: Design of Heat Transfer Equipment	**4**	**-**	**-**	**4**	**40**	**60**	**--**	**100**
5. METE2005: Elective-III	**4**	**-**	**-**	**4**	**40**	**60**	**--**	**100**
6. METE2006: Elective-IV	**4**	**-**	**-**	**4**	**40**	**60**	**--**	**100**
7. METE2051: Computational Lab	**-**	**-**	**3**	**2**	**25**	**--**	**50**	**75**
8. METE2052: Mini Project	**-**	**-**	**3**	**2**	**25**	**--**	**50**	**75**
Total	**24**	**-**	**6**	**28**	**290**	**360**	**100**	**750**

ELECTIVE III

METE2005/A: Energy Conservation & Management
METE2005/B: Computational Fluid Dynamics
METE2005/C: Fluidics and Control Systems

ELECTIVE IV

METE2006/A: Environmental Engg. & Pollution Control
METE2006/B: Cryogenic Engineering
METE2006/C: Gas Dynamics

THIRD SEMESTER & FOURTH SEMESTER:

Name of the Subjects	Hrs/Week			Credits	Evaluation (marks)			
	L	T	P		Internal	External		Total
						Theory	Practical	
METE3051: Major Project	**--**	**--**	**24**	**---**	**50**	**--**	**--**	**50** [end of III sem]
	--	**--**	**24**	**24**	**50**	**--**	**200**	**250** [end of IV sem]

METE1001: OPTIMIZATION TECHNIQUES

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I

LINEAR PROGRAMMING: Two-phase simplex method, Big-M method, duality, interpretation.

INTEGER PROGRAMMING: Branch and bound method, Gommary cut plane method

UNIT II

ASSIGNMENT PROBLEM: Hungarian's algorithm, Maximization Problem, unbalanced problems,

DYNAMIC PROGRAMMING: Introduction, Recursive Relationship, Dynamic Programming Algorithm, Applications to linear programming.

UNIT III

NUMERICAL METHODS FOR OPTIMIZATION: Interval halving method, Fibonacci method, Quadratic interpolation method, Newton method, Quasi Newton method, Secant method, Simmulated Aneealing.

Particle Swarm Optimization

GENETIC ALGORITHM (GA): Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA.

UNIT IV

MULTI-OBJECTIVE GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems.

CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.

Text Books:

1. *Engineering Optimization – S.S. Rao, New Age Publishers*
2. *Operations Research – Kanti swaroop, Gupta P K & Manmohan*
3. *Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers*

References:

1. *Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers*
2. *Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison- Wesley Publishers*
3. *Genetic Programming- Koza*
4. *Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers*

METE1002: ADVANCED THERMODYNAMICS

Lectures: 4 Periods / Week *Internal Assessment: 40*

Final Exam: 3 hrs *Final Examination: 60*

Credits: 4

UNIT I

BASIC CONCEPTS: Thermodynamics - Temperature and zeroth law of thermodynamics - first law of thermodynamics -concept of internal energy- First law for steady flow processes limitations of first law.

SECOND LAW OF THERMODYNAMICS –Carnot Principles-Clausius-Inequality - concept of entropy- Entropy principle-Applications of entropy principle—

UNIT II

EXERGY: Introduction - availability of heat - availability of a closed system - availability function of the closed system - availability of steady flow system – availability function of open system.

IRREVERSIBILITY: Introduction - irreversibility for closed and open system - steady flow process - effectiveness - second law analysis of the power plant.

UNIT III

THERMODYNAMIC RELATIONS:

Maxwell relations- Tds equations-Difference in Heat Capacities- Ratio of Heat Capacities-Energy Equation- Joule-Thomson's Effect- Clausius Clayperon equation-Evaluation of thermodynamic properties from an equation of state, general thermodynamic considerations on an equation of state.

CHEMICAL REACTIONS: Combustion, Theoretical and actual combustion processes – Enthalpy of formation – Enthalpy of Combustion – First Law analysis of Reacting Systems – Adiabatic flame temperature – Entropy change of Reacting mixtures – Second Law analysis of Reacting systems.

UNIT IV

COMPRESSIBLE FLOW:

Stagnation properties-Speed of sound and Mach Number-One dimensional isentropic flow-Isentropic flow through nozzles-Shock Waves and Expansion Waves-Duct flow with heat transfer and negligible friction (Ralyleigh Flow) - Steam Nozzles.

Text Books:

1. *P.K. Nag – 'Engineering Thermodynamics', TMH*
2. *Yunus A Cengel & Michael A Boles – 'Thermodynamics', TMH*

References:

1. *Kenneth Wark Jr. – 'Advanced Thermodynamics for Engineers', McGraw-Hill Inc.*
2. *Bejan, A. - 'Advanced Engineering Thermodynamics', John Wiley and Sons.*
3. *Holman, J.P. – 'Thermodynamics', Fourth Edition, McGraw-Hill Inc.*
4. *Gordon Rogers and Yon Mayhew – 'Engg.Thermodynamics', Addison Wesley Longman*
5. *Van Wylen, Richard E. Sonntag – 'Classical Thermodynamics', Wiley Eastern Ltd.*

METE1003: ADVANCED HEAT TRANSFER

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I

1-D STEADY STATE CONDUCTION: Fins of Uniform and Non Uniform cross sections, Rectangular Fin of minimum weight.

2-D STEADY STATE CONDUCTION: Method of separation of variables, FDM.

TRANSIENT HEAT CONDUCTION: General Lumped capacitance analysis, Transient heat flow in finite and semi infinite solid, Multidimensional systems, use of Heisler chart, Schmidt's method.

UNIT II

FORCED-CONVECTION: General review, Laminar Flow: a similarity solution, Turbulent flow, mixed boundary layer conditions, flow across cylinders and spheres, tube banks – inline and staggered arrangement.

UNIT III

FREE-CONVECTION: Inclined and horizontal plates – the flow pattern and heat transfer, tubes, enclosures, combined free and forced convection.

HEAT TRANSFER WITH PHASE CHANGE: Boiling modes, Pool boiling, flow boiling, condensation: Nusselt's theory, Film condensation, drop-wise condensation.

UNIT IV

RADIATION: Review of radiation principles - laws of thermal radiation - Surface properties - radiative heat exchange among diffuse, gray and non-gray surfaces Separated by non-participating media.

GAS RADIATION: Radiation transfer in enclosures containing absorbing and emitting media - interaction of radiation with conduction and Convection.

Text Books:

1. *Incropera, P.P. and Dewitt, D.P. – 'Fundamentals of Heat and Mass Transfer', Wiley.*
2. *P.K. Nag – 'Heat and Mass transfer', TMH.*

References:

1. *Ozisik M.N. – 'Heat Transfer - A Basic Approach', McGraw-Hill.*
2. *Kays, W.M. and Crawford, M.E. – 'Convective heat and mass transfer', McGraw Hill*
3. *D.S.Kumar – 'Heat and mass transfer', Kataria & sons.*

NOTE: Heat and Mass Transfer Data Book by Kothandaraman and Subramanian (OR) by Domkundwar to be allowed in Examination.

METE1004: MEASUREMENTS IN THERMAL ENGINEERING

Lectures: 4 Periods / Week *Internal Assessment: 40*

Final Exam: 3 hrs *Final Examination: 60*

Credits: 4

UNIT I

ANALYSIS OF EXPERIMENTAL DATA: Causes and types of experimental errors, Error analysis on a commonsense basis, Uncertainty analysis, Statistical analysis of experimental data probability distributions, Standard deviation of the mean

BASIC ELECTRICAL MEASUREMENTS AND SENSING DEVICES: Transducers, - the differential transformer (LVDT), Photoelectric effects, Photoconductive transducers, Photovoltaic cells, Hall-effect transducers.

UNIT II

PRESSURE MEASUREMENT: Mechanical pressure -Measurement devices, Dead-weight tester, Bourdon-tube pressure gauge, Diaphragm and bellows gauges, Low-pressure measurement. The McLeod gauge, Pirani thermal-conductivity gauge, The Knudsen gauge, the ionization gauge

FLOW MEASUREMENT: Positive displacement methods, flow - Obstruction methods, Practical consideration for obstruction meters, and the sonic nozzle. Flow measurement ,Hot-wire and hot-film anemometers, Magnetic flow meters.

UNIT III

MEASUREMENT OF TEMPERATURE: Temperature scales, ideal-gas thermometer, Temperature measurement by mechanical effect. Temperature measurement by electrical effects, Temperature measurement by radiation, Transient response of thermal systems, Thermocouple compensation

THERMAL AND TRANSPORT PROPERTY MEASUREMENT: Thermal conductivity measurements, Measurement of viscosity, Gas diffusion, Calorimetry, Humidity measurements, Heat-flux meters.

UNIT IV

MEASUREMENT ANALYZERS: Orsat apparatus, Gas Analyzers, Smoke meters, gas chromatography, spectrometry.

THERMAL RADIATION MEASUREMENTS: Measurement of Emissivity, Reflectivity and Transmisivity Solar radiation measurements.

Text Books:

1. *Holman J.P. – 'Experimental Methods for Engineers', TMH.*
2. *D S Kumar – 'Mechanical Measurements & Control', Metropolitan Book Co.*

References:

1. *Thomas G. Beckwith, N. Newis Buck – 'Mechanical Measurements'*
2. *Eckert and Gold stein – 'Measurements in Heat Transfer''.*
3. *Morris. A.S. – 'Principles of Measurements and Instrumentation', Prentice Hall of India.*
4. *R S Sirohi and H C Radhakrishnan – 'Mechanical Measurements', New Age Intl.*
5. *A K Sawhney, 'Course in Mechanical Measurements and Instrumentation', Dhanapat Rai*

METE1005/A: FINITE ELEMENT ANALYSIS

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I:

FORMULATION TECHNIQUES: Potential energy method, Raleigh Ritz method, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions, introduction to FEM.

1-D STATIC ANALYSIS OF BARS: Element matrices, assembling of global stiffness matrix, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Stiffness matrix for a Quadratic Element.

UNIT II:

1-D STEADY-STATE HEAT TRANSFER: FE Formulation using linear and quadratic elements, Numerical problems in composite walls and fins of uniform cross section using linear elements.

1-D TRANSIENT HEAT TRANSFER: Derivation of element matrices, solution techniques, A numerical problem with 2 elements.

UNIT III:

2-D STEADY-STATE HEAT TRANSFER: FE Formulation using linear triangle elements, Problem modeling and boundary conditions.

INTERPOLATION FUNCTIONS: Compatibility and completeness requirements, Selection of polynomials and derivation of interpolation functions for 1-D and 2-D elements

UNIT IV:

Isoparametric formulation, Numerical integration (1-D, 2-D).

APPLICATIONS IN FLUID MECHANICS: Finite Element formulation of 1-D and 2-D Steady, incompressible, inviscid, irrotational fluid flows, Problem modeling and boundary conditions

Text Book:

1. *David V.Hutton – Fundamentals of Finite Element Analysis, Tata McGrawHill*
2. *S.S. Rao – The finite element method in Engineering- BH Publication*

References:

1. *Chandraputla & Belagondu –Introduction to Finite elements in Engineering*
2. *J.N. Reddy - Finite element method in Heat transfer and fluid dynamics, CRC press*

METE1005/B: FUELS, COMBUSTION & EMISSION CONTROL

Lectures: 4 Periods / Week *Internal Assessment: 40*

Final Exam: 3 hrs *Final Examination: 60*

Credits: 4

UNIT I

FUELS: Detailed classification – Conventional and Unconventional Solid, Liquid, gaseous fuels – coal – Carborisation, Gasification and liquification – Lignite: petroleum based fuels – problems associated with very low calorific value gases: Coal Gas – Blast Furnace Gas Alcohols and Biogas and Nuclear fuels

PRINCIPLES OF COMBUSTION: Adiabatic flame Temperature – Laminar and turbulent flames propagation and structure – Flame stability – Combustion of fuel, droplets and sprays.

UNIT II

COMBUSTION SYSTEMS: Pulverised fuel furnaces – fixed, Entrained and Fluidised Bed Systems

CHEMICAL KINETICS: Important chemical mechanisms - Simplified conservation equations for reacting flows - Laminar premixed flames - Simplified analysis

UNIT III

Factors influencing flame velocity and thickness flame stabilization - Diffusion flames

COMBUSTION APPLIANCES: Ga burners - Functional requirement of burners – Gas burner Classification –Stoker firing –pulverized system of firing

UNIT IV

EMISSIONS: Emission index - Corrected concentrations - Control of emissions for premixed and non-premixed combustion.

ENVIRONMENTAL CONSIDERATIONS: Air pollution – Effects on Environment, Human Health etc. Principal pollutants – Legislative Measures.

Text Books:

1. *Sharma and Chandra Mohan – Fuels and combustion, Tata Mc Graw Hill*
2. *Shaha A.K - Combustion engineering and Fuel Technology, Oxford and IBH*

References:

1. *Roger A strehlow - Combustion Fundamentals, Mc Graw Hill*
2. *Kenneth K.Kuo - Principles of Combustion, Wiley and Sons.*
3. *Turns, S.R. - An Introduction to Combustion - Concepts and Applications*
4. *Sarkar S. - Fuels and Combustion, Orient Longman.*

METE1005/C: NUCLEAR POWER PLANTS

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I

INTRODUCTION TO NUCLEAR ENGINEERING: Introduction - Why Nuclear Power for Developing Countries, Atomic Nuclei, Atomic Number and Mass Number, Isotopes, Atomic Mass Unit, Radioactivity and Radioactive Change Rate of Radioactive Decay, Mass – Energy Equivalence, Binding Energy, Release of Energy by Nuclear Reaction.

TYPES OF NUCLEAR REACTIONS: Initiation of Nuclear Reaction, Nuclear Cross-section, Nuclear Fission, Fission Chain Reaction, moderation, Fertile Materials and Breeding.

UNIT II

NUCLEAR REACTORS: Introduction, General Components of Nuclear Reactor, General Problems of Reactor Operation, Different Types of Reactors, Pressurized Water Reactors (PWR), Boiling Water Reactors (BWR), Heavy Water – cooled and Moderated CANDU (Canadian Deuterium Uranium),Gas-cooled Reactors, Breeder Reactors, Reactor Containment Design,

UNIT III

FLUIDIZED BED REACTORS: Analysis of gas cycle – Steam cycle – Simple and dual pressure cycles – Pebble bed reactors, Liquid metal cooled reactors – Compatibility with materials - Fast reactors – Fluid fuel reactors – types – Corrosion and Erosion characteristics.

Location of Nuclear Power Plant, Nuclear Power Stations in India, India's 3-stage Program for Nuclear Power Development, Comparison Nuclear Plants with Thermal Plants.

UNIT IV

NUCLEAR MATERIALS: Introduction, Fuels, Cladding and Structural materials Coolants, Moderating and Reflecting materials, Control Rod Materials, Shielding materials.

NUCLEAR WASTE & ITS DISPOSAL: Introduction, Unit of Nuclear Radiation, Types of Nuclear Waste, Effects of Nuclear Radiation, Radioactive Waste Disposal System, Gas Disposal System. SAFETY RULES**:** Personal Monitoring, Radiation Protection, Radiation Dose.

Text Books:

1. *El-Wakil M.M. – 'Nuclear Power Engineering', McGraw Hill Co., New York*
2. *Arora & Domkundwar – 'Power Plant Engineering', Dhanpat Rai & Co.*
3. *J.H.Horlock – 'Combined Power Plants', Pergamon Press.*

References:

1. *P.K.Nag - 'Power Plant Engineering' , Tata McGraw Hill*
2. *Black / Veatch – 'Power Plant Engineering', CBS Published & Distributors.*
3. *Suresh – 'Physics of Nuclear Reactors', Tata McGraw hill publishing Co. Ltd.*
4. *Rajput R.K. – 'Power system engineering', Laxmi Publications.*
5. *Loftness – 'Nuclear Power Plants'*

METE1006/A: ADVANCES IN INTERNAL COMBUSTION ENGINES

Lectures: 4 Periods / Week *Internal Assessment: 40*

Final Exam: 3 hrs *Final Examination: 60*

Credits: 4

UNIT I

SPARK IGNITION ENGINES: Spark ignition Engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, direct injection – Stages of combustion – Normal and abnormal Combustion – factors affecting knock – Combustion chambers.

COMPRESSION IGNITION ENGINES: States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behavior – spray structure, spray penetration and evaporation – air motion.

UNIT II

SCAVENGING AND SUPER-CHARGING: Scavenging and supercharging in CI engines - types of scavenging systems in two stroke SI engines – improved and modified scavenging systems – super charging and engine performance – methods of super charging.

RECENT TRENDS: Lean Burn Engines – Stratified charge Engines – homogeneous charge compression Ignition engines – Plasma Ignition - Measurement techniques – laser Doppler, Anemometry – Introduction to Wankel engine, Stirling cycle engine.

UNIT III

ALTERNATIVE FUELS: Solid, liquid fuels- Alcohol, Methanol, Ethanol, Gaseous fuels - Hydrogen, Natural Gas and Liquefied Petroleum Gas, Properties, Suitability, Merits and Demerits & Engine Modifications.

UNIT IV

POLLUTANT FORMATION: Pollutants – Sources – Formation of carbon monoxide, unburnt hydrocarbon, NOx, Smoke and Particulate matter.

POLLUTION CONTROL: Methods of controlling Emissions – Catalytic converters and Particulate Traps – Emission Instrumentation – Non-dispersive infrared gas analyzer, flame ionization detector – chromoautograph – chemiluminiscent analysis of nitrogen oxides.

Text Books:

1. *V. Ganesan – 'Internal Combustion Engines', TMH Pub.*
2. *Mathur & R.P. Sharma – 'Internal combustion Engines'.*

References:

1. *K.K. Ramalingam – 'Internal Combustion Engine Fundamentals', Scitech Pub.*
2. *Heywood J.B. – 'Internal combustion engines fundamentals', McGraw hill Int. editions.*
3. *Rao M.N. – 'Air pollution', TMH*
4. *Rao C.S. – 'Environmental pollution control Engg', Wiley Eastern Ltd.*
5. *Sharma S.P. – 'Fuels & Combustion', TMH.*

METE1006/B: ADVANCED FLUID MECHANICS

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I

BASIC CONCEPTS: Eulerian and Lagrangian descriptions. Derivation of general differential equations – continuity momentum and energy of incompressible flow- Navier Stokes equation for Viscous Fluids (Rectangular Co-ordinate Systems) - Euler's equations for ideal fluids-Bernoulli's equations (one dimensional)

LAMINAR FLOW VISCOUS INCOMPRESSIBLE FLUIDS: Flow similarity – Reynolds number, flow between parallel flat plates, couette-flow, plane poiseuille flow, Hagen – poiseuille flow.

UNIT II

LAMINAR BOUNDARY LAYER: Boundary layer concept, Prandtl's approximations, Blassius solution for a flat plate without pressure gradient – momentum integral equation – Von-Kerman integral relation – Pohlhausen method of obtaining approximate solutions.

Displacement thickness, momentum thickness and energy thickness. Boundary layer separation and control. Karman's integral equation.

UNIT III

INTRODUCTION TO TURBULENCE: Origin of turbulence, nature of turbulent flow – Reynolds equations and Reynolds stresses, velocity profile.

COMPRESSIBLE FLUID FLOW BASICS: Mach number, Flow pattern in compressible flow, classification of compressible flow, isentropic flow, stagnation properties.

UNIT IV

GAS DYNAMICS: Compressible flow through ducts and nozzles – area velocity relations. Flow through convergent and convergent divergent nozzles. Real nozzles flow at design conditions. Introduction to normal compression shock – normal shock relations. Introduction to Fanno Raleigh equations.

FLOW IN DUCTS WITH FRICTION: Fanno line, adiabatic constant area - Flow of perfect gas, chocking due to friction in constant area flow- Introduction to constant area flow with heat transfer (Raleigh line)

Text Books:

1. *Yuan S.W. – 'Foundations of Fluid Mechanics', Prentice Hall, Eastern economy.*
2. *K. Muralidhar & G. Biswas – 'Advanced Engineering Fluid Mechanics', Alpha Science*

References:

1. *K.L. Kumar – 'Engineering Fluid Mechanics', S. Chand & Co.*
2. *Yahya S.M. – 'Fundamentals of Compressible Flow', Wiley Eastern.*
3. *Young, Munsen and Okisyi – 'A Brief Int. to Fluid Mechanics', John Wiley.*
4. *Frank. M. White – 'Fluid Mechanics', McGraw Hill.*

METE1006/C: SOLAR ENERGY UTILISATION

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I

INTRODUCTION: Solar energy option, specialty and potential – sources of radiation, measurement of beam and diffuse – estimation of average solar radiation on horizontal and tilted surfaces – problems – Applications.

UTILISATION OF SOLAR RADIATION: physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

UNIT II

SOLAR WATER HEATING SYSTEM: Design of solar water heating system and layout.

POWER GENERATION: solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers.

UNIT III

THERMAL ENERGY STORAGE: Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – Thermo-chemical storage solar pond – working principle – construction – application and limitations.

DIRECT ENERGY CONVERSION: Solid-state principles – semiconductors, Photovoltaic cell – characteristics- cell arrays-power electric circuits for output of solar panels-choppers-inverters-batteries-charge regulators, Construction concepts.

UNIT IV

OTHER SOLAR DEVICES: Stills, ponds, air heaters, dryers.

Solar thermal systems applications to power generation , heating and cooling.

Text Books:

1. *Duffie J.A. and Beckman W.A. - Solar engineering of thermal processes*
2. *Sukhatme S.P. - Solar energy, TMH.*
3. *G.D. Rai - Solar energy utilization, Khanna Publishers*

References:

1. *S.K.Dubey, S.K.Bhargava - Non conventional Energy resources*
2. *D.Y.Goswami,F.Kreith and J.F.Kerider - Principles of solar engineering*
3. *Edward E.Anderson - Fundamentals of solar energy conversion*

METE1051: ADVANCED THERMAL ENGINEERING LAB

Practicals: 3 Periods / Week *Internal Assessment: 25*

Final Exam: 3 hrs *Final Examination: 50*

Credits: 2

- Computerized multi cylinder S.I. Engine test rig
- Multi fuel testing in CI engines.
- Variable Compression Ratio petrol engine.
- Emission measurement in SI / CI engines.
- Wind Tunnel test rig
- Variable speed Air blower test rig
- Vapor Absorption Refrigeration test rig
- Air conditioning test rig.
- Shell and Tube Heat exchanger
- Experimental Cooling Tower.
- Transient heat conduction test rig.
- Performance study of a Solar water heater.
- Critical heat flux in Pool Boiling.
- Drop wise and Film wise Condensation.
- Stefan Boltzmann Apparatus
- Emissivity measurement test.
- Fuidized bed heat transfer.

METE1052: SEMINAR

Practicals: *3 Periods / Week* *Internal Assessment: 25*

Final Exam: *3 hrs* *Final Examination: 50*

Credits: *2*

METE2001: GAS TURBINE

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I

INTRODUCTION: power plant cycles for stationary and aerospace applications, component behaviors, open and closed cycles, ideal cycles and their analysis - simple cycle - reheat cycle - heat exchange cycle - intercooler cycle - comparison of cycles - Ericsson cycle. Practical cycles and their analysis - compressor and turbine efficiency - pressure losses - cycle efficiency - polytrophic efficiency - performance of practical cycle.

UNIT II

CENTRIFUGAL COMPRESSORS: Centrifugal compressors, method of operation, Ideal & Actual energy transfers, Inlet or inducer section, Impeller passage, Diffuser system, Losses, Compressor characteristics, Surging and choking.

UNIT III

AXIAL FLOW COMPRESSORS: Principle of operation, Momentum or Filament analysis and energy transfer in rotors, Losses & coefficients of performance, cascade characteristics, three dimensional flow analysis, overall performance, compressor characteristics.

UNIT IV

AXIAL FLOW GAS TURBINES: Elementary Theory, Turbine and nozzle efficiencies, Degree of reaction, Impulse turbine analysis, Reaction turbine analysis, comparison of Turbine types.

COMBUSTION SYSTEMS: combustion mechanism, combustion efficiency, combustion requirements, combustion chamber shapes & arrangements,.

APPLICATIONS OF GAS TURBINES: characteristics-turbo jet engine, typical applications of gas turbines-electric power generation applications-marine application-locomotive applications-automotive applications-aircraft applications-process applications-additional features of gas turbine engines-trends in future development.

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Text Books:

1. *Cohen H, Rogers G and Saravanamuthu H. – 'Gas Turbine Theory', John Wiley.*
2. *Khajuria P.R., Dubey S.P. – 'Gas turbines and propulsive systems', Dhanpat Rai pub.*
3. *Ganesan V. – 'Gas Turbines', TMH.*

References:

1. *Yahya S.H, 'Turbines, Compressors and Fans', - Tata McGraw-Hill.*
2. *Gordon Oates – 'Aero-thermodynamics of gas turbine and rocket propulsion', AIAA Education series*
3. *Mathur M.L., Sharma R.P. – 'Gas turbines and jet & rocket propulsion'*

METE2002: RENEWABLE ENERGY SYSTEMS

Lectures: 4 Periods / Week *Internal Assessment: 40*

Final Exam: 3 hrs *Final Examination: 60*

Credits: 4

UNIT I

SOLAR ENERGY: Availability of solar energy, Measurement of sunshine, solar radiation data, estimation of average solar radiation, the black body, Absorptivity and emissivity, Kirchhoff's law. Reflection from surfaces, solar energy selection, selective surfaces, Construction of solar flat plate and evacuated tube collectors, Performance of solar energy collectors, Solar heating and cooling.

PHOTO VOLTAIC ENERGY: solar cells. Photovoltaic conversion efficiency, Performance characteristics of solar cells as a function of light intensity, temperature and cell area, Solar cell response under normal condition, solar cell arrays, energy calculation of solar cells, Methods of concentration.

UNIT II

WIND ENERGY: wind mills and wind turbine systems, Classification of wind machines: Horizontal & Vertical axis configuration. High and low solidity rotors, Elements of wind mills and wind turbine systems, Aerodynamic models, Rankine Froud Actuator disc model, Betz limit, angular momentum wake rotation theory, Aerofoil sections and their characteristics, Estimation of power output and energy production – gust parameters.

GEOTHERMAL ENERGY: Earth as source of heat energy, stored heat and renewability of earth's heat, Nature and occurrence of geo thermal field, Classification of thermal fields, Model of Hyper thermal fields & Semi thermal fields, Aims of exploration, drilling hot water measurements, Heat & Power capacity of a bore.

UNIT III

OCEAN THERMAL ENERGY: Ocean thermal energy sources, Ocean thermal energy power plant development, Closed and open cycles, advantages and operating difficulties.

TIDAL & WAVE ENERGY: Tidal power sources, Conventional and latest design of tidal power system, The ocean wave, Oscillating water column (Japanese) and the Dam, Atol design.

UNIT IV

FUEL CELL ENERGY: Description, properties and operation of fuel cells, Major components & general characteristics of fuel cells, Description of low power fuel cell systems, portable fuel cell systems, Indirect methanol fuel cell systems, Phosphoric acid fuel cell systems and molten carbonate fuel cell systems.

BIOMASS ENERGY: Types of conversion techniques for the production of solid, liquid and gaseous fuels by chemical and biochemical methods - Technology of biogas, - Principles and feed stock Design of bio-gas plants - Biomass gasifiers - Selection of a model and size, Technical, Climatic, geographical and economic issues.

Text Books:

1. *Leemann & Meliss – Renewable energy sources & conversion technology, TMH.*
2. *Twidell J.W. & Weir, A. - Renewable Energy Sources, EFN Spon Ltd., UK.*
3. *G.D. Rai - Non Conventional Energy Sources, Khanna Publishers, New Delhi*

References:

1. *S.P. Sukhatme - Solar Energy, Tata McGraw Hill Publishing Company Ltd.*
2. *Godfrey Boyle - Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K.*
3. *G.N. Tiwari - Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi.*
4. *L.L. Freris - Wind Energy Conversion systems, Prentice Hall.*
5. *Johnson Gary L. - Wind Energy Systems, Prentice Hall, New York.*
6. *Hall D.D. & Grover R.P. - Biomass Regenerable energy, John Wiley.*

METE2003: ADVANCED REFRIGERATION AND AIR CONDITIONING

Lectures: 4 Periods / Week *Internal Assessment: 40*

Final Exam: 3 hrs *Final Examination: 60*

Credits: 4

UNIT I

VAPOUR COMPRESSION SYSTEM: Classification of refrigerants, coding of refrigerants, Environmental impact – ODP, GWP, Environment friendly refrigerants.
Analysis of Multi-pressure vapour compression systems – Multi compressor system, cascade system – Analysis of multi evaporator systems.

UNIT II

VAPOUR ABSORPTION SYSTEM: Vapour absorption systems – comparison of absorption with compression system - Analysis of Aqua Ammonia system. Water-LiBr system.
OTHER REFRIGERATION METHODS: Steam jet refrigeration – Thermo electric refrigeration – Vortex tube refrigeration – Magnetic cooling system

UNIT III

ADVANCED PSYCHROMETRIC CALCULATIONS: Psychrometry – Comfort air-conditioning - Factors affecting human comfort - Cooling load calculations.

UNIT IV

APPLICATIONS OF REFRIGERATION AND AIRCONDITIONING: Food preservation –, methods of food preservation; Freezing method of food preservation – Indirect contact, direct contact and drying. Comfort air conditioning, Industrial applications, Commercial applications, Transport air conditioning & Special applications.

DUCT DESIGN and AIR DISTRIBUTION SYSTEMS: Pressure losses, Duct design methods, Duct arrangements, Air distribution systems – Up draught, down draught systems, ventilation systems

Text Books:

1. *Arora C.P. - Refrigeration and Air Conditioning, Tata McGraw-Hill.*
2. *Arora & Domkundwar – Refrigeration and Air conditioning, Dhanpat Rai & Co.*

References:

1. *Stoeker, W.P. Jones – 'Refrigeration & Air Conditioning', Tata McGraw-Hill.*
2. *Manohar Prasad – 'Refrigeration and Air Conditioning', New Age International.*
3. *Gosney, W.B. – 'Principles of Refrigeration', Cambridge Univ. Press.*
4. *Dossat R.J. – 'Principles of Refrigeration', John Wiley Pub.*
5. *Barron R.F. – 'Cryogenic systems', Oxford University press.*

NOTE: Refrigeration and Airconditioning Data Book allowed in Examination.

METE2004: DESIGN OF HEAT TRANSFER EQUIPMENT

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I

Classification of heat exchangers - basic design methods for heat exchangers, double pipe heat exchangers, parallel and counter flow. Design of shell and tube heat exchangers; TEMA codes.

UNIT II

Flow arrangements for increased heat recovery, design considerations for different plate type heat exchangers. Compact heat exchangers – types, plate fin, tube fin, Design and Selection.

UNIT III

Design of different types of condensers, Estimation of heat transfer coefficient, Fouling factor, Friction factor, Wilson plots. Different types of evaporators, Design procedure, Selection procedure, Thermal stress calculations, Design of evaporative condensers.

UNIT IV

Direct contact heat transfer - Classification of cooling towers, wet-bulb and dew point temperatures, Lewis number, cooling-tower internals, heat balance, heat transfer by simultaneous diffusion and convection; Design and analysis of cooling towers, determination of the number of diffusion units, performance evaluation of cooling towers, influence of process conditions and operating variables on their design.

Text Books:

1. *Donald Kern – 'Process heat transfer'*
2. *Sadik kakac, Hongtan Liu – 'Heat Exchangers: Selection, Rating, and Thermal Design'.*

References:

1. *Heat exchanger design by Press and N. Ozisik*
2. *Compact Heat exchangers by Kays, W.M., and A.L. London, McGraw Hill.*

METE2005/A: ENERGY CONSERVATION & MANAGEMENT

Lectures: 4 Periods / Week *Internal Assessment: 40*

Final Exam: 3 hrs *Final Examination: 60*

Credits: 4

UNIT I

ENERGY CONSERVATION: Rules for efficient energy conservation – technologies for energy conservation – outline of waste heat and material reclamation, load management, alternate energy sources, and energy storage.

THERMAL INSULATION & REFRACTORS: Heat loss through un-insulated surfaces, effects of insulation on current carrying wires – economic thickness of insulation – critical radius of insulation – properties of thermal insulators – classification of insulation materials – classification of refractors – properties of refractors – criteria for good refractory material – applications of insulating & refractory materials.

UNIT II

WASTE HEAT RECOVERY SYSTEMS: Guideline to identify waste heat – feasibility study of waste heat – shell and tube heat exchanger – thermal wheel – heat pipe heat exchanger – heat pump – waste heat boilers – incinerators.

HEAT RECOVERY SYSTEMS & HEAT EXCHANGER NETWORKS: Liquid to liquid heat exchangers – gas to liquid heat recovery systems, regenerators, recuperators, rotating regenerators – miscellaneous heat recovery methods – selection of materials for heat exchangers – combined radiation and convective heat exchanger, U-tube heat exchanger, tube heat exchanger, fluidized bed heat exchanger – economizer.

UNIT III

ENGINEERING ECONOMICS: Managerial objectives, steps in planning – efficiency of organization- capital budgeting – classification of costs – interest – types – nominal and effective interest rates – discrete and continuous compounding – discounting - time value of money – cash flow diagrams – present worth factor, capital recovery factor, equal annual payments – equivalent between cash flows.

PROJECT MANAGEMENT: Method of investment appraisal – rate of return method, pay back method, net present value method (NPV) – adoption of the methods in energy conservation campaign – types of projects — propose of project management – classification – role and qualities of project manager – types of budgets - budget committee – budgeting.

UNIT IV

ENERGY AUDITING: A definition – objectives – level of responsibility – control of energy – uses of energy – check lists – energy conservation schemes – energy index – cost index – pie charts – sankey diagrams – load profiles – types of energy audits – questionnaire – energy audit of industries – general energy audit – detailed energy audit – energy saving potential.

ENERGY MANAGEMENT PROGRAMS: Necessary steps of energy management programme – concepts of energy management – general principles of energy management – energy management in manufacturing and process industries – qualities and functions of energy managers – duties of energy manager - language of energy manager – checklist for top management.

Text Books :

1. *W.R. Murphy & G.Mickay – 'Energy Management'*
2. *P.W.O Callaghan – 'Energy Conservation', Pargamon Press*

References:

1. *D.A. Reay – 'Waste heat recovery systems', Pergmon Press*
2. *Albert Thumann – 'Hand book of energy audits'*
3. *C.P. Gupta & Rajendra Prakash – 'Engineering Heat Audits', Chand & Bros.*
4. *Albert Thumann – 'Hand book of energy audits', Fairmont Press Inc. Atlanta Georgia.*
5. *Craig B. Smith – 'Energy Management Principles', Pergarmon Press*
6. *EEO – 'The role of Energy Manager', U.K.*
7. *Dr. O.P. Khanna – 'Industrial Engineering & Management', Dhanapat Rai & Sons.*

METE2005/B: COMPUTATIONAL FLUID DYNAMICS

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT-I:
Philosophy of CFD, Areas of Application, Numerical methods: FDM, FEM, FVM. Governing equations of Fluid Dynamics- Derivation, Boundary conditions.

Classification of Partial Differential equations, behavior and impact on CFD, Derivation of Finite Difference equations, Accuracy of Finite Difference solutions.

UNIT-II
Solution methods of FD equations: Elliptic, Parabolic, Hyperbolic and Burgers equations, Explicit and Implicit schemes, Sources of Errors, simple numerical problems

UNIT-III
Solution procedures for Incompressible Viscous flows – Artificial compressibility method, Pressure correction methods, Vortex methods.

Formulation and Solution procedures for Compressible Inviscid flows – Potential equation: Artificial viscosity, Artificial compressibility and Artificial Flux methods.

UNIT-IV
Formulation and Solution procedures for Compressible Inviscid flows – Euler equations: Central schemes, First order upwind scheme, Second order upwind scheme with low resolution, Boundary conditions for Euler equations, Pre conditioning process for compressible and incompressible flows.

Text Books:

1. *John. D. Anderson - 'Computational fluid dynamics - Basics with applications', Mc Graw Hill.*
2. *T. J.Chung – 'Computational fluid dynamics', Cambridge University press*

References:

1. *Tapan K. Sengupta – 'Fundamentals of Computational Fluid Dynamics', Universities Press.*
2. *Niyogi , Chakravarty, Laha – 'Introduction to computational fluid mechanics', Pearson publications*

METE2005/C: FLUIDICS AND CONTROL SYSTEMS

Lectures: 4 Periods / Week *Internal Assessment: 40*

Final Exam: 3 hrs *Final Examination: 60*

Credits: 4

UNIT-I

Oil Hydraulic Systems: Introduction, Hydraulic power generators-selection and specification of pumps, pump characteristics

Hydraulic Actuators: Linear and Rotary Actuators-Selection, Specification and Characteristics

UNIT-II

Control and Regulation Elements: Pressure-direction and flow control valves-relief valves, servo and proportional valves

UNIT-III

Hydraulic Circuits: Reciprocation, quick return, sequencing and synchronizing circuits-accumulator circuits-industrial circuits-punching press circuit-hydraulic milling machine, shaper, forklift, safety circuits and selection of components

Pneumatics: Basic Pneumatic system, Pneumatic valves, pneumatic circuits – Basic circuit, speed control circuit, Two step feed control circuit, Time delay circuit and selection of components.

UNIT-IV

Pneumatic Logic Controls: Position and pressure sensing-logic and switching circuits - sequential circuits.

Design of pneumatic logic circuits: Classic methods cascade methods- step counter method- mapping method -combination circuit design.

Maintenance: Fault finding-hydro pneumatic circuits-use of microprocessors for sequencing-PLC-Low cost automation-Robotic circuits.

Textbook:

1. Antony Espossito, "Fluid power with Applications", Prentice Hall, 1980
2. R Srinivasulu,"Hydraulic Pneumatic Controls", 2nd edition, TMH, 2009

References:

1. Dudleyt A.Pease and John J.Pippenger, "Basic Fluid Power", Prentice Hall, 1987
2. Andrew Parr, "Hydraulics and Pneumatics", (HB), Jaico Publishing House, 1999
3. Bolton. W. "Pneumatic and Hydraulic systems", Butterworth - Heinneman, 1997

Web References:

1. http:// www.pneumatics.com
2. http:// www.fluidpower.com.tw

METE2006/A: ENVIRONMENTAL ENGG. & POLLUTION CONTROL

Lectures: 4 Periods / Week *Internal Assessment: 40*

Final Exam: 3 hrs *Final Examination: 60*

Credits: 4

UNIT I

Introduction, Global Atmospheric change – Green House effect – Ozone depletion – natural cycles – mass and energy transfer – material balance – environmental chemistry and biology - impacts – environmental Legislations. Air pollution, pollutants – sources and effect – air pollution meteorology atmospheric dispersion

UNIT II

Water pollution, water resources – water pollutants – characteristic water treatment systems – waste water treatment – utilization and disposal of sludge

Waste management, sources and classification – solid waste – Hazardous Waste – characteristics – collection and transportation – disposal

UNIT III

Environmental Management systems Introduction, Evolution of ISO 14000: Background step by step preparation of EMS certification, ISO 14001: EMS, Basic ISO 14004 Guidance Document, ISO 14010 Audit standards, ISO 14020 Labeling Standards. Environmental Audit, Introduction – Range of Audit objectives – prevailing practices – Audit Methodology Benefits of E. A.

UNIT IV

Environmental Impact Assessment (E.I.A): Introduction – Methodology of E. I. A. – organising the job- performing the assessment – preparation of E.I. Statement, Role of E.I.A. in sustainable development, E.I.A. of hazardous waste - Limitations of E.I.A. – case study.

Environmental Legislation, Introduction – Environment Protection Law in India, Water act 1974 – Air Act 1981 – Wild Life Protection Act 1972 – Indian Forest Act 1927 – Environmental Act 1986 - Motor Vehicle Act 1988. Pollution Control Boards (PCBs) – Activities Current Issues - Miscellaneous Topics – Tragic Incidents.

Text Books:

1. *Dr. Suresh, K Dhameja – 'Environmental Engineering and Management', S. K. Kataria &Sons Publishers*
2. *C.S. Rao – 'Environmental Pollution control Engineering', New Age Intl. Pvt. Ltd.*

References:

1. *G.L. Karia & R. A. Christian – 'Waste Water Treatment', Prentice Hall of India Pvt. Ltd.*
2. *G. N. Pandey & G. C Karney - 'Environmental Engineering', Tata McGraw Hill Co. Ltd*
3. *M. Anji Reddy - 'Environmental Impact Assessment', B.S. Publications, Hyderabad*
4. *Venu Gopala Rao – 'Environmental Science & Engineering', Prentice Hall India Pvt. Ltd.*

METE2006/B: CRYOGENIC ENGINEERING

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I

Introduction: Historical development – present areas involving cryogenic engineering. Basic thermodynamic as applied to liquefaction and refrigeration process – isothermal, adiabatic and Joule Thomson expansion process –

Low temperature properties of engineering materials: Mechanical properties – thermal properties – electrical and magnetic properties. Properties of cryogenic fluids

UNIT II

Gas liquefaction systems: Production of low temperatures - general liquefaction systems – liquefaction systems for neon, hydrogen, nitrogen and helium.

Gas separation systems: Thermodynamically ideal separation systems, Simple condensation or evaporation, Rectification, Rectifying columns – packed columns, plate columns.

UNIT III

Cryogenic refrigeration systems: ideal refrigeration systems – refrigerators using liquids and gases as refrigerants – refrigerators using solids as working media.

Air separation systems: Linde-single column system, Linde-double column system Linde-Frankl system, Heylands system.

UNIT IV

Cryogenic storage and transfer systems: Cryogenic fluid storage vessels, cryogenic fluid transfer systems.

Application of cryogenics: Cryo pumping – Superconductivity and super fluidity – cryogenics in space technology – cryogenics in biology and medicine.

Text Book:

1. *Randall F. Barron - Cryogenic Systems, McGraw Hill.*

References:

1. *Scott R.B. – 'Cryogenics Engineering', Van Nostrand & Co.*
2. *Herald Weinstock, 'Cryogenic Technology'.*
3. *Vance, R. W. and Duke, W. M., 'Applied Cryogenic Engineering', John Wiley.*
4. *Sengapatha, Bose A., 'Cryogenics – Progress and Applications', Tata McGraw Hill*
5. *Timmerhaus, K. D. and Flynn, T. M., 'Cryogenic Process Engineering', Plenum Press.*

METE2006/C: GAS DYNAMICS

Lectures: *4 Periods / Week* *Internal Assessment: 40*

Final Exam: *3 hrs* *Final Examination: 60*

Credits: *4*

UNIT I

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

Wave propagation: Wave propagation, Velocity of Sound, Subsonic and Supersonic Flow.

UNIT II

Steady one dimensional Flow: Fundamental Equations, Discharge from a Reservoir, Streamtube, Area–Velocity Relation, De-laval Nozzle, diffusers, dynamic head, Measurement in Compressible Flow, Pressure Coefficient.

Two –Dimensional compressible Flow: General linear solution for supersonic Flow, flow along Wave- Shaped Wall.

UNIT III

Normal Shock Waves: Equation of Motion for normal shock waves, the normal shock Relations, total pressure across the shock wave, Hugoniot equation, propagating shock wave, reflected shock wave, shock tube.

Oblique shock waves: Oblique shock Relations, Prandtl's equation, Hugoniot equation, variation of floe parameters, oblique shock Relations from the normal shock equation, Mach waves.

UNIT IV

Flow with Friction: Flow in constant Area duct with friction, Adiabatic, Constant –Area Flow of a Perfect Gas, The Fanno curves. Solution of Fanno flow equations, variation of flow properties, tables and charts for Fanno Flow.

Flow with Heat Transfer: flow with Heating or cooling in ducts, Rayleigh line, Fundamental equations, Rayleigh flow relations, variation of flow properties, Maximum heat transfer, tables and charts for Rayleigh flow.

Text Books:

1. *S.M.YAHYA – 'Fundamentals of compressible flow'*
2. *E Rathakrishnan – 'Gas Dynamics', Prentice Hall of India*

References:

1. *Bird G A – 'Molecular Gas Dynamics and the Direct Simulation of Gas Flows', Oxford University*
2. *Carlo Cercignani – 'Kinetic Theory and Gas Dynamics', Springer Verlog*
3. *Maurice JosephZucrow – 'Gas Dynamics: Multidimensional Flow'*
4. *Liepmann – 'Elements of Gas Dynamics', Dover Publication*
5. *Zucrwo M.J. and Hoffman J.D. "Gas Dynamics", Vol-I & Vol-II, John Wiley and Sons Inc.*

METE2051: COMPUTATIONAL LAB

Practicals: *3 Periods / Week* *Internal Assessment: 25*

Final Exam: *3 hrs* *Final Examination: 50*

Credits: *2*

(Problems are to be formulated in the following areas using FE Software.)

- Steady state, Multi-dimensional Heat Conduction
- (Variable thermal conductivity, Heat generation, Composite slabs / cylinders / spheres)
- Transient Heat Conduction in Plane wall / cylinders / spheres
- Thermal Radiation in Black and Non Black bodies.
- Heat transfer during Phase change.
- Structural – Thermal Analysis.
- Elementary treatment of CFD problems.

METE2052: MINI PROJECT

Practicals: 3 Periods / Week *Internal Assessment: 25*

Final Exam: 3 hrs *Final Examination: 50*

Credits: 2

III & IV SEMESTERS

METE3051: MAJOR PROJECT

Practicals: 24 Periods / Week *Internal Assessment: 100*

Credits: 24 *50 [at the end of III semester]*

50 [at the end of IV semester]

Final Exam: Viva-voce & Presentation *Final Examination: 200*