Kalinga University Atal Nagar (C.G.)

SCHEME OF EXAMINATION

& SYLLABUS

of

M.Tech
Mechanical
(Thermal Engineering)

UNDER

Faculty of Engineering and Technology

w.e.f. Session 2021-22

Kalinga University, Raipur
Master of Technology (M.Tech) Mechanical
(Thermal Engineering)
(2 yrs Programme) w.e.f 2021-22 Session

M.Tech in Thermal Engineering						
Semester -I						
Code No.	**Paper**	**Lecture**	**T/P (Tutorial/ Practical**	**End Semester Exam**	**Internal Marks**	**Total Marks**
METE101	Numerical Methods in Thermal Engineering	3	1	100	50	150
METE102	Advanced Thermodynamics	3	1	100	50	150
METE103	Advance Fluid Mechanics	3	1	100	50	150
METE104	Advanced Heat Transfer	3	1	100	50	150
Refer Below Elective – I		3	1	100	50	150
METE105A	Design of Heat Exchangers					
METE105B	Fluid Power Engineering					
METE105C	Advanced I.C. Engines Technology					
METE106-P	Computational Fluid Flow & Heat Transfer Lab		5	30	20	50
METE107-P	Experiments in Thermal Engineering		5	30	20	50
	Total	**15**	**15**	**560**	**290**	**850**
Semester - II						
Code No.	**Paper**	**Lecture**	**T/P (Tutorial/Practical**	**End Semester Exam**	**Internal Marks**	**Total Marks**
METE201	Modeling & Simulation of Thermal Systems	3	1	100	50	150
METE202	Experimental Methods in Thermal Engineering	3	1	100	50	150
METE203	Energy Management	3	1	100	50	150
METE204	Refrigeration & Air Conditioning System Design	3	1	100	50	150
Refer Below Elective – II		3	1	100	50	150
METE205A	Boundary layer Theory					
METE205B	Two Phase Flow & Heat Transfer					
METE205C	Advance Gas Dynamics					
METE206-P	Instrumentation Lab		5	30	20	50
METE207-P	Modeling & Simulation Lab		5	30	20	50

	Total	**15**	**15**	**560**	**290**	**850**
Semester - III						
Code No.	**Paper**	**Lecture**	**T/P (Tutorial/Practical**	**End Semester Exam**	**Internal Marks**	**Total Marks**
METE301	Computational Fluid Dynamics & Heat Transfer	3	1	100	50	150
METE302	Communication & Research Methodology	3	1	100	50	150
Refer Below Elective – III		3	1	100	50	150
METE303A	Power Plant Engineering					
METE303B	Bio-Fluid Mechanics					
METE303C	Micro & Nano Scale Thermal Engineering					
METE304	Preliminary Work on Dissertation			100	50	150
METE305	Seminar Based on Dissertation			100	50	150
	Total	9	3	500	250	750
Semester - IV						
Code No.	**Paper**	**Lecture**	**T/P (Tutorial/Practical**	**End Semester Exam**	**Internal Marks**	**Total Marks**
METE401	Dissertation			300	200	500
	Total			**300**	**200**	**500**

SEMESTER -1

METE101

Numerical Methods in Thermal Engineering

Unit – I

Introduction: Concepts of consistency, stability and convergence of numerical scheme. Various finite difference and finite element methods and their applications to fundamental partial differential equations in engineering and applied sciences.

Unit– II

Case studies selected from fluid mechanics and heat transfer.

Unit– III

Finite Difference Method: Classification, Initial and Boundary conditions, Forward, Backward difference, Uniform and non-uniform Grids, Grid Independence Test. Basic finite difference schemes. Boundary treatments.

Unit-IV

Fourth order RK methods and Predictor-corrector methods and Nachsheim-Swigert iteration with applications to flow and heat transfer, Parabolic and hyperbolic problems. Model problems and stability estimates.

Unit – V

Discrete Fourier series. Von- Neumann stability analysis. Consistency, convergence and error estimates. Keller Box and Smith's method with application to thermal boundary layers.

Convection dominated problem: The failure of standard discretization, Upwinding and Higher order methods.

Text Books:

1. Muralidhar K, Sundararajan T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 1995
2. Ghoshdasdidar P.S., Computer Simulation of flow and heat transfer, Tata McGraw-Hill Publishing Company Ltd., 1998
3. Patankar S.V., Numerical heat transfer fluid flow, Hemisphere Publishing Corporation, 1980
4. Anderson D.A., Tannehill I.I. and Pletcher R.H., Computational Fluid Mechanics and Heat Transfer, Hemisphere Publishing Corporation, New York, USA, 1984

References:

1. Fletcher C.A.J., Computational Techniques for Fluid Dynamics,
2. Fundamental and General Techniques, Springer-Verlag, 1987
3. Sengupta T.K., Fundamentals of Fluid Dynamics, University Press, Hyderabad

METE102

Advanced Thermodynamics

Unit – I

Review of I & II laws of thermodynamics, transient flow analysis, entropy balance, entropy generation.

Exergy Analysis, concepts, exergy balance, exergy transfer, exergetic efficiency, exergy analysis of power and refrigeration cycles.

Unit–II

Real Gases and mixtures, equations of state, thermodynamic property relations, residual property functions, properties of saturation states

Unit– III

Thermodynamic properties of homogeneous mixtures, partial molal properties, chemical potential, fugacity and fugacity coefficient, fugacity relations for real gas mixtures, ideal solutions, phase equilibrium, Rault's law.

Unit-IV

Reacting Systems, I and II law analysis of reacting systems, absolute entropy and the third law, fuel cells, chemical energy, Exergetic efficiency of reacting systems, Chemical equilibrium, equilibrium flame temperature.

Unit – V

Statistical Mechanics: Maxwell-Boltzman Statistics, microstate & Macrostate, Thermodynamic probability.

Text Books:

1. Wark K., Advanced Thermodynamic for Engineers, John Wiley & Sons Inc. , 1995
2. Bejan A., Advanced Engineering Thermodynamics, John Wiley & Sons Inc. 1988

References:

1. Annamalai K. & Puri, Advaced Engineering Thermodynamics, CRC Press, 2001
2. Bejan A., Tsatsarones G. & Moran M., Thermal Design & Optimization, John Wiley & Sons, 1996
3. Moran M.J. a& Shapiro H.N., Fundamentals of Engineering Thermodynamics, John Wiley & Sons Inc., 1992

METE103

Advance Fluid Mechanics

Unit – I

Review of basic concept, concept of continuum, type of fluids, tensor analysis.

Basic laws in integral form, Reynold's transport theorem, mass, momentum and energy equations in integral form and their applications.

Unit – II

Differential fluid flow anaysis, continuity equation. Navier-Stokes equations and exact solutions, energy equation.

Unit-III

Ideal fluid flow analysis, two dimensional flow in rectangular and polar coordinates; continuity equation and the stream function; irrotationality and the velocity potential function; vorticity and circulation; plane potential flow and the complex potential function; vorticity and circulation; plane potential flow and the complex potential function. Sources, sinks doublets and vortices; Flow over bodies and D Alembert's paradox; aerofoil theory and its application.

Unit-IV

Low Reynolds no. flow, approximation of N-S equation, approximate solutions of Navier-Stokes equation, Stokes and Oseen flows, hydrodynamic theory of lubrication.

Large Reynolds number flow approximation, Prandtl's boundary layer equations, Blausius solutions, Falkner-Skan solutions, momentum integral equation, Halstein and Bohlen method, thermal boundary layers.

Unit-V

Compressible Fluid Flow: Thermodynamic basics – Equations of continuity, Momentum and Energy - Acoustic Velocity Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State.

Text Books:

1. Kundu P.K. and Cohen, I.M., Fluid Mechanics, 3rd Edition, Academic Press (Indian reprint), 2004
2. Murlidhar K. and Biswas G., Advanced Engineering Fluid Mechanics, 2nd Edn., Narosa Pub., 2005
3. Yuan S.W., Foundation of Fluid Mechanics, Prentice Hall, 1968

References:

1. Schlichting H and Gersten K, Boundary Layer Theory, 8th Edn., Springer, 2001
2. Batchlor G.K., Introduction to Fluid dynamics, Cambridge, 2000
3. White F.M, Viscous Fluid Flow, 3rd Edn., McGraw Hill, 2006
4. Munson B.R, Young D.F & Okiishi T.H, Fundamentals of Fluid Mechanics, 5th Edn., Wiley, 2006

METE104

Advanced Heat Transfer

Unit – I

Heat conduction: General Equation; boundary & initial conditions, radial fins & fin optimization, transient heat conduction, moving boundaries & moving heat sources problems analysis, ablation heat transfer.

Unit – II

Heat Convection:Boundary layers concepts, laminar & turbulent flows, conservation equation, non-dimensional analysis, B.L. equations, internal and external forced convection, Reynolds Analogy.

Unit – III

Natural convection: combined free and forced convection; combined convection and radiation.

Unit – IV

Condensation and Boiling, Heat pipes

Unit – V

Thermal Radiation: Poljack's and Gehbart's methods, and view factor
Radiation in Enclosures with absorbing and emitting media, Flame Radiation, Solar Radiion.

Text Books:

1. Kreith, Frank, Bohn, M.S., Principles of Heat Transfer, 6th Edn, Brooks Cole Pub. Co., 2000
2. Kesseler D and Greenkorn RA, Momentum, Heat and Mass Transfer Fundamentals, Marcel Dekker, Incl., 1999
3. Arpaci V.S., Kao S.H. and Selamet A, Introduction to Heat Transfer, Prentice Hall, 2000

References:

1. Burmeister LC, Convective Heat Transfer, John Wiley & Sons Inc., 1983
2. Kays W.M., Crawford M.E. and Weigand B, Convective Heat and Mass Transfer, Tata McGraw Hill, 2005
3. Ozisik M.N, Heat Conduction, John Wiley & Sons Inc., 1980
4. Siegel R and Howell J.K., Thermal Radiation Heat Transfer, Taylor & Francis, 2002
5. Rohesnow & Chai, Heat Transfer

METE105A

Design of Heat Exchangers

Unit – I

INTRODUCTION : Classification, Constructional details, Two and Multi-fluid heat exchangers, extended surfaces.

Unit – II

DESIGN OF HEAT EXCHANGERS: Engineering Design – Steps for Designing, Designing a Workable System, Feasible/Workable design and Optimum Systems, Economics, Equation Fitting, Probabilistic Approach to Design, Sizing and Rating Problems.

Unit – III

LMTD and NTU approach of design. Design of Tubular, Shell & Tube, Finned (Radial and Longitudinal), Regenerative and Compact heat exchangers.

Unit – IV

OPTIMUM DESIGN: Criteria for optimization of heat exchangers, different constraints, feasible and optimum design, optimization based on Volume, Weight, Cost, Entropy generation and Thermoeconomics.
Brief introduction to some traditional and non-traditional optimization techniques.

Unit – V

PERFORMANCE BEHAVIOUR: Design Vs Simulation, Steady State Performance – Effectiveness, Transient Performance, Non-uniformities in temperature and flow. Three fluid/multifluid heat exchanger behaviour.

Text Books:

1. Kays W.M. and London A.L. "Compact Heat Exchanger", Krieger Publishing Company,1998.
2. Rosenhow, Hartnett and Cho eds. "Handbook of Heat Transfer", McGraw Hill Professional, New York 1998
3. Kraus Aziz and Welty, "Extended Surface Heat Transfer", Wiley- Interscience. New York.2001

References:

1. Rao S.S."Optimization theory and application", 3rd Ed.Wiley-Interscience.1996
.
2. Hesselgreaves J.E., "Compact Heat Exchangers: selection, design and operation", Pergamon
Press.2001
3. Webb R.L. and Kim N.H., "Principles of Enhanced Heat Transfer", Taylor and Fracis,2005

METE105B

Fluid Power Engineering

Unit – I

INTRODUCTION: Type of Fluid power control systems and its components, Physical properties of hydraulic fluids and governing equations.

Unit – II

Pumps and valves: Classification, Working and performance of gear, vane, piston pumps and their selection, Pressure intensifiers, Direction control valves, Pressure control valves, Flow control valves, Servo valves, Pressure switches.

Unit – III

Hydraulic Actuators: Linear and rotary actuators, Gear, vane and piston motors, Performance of Hydraulic motors, Hydrostatic transmission.

Hydraulic circuit design and analysis: Control of single-acting and double-acting cylinders, Study of various circuits like regenerative, unloading, counterbalance, speed control etc., maintenance of hydraulic circuits.

Unit – IV

Pneumatic control systems: air preparation and components, Compressors and conditioners, Air control valves and actuators.

Pneumatic circuit design and analysis: Design considerations, Pressure and energy loss, Basic Pneumatic systems, Vacuum and accumulator systems, Circuit analysis.

Unit – V

Fluid logic control system: Principles, Basic fluidic devices, fluid sensors, Boolean algebra, fluidic control of fluid powers systems.

Text Books:

1. Esposito Anthony, " Fluid Power with Applications" 5th Edition, Anthony Esposito 2007
2. Burrow, C.R.,"Fluid Power Servomechanism" Van Nostard Reinhold Co. New York.1972

References:

1. Dudley A, Pippenger, John J. Pease, Basic Fluid Power, Prentice Hall Inc., N.J. (USA), 1987
2. Dudley, Fluid Power with application, Prentice Hall, 1980
3. Fluid Logic, Festo

METE105C

Advanced I.C. Engines Technology

Unit – I

SI Engine, Introduction, carburetion, mixture requirements, Fuel supply, Ignition, Stages of combustion, Normal and abnormal combustion, factors affecting knock, Combustion Chambers.

Unit – II

CI engine, Injection systems, Mechanical and electronic, Combustion in CI engines, stages of combustion, Factors affecting combustion, Direct and indirect injection systems, Combustion Chambers.

Unit – III

Basic concepts of engine simulation, governing equations, simulation of various engine processes for SI and CI Engines.

Unit – IV

Different types of combustion chamber; Engine instrumentation, Types of pollutants –Euro and Bharat norms, Emission control methods in SI and CI engines, catalytic converters, EGR, Modern evaporative emission control system; Lean Burn Engines, Stratified charge Engines, homogeneous charge compression ignition engines.

Unit – V

Engines for special applications, Mining, Defence, Off, highway, Tractor, Bulldozer etc. Submarines, Race car Engine systems, Flexible fuel systems. Surface ignition.

Text Books:

1. Heywood J.B., Internal Combustion Engine Fundamentals, McGraw Hill
2. Ganesan V., Internal Combustion Engines, II Edition, 2002

References:

1. Mathur M.L. and Sharma R.P., A course in internal Combustion Engines, Dhanapat Rai Publications, New Delhi
2. Mathur R.B. and Sharma R.P., Internal Combustion Engines
3. Ramalingam K.K., Internal Combustion Engine Fundamentals, Scitech Publications.
4. Smith D, Auto Fuel Systems, The Good Heart Willox Company, Inc.
5. Ganesan V, Computer Simulation of spark ignition process: University Process, Hyderabad, 1993
6. Ganesan V, Computer Simulation of compression ignition engine, Orient Long man.

METE106-P

Computational Fluid Flow & Heat Transfer Lab

One Lab/Field/Industrial oriented Project/Problem will be allotted to each student related to subject taught in 1st semester.

METE107-P

Experiments in Thermal Engineering

Lab Experiments in the field of:-

1. Fluid Mechanics
2. Heat Transfer
3. Refrigeration & Air Conditioning

Results be presented after due uncertainty analysis.

Semester - II

METE201

Modeling & Simulation of Thermal Systems

Unit – I

Introduction to Modeling, concept of system, continuous and discrete systems, types of models, steps in simulation study.

Mathematical modeling of thermal processes, conservation laws, mass momentum & energy balance.

Unit – II

Dimensional analysis model development for various thermal processes and system.

Dynamics of thermo fluid system.

Unit-III

Simulation of thermal systems, steady state and dynamic simulation.

Unit-IV

Optimization of thermal systems, Introduction to optimization, formulation of objective function, constrained single and multivariable optimization, dynamic integer and geometric programming

Unit-V

Thermodynamic optimization, entropy generation minimization, application to internal and external flows, heat exchangers and other energy-equipment optimization.

Text Books:

5. Suryanarayana N.V. and Arici, Design and simulation of Thermal System, McGraw Hill Inc., 2001
6. Jaluria Y., Design and optimization of Thermal Systems, McGraw Hill Inc., 1997
7. Tsatsaronic G, Moran, M. Bejan, Thermal Design and Optimization, John Wiley & Sons Inc., 1995

References:

4. Gorden G, System Simulation, Prentice Hall Inc., 1978
5. Shannon RE, System Simulation : the Art and Science, Prentice Hall Inc., 1990
6. Close C.M. and Frederick D.K., Modeling and Analysis of Dyanmic Systems, John Wiley & Sons Inc., 2001
7. Jaluria Y and Torrance K.E, Computational Heat Transfer, Taylor & Francis, 2002

METE202

Experimental Methods in Thermal Engineering

Unit – I

Significance of Measurement and Instrumentation : Introduction; generalized configuration and functional stages of measuring systems. The transducer and its environment; an overview; sensing process and physical laws.

Dynamic Response of Instruments: Mathematical model of a measuring system, response of general form of instruments to various test inputs; time-domain and frequency domain analysis. Elementary transfer functions and Bode plots of general transfer functions.

Unit– II

Errors in Measurement and Its analysis: Causes and type of experimental errors; systematic and random errors. Uncertainty analysis; computation of overall uncertainty; estimation for design and selection for alternative test methods.

Unit– III

Flow Measurement: Flow visualization, shadowgraph; schilieren and interferometric techniques; Pitot static tubes; hot wire anemometers; Laser Doppler velometer; flow measurements using coriolis effect.

Unit-IV

Temperature and Heat Flux Measurement: Thermoelectric sensors; electric resistance sensors; thermistors; radiations pyrometers; Temperature measuring problems in flowing fluids, dynamic compensation.

Unit – V

Data acquisition systems:analog input-output communication, analog to digital converter, static and dynamic characteristic of signals, Bits, Transmitting digital numbers, resolution, quantization error, signal connections, single and differential connections, signal conditioning.

Text Books:

3. Doeblin, Measurements System Application and Design, 5th Ed., McGraw Hill, 2004
4. Trietly, Harry L, Transducers in Mechanical and Electronic Design, Marcel Dekker, CRC Press, 1986

References:

4. Marrangoni and Lienhard, Mechanical Measurement by Beckwith, 6th Edn, Prentice Hall, 2006
5. Eckert and Goldstein, Measurement in Heat Transfer, 2nd Ed., Sprinter, 1986
6. Goldstein R.J., Fluid Mechanics Measurement, Hemisphere Publishing Company, 1983

METE203

Energy Management

Unit – I

Introduction : Energy Scenario, various forms of energy, energy management and its importance, recent trends in energy conservation.

Energy Auditing and Instrumentation: Definition, methodology, analysis of past trends (plan data), closing the energy balance, laws of thermodynamics, measuring instruments, portable and online instruments. Role of Instrumentation in Energy Conservation.

Unit – II

Energy Economics : Simple payback period, time value of money, IRR NPV, life cycle costing, cost of saved energy, cost of energy generated.

Unit-III

Monitoring and Targeting: Defining monitoring and targeting, elements of monitoring and targeting, data and information, analysis techniques, energy consumption, production, cumulative sum of difference.

Unit-IV

Energy Efficiency in Thermal Utilities: Boilers, steam systems, furnaces insulation and refractories, FBC boilers, cogeneration, waste heat recovery.

Unit-V

Energy Efficiency in Electrical Utilities : Electrical systems, electric motors, compressed air system, HVAC and refrigeration systems, fans and blowers, pumps and pumping systems, cooling towers, lighting system, diesel generating system.

Text Books:

4. Witte L.C., Schmidt P.S., Brown D.R., Industrial Energy Management and Utilization, Hemisphere, 1982
5. Gyftopoulos E.P., Industrial Energy Conservation Manuals, MIT Press, 1988
6. Dryden IGC, The Efficient Use of Energy, 2nd Ed., Butterworth Heinemann, 1982

References:

5. Capehart B.L, Turner W.C., Kennedy W.J., Energy Management Handbook, John Wiley and Sons, 1982
6. Technology Menu for Efficient Energy Use: Motor Drive Systems, Prepared by National Productivity Council and Centre for Environmental Studies, Princeton University, 1993
7. F. Krieth & RE West, Economics of Solar Energy & Conservation Systems, Vol. I & II, CRC Press,
8. D.A. Reay, Industrial Energy Recovery, Wiley

METE204

Refrigeration & Air Conditioning System Design

Unit - I

Cooling and Heating Load Calculations:

Estimation of Solar Radiation : Introduction to cooling and heating load calculations, Solar radiation, Solar geometry, Calculation of direct, diffuse and reflected radiation using ASHRAE solar radiation model, Effect of clouds.

Solar Radiation Through Fenestration Ventilation And Infiltration

Need for fenestration in buildings and effects of fenestration on air conditioning systems, concepts of Solar Heat Gain Factor (SHGF) and Shading Coefficient, calculation of shaded area of fenestrations, Need for ventilation and recommended ventilation rates, Infiltration and causes for infiltration, Estimation of heat transfer rate due to infiltration and ventilation.

Heat Transfer Through Buildings - Fabric Heat Gain/Loss

General aspects of heat transfer through buildings, one-dimensional, steady state heat transfer through homogeneous, non-homogeneous walls, opaque walls and roofs with suitable initial and boundary conditions, semi-empirical methods based on Effective Temperature Difference or Cooling Load Temperature Difference, discuss the physical significance of decrement and time lag factors and present typical tables of CLTD for walls and roof.

Unit - II

Selection of Air Conditioning Systems:

Introduction to thermal distribution systems and their functions, Selection criteria for air conditioning systems, Classification of air conditioning systems, Working principle, advantages, disadvantages and applications of all air systems, eg. single duct, constant volume, and single/multiple zone system, single duct, dual duct, constant & variable air volume (VAV) systems, outdoor air control in all air systems, advantages/disadvantages & applications of all air systems, working principle, advantages, disadvantages and applications of all water systems, air-water systems, working principle, advantages, disadvantages and applications of unitary refrigerant based systems

Unit - III

Transmission of Air in Air Conditioning Ducts:

Air Handling Unit (AHU) and its functions, need for transmission aspects of air in air conditioning, airflow through air conditioning ducts, Bernoulli and modified Bernoulli equations, Static, dynamic, datum and total head, Fan Total Pressure (FTP) and power input to fan, estimation of pressure loss through air conditioning ducts,, Estimation of frictional pressure drop of circular and rectangular ducts using friction charts and equations, Estimation of dynamic pressure drop in various types of fittings, Static regain

Unit - IV

Design of Air Conditioning Ducts:

Important requirements of an air conditioning duct, General rules for duct design, Classification of duct systems, Commonly used duct design methods, Principle of velocity method, Principle of equal friction method, Principle of static regain method, Performance of duct systems, System balancing and optimization, Introduction to fans and fan laws, Interaction between fan and duct system.

Ventilation for Cooling

Use of ventilated air for cooling of buildings and cooling of occupants, comparison between natural ventilation and mechanical ventilation, characteristics of natural ventilation and estimation of airflow rate due to wind and stack effects, general guidelines for natural ventilation and forced ventilation using electric fans, interior air movement using interior fans, unit ventilators, whole house fans and solar chimneys.

METE205A

Boundary layer Theory

Unit – I

Introduction : Ideal and real fluids, the concept of boundary layer Navier – Stokes equations, the limiting cases of layer and small Reynolds number, energy equation.

Laminar Boundary Layer Equation: Two dimensional equations; displacement and momentum thickness; general properties of the boundary layer equations; skin friction.

Unit – II

Similarity Solutions: Wage flow and its particular cases; flow past a cylinder; two dimensional inlet flow in straight channel.

Approximate Methods: Karman-Pohthausen methods; numerical methods Axially symmetrical boundary layer Circular jet; body of revolution; Manglers transfixion

Unit – III

Axially Symmetrical Boundary Layer: Circular jet; body of revolution; Manglers transfixion **Boundary Layer Control**: Different methods, flow over a flat plate with uniform section.

Unit – IV

Turbulent Boundary Layer: Two-dimensional equation; prandtl's misusing layer karman's hypothesis universal velocity distribution; flow over a flat plate; skin friction drag.

Unit – V

Thermal Boundary Layers: Two-dimensional equations forced flow over flat plate at zero in advances, national flow over a vertical plate.

Text Books:

4. Schlichting, Boundary Layer Theory, Springer-Verlag, 2004
5. Rozenhead, Laminar Boundary Layers, Dover Publications, 1988
6. Hinze, Turbulence, McGraw Hill, 1975

References:

4. Kays and Crawford, Convective Heat & Man Transfer, McGraw Hill, 1980
5. Wellty, Wicks & Wilson, Fundamentals of Momentum Heat and Mass Transfer, John Wiley & Sons, 1984
6. Goldstein, Modern Development in Fluid Dynamics, Vol. 5, Dover Publications, 1965

METE205B

Two Phase Flow & Heat Transfer

Unit – I

Introduction: Types of flow; volumetric concentration; void fraction; volumetric flux; relative velocity; drift velocity; flow regimes; flow maps; analytical models.

Homogeneous Flow: One dimensional steady homogeneous equilibrium flow; homogeneous friction factor; turbulent flow friction factor.

Unit – II

Separated Flow: Slip; Lockhart-Martinelli method for pressure drop calculation; pressure drop for flow with boiling; flow with phase change.

Unit – III

Drift Flow Model: General theory; gravity flows with no wall shear; correction to simple theory; Armond or Bankoff flow parameters.

Unit – IV

Boilers: Regimes of boiling; nucleation; gas nucleation in bulk liquid; growth of bubbles; motion at a heating surface; heat transfer rates in pool boiling; forced convection boiling; heat transfer correlations; maximum heat flux or burnout; metal boiling.

Unit – V

Condensation: Nusselt theory; boundary layer treatment of laminar film condensation; experimental results for vertical and horizontal tubes; condensation inside a horizontal tube.

Text Books:

3. Wallis, One Dimensional Two Phase Flow, McGraw Hill, 1969
4. Butterworth and Hewitt, Two Phase Flow and Heat Transfer, Oxford, 1977
5. Collier, Convective Boiling and Condensation, McGraw Hill, 1982
6. Rohsenow and others (ed), Handbook of Heat Transfer Fundamentals, McGraw Hill, 1998

References:

4. Tong, Boiling Heat Transfer and Two-Phase Flow, John Wiley (CRC Press), 1997
5. Whalley P.B., Boiling, Condensation and Gas-Liquid Flow, Clarendonpron, Oxford, 1987
6. Chisholm D, Two-phase flow in Pipe Lines and Heat Exchangers, Longman Inc. New York, 1987
7. Kakae and Veziroglu T.N., Two-phase Flows and Heat Transfer, Hemisphase Publising Corporation, 1977

METE205C

Advance Gas Dynamics

Unit – I

Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves; One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations.

Unit – II

Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number; Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves; Expansion Waves.

Unit – III

Prandtl Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves; Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles convergent-divergent supersonic diffuses.

Unit – IV

Adiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, the Fanno line; Flow with Heat addition or removal: One-dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition, one-dimensional constant area flow with both heat exchanger and friction, Generalized Quasi-One-Dimensional Flow: Governing equations and influence coefficients; solution procedure for generalized flow with and without sonic point;.

Unit – V

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

Text Books:

3. Landau L.D. and Lifshitz, Fluid Mechanics, 2nd Edn. Butterworth-Heinemann, 1995
4. Liepmann H.W. and Roshko A, Elements of Gas Dynamics, Dover Pub., 2001

References:

7. Oosthuizen P.H. and Carscallen W.E., Compressible Fluid Flow, NY, McGraw-Hill, 1997
8. Saad M.A., Compressible Fluid Flow, 2nd Ed., Upper Saddle River, NJ: Prentice-Hall, 1993
9. White F.M., Viscous Fluid Flow, 2nd Ed. New York, McGraw Hill, 1991
10. Shapiro A.H, Compressible Fluid Flow 1 and 2, Hoboken N.J., John Wiley

METE206-P

Instrumentation Lab

1. **Different methods of measuring different parameters viz. Temperature, Pressure, Air velocity, flow etc.**
2. **For above Data Acquisition System is to be used.**

METE207-P

Modeling & Simulation Lab

One Problem/ Minor Project will be allotted to each student related to subject taught in 2nd semester.

SEMESTER-III

METE301

Computational Fluid Dynamics & Heat Transfer

Unit – I

Introduction: Conservation equation mass momentum and energy equations convective forms of the equations and general description.

Unit – II

Classification and Overview of Numerical Method: Classification into various types of equation parabolic elliptic and hyperbolic boundary and initial conditions over view of numerical methods.

Unit – III

Finite Difference Formulations: Finite difference methods different means for formulating finite difference equation 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 various property interface accuracy of f.d. method.

Unit – IV

Methods of Solution: Solution of finite difference equations iterative methods matrix inversion methods ADI method operator splitting fast Fourier transform applications.

Unit – V

Grid Generation Method: Definition and types of grid, Transformation of equation, Matrices and Jacobians, Stretched Grids, Elliptic Grids, Adaptive grids. QUICK and SIMPLE algorithm.
Finite Volume Method for one and two dimensional diffusion problem.

Text Books:

8. Anderson D.A. Tannehill, J.C. and R.H. "Computational Fluid Mechanics and Heat Transfer". Taylor & Francis.1997
9. Roche P.J. "Computational Fluid Dynamics", Hermosa New Mexico 1976

References:

8. Incropera F.P. and Dewitt, D.P. "Fundamentals of Heat and Mass Transfer", Wiley N.Y. 1998
9. Patankar S.V. "Numerical Heat and Fluid Flow", Hemisphere Washington D.C.1980
10. Zienkiewicz O.C. "The Finite Element Method in Engineering Science" McGraw Hill 1971
11. Shih T.M. "Numerical Heat Transfer", Hemisphere Washington D.C.1984

METE302

Communication and Research Methodology

Unit 1

Concepts of Communications: Definition, Forms of Communication, Objectives of Communication, Characteristics of Communication, Process of Communication, Communication, Roadblocks, Role of Verbal and Non-verbal Symbols in Communication, Barriers to Effective Communication, Overcoming Communication Barriers.

Nonverbal communication: Body Language, Gestures, Postures, Facial Expressions, Dress codes; the Cross Cultural Dimensions of Business Communication; Listening and Speaking, techniques of electing response, probing questions, Observation. Business and social etiquettes;

Listening Skills: Definition, Anatomy of poor Listening, Features of a good Listener, Role Play, Group Discussion and Interviews, Meetings: Ways and Means of conducting meetings effectively, Mock Meetings and Interviews

Unit 2

Reading and language skills: The reading process, purpose, different kinds of texts, reference material, scientific and technical texts, active and passive reading, strategies - vocabulary skills, eye reading and visual perception, prediction techniques, scanning skills, distinguishing facts and opinions, drawing inferences and conclusions, comprehension of technical material - scientific and technical texts, instructions and technical manuals, graphic information.

Forms of Communication in Written mode: Basics Body language of Business Letters and Memos, Tone of writing,

Enquiries, orders and replying to them, sales letters, Job applications and resume, E-mail: How to make smart e-mail, Writing Business Reports and Proposals, Practice for Writing.

Unit 3

Referencing and Writing skills: Business letters: Enquiries, Circulars, Quotations, Orders, Acknowledgments, Executions, Complaints, Claims and adjustments, Collection letter, Banking correspondence, Agency correspondence, Bad news and persuading letters, Sales letters, Job application letters - Biodata, Covering Letter, Interview Letters, Letter of Reference, Memos, minutes, Circulars & notices.

Types of Business Reports - Format, Choice of vocabulary, coherence and cohesion, paragraph writing, organization reports by individual, Report by committee.

Unit 4

Introduction to Research and Research Design: Nature and scope of research, information based decision making and source of knowledge. The research process; basic approaches and terminologies used in research. Defining research question and framing of hypotheses, preparing a research plan, qualitative and quantitative research designs, Experimentation, Observational studies, Exploring secondary data.

Measurement and Scaling, Data Source and Data Collection Field research: primary data collection from observations, surveys and experimentation. Measurement and scaling; commonly used scales in reliability and validity of scales. Designing instrument for data collection; testing the instrument, data collection process, Sampling methods and procedures and sample size decisions.

Unit 5

Data Analysis and Presentation Editing and coding of data, tabulation, graphic presentation of data, cross tabulation, Testing of hypotheses; type I and II errors, one tailed and two tailed tests of

significance, Parametric and nonparametric tests for Univariate and Bivariate data. Tests of association; simple linear regression and other non parametric tests.
Technical Writing: Technical Proposal writing: Definition, Purpose, types, characteristics, Elements of structure, style and appearance, evaluation, exercises, Research report writing, Proposal writing, referencing, forms of reports, bibliography, etc. Research paper, Dissertation, and Thesis, Instruction Manuals, Type of instructions, Writing Instructions, Technical Descriptions, Process descriptions, Guidelines for Writing Good Descriptions.

Text Books:

1. Lesikar, R. V. & Flatley, Basic Business Communication Skills for Empowering the Internet Generation. TMH.
2. Meenakshi Raman, Sangeeta Sharma, Technical Communications, Oxford Latest Edition.
3. D. K. Bhattacharyya, Research Methodology, Excel Books 2nd Edition.

Reference Books:

1. Bowman, J.P. &Branchaw, P.P. Business Communications, Process to Product Dryden Press, Chicago.
2. M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill.
3. E. H. McGrath, Basic Managerial Skills, Prentice hall India
4. Sajitha, Technical Writing, Himalaya Latest Edition

METE303A

Power Plant Engineering

UNIT – I

Introduction to the Sources of Energy – Resources and Development of Power in India.

Steam Power Plant: Plant Layout, Working of different Circuits, Fuel and handling equipments, types of coals, coal handling, choice of handling equipment, coal storage, Ash handling systems.

Steam Power Plant: COMBUSTION PROCESS: Properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, Dust collectors, cooling towers and heat rejection. Corrosion and feed water treatment.

UNIT II

Gas Turbine Plant: Introduction – classification - construction – Layout with auxiliaries – Principles of working of closed and open cycle gas turbines. Combined Cycle Power Plants and comparison.

UNIT – III

Cogeneration: What is Cogeneration, Why Cogeneration, Application of Cogeneration, The Benefits of Cogeneration, Steam Turbine Cogeneration System, Gas Turbine Cogeneration System, Reciprocating Engine Cogeneration System, Classifications of Cogeneration Systems, topping cycle cogeneration systems, Bottoming cycle, Assesment of cogeneration system Calculations For Steam Turbine Cogeneration System, Energy Efficiency Opportunities in Steam Turbine Cogeneration System, Energy Efficiency Opportunities in a Gas Turbine Cogeneration System, Economics of Cogeneration,

UNIT IV

Power from Non-Conventional Sources: Utilization of Solar- Collectors- Principle of Working,

DIRECT ENERGY CONVERSION: Solar energy, Fuel cells, Thermo electric and Thermo ionic, MHD generation.

Nuclear Power Station: Nuclear fuel – breeding and fertile materials – Nuclear reactor – reactor operation. **Types of Reactors**: Pressurized water reactor, Boiling water reactor, sodium-graphite reactor, fast Breeder Reactor, Homogeneous Reactor, Gas cooled Reactor, Radiation hazards and shielding –

Radioactive waste disposal.

UNIT – V

Power Plant Economics: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, Load curves, load duration curve.

Definitions of connected load, Maximum demand, demand factor, average load, load factor, diversity factor– related exercises.

TEXT BOOK :

5. P.K.Nag, Power Plant Engineering, II Edition, TMH.
6. Arora and S. Domkundwar, A Course in Power Plant Engineering

REFERENCES :

7. Rajput , A Text Book of Power Plant Engineering, Laxmi Publications
8. Ramalingam, Power plant Engineering, Scietech Publishers
9. P.C.Sharma , Power Plant Engineering, S.K.Kataria Pub.
10. ElWakil, Power station Engineering, McHill.
11. G.D. Rai, An Introduction to Power Plant Technology
12. Elanchezhian, Power plant Engg, I.K. International Pub.

METE303B

Bio-Fluid Mechanics

UNIT I

Overview of basic anatomy and physiology from fluid flow perspective.

Review of basic equations and constitutive models: mass and momentum conservation, models for non-Newtonian fluids.

UNIT II

Blood rheology and mechanics of circulation: composition, structure and flow properties of blood; structure, flow and pressure characteristics of the blood flow in cardio-vascular system, flow of non-Newtonian fluids in elastic tubes.

UNIT III

Arterial wave propagation-oscillatory and pulsatile flow, pulse waves, behaviour at bifurcations, wave propagation, fluid mechanics of breathing.

UNIT IV

Flow through the pulmonary system: structure and function of pulmonary system, fluid exchange processes, fluid mechanics of breathing.

Flow and lubrication in musculo-skeletal system: hemodynamics of red blood cells, synovial fluid in joints.

UNIT V

Flow through the porous media: oxygen diffusion from blood to tissues, flow in ocular and renal system. Computational biofluid mechanics: computational methods for flow and wave propagation through elastic tubes, flow through porous media.

Text Books:

4. Chandran K.B., Yoganathan, A. and Rittgers S, Fluid Mechanics in the Human Circulation, Pearson Education, 2005
5. Humphrey J.D. and Delange S.L., An Introduction to Biomechanics, Springer-Verlag, 2004
6. Fournier R.L.L., Basic Transport Phenomena in Biomedical Engineering, Taylor & Francis, 1998

References:

6. Fung Y.C., Biomechanics: Circulation, Springer-Verlag, 1996
7. Mazumdar J.N., Biofluid Mechanics, World Scientific, 1992
8. Pedley T.J., Fluid Mechanics of Large Blood Vessels, Cambridge University Press, 1980
9. Caro C.G, Pedly T.J., Schroter RC, Seed W.A., Mechanics of the Circulation, Cambridge University Press, 1978

METE303C

Micro & Nano Scale Thermal Engineering

UNIT I
Introduction
Microscale energy transport in solids

UNIT II
Molecular clusters
Molecular forces and phase change in thin liquid films

UNIT III
Heat Transfer in microchannels
Micro heat pipes

UNIT IV
Microscale heat transfer in biological systems at low temperature

UNIT V
Nanofluids

Text Books:

7. Tien CL, Majumdar A and Gerner F.M., Microscale Energy Transport, Taylor & Francis, 2003
8. Berman R, Thermal Conduction in Solids, Oxford Press, 1976

References:

7. Tien C.L, Molecular and Microscale Heat Transfer, Begell House, 1994
8. Celate G.P., Heat Transfer and Transport Phenomena in Microscale, Begell House, 2000
9. Kakac S, Vasiliev L.L., Bayazitoglu Y, Yener Y, Microscale Heat Transfer: Fundamentals and Applications, Springer-Verlag, 2005

METE304

Preliminary work on Dissertation

The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format. The student will have to present the progress of the work through seminars and progress reports.

METE305

Seminar Based on Dissertation

The student will deliver a seminar on the topic chosen by him and approved by Departmental committee for evaluation at the end of semester.

Semester – IV

METE401

Dissertation

The student will submit a detailed Project Report on the topic approved by Departmental committee in a specified format and will also deliver a Presentation on the topic chosen at the end of semester.