Vivekananda Global University

M.Tech (Thermal Engineering) **Semester I**

MTH 101 RESEARCH METHODOLOGY

3L-0T-0P-3.0C **MM 100**

MODULE I

Research - (a) Types, Research process and steps in it, Hypothesis, Research proposals and aspects. (b) Research Design: Need, Problem Definition, variables, research design concepts, Literature survey and review, Research design process, Errors in research. (c) Research Modeling: Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling.

MODULE II

Report Writing - Pre writing considerations, Formats of report writing, formats of publications in Research journals.

MODULE III

Design Of Experiments – (a) Objectives, strategies, Factorial experimental design, Designing engineering experiments, basic principles-replication, randomization, blocking, Guidelines for design of experiments. (b) Single Factor Experiment: Hypothesis testing, Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking. (c) Two factor Factorial Design, Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two-factor factorial design; Models-Effects, means and regression, Hypothesis testing.

MODULE IV

Spreadsheet Tool - Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. Tools used may be Microsoft Excel, Open office or similar tool.

MODULE V

Presentation Tool - Introduction to presentation tool, features and functions, Creating presentation, Customizing presentation, showing presentation. Tools used may be Microsoft Power Point, Open Office or similar tool. **Web Search:** Introduction to Internet, Use of Internet and WWW, Using search engine like Google, Yahoo etc, and Using advanced search techniques.

Text/ Reference Books:

1. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India)
2. Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India)
3. Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi)
4. The complete reference Office Xp, Stephan L. Nelson, Gujulia Kelly (TMH)
5. Basic Computer Science and Communication Engineering, R. Rajaram (SCITECH)

M.Tech (Thermal Engineering) **Semester I**

MTH 102 ADVANCED THERMODYNAMICS

3L-0T-0P-3.0C **MM 100**

MODULE I

Review of Thermodynamic Laws And Corollaries: Transient flow analysis, Second law thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation. Evaluation of thermodynamic properties of working substance

MODULE II

P.V.T Surface: Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius, Clapeyro equation. Throttling, Joule. Thompson coefficient. Non reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air conditioning processes, cooling towers. Real gas mixture.

MODULE III

Combustion: Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat reaction, Adiabatic flame temperature generated product, Enthalpies, Equilibrium. Chemical equilibrium of ideal gased, Effect of non reacting gases equilibrium in multiple reactions, The vent hoff's equation. The chemical potential and phase equilibrium. The Gibbs phase rule.

MODULE IV

Power Cycles: Review binary vapour cycle, co generation and combined cycles, Second law analysts of cycles. Refrigeration cycles. Thermodynamics off irreversible processes. Introduction, Phenomenological laws, Onsaga Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

MODULE V

Direct Energy Conversion Introduction: Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydronamic generations, Photovoltaic cells.

Text/Reference Books:

1. Advanced Thermodynamics For Engineers Wark TMH
2. Advanced Engineering Thermodynamics Bejan A. John Wiley & sons
3. Thermodynamics: Kinetic Theory of Gass and Statistical Mechanics Sears Addison Wesley
4. Engineering Thermodynamics, Nag P.K., Tata McGraw-Hill, New Delhi
5. Fundamentals of Classical Thermodynamics, Gordan J Van Wylen, Willey EasternLtd.
6. Engineering Thermodynamics, Cengel & Boles, Tata McGraw-Hill, New Delhi.

M.Tech (Thermal Engineering) **Semester I**

MTH 103 ADVANCED HEAT TRANSFER

3L-1T-0P-3.5C **MM 100**

MODULE I

Review: Reviews of basic laws of Conduction, Convection and Radiation **Conduction:** One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source, Local heat source in non-adiabatic plate, 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, Fin design.

MODULE II

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

MODULE III

Radiation: Review of radiation principles, diffuse surfaces and the Lambert's cosine law. Radiation through non-absorbing media, Hottel's method of successive reflections, Gebhart's unified method, Poljak's method. Radiation through absorbing media, Logarithmic decrement of radiation, Shape Factor, configuration Factor.

MODULE IV

Apparent absorptive of simple shaped gas bodies: Net heat exchange between surfaces separated by absorbing medium, Radiation of luminous gas flames between skin friction and heat transfer, Prandtl-Taylor, Von Karman and Martineli's analogies

MODULE V

Convection: Heat transfer in laminar flow, free convection between parallel plates, forced internal flow through circular tubes, Fully developed flow, Velocity and thermal entry length, solutions with constant wall temperature and with constant heat flux, Forced external flow over a flat plate, two-dimensional velocity and temperature boundary layer equations. Design of heat exchangers.

Text/Reference Books:

1. Advance in Heat Transfer, James P Hartnett, Academic Press
2. Principle of Heat Transfer, K. M, Wiley Int.
3. Heat Transfer, A.F.Mills, Printice Hall
4. A Text Book on Heat Transfer, S.P.Suchatme, University Press

M.Tech (Thermal Engineering) **Semester I**

MTH 104 ADVANCED NUMERICAL METHODS AND ANALYSIS

3L-1T-0P-3.5C **MM 100**

MODULE I

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

MODULE II

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

MODULE III

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

MODULE IV

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

MODULE V

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.

Text/Reference Books:

1. Numerical Method for Scientific and Engineering, M.K. Jain, S.R.K. Iyenger
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern Ltd.
3. Numerical Methods, B.S. Grewal, Khanna Publications
4. Numerical Methods, A.D. Booth, Academic Press, NY
5. An Introduction to Numerical Analysis , K.E.Atkinson , John Wiley & Sons, NY
6. Introduction Methods of Numerical Analysis , S.S. Sastry,Prentice Hall of India
7. Elementary Numerical Analysis, S.D. Conte, McGraw Hill

M.Tech (Thermal Engineering) **Semester I**

MTH 105 DESIGNS OF REFRIGERATION SYSTEMS

3L-0T-0P-3.0C **MM 100**

MODULE I

Refrigeration Systems: Vapor compression; multiple evaporator and compound compression system with and without inter-cooling; dual compressors; cascade systems; vapor absorption system-analysis.

MODULE II

Solid carbon dioxide; principles of production; three stage system with water and flash inter-cooler; pressure snow chambers; regenerative liquid precooler; binary system. Minimum work cycle; Linde and Claude method; use of precooling; liquefaction of hydrogen and neon

MODULE III

Cryogenics: Engineering applications; properties of substances at cryogenic temperature; ortho-para conversion of hydrogen; properties of helium; Lambda point; super fluidity.

MODULE IV

Liquefaction of gases; liquefaction of helium; separation of gases from air. Insulation, storage and transport of cryogenic fluids; magnetic and nuclear cooling.

MODULE V

Pressure Drop And Heat Transfer: Two phase flow; flow regimes; maps pressure drop in evaporator evaporation in tubes; inside and outside condensation for vertical and horizontal tubes. and condensers; Martinlli approach. Heat transfer, boiling in flooded evaporators; forced connection

Text/Reference Books:

1. Mechanical Refrigeration, Sparks & Dillio, McGraw Hill
2. Cryogenic Systems, Barron, McGraw Hill
3. ASHRAE Handbook (Fundamentals), ASHRAE
4. Thermal Environmental Engineering, Threlkeld, Prentice Hall
5. Convective Boiling and Condensation, Collier, McGraw Hill

M.Tech (Thermal Engineering) **Semester I**

MTH 106 THEORY AND DESIGN OF HEAT EXCHANGER

3L-0T-0P-3.0C **MM 100**

MODULE I

Applications, Basic Design methodologies- LMTD and effectiveness NTU methods. Overall heat transfer coefficient, fouling. Correlations for heat transfer coefficient and friction factor.

MODULE II

Classification and types of heat exchangers and construction detail: Design and rating of double pipe heat exchangers, compact heat exchangers, plate and heat pipe type, condensers, and cooling towers.

MODULE III

Cleanliness factor, percent over surface, techniques to control fouling, additives, rating and sizing problems, heat exchanger design methodology Heat exchanger standards and testing, heat transfer enhancement and efficient surfaces.

MODULE IV

Design of double pipe heat exchangers: Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop.

MODULE V

Design of compact heat exchangers: Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop. **:** Use of commercial software packages for design, analysis and optimization.

Text/Reference Books:

1. Heat Exchanger Selection, Rating and Thermal Design by Sadik, Kakac, CRC Press
2. Fundamentals of Heat Exchanger Design by Ramesh K Shah, Wiley Publication
3. Compact Heat Exchangers by Kays, V.A. and London, A.L., McGraw Hill
4. Heat Exchanger Design Handbook by Kuppan, T, Macel Dekker, CRC Press
5. Heat Exchanger Design Hand Book by Schunder E.U., Hemisphere Pub.
6. Process Heat transfer by Donald Q Kern, McGraw Hill

M.Tech (Thermal Engineering) **Semester I**

MTH 107 FUEL CELL TECHNOLOGY

3L-0T-0P-3.0C **MM 100**

MODULE I

Introduction: Fuel cells- definition, relevance and importance, classification of fuel cells. Electrochemistry basis of fuel cells.

MODULE II

Alkaline fuel cells (AFC): Description, working principle, components, general performance characteristics, Ammonia as AFC fuel. Phosphoric Acid fuel cell.

MODULE III

Solid oxide fuel cell (SOFC): History, benefits and limitations, cell components, Cathode and Anode materials, fuel, configuration and performance. Environmental impact of SOFC. Application and future of SOFC.

MODULE IV

Molten carbonate fuel cells (MCFC): General principle, cell components, mechanisms of electrode reactions, status of MCFC.

MODULE V

Introduction to Direct Methanol Fuel Cell and Proton Exchange Membrane Fuel Cell. Hydrogen processing and Storage: Processing from Alcohols, Hydrocarbons and other sources. Hydrogen as an engine fuel, methods of hydrogen storage

Text/Reference Books:

1. Appleby, A. John. *Fuel Cell Handbook*. New York: Van Reinhold Co., 1989.
2. Blomen, Leo, and Michael Mugerwa. *Fuel Cell Systems*. New York: Plenum Press, 1993.
3. Breeze, Paul. *Power Generation Technologies: Evaluating the Cost of Electricity*. London: Financial Times Energy, 1998.
4. Hacker, Barton C. and James M. Grimwood. *On the Shoulders of Titans: a history of Project Gemini*. NASA: Washington, DC, 1977.

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M.Tech (Thermal Engineering) **Semester I**

MTH 108 EXPLOSION AND SAFETY

3L-0T-0P-3.0C **MM 100**

MODULE I

Introduction: Introduction to basic industrial safety and health incorporating OSHA/WISHA rules and regulations, personal protective equipment, chemical safety, tool safety, material handling safety, machine safety, electrical safety, fire protection, health protection and safe working practices.

MODULE II

Make Safety Work: Responsibility for safety, Accidents and injuries, the accident chain, Built in hazards, Human influences on safety, the accident prevention plan

MODULE III

Work Area Safety: Safety where you work**,** Safety around machinery**,** Safety at heights - fall protection**,** Safety in enclosed areas - confined space entry**,** Chemical Safety

MODULE IV

Fire Prevention: How fires start, Preventing fires and explosions, Fire fighting agents and extinguishers, Hot work permits

MODULE V

Hazardous Materials and Operations: Introduction to process safety management, Hazardous liquids, Exposure to chemicals, Chemical spill response and cleanup, Industrial noise, Welding hazards and chemical exposure.

Text/Reference Books:

1. Accident Prevention Manual for Industrial Operations" NSC, Chicago, 1982.
2. GREEN, A.E., "High Risk Safety Technology", John Wiley and Sons,. 1984.
3. Petroleum Act and Rules, Government of India.
4. Carbide of Calcium Rules, Government of India.

M.Tech (Thermal Engineering) **Semester-I**

MTH 109 ADVANCED HEAT TRANSFER LAB

0L-0T-4P-2.0C **MM 100**

Following Experiments to be performed:-

1. To find thermal conductivity of Asbestos powder/wood powder
2. To determine Thermal Conductivity of a Good Conductor of Heat (Copper Rod/Aluminium Rod) and find mass flow rate of water
3. To determine Stefan Boltzmann Constant of Radiation Heat Transfer and find out losses.
4. To find out the thermal conductivity of given slab material.
5. To determine Critical Heat Flux in Saturated Pool Boiling.
6. Study of Reynold Number, Grashoff Number, Nusselt Number, Prandtl Number
7. Study of critical thickness of insulation.
8. Study of Boiling Curve.
9. Design of heat exchanger for 4- cylinder 4 –stroke diesel engine.
10. Design a fin of single cylinder 4 stroke petrol engine.
11. To find out effectiveness of fin for multi stage air compressor.

Mechanical Engineering **Semester I**

MTH 110 ADVANCED THERMODYNAMICS LAB.

0L-0T-4P-2.0C **MM 100**

LIST OF EXPERIMENTS:

1. Study of 2 stroke IC(SI & CI) engines (cut models) and Performance parameters.
2. Study of 4 stroke IC(CI & SI) engines (cut models) and Performance parameters.
3. To study & draw valve timing diagram for a single cylinder diesel engine.
1. 4.To perform constant speed load test on a single cylinder diesel engine and to plot performance curves: brake thermal efficiency v/s Brake power, specific fuel consumption v/s Brake power.
4. To prepare heat balance sheet of a four stroke diesel engine.
5. Morse Test: To estimate the Indicated Power, Friction Power and Mechanical
2. Efficiency of a multi-cylinder Petrol Engine.
6. Study of fire tube boilers-its mountings and accessories.
7. Study of water tube boiler-its mountings and accessories.
8. Study of two stage reciprocating air compressor.
9. To Plot P-θ diagrams for constant speed C.I.Engine.

M.Tech (Thermal Engineering) **Semester II**

MTH 201 COMPUTATIONAL FLUID DYNAMICS

3L-1T-0P-3.5C **MM 100**

MODULE I: Review of governing equations of fluid flow and heat transfer, review of numerical methods.

DISCRETIZATION: Introduction to finite differences, difference equations, explicit and implicit approaches: definition and contrasts, errors and analysis of stability.

MODULE II: Classification Of Partial Differential Equations: Explicit and Implicit methods, solution of select model equations; Laplace heat and wave equation, laminar boundary layer solution.

MODULE III:CFD Techniques: The lax -wendroff technique, Mac Cormack's technique, Relaxation technique and its use with low speed inviscid flows, aspects of numerical dissipation and dispersion; artificial viscosity, Alternating Direction Implicit (ADI) technique, pressure correction technique with application to incompressible viscous flow.

MODULE IV: Initial And Boundary Value Problems: free falling of a spherical body, two dimensional motions of a body through a fluid radial flow.

MODULE V: Steady State Conduction In Rectangular & Cylindrical Geometry: transient conduction finite difference applications in convective heat transfer, thermally developing flow inside a circular pipe.

Text/Reference Books:

1. Computational fluid flow and heat transfer D.A. Anderson et .al CRC Press
2. Computational Fluid Dynamics -John D. Anderson Jr. TMH
3. Introduction to Computational fluid Mechanics -Chuen –Yen Chow. NASA Ames Research Center,
4. Computational Fluid Flow and Heat Transfer -K.Muralidhar and T.Sunderrajan, Narosa Publishing House.

M.Tech (Thermal Engineering) **Semester II**

MTH 202 ADVANCED FLUID MECHANICS

3L-1T-0P-3.5C **MM 100**

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

Two-Dimensional Irotational Flow: Two dimensional irotational flows in rectangular and polar function; Voriticity and circulation; Plane potential flow and the complex potential function. Coordinates- Continuity equation and the stream function; Irrotationality and the velocity potential Ranbkine ovals; Flow around circular cylinders with and without Circulation;

MODULE II: Pressure distribution on the Sources, sinks, doublets and vorities-Superposition of uniform stream with above; Flow around corners; surface of these bodies and D'Alembert's Paradox; Blasuis theorem for forces and moments; Method of theory; Joukowski transformation; Circular are symmetrical aerofoil theory; Joukowski hypothesis, Lift residues,

MODULE III: Conformal transformation of flows with solid boundaries.Elements of two-dimensional aerofoil and moment and the Stokes stream function; Sources, sinks.**Three-Dimensional Irotational Flow:** Irrotationality and the velocity potential function; Symmetric flows

MODULE IV: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 filaments; Ringvortices; Vortex sheets; Karman vortex sheet.for induced velocities; Rectilinear vortex filaments; System of vortex filaments; Horse-shoe vortex

MODULE V: 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.

Text/Reference Books:

1. Fluid Mechanics, Vijay Gupta & S.K. Gupta, New Age publication, new delhi.
2. Fluid Mechanics and Machinery, R K Bansal, LAXMI PUBLICATIONS (P) LTD, Delhi.
3. Engineering Fluid Mechanics ,J A Roberson &C T Crowe, Jaico Publishing.

M.Tech (Thermal Engineering) **Semester II**

MTH 203 I. C. ENGINE & EMISSION CONTROL

3L-0T-0P-3.0C **MM 100**

MODULE I: Types of fuels and their properties, Coal characterization - Combustion chemistry,Stoichiometry Heat of reaction , Calorific value - Adiabatic flame temperature, Equilibrium

MODULE II: Mass transfer. Chemical kinetics - Important chemical mechanisms - Simplified conservation equations for reacting flows - Laminar premixed flames - Simplified analysis.

MODULE III: Factors influencing flame velocity and thickness flame stabilization, Diffusion flames.

MODULE IV: Introduction to turbulent flames. FBC - Different types of FBCs - Models for droplet and Carbon particle combustion.

MODULE V: Emissions - Emission index - Corrected concentrations - Control of emissions for premixed and non-premixed combustion.

Text/Reference Books:

1. Turns, S.R., An Introduction to Combustion - Concepts and Applications, 2nd ed., McGraw-Hill, 2000.
2. Sharma, S.P. and Mohan, C., Fuels and Combustion, Tata McGraw-Hill, 1987.
3. Sarkar. S., Fuels and Combustion, Orient Longman, 2005.
4. Internal Combustion Engines: Applied Thermo sciences, Ferguson Colin R John Wiley
5. Fundamentals of Internal Combustion Engines, H.N. Gupta, Prentice Hall
6. Internal Combustion Engines, SK Agrawal, New Age international Publication, Delhi.

M.Tech (Thermal Engineering) **Semester II**

MTH 204 APPLICATION OF NANO MATERIALS IN ENERGY CONVERSION PROCESS

3L-0T-0P-3.0C **MM 100**

MODULE I

Organic Solar Cells and Quantum dots in energy conversion: Solar cells - Thin film Si solar cells - Chemical semiconductor solar cells - Dye sensitized solar cells - Polymer solar cells - Nano quantum dot solar cells - Hybrid nano-polymer solar cells Fuel Cells – principle of working – basic thermodynamics and electrochemical principle – Fuel cell classification –Fuel cell Electrodes and Carbon nano tubes – application of power and transportation.

MODULE II

Polymer-based light-emitting diodes part 1: Fundamental processes; Charge injection; Charge transport; Exciton formation Mutual capture Exciton characteristics (binding energy, spin-multiplicity, capture cross-section); Exciton decay, Radiative and non-radiative decay; Exciton lifetime Efficiency; Characterisation of PLEDs;

MODULE III

Polymer-based light-emitting diodes part 2: Relevant performance parameters; Characterising metal-semiconductor contacts: electro absorption measurements as a non-invasive tool for the study of the energy level line up in finished devices; Practical implementations; Fabrication technology: the advantage of solution processability; Spin-coating Ink-jet printing (IJP); Screen printing and other examples.

MODULE IV

Polymer-based photovoltaic diodes (PVDs) Part 1: Fundamental process; Exciton absorption; Exciton dissociation; Charge collection; Characterisation of PVDs; Relevant performance parameters; Examples of polymer-based PVDs; Polymer polymer hetero junctions;

MODULE V: Polymer-based photovoltaic diodes (PVDs) Part 2

Enhanced dissociation at type II hetero junctions; Preparation methods: polymer blends and spontaneous phase separation; C60- polymer structures; Hetero junctions with nano crystals, nano rods, etc; State of the art devices and future prospects

Text/Reference Books:

1. S.P. Sukhtame, "Solar Energy: Principles of Thermal Collection and Storage", TMH
2. D D C Bradley, Current Opinion in Solid State & Materials Science Vol. 1, 789 (1996)
3. Rainer Waser, Nano Electronics And Information Technology, John Wiely and sons publication, 2003
4. Narayan R and B Viswanathan, "Chemical and Electrochemical Energy Systems", University press (India) Ltd., 1998
5. A.B. Hart and G. J. Womack, "Fuel Cells: Theory & Applications", Prentice Hall, NY
6. Wu YH, "Nano Spintronics for Data Storage", Encyclopedia for Nanoscience and Nanotechnology, vol.7, American Scientific Publishers, 2003.

M.Tech (Thermal Engineering) **Semester II**

MTH 205 DESIGNS OF THERMAL SYSTEMS

3L-0T-0P-3.0C **MM 100**

MODULE I

Introduction to Thermal System Design, Engineering design, Designing a workable systems.

MODULE II

Exergy Analysis Heat Transfer, Modeling, and Design Analysis , Equation fitting, Emperical equation, Best fit method, method of least squares, Depreciation, Gradient-present worth factor,

MODULE III

Optimization, Objective function formulation, Constraint equations, Mathematical formulation, Calculas method, Dynamic programming, Geometric programming, Linear programming methods, solution procedures.

MODULE IV

Applications with Heat and Fluid Flow, Applications with Thermodynamics and Heat and Fluid Flow Economic analysis, Thermo economic Analysis and Evaluation, Thermo economic Optimization,

MODULE V

Modeling of thermal equipments such as turbines, compressors, pumps, heat exchangers, evaporators and condencers.

Text/Reference Books:

1. Design of Thermal Systems: Wilbert Stoecker: McGraw-Hill
2. Thermal Design and Optimization Adrian Bejan, George Tsatsaronis, Michael Moran
3. Bejan, A., Tsatsaronis, G and Moran, Michel, “Thermal Design and Optimization” John Wiley and Sons, Inc., 1996.
4. Jaluria, Y., Design and Optimisation of Thermal Systems, McGraw-Hill, 1998.
5. Burmeister, L.C., Elements of Thermal-Fluid System Design, Prentice Hall, 1998.

M.Tech (Thermal Engineering) **Semester II**

MTH 206 CONVECTION

3L-0T-0P-3.0C **MM 100**

MODULE I

Derivation of governing equation for convection. 2D laminar coquette flow and non dimensional numbers. Concept of Adiabatic wall temperature. Integral methods for momentum and thermal boundary layers.

MODULE II

Pipe flow – concept of developed temperature profile and solutions for constant wall flux and constant wall temperature boundary conditions. Solution of entry length problem for constant wall and constant wall flux boundary conditions. Natural convection – governing equation, integral solution for flat surface.

MODULE III

Laminar External Flow And Heat Transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method).

MODULE IV

Laminar Internal Flow And Heat Transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flows with different wall boundary conditions.

MODULE V

Turbulent Convection: Governing equations for averaged turbulent flow field (RANS), Analogies between heat and Mass transfer (Reynolds, Prandtl-Taylor and von Karman Analogies), Turbulence Models (Zero, one and two equation models), Turbulent flow and heat transfer across flat plate and circular tube, Turbulent natural convection heat transfer, Empirical correlations for different configurations.

Text/Reference Books:

1. Fundamentals of Heat & Mass Transfer by Thirumaleshwar, Pearson
2. Poulikakos, Conduction Heat transfer, Prentice Hall, 1994.
3. G.E. Mayers, Analytical methods in Conduction Heat Transfer, McGraw Hill, 1971.
4. Kays W M and Crawford M E, Convective Heat and Mass Transfer, McGraw Hill Int Edition, 3rd edition, 1993.

M.Tech (Thermal Engineering) **Semester II**

MTH 207 NUMERICAL METHODS IN CONDUCTION

3L-0T-0P-3.0C **MM 100**

MODULE I:

Introduction to conduction: Derivation of energy equation for conduction in three dimensions – Initial and boundary conditions. Solution of simple problems in steady state conduction with analytical solutions – Concept of electrical analogy – fin heat transfer and concept of fin efficiency and fin effectiveness.

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MODULE II:

Unsteady conduction Concept of Biot number – Lumped capacitance formulation – simple problems – unsteady conduction from a semi-infinite solid- solution by similarity transformation method.

Solution of the general 1D unsteady problem by separation of variables and charts- example problem

MODULE III

2D steady conduction and phase change problems: Laplace equation – solution by variable separable method – concept of superposition and homogeneous boundary conditions.

Phase change problems – The Stefan and Neumann problems – analytical solutions.

MODULE IV:

Numerical solution of conduction problems:

Basic ideas of finite difference method – forward, backward and central differences – Discretization for the unsteady heat equation – simple problems.

Basis ideas of the finite volume method – application to Laplace and Poisson equations.

MODULE V:

Solution of tri diagonal systems, solution of simultaneous non-linear equations by iteration and Newton Raphson Method, Evaluation of double integrals, solution of initial value problems, solution of B.V.P. by finite difference method, solution of Laplace and Poisson equations, solution of heat conduction equation, solution of wave equation

Text/Reference Books:

1. Conduction Heat Transfer, D. Poulikakos, Prentice Hall, 1994.
2. Heat Conduction, S. Kakac and Y. Yener, Taylor and Francis, 1994.
3. Analytical methods in Conduction Heat Transfer, G.E.Myers, McGraw Hill, 1971.
4. Conduction Heat Transfer, V.S. Arpaci, Addison Wesley, 1996 (Abridged edition Ginn press 1998)
5. Heat Transfer, A.J.Chapman, Macmillan, 1984.

.**M.Tech (Thermal Engineering)** **Semester II**

MTH 208 ADVANCED GAS TURBINE AND ENGINE

3L-0T-0P-3.0C **MM 100**

MODULE I

Thermodynamics of gas turbines: Cycle analysis; Gas Turbine Components: compressor, combustor, heat exchangers, turbine - description: analytical considerations, performance; Matching of compressor and turbine: cooling of turbine blades. Compressor and turbine impeller construction, blade fixing details, sealing;

MODULE II

Material selection for components, Protective coating for hot turbine parts, Components fabrication techniques, Gas turbine turbocharger, gas turbine power generation, turbo expander, gas turbine application, Closed cycle gas turbines, Co-generation - Introduction, Thermodynamics of co-generation, Criteria for component performance, Some practical schemes.

MODULE III

Gas Turbines - Performances of practical gas turbine cycles. Design point performance of simple and series flow cycles, factors affecting performance.

MODULE IV

Turbine stage: Turbine Blade 2-D (cascade) analysis; Work Done, Degree of Reaction, Losses and Efficiency. Multi-staging of Turbine. Turbine Cooling Technology. Radial Turbine Aerodynamics and Thermodynamics. Losses in radial turbine and efficiency

MODULE V

The Gas Turbine Engine development for Aircraft Propulsion. How the jet engines makes thrust: conceptual basis. Jet engine performance parameters; Thrust, SFC, Efficiencies Simple Turbojet and Reheat engines: Low and High bypass Turbofan engines. Single and Multi-spool Gas Turbine based propulsive devices

TEXT/ REFERENCE BOOKS:

1. Elements of gas turbine technology, J. D. Mattingly, Tata McGrawHill (2005)
2. Gas turbine theory, Cohen, Rogers, Saravanamutto, Pearson education (2001)
3. Ahmed F. El-Sayed; Aircraft Propulsion and Gas Turbine Engines; CRC press, 2008.
4. Turbine, Compressors and Fans by S.M.Yahya, TMH

M.Tech (Thermal Engineering) **Semester II**

MTH 209 SIMULATION LAB

0L-0T-4P-2.0C **MM 100**

Following Experiments to be performed:-

I CYCLE

1. Steady state conduction in Solids
2. Steady state nature convection
3. Steady state Radiation between Black bodies
4. Combined conduction & convection (Fluid - Solid)
5. Unsteady state conduction in Solids
6. Unsteady state Conduction & Convection Fluid - Solid

II CYCLE

1. Steady state conduction in Fluids
2. Steady state Forced convection between Grey bodies.
3. Steady state Radiation
4. Combined conduction & convection in Fluids
5. Unsteady state conduction and convection in Fluids
6. Unsteady state Conduction & Convection in Fluids - Solid

SIMULATION LAB – REQUIREMENT:

1. Software - Modeling software like ProE, Gambit, Ansys etc
2. 2 Analysis software like Ansys, fluent, CFX, etc
3. 3 Equation solving software like Matlab, Engg equation solver

Mechanical Engineering **Semester II**

MTH 210 ADVANCED FLUID MECHANICS LAB.

0L-0T-4P-2.0C **MM 100**

LIST OF EXPERIMENTS:

1. Determine Metacentric height of a given body.
2. Determine Cd, Cv and Cc for given orifice.
3. Determine flow rate of water by V-notch.
4. Determine velocity of water by pitot tube.
5. Verify Bernoulli's theorem.
6. Determine flow rate of air by Venturi meter.
7. Determine flow rate of air by orifice meter.
8. Determine head loss of given length of pipe.
9. Determine flow rate of air by nozzle meter.

M.Tech (Thermal Engineering) **Semester III**

MTH 301 SEMINAR

0L-0T-P-2.0C **MM 100**

Objective: To assess the debating capability of the student to present a technical topic. Also to impart training to students to face audience and present their ideas and thus creating in them self esteem and courage that are essential for engineers.

Individual students are required to choose a topic of their interest from Thermal Engineering related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Thermal Engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

M.Tech (Thermal Engineering) **Semester III**

MTH 302 DISSERTATION PART- I

0L-0T-P-8.0C **MM 100**

Objective: To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project/experimental project and/or computer simulation project on any of the topics in MATLAB/ANSYS software design related topics and other tools. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to continue their project outside the parent institute.Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.The student is required to undertake the master research project phase 1 during the third semester and the same is continued in the 4thsemester (Phase 2). Phase 1 consist of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members. The technical paper is to be submitted along with the thesis

M.Tech (Thermal Engineering) **Semester III**

MTH 303 LIBRARY (REVIEW OF LITERATURE FOR RESEARCH)

0L-0T-P-4.0C **MM 100**

Literature survey Overview -What is literature survey, Functions of literature survey, maintaining a notebook, developing a Bibliography.

Methods of data collection –Observation, survey, contact methods, experimental,determining sample design Searching for publications –Publication databases, search engines and patent databases,Find some/all of the references for a given paper, including those that are not on the web.

M.Tech (Thermal Engineering) **Semester IV**

MTH 401 DISSERTATION PART- II

0L-0T-P-16.0C **MM 100**

Objective: To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Master Research project phase II is a continuation of project phase I started in the third semester. There would be two reviews in the fourth semester, first in the middle of the semester and the second at the end of the semester. First review is to evaluate the progress of the work, presentation and discussion. Second review would be a pre-submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a pre qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.