GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY, HYDERABAD

(Autonomous Institute under JNTU, Hyderabad)

COURSE STRUCTURE AND SYLLABUS FOR M. TECH. (THERMAL ENGINEERING)

I SEMESTER

Code	Group	Suject	L	P	Credits
GR11D5131		Advanced Thermodynamics	3	0	3
GR11D5132		Advanced Heat And Mass Transfer	3	0	3
GR11D5114		Advanced Fluid Mechanics	3	0	3
Create new		Advanced Finite Element analysis	3	0	3
Create new	Elective - I	Turbo machines			
GR11D5137		Optimization techniques			
GR11D5147		Theory of Heat Pipes	3	0	3
Create new	Elective - II	Refrigeration & Air- Conditioning			
Create new		Jet Propulsion And Rocketry			
GR11D5139		Thermal And Nuclear Power Plants	3	0	3
Create new	Lab	Thermal Engineering Lab	0	3	2
GR11D5012		Seminar	-	-	2
		Total Credits (6 Theory + 1 Lab.)			22

II SEMESTER

Code	Group	Suject	L	P	Credits
Create new		Convective Heat Transfer	3	0	3
GR11D5136		Computational Methods In Heat Transfer	3	0	3
Create new		Advanced IC Engines	3	0	3
GR11D5138		Equipment Design For Thermal Systems	3	0	3
Create new	Elective - III	Thermal Measurements And Process Controls			
GR11D5142		Alternate Energy Sources			
GR11D5133		Cryogenics Engineering	3	0	3
GR11D5141	Elective - IV	Fuels, Combustion and Environment			
GR11D5140		Multiphase Flow			
Create new		Solar Energy Technology			
GR11D5143	Lab	CFD and Thermal measurements and process control lab	0	3	2
GR11D5024		Seminar	-	-	2
		Total Credits (6 Theory + 1 Lab.)			22

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY, HYDERABAD

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II YEAR – I Semester

Code	Group	Subject	L	P	Credits
		Comprehensive Viva	-	-	2
		Project Seminar	0	3	2
		Project Work	-	-	18
		Total Credits			22

II YEAR - II Semester

Code	Group	Subject	L	P	Credits
		Project Work and Seminar	-	-	22
		Total Credits			22

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

ADVANCED THERMO DYNAMICS

UNIT -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

UNIT-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.

UNIT-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.

UNIT-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.

UNIT-V:
DIRECT ENERGY CONVERSION INTRODUCTION: Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydronamic generations, Photovoltaic cells.

TEXT BOOKS:
1. Basic and Applied Thermodynamics/ P.K.Nag/ TMH
2. Thermodynamics/Holman/ Me Graw Hill.
3. Engg. Thermodynamics/PL.Dhar / Elsevier

REFERENCE BOOKS :
4. Thermodynamics/Sonnatag & Van Wylen / John Wiley & Sons
5. Thermodynamics for Engineers/Doolittle-Messe / John Wiley & Sons
6. Irreversible thermodynamics/HR De Groff.
7. Thermal Engineering / Soman / PHI
8. Thermal Engineering / Rathore / TMH
9. Engineering Thermodynamics/Chatopadyaya/

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

ADVANCED HEAT AND MASS TRANSFER

UNIT- 1:

Brief Introduction to different modes of heat transfer;

Conduction: General heat conduction equation-in cartesian, cylindrical and spherical coordinate systems Initial and Boundary conditions

One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders and spheres – overall heat transfer coefficient – electrical analogy– Critical radius of insulation.

One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity – systems with heat sources or Heat generation..

UNIT - 2: heat conduction
Methods of formulation – lumped, integral, and differential formulations; initial and boundary conditions, different kinds of boundary conditions, homogeneous boundary conditions; transient response of thermocouples in the measurement of fluctuating gas temperature; integral formulation of heat conduction in a pin fin of uniform cross section and its approximate analytical solution – heat transfer characteristics of straight, annular, and pin fins of uniform and non-uniform cross sections.

UNIT - 3: transient heat conduction
Differential formulation of transient heat conduction problems with time- independent boundary conditions in rectangular, cylindrical, and spherical geometries and their analytical solution - method of separation of variables, method of Laplace transforms; differential formulation of steady two-dimensional heat conduction problems in rectangular, cylindrical, and spherical geometries and their analytical solution - methods of separation of variables; treatment of nonhomogeneity in differential equations and boundary conditions – method of superposition.

UNIT - 4:
Radiation Heat Transfer: Review of basic definitions – black, gray, opaque, transparent, and translucent bodies, transmissivity of a body, diffuse and specular surfaces; emissivity, absorptivity, and reflectivity of real surfaces; solid angle; radiation intensity, emissive power; irradiation, radiosity; radiant energy exchange between two differential area element; radiation shape factor, radiation shape factor between a differential element and a finite area and between two finite areas, crossed-string method, properties of shape factor – reciprocal, additive, and enclosure properties, shape factor algebra.

UNIT-5:
Radiant energy exchange between two surfaces, reradiating surfaces, radiation shields; Radiant energy exchange in enclosures – enclosure composed of black surfaces, enclosure composed of diffuse-gray surfaces; electrical network analogy; radiant energy exchange in presence of absorbing and transmitting media, radiant energy exchange in presence of transmitting, reflecting and absorbing media; radiant energy exchange in the presence of conduction and convection.

TEXT BOOKS :

1. Heat Transfer – Necati Ozisik (TMH)
2. Heat and Mass Transfer – O P Single (Macmillan India Ltd)
3. Heat Transfer – P.S. Ghoshdastidar (Oxford Press)
4. Engg. Heat & Mass Transfer- Sarit K. Das (Dhanpat Rai)

REFERENCE BOOKS :

1. Fundamentals of Heat & Mass Transfer – Incroera Dewitt (Jhon Wiley)
2. Heat Transfer : A basic approach – Yunus Cangel (MH)
3. Heat & Mass Transfer – D.S. Kumar
4. Heat Transfer – P.K. Nag(TMH)
5. Principle of Heat Transfer – Frank Kreith & Mark.Bohn.
6. Convective Heat and Mass Transfer / W.M.Kays & M.E.Crawford(TMH)
7. Radiation Heat Transfer –G.M.Sparrow& R.D.Cess
8. Thermal Radiation heat transfer – R.Siegel & J.R.Howell
9. Radiation Heat Transfer – H.G.Hottel & A.F.Sarofim

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

ADVANCED FLUID MECHANICS

UNIT I:

Non – viscous flow of incompressible Fluids: Lagrangian and Eulerain Descriptions of fluid motion- Path lines, Stream lines, Streak lines, stream tubes – velocity of a fluid particle, types of flows, Equations of three dimensional continuity equation- Stream and Velocity potential functions.

Basic Laws of fluid Flow: Condition for irrotationality, circulation & vorticity Accelerations in Cartesystems normal and tangential accelerations, Euler's, Bernouli equations in 3D– Continuity and Momentum Equations

UNIT 2:

Principles of Viscous Flow: Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases : Plain Poisoulle flow - Coutte flow with and without pressure gradient - Hagen Poisoulle flow - Blasius solution.

UNIT 3:

Boundary Layer Concepts

Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory - Boundary layer thickness for flow over a flat plate – Approximate solutions – Creeping motion (Stokes) – Oseen's approximation - Von-Karman momentum integral equation for laminar boundary layer – – Expressions for local and mean drag coefficients for different velocity profiles.

UNIT 4:

Introduction to Turbulent Flow: Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations - Prandtl Mixing Length Model - Universal Velocity Distribution Law: Van Driest Model –Approximate solutions for drag coefficients – More Refined Turbulence Models – k-epsilon model - boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders

Internal Flow: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth rough Pipes – Roughness of Commercial Pipes – Moody's diagram.

UNIT 5:

Compressible Fluid Flow – I:

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

Compressible Fluid Flow – II:

Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Releigh Lines, Property Relations – Isothermal Flow in Long Ducts – Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag.

TEXT BOOKS:

1. Schlichting H – Boundary Layer Theory (Springer Publications).
2. Convective Heat and Mass Transfer – Oosthigen, McGrawhill
3. Convective Heat and Mass Transfer – W.M. Kays, M.E. Crawford, McGrawhill

REFERENCE BOOKS:

1. Yuman S.W – Foundations of Fluid Mechanics.
2. An Introduction to Compressible Flow – Pai.
3. Dynamics & Theory and Dynamics of Compressible Fluid Flow – Shapiro.
4. Fluid Mechanics and Machinery – D. Rama Durgaiah.(New Age Pub.)
5. Fluid Dynamics – William F. Hughes & John A. Brighton (Tata McGraw-Hill Pub.)

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

ADVANCED FINITE ELEMENT ANALYSIS

UNIT-I

Introduction to FEM, basic concepts, historical back ground, applications of FEM, general description,
comparison of FEM with other methods, variational approach, Galerkin's Methods. Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain- displacement relations.

UNIT-II

1-D STRUCTURAL PROBLEMS: Axial bar element – stiffness matrix, load vector, temperatureeffects, Quadratic shape functions and problems.
ANALYSIS OF TRUSSES : Plane Trusses and Space Truss elements and problems
ANALYSIS OF BEAMS : Hermite shape functions – stiffness matrix – Load vector – Problems.

UNIT-III

2-D PROBLEMS: CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions,
Isoparametric elements – quadrilateral element, shape functions – Numerical Integration.
Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements.
3-D PROBLEMS: Tetrahedran element – Jacobian matrix – Stiffness matrix.

UNIT-VI

SCALAR FIELD PROBLEMS: 1-D Heat conduction-Slabs – fins - 2-D heat conduction problems –Introduction to Torsional problems.

UNIT-V

Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector,natural frequencies – mode shapes – modal analysis.

TEXT BOOKS:

1. The Finite Element Methods in Engineering / SS Rao / Pergamon.
2. Finite Element Methods: Basic Concepts and applications, Alavala, PHI
3. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice –Hall

REFERENCE BOOKS:

1. Finite Element Method – Zincowitz / Mc Graw Hill
2. Introduction to Fininte element analysis- S.Md.Jalaludeen,Anuradha Publications, print-2012
3. A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5th Edition
4. Finite Element Method – Krishna Murthy / TMH
5. Finite Element Analysis – Bathe / PHI

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

TURBO MACHINES
(ELECTIVE-I)

UNIT-I:
FUNDAMENTALS OF TURBO MACHINES: Classifications, Applications, Thermodynamic analysis,Isentropic flow. Energy transfer. Efficiencies, Static and Stagnation conditions, Continuity equations,Euler's flow through variable cross sectional areas, Unsteady flow in turbo machines

UNIT -II:
STEAM NOZZLES: Convergent and Convergent-Divergent nozzles, Energy Balance, Effect of backpressure of analysis. Designs of nozzles.
Steam Turbines: Impulse turbines, Compounding, Work done and Velocity triangle, Efficiencies, Constant reactions, Blading, Design of blade passages, Angle and height, Secondary flow. Leakage losses, Thermodynamic analysis of steam turbines.

UNIT-III:
GAS DYNAMICS: Fundamental thermodynamic concepts, isentropic conditions, mach numbers andarea, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Super sonic flow,oblique shock waves. Normal shock recoveries, Detached shocks, Aerofoil theory.
Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuserand pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

UNIT-IV:
AXIAL FLOW COMPRESSORS: Flow Analysis, Work and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Drgree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance
Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force,Vortex Blades.

UNIT-V:
AXIAL FLOW GAS TURBINES: Work done. Velocity triangle and efficiencies, Thermodynamic flow
analysis, Degree of reaction, Zweifels relation, Design cascade analysis, Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, Off design performance.

TEXT BOOKS:
1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Fundamentals of Turbomachinery/William W Perg/John Wiley & Sons
3. Element of Gas Dynamics/Yahya/TMH

REFERENCE BOOKS:

4. Principles of Jet Propulsion and Gas Turbine/NJ Zucrow/John Wiley & Sons/Newyork
5. Turbines, Pumps, Compressors/Yahya/TMH
6. Practice on Turbo Machines/ G.Gopal Krishnan & D.Prithviraj/ Sci Tech Publishers, Chennai
7. Theory and practice of Steam Turbines/ WJ Kearton/ELBS Pitman/London
8. Gas Turbines Theory and Practice/Zucrow/John Wiley & Sons/Newyork
9. Element of Gas Dynamics/Liepeman and Roshkow/ Dover Publications

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GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

OPTIMIZATION TECHNIQUES

(ELECTIVE-I)

UNIT I

SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION:

One dimensional Optimization methods:- Uni-modal function, elimination methods, ,, Fibonacci method, golden section method, interpolation methods – quadratic & cubic interpolation methods.

Multi variable non-linear unconstrained opt imization: Direct search method – Univariant method - pattern search methods – Powell's- Hook -Jeeves, Rosenbrock search methods- gradient methods, gradient of function, steepest decent method, Fletcher Reeves method, variable metric method.

UNIT II

GEOMETRIC PROGRAMMING:

Polynomials – arithmetic - geometric inequality – unconstrained G.P- constrained G.P

UNIT III

DYNAMIC PROGRAMMING:

Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory, allocation, scheduling replacement.

UNIT IV

Linear programming – Formulation – Sensivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints.

Simulation – Introduction – Types- steps – application – inventory – queuing – thermal system

UNIT V

Integer Programming- Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method

STOCHASTIC PROGRAMMING:

Basic concepts of probability theory, random variables- distributions-mean, variance, correlation, co variance, joint probability distribution- stochastic linear, dynamic programming.

Text Books:

1. Optimization theory & Applications / S.S.Rao / New Age International.
2. Introductory to operation Research / Kasan & Kumar / Springar
3. Optimization Techniques theory and practice / M.C.Joshi, K.M.Moudgalya/ Narosa Publications

Reference Books:

1) S.D.Sharma / Operations Research
2) Operation Research / H.A.Taha /TMH
3) Optimization in operations research / R.LRardin
4) Optimization Techniques /Benugundu & Chandraputla / Pearson Asia

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

THEORY OF HEAT PIPES
(ELECTIVE-I)

UNIT -I

Operating principle , Working fluids and its temperature ranges, heat transfer limits and heat pipe characteristics , various applications

Interfacial heat and transfer , physical surface phenomena , capillary and disjoining forces – Interfacial resistance in vaporization and condensation process , Interfacial mass , momentum energy , pressure balance – interfacial phenomena in grooved structures

UNIT -II

Steady Hydrodynamics – thermal characteristics and heat transfer limitation , thermal fluid phenomena in capillary media , vapor flow analysis , thermal characteristics including the wall effects and effect of vapor flow – capillary boiling – sonic , entrainment , viscous , condenser , continuum and frozen startup limitations

UNIT- III

Area temperature relations , Pipe dimensions and structural considerations. Heat pipe heat exchanger, transient model calculations and procedures

UNIT- IV

Heat Pipe Behavior- Transient response to sudden change in temperature heat input , frozen startup and shut down of heat pipe – numerical and analytical model for frozen startup.

UNIT -V

Two phase closed thermo siphon reflux-condensation heat transfer in analysis, evaporation heat transfer analysis, transient and oscillatory behavior of thermo siphon, Minimum liquid fill requirement, Thermo syphon with capillary wicks

Text Books:

1. S.W.Chi,1976 , Heat pipe theory and practice, Hemisphere publishing corporation , Washington
2. Dunn, P.D.and Reay D.A. 1982 , “Heat Pipes” , Third Edition , Pregamon Press
3. Amir Faghri , 1995 Heat Pipe science and Technology , publisher , Taylor and Francis
4. V.P. Carey , 1992 , Liquid – Vapor phase – Change phenomena. An Introduction to the Thermophysics of vaporization and condensation processes in heat transfer equipment , Hemisphere Publishers , New York
5. J.N.Israelachvili , 1985 , Inrtermolecular and surface forces – Academic press, London
6 I.B.Ivanov , 1988, Thin liquid films :Fundamentals and application – Marcel Dekkar , New York

M.N.Ivanovskii , V.P.Sorokin and I.V. Yagodkin , 1982 , The physical principles of heat pipes Clarendon press , Oxford

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

REFRIGERATION AND AIR CONDITIONING
(ELECTIVE-II)

UNIT – I

VAPOUR COMPRESSION REFRIGERATION: Performance of Complete vapor compression system.

Components of Vapor Compression System: The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit.

Compound Compression: Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems.

UNIT – II

PRODUCTION OF LOW TEMPERATURE: Liquefaction system ;Cascade System – Applications.– Dry ice system.

Vapor absorption system – Simple and modified aqua – ammonia system – Representation on Enthalpy –Concentration diagram.

Lithium – Bromide system Three fluid system – HCOP.

UNIT – III

AIR REFRIGERATION: Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems.

Steam Jet refrigeration system: Representation on T-s and h-s diagrams – limitations and applications.

Unconventional Refrigeration system – Thermo-electric – Vortex tube & Pulse tube – working principles.

UNIT – IV

AIR –CONDITIONING: Psychrometric properties and processes – Construction of Psychrometric chart. Requirements of Comfort Air –conditioning – Thermodynamics of human body – Effective temperature and Comfort chart – Parameters influencing the Effective Temperature. Summer , Winter and year round air – conditioning systems.

Cooling load Estimation: Occupants, equipments, infiltration, duet heat gain fan load, Fresh air load.

UNIT – V

AIR –CONDITIONING SYSTEMS: All Fresh air , Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP,RSHF, ESHF and GSHF for different systems.

Components: Humidification and dehumidification equipment – Systems of Air cleaning – Grills and diffusers – Fans and blowers – Measurement and control of Temperature and Humidity.

REFERENCES:

1. Refrigeration & Air Conditioning /C.P. Arora/TMH
2. Refrigeration & Air Conditioning /Arora & Domkundwar/ Dhanpat Rai
3. Refrigeration and Air Conditioning /Manohar Prasad/
4. Refrigeration and Air Conditioning /Stoecker /Mc Graw Hill
5. Principles of Refrigeration/Dossat /Pearson
6. Refrigeration and Air Conditioning /Ananthanarayana /TMH
7. Refrigeration and Air Conditioning /Jordan& Preister /Prentice Hall
8. Refrigeration and Air Conditioning/Dossat /Mc Graw Hil

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

JET PROPULSION AND ROCKETRY
(ELECTIVE-II)

UNIT - I:

TURBO JET PROPULSION SYSTEM: Gas turbine cycle analysis – layout of turbo jet engine. Turbo machinery- compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis.

Flight Performance: Forces acting on vehicle – Basic relations of motion – multi stage vehicles.

UNIT - II:

PRINCIPLES OF JET PROPULSION AND ROCKETRY: Fundamentals of jet propulsion, Rockets and air breathing jet engines – Classification – turbo jet , turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

Nozzle Theory and Characteristics Parameters: Theory of one dimensional convergent – divergent nozzles – aerodynamic choking of nozzles and mass flow through a nozzle – nozzle exhaust velocity – thrust, thrust coefficient, Ac / At of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters – 1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

UNIT - III:

AERO THERMO CHEMISTRY OF THE COMBUSTION PRODUCTS: Review of properties of mixture
of gases – Gibbs – Dalton laws – Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation – calculation of adiabatic flame temperature and specific impulse – frozen and equilibrium flows.

Solid Propulsion System: Solid propellants – classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates.

UNIT - IV:

Solid propellant rocket engine – internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design. Heat transfer considerations in solid rocket motor design. Ignition system, simple pyro devices.

Liquid Rocket Propulsion System: Liquid propellants – classification, Mono and Bi propellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine – system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors – various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.

UNIT - V:

RAMJET AND INTEGRAL ROCKET RAMJET PROPULSION SYSTEM: Fuel rich solid propellants,
gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification – critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of IIRR propulsion systems.

TEXT BOOKS:

1. Mechanics and Dynamics of Propulsion/ Hill and Peterson/John Wiley & Sons
2. Rocket propulsion elements/Sutton/John Wiley & Sons/8th Edition
3. Gas Turbines/Ganesan /TMH

REFERENCE BOOKS :

4. Gas Turbines & Propulsive Systems/Khajuria & Dubey/Dhanpat Rai & Sons
5. Rocket propulsion/Bevere/
6. Jet propulsion /Nicholas Cumpsty/

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

THERMAL AND NUCLEAR POWER PLANTS

(ELECTIVE II)

Unit - 1:

Introduction – Sources of Energy, types of Power Plants, Direct Energy Conversion System, Energy Sources in India, Recent developments in Power Generation. Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, Flue gas Analysis.

Steam Power Plants: Introduction – General Layout of Steam Power Plant, Modern Coal-fired Steam Power Plants, Power Plant cycles, Fuel handling, Combustion Equipment, Ash handling, Dust Collectors.

Steam Generators: Types, Accessories, Feed water heaters, Performance of Boilers, Water Treatment, Cooling Towers, Steam Turbines, Compounding of Turbines, Steam Condensers, Jet & Surface Condensers.

Unit - 2:

Gas Turbine Power Plant: Cogeneration, Combined cycle Power Plants, Analysis, Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion – Advantages & Disadvantages.

Unit -3:

Nuclear Power Plants: Nuclear Physics, Nuclear Reactors, Classification – Types of Reactors, Site Selection, Methods of enriching Uranium, Applications of Nuclear Power Plants.

Nuclear Power Plants Safety: By-Products of Nuclear Power Generation, Economics of Nuclear Power Plants, Nuclear Power Plants in India, Future of Nuclear Power.

Unit -4:

Economics of Power Generation: Factors affecting the economics, Load Factor, Utilization factor, Performance and Operating Characteristics of Power Plants. Economic Load Sharing, Depreciation, Energy Rates, Criteria for Optimum Loading, Specific Economic energy problems.

Unit - 5:

Power Plant Instrumentation: Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Pollution – Types, Methods to Control.

TEXT BOOKS:

1. Power Plant Engineering / P.K. Nag / TMH.
2. Power Plant Engineering / R.K. Rajput / Lakshmi Publications.
3. Power Plant Engineering / P.C.Sharma / Kotaria Publications.
4. Power Plant Technology / Wakil.

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

THERMAL ENGINEEIRNG LAB

1. Compressibility factor measurement of different real gases.
2. Dryness fraction estimation of steam.
3. Flame propagation analysis of gaseous fuels.
4. Performance test and analysis of exhaust gases of an I.C. Engine.
5. Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C. Engine.
6. COP estimation of vapour compression refrigeration test.
7. Performance analysis of Air conditioning unit.
8. Performance analysis of heat pipe.
9. Solar Flat Plate Collector

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – I Semester

CONVECTIVE HEAT TRANSFER
(ELECTIVE-III)

UNIT-I:
Introduction to Forced, free & combined convection – convective heat transfer coefficient – Application of dimensional analysis to convection – Physical interpretation of dimensionless numbers.
Equations of Convective Heat Transfer: Continuity, Navier-Strokes equation & energy equation for steady state flows – similarity – Equations for turbulent convective heat transfer – Boundary layer equations for laminar, turbulent flows – Boundary layer integral equations.

UNIT-II:
EXTERNAL LAMINAR FORCED CONVECTION: Similarity solution for flow over an isothermal plate– integral equation solutions – Numerical solutions – Viscous dissipation effects on flow over a flat plate.
External Turbulent Flows: Analogy solutions for boundary layer flows – Integral equation solutions – Effects of dissipation on flow over a flat plate.
Internal Laminar Flows: Fully developed laminar flow in pipe, plane duct & ducts with other crosssectionalshapes – Pipe flow & plane duct flow with developing temperature field – Pipe flows & planeduct flow with developing velocity & temperature fields.
Internal Turbulent Flows: Analogy solutions for fully developed pipe flow –Thermally developing pipe & plane duct flow.

UNIT – III:
NATURAL CONVECTION: Boussineq approximation – Governing equations – Similarity – Boundary layer equations for free convective laminar flows – Numerical solution of boundary layer equations. Free Convective flows through a vertical channel across a rectangular enclosure – Horizontal enclosure – Turbulent natural convection.

UNIT – IV:
COMBINED CONVECTION: Governing parameters & equations – laminar boundary layer flow over an isothermal vertical plate – combined convection over a horizontal plate – correlations for mixed convection – effect of boundary forces on turbulent flows – internal flows - internal mixed convective flows – Fully developed mixed convective flow in a vertical plane channel & in a horizontal duct.

UNIT - V:
CONVECTIVE HEAT TRANSFER THROUGH POROUS MEDIA: Area weighted velocity – Darcy flow model – energy equation – boundary layer solutions for 2-D forced convection – Fully developed duct flow – Natural convection in porous media – filled enclosures – stability of horizontal porous layers.

TEXT BOOKS:

1. Introduction to Convective Heat Transfer Analysis/ Patrick H. Oosthuigen & David Naylor /McGraw Hill
2. Convective Heat & Mass Transfer /Kays & Crawford/TMH

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech(Thermal Engineering) I Year – II Semester

ADVANCED I.C. ENGINES
(ELECTIVE-II)

UNIT - I: Introduction – Historical Review – Engine Types – Design and operating Parameters.
Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles
– Real Engine cycles - differences and Factors responsible for – Computer Modeling.

UNIT - II:
GAS EXCHANGE PROCESSES: Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging.
Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows.

UNIT - III:
ENGINE COMBUSTION IN S.I ENGINES: Combustion and Speed – Cyclic Variations – Ignition –Abnormal combustion Fuel factors, MPFI, SI engine testing.
Combustion in CI engines: Essential Features – Types off Cycle. Pr. Data – Fuel Spray Behavior – Ignition Delay – Mixing Formation and control, Common rail fuel injection system.

UNIT - IV:
POLLUTANT FORMATION AND CONTROL: Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, un burnt Hydrocarbon and particulate – Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

UNIT - V:
ENGINE HEAT TRANSFER: Importance of heat transfer, heat transfer and engine energy balance,Convective heat transfer , radiation heat transfer, Engine operating characteristics.
Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen.
Modern Trends in IC Engines: Lean Burning and Adiabatic concepts, Rotary Engines, Modification in I.C engines to suit Bio – fuels, HCCI and GDI concepts.

TEXT BOOKS :
1. I.C. Engines / V.Ganesan/TMH
2. I.C. Engines Fundamentals/Heywood/TMH
3. I.C. Engines/G.K. Pathak & DK Chevan/ Standerd Publications
4. I.C. Engines /RK Rajput/Laxmi Publications

REFERNCE BOOKS :

5. Computer Simulation of C.I. Engine Process/ V.Ganesan/University Press
6. Fundamentals of IC Engines/HN Gupta/PHI/2nd edition
7. I.C. Engines/Fergnson/Wiley
8. The I.C. Engine in theory and Practice Vol.I / Teylor / IT Prof. And Vol.II

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

COMPUTATIONAL METHODS IN HEAT TRANSFER

UNIT 1: Introduction to Numerical Methods - Finite Difference, Finite Element and Finite Volume Methods – Classification of Partial Differential Equations – Solution of Linear Algebraic Equations – Direct and Iterative Approaches

Finite difference methods: Taylor's series – FDE formulation for 1D and 2D steady state heat transfer problems – Cartesian, cylindrical and spherical co-ordinate systems – boundary conditions – Un steady state heat conduction – Errors associated with FDE - Explicit Method – Stability criteria – Implicit Method – Crank Nickolson method – 2-D FDE formulation – ADI – ADE

UNIT 2: **Finite Volume Method**: Formation of Basic rules for control volume approach using 1D steady heat conduction equation – Interface Thermal Conductivity - Extension of General Nodal Equation to 2D and 3D Steady heat conduction and Unsteady heat conduction

UNIT 3: **FVM to Convection and Diffusion**: Concept of Elliptic, Parabolic and Hyperbolic Equations applied to fluid flow – Governing Equations of Flow and Heat transfer – Steady 1D Convection Diffusion – Discretization Schemes and their assessment – Treatment of Boundary Conditions

UNIT 4: **Calculation of Flow Field**: Vorticity & Stream Function Method - Staggered Grid as Remedy for representation of Flow Field - Pressure and Velocity Corrections – Pressure Velocity Coupling - SIMPLE & SIMPLER (revised algorithm) Algorithm.

UNIT 5: **Turbulent Flows**: Direct Numerical Simulation, Large Eddy Simulation and RANS Models

Compressible Flows: Introduction - Pressure, Velocity and Density Coupling.

TEXT BOOKS:

1. Computational Fluid Flow and Heat Transfer – Muralidharan & Sundarajan (Narosa Pub)
2. Numerical heat transfer and fluid flow – S.V. Patankar (Hemisphere Pub. House)
3. An Introduction to Computational Fluid Dynamics – FVM Method – H.K. Versteeg, W. Malalasekhara (PHI)
4. Computational Fluid Dynamics – Anderson (TMH)
5. Computational Methods for Fluid Dynamics – Ferziger, Peric (Springer)

REFERENCE BOOKS:

1. Computational Fluid Dynamics, T.J. Chung, Cambridge University
2. Computaional Fluid Dynamics – A Practical Approach – Tu, Yeoh, Liu (Elsevier)
3. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

EQUIPMENT DESIGN FOR THERMAL SYSTEMS

Unit - 1: Classification of heat exchangers: Introduction, Recuperation & Regeneration – Tubular heat exchangers: double pipe, shell & tube heat exchanger, Plate heat exchangers, Gasketed plate heat exchanger, spiral plate heat exchanger, Lamella heat exchanger, extended surface heat exchanger, Plate fin, and Tubular fin.

Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient – LMTD method for heat exchanger analysis – parallel flow, counter flow, multipass, cross flow heat exchanger design calculations.

Unit - 2: Double Pipe Heat Exchanger: Film Coefficient for fluids in annulus, fouling factors, calorific temperature, average fluid temperature, the calculation of double pipe exchanger, Double pipe exchangers in series-parallel arrangements.

Shell & Tube Heat Exchangers: Tube layouts for exchangers, baffle Heat exchangers, calculation of shell and tube heat exchangers – shell side film coefficients, Shell side equivalent diameter, the true temperature difference in a 1-2 heat exchanger, influence of approach temperature on correction factor, shell side pressure drop, tube side pressure drop, Analysis of performance of 1-2 heat exchanger, and design calculation of shell & tube heat exchangers. Flow arrangements for increased heat recovery, the calculations of 2-4 exchangers.

Unit - 3: Condensation of single vapors: Calculation of a horizontal condenser, vertical condenser, De-super heater condenser, vertical condenser – sub-cooler, horizontal condenser – subcooler, vertical reflux type condenser, condensation of steam.

Unit – 4: Vaporizers, Evaporators and Reboilers: Vaporizing processes, forced circulation vaporizing exchangers, natural circulation vaporizing exchangers, calculations of a reboiler.

Extended Surfaces: Longitudinal fins, weighted fin efficiency curve, calculation of a double pipe fin efficiency curve, calculation of a double pipe finned exchanger, calculation of a longitudinal fin shell and tube exchanger.

Unit - 5: Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, the Lewis number, and classification of cooling towers, cooling tower internals and the roll of fill, Heat balance, heat transfer by simultaneous diffusion and convection. Analysis of cooling tower requirements, Design of cooling towers, Determination of the number of diffusion units, calculation of cooling tower performance.

TEXT BOOKS :

1. Process Heat Transfer – D.Q. Kern, TMH.
2. Cooling Towers by J.D. Gurney
3. Heat Exchanger Design – A.P.Fraas and M.N. Ozisick. John Wiely & sons, New York.

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering)
I Year – II Semester

THERMAL MEASUREMENTS AND PROCESS CONTROLS
(ELECTIVE-III)

UNIT-I

GENERAL CONCEPTS: Fundamental elements of a measuring instrument. Static and dynamic characteristics – errors in instruments – Different methods of measurement and their analysis – Sensing elements and transducers.

Measurement of pressure – principles of pressure measurement, static and dynamic pressure, vacuum and high pressure measuring – Measurement of low pressure, Manometers, Calibration methods, Dynamic characteristics- design principles.

UNIT-II

MEASUREMENT OF FLOW: Obstruction meters, variable area meters. Pressure probes, compressible fluid flow measurement, Thermal anemometers, calibration of flow measuring instruments. Introduction to design of flow measuring instruments.

UNIT-III

TEMPERATURE MEASUREMENT: Different principles of Temperature Measurement, use of bimetallic thermometers – Mercury thermometers, Vapor Pressure thermometers,

Thermo positive elements, thermocouples in series & parallel, pyrometry, measurement of heat flux, calibration of temperature measuring instruments. Design of temperature measuring instruments.

UNIT-IV

Level Measurement: Direct & indirect methods, manometric methods, float level meters, electrical conductivity, Capacitive, Ultrasonic, and Nucleonic Methods.

Measurement of density – Hydrometer, continuous weight method, Gamma rays, Gas impulse wheel.

Velocity Measurement – Coefficient of viscosity, Ostesld method, free fall of piston under gravity, torque method.Measurement of moisture content and humidity.Measurement of thermal conductivity of solids, liquids and gases.

UNIT-V

PROCESS CONTROL: Introduction and need for process control principles, transfer functions, block diagrams, signal flow graphs, open and closed loop control systems – Analysis of First & Second order systems with examples of mechanical and thermal systems.

Control System Evaluation – Stability, steady state regulations, transient regulations.

REFERENCES:

1. Measurement System, Application & Design – E.O. Doeblin.
2. Mechanical and Industrial Measurements – R.K. Jain – Khanna Publishers.
3. Mechanical Measurements – Buck & Beckwith – Pearson.
4. Control Systems, Principles & Design, 2nd Edition – M. Gopal – TMH.

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

ALTERNATE ENERGY RESOURCES
(ELECTIVE-III)

Unit – 1: Introduction – Energy Sinario - Survey of Energy Resources – Classification – Need for Non-Conventional Energy Resources. **Solar Energy:** The Sun – Sun-Earth Relationship – Basic matter to waste heat energy circuit – Solar radiation – Attention – Radiation measuring instruments.

Solar Energy Applications:

Solar water Heating, space heating – active and passive heating – energy storage – selective surface – solar stills and ponds – solar refrigeration – photovoltaic generation .

Unit - 2: Geothermal Energy:

Structure of Earth – Geothermal Regions – Hot springs – Hot Rocks – Hot Aquifers – Analytical Methods to estimate Thermal Potential – Harnessing Techniques – Electricity Generating Systems.

Unit - 3: Direct Energy Conversion:

Nuclear Fusion:

Fusion – Fusion Reaction- P-P Cycle carbon Cycle, Deuterium cycle – condition for controlled Fusion.

Fuel Cells and Photovoltaic –Thermionic and Thermoelectric Generation – MHD Generator.

Hydrogen gas a Fuel – Production methods – Properties – I.C. Engines Applications – Utilization Strategy – Performances.

Unit – 4: Bio – Energy:

Biomass Energy Sources – Plant Productivity, Biomass Wastes – Aerobic and Anaerobic bio-conversion processes – Raw Materials and properties of Bio-gas-Bio-gas plant Technology and Status – The Energetics and Economics of Biomass Systems – Biomass gasification.

Unit – 5: Wind Energy:

Wind – Beaufort number – characteristics – wind energy conversion systems – types – Betz model – Interference Factor – Power Coefficient – Torque Coefficient and thrust coeff.- Lift machines and drag machines – matching – electricity generation.

Energy from Oceans:

Tidal Energy; Tides – Diurnal and Semi – Diurnal Nature – Power from Tides.

Wave Energy ; Waves – Theoretical Energy Available – Calculation of period and phase velocity of waves – wave power systems – submerged devices. Ocean Thermal Energy : principles – Heat Exchangers – Pumping requirements – Practical Considerations.

TEXT BOOKS:

1. Renewable Energy Resources – Basic Principles and Applications – G.N.Tiwari and M.K.Ghosal, Narosa Pub

REERENCE BOOKS :

1. Renewable Energy Resources / John Twidell & Tony Weir
2. Biological Energy Resources / Malcolm Flescher & Chrris Lawis

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

CRYOGENIC ENGINEERING

(ELECTIVE-III)

UNIT - 1: Introduction to CRYOGENIC Systems – Mechanical Properties at low temperatures – Properties of cryogenic fluids.

Gas Liquefaction: Minimum work for liquefaction – Methods to produce low temperature – Liquefaction systems for gases other than Neon, Hydrogen and Helium

UNIT - 2: Liquefaction systems for Neon, Hydrogen and Helium Components of Liquefaction systems – Heat Exchangers – Compressors and Expanders – expansion valve – Losses for real machines

UNIT - 3: Gas separation and purification systems – Properties of mixtures – Principles of mixtures – Principles of gas separation – Air separation systems

UNIT - 4: Cryogenic Refrigeration Systems – Working media – Solids, Liquids and gases

Cryogenic fluid storage & transfer – Cryogenic storage systems – Insulation – Fluid transfer mechanisms – Cryostat – Cryo Coolers

UNIT - 5: Applications – Space technology – In-flight air seperation and collection of LOX – Gas Industry – Biology – Medicine - Electronics

TEXT BOOKS:

1. Cryogenic Systems – R.F. Barron, Oxford University Press

REFERENCE BOOKS:

1. Cryogenic Research and Applications – Marshall Sitting, Von Nostrand Inc, New Jersey
2. Cryogenics Engineering Edit by B.A.Hands, Academic Press, 1986
3. Cryogenics Engineering – R. B. Scott, Von Nostrand Inc, New Jersey, 1959
4. Experimental Techniques in Low Temperature Physics – G.K. White, Oxford Press, 1968
5. Cryogenics process Engineering – K.D.Timmerhaus & TM Flynn, Plenum press, 1998
6. Cryogenic Heat Transfer - R.F. Baron.
7. Cryogenic Two Phase flow – N.N . Falina and J.G. Weisend –II
8. Cryogenic Regenerative Heat Exchangers – Robort Ackermann, Plenum Press, 1997
9. Cryogenic Engineering – Thomas M. Flynn
10. Safety in Handling of Cryogenic Fluids – Fredrick J. Edeskutty and Watter F. Stewart, Plenum Press, 1996
12. Hand Book of Cryogenic Engineering – J.G.Weisend –II, Taylor and Francis, 1998

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

FUELS, COMBUSTION AND ENVIRONMENT
(ELECTIVE IV)

UNIT- I

Fuels - Detailed Classification – Conventional and Unconventional Solid, Liquid, gaseous fuels and nuclear fuels – Origin of Coal – Analysis of coal.

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.

UNIT- II

Principles of Combustion – Chemical composition – Flue gas anlaysis – dew point of products – Combustion stoichiometry.

Chemical kinetics – Rate of reaction – Reaction order – Molecularity – Zeroth, first, second and third order reactions - complex reactions – chain reactions. Theories of reaction Kinetics – General oxidation behavior of HC's.

UNIT- III

Thermodynamics of Combustion – Enthalpy of formation – Heating value of fuel - Adiabatic flame Temperature – Equilibrium composition of gaseous mixtures.

UNIT- IV

Laminar and Turbulent flames Propagation and Structure – Flame stability – Burning velocity of fuels – Measurement of burning velocity – factors affecting the burning velocity.

Combustion of fuel, droplets and sprays – Combustion systems – Pulverised fuel furnaces – fixed, Entrained and Fluidised Bed Systems.

UNIT- V

Environmental Considerations – Air pollution – Effects on Environment, Human Health etc. Principal pollutants – Legislative Measures – Methods of Emission control.

TEXT BOOKS :

1. Combustion Fundamentals by Roger A strehlow – Mc Graw Hill
2. Fuels and combustion by Sharma and Chander Mohan – Tata Mc Graw Hill
3. Combustion Engineering and Fuel Technology by Shaha A.K. Oxford and IBH.
4. Principles of Combustion by Kanneth K.Kuo, Wiley and Sons.
5. Combustion by Sarkar – Mc. Graw Hill.
6. An Introduction to Combustion – Stephen R. Turns, Mc. Graw Hill International Edition.
7. Combustion Engineering – Gary L. Berman & Kenneth W. Ragland, Mc. Graw Hill International Edition.
8. Combustion- I. Glassman

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

MULTI PHASE FLOW
(ELECTIVE IV)

Unit - 1
Introduction- multi phase and multi-component flow, practical examples; method of analysis of multi phase and
multi-component flow problems; basic definitions; two phase, one-dimensional conservation equations; pressure
gradient components; flow patterns, Two phase flow patterns in mini and micro-channels.

Unit - 2
Basic flow models – homogeneous flow model, pressure gradient, two phase friction factor for laminar flow and
turbulent flow, two phase viscosity, friction multiplier; separated flow model – pressure gradient, Lokhart Martinelli correlation; Multidimensional two fluid model.

Unit - 3
Drift flux model – gravity dominated flow regime, corrections for void fraction and velocity distribution in
different flow regimes, pressure loss due to multi phase flow in pipe fittings, velocity and concentration profiles
in multi phase flow; one-dimensional waves in two component flow, void-quality correlations.

Unit - 4
Boiling and condensation – evaporation, nucleate boiling, convective boiling; bubble formation and limiting
volume; boiling map; DNB; critical boiling conditions ; static and dynamic instabilities

Unit - 5
condensation process– types of condensation, Nusselt theory, deviations from Nusselt theory, practical equations, condensation of flowing vapors; introduction to boiling and condensation in small passages.

References
1. Collier, J. G., Convective Boiling and Condensation, McGraw-Hill, 1981.
2. Wallis, G. W., One-dimensional Two Phase Flow, McGraw-Hill, 1969.
3. Stephen, K. Heat Transfer in Condensation and Boiling, Berlin Hiedelberg, 1992.
4. Hsu, Y. Y. and Graham, R. W., Transport Processes in Boiling and Two phase Systems, McGraw-Hill, 1976.
5. Ginoux, J. J., Two Phase Flows and Heat Transfer, McGraw-Hill, 1978.
6. Hewitt, G., Delhaye, J. M., and Zuber, N., Multiphase Science and Technology, Vol. I, McGraw-Hill, 1982.
7. Ghiaasiaan, S. M., Two-Phase Flow, Boiling and Condensation: In Conventional and Miniature Systems, Cambridge University Press, 2008.
8. Tong, L. S. and Tang, Y. S., Boiling Heat Transfer and Two-Phase Flow, second Edition, Taylor & Francis, 1997.

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

SOLAR ENERGY TECHNOLOGY
(ELECTIVE IV)

UNIT - I
Introduction – Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications.
Capturing 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
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, concentration ratio.

UNIT - III
THERMAL ENERGY STORAGE: Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations.
Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration, active and passive heating systems.

UNIT - IV
DIRECT ENERGY CONVERSION: solid-state principles – semiconductors – solar cells – performance – modular construction – applications. conversion efficiencies calculations.

UNIT - V
ECONOMICS: Principles of Economic Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost based analysis of water heating and photo voltaic applications.

REFERENCES:
1. Principles of solar engineering/ Kreith and Kerider/Taylor and Franscis/2nd edition
2. Solar energy thermal processes/ Duffie and Beckman/John Wiley & Sons
3. Solar energy: Principles of Thermal Collection and Storage/ Sukhatme/TMH/2nd edition
4. Solar energy/ Garg/TMH
5. Solar energy/ Magal/Mc Graw Hill
6. Solar Thermal Engineering Systems / Tiwari and Suneja/Narosa
7. Power plant Technology/ El Wakil/TMH

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
M.Tech(Thermal Engineering) I Year – II Semester

CFD AND THERMAL MEASUREMENTS AND PROCESS CONTROL LABORATORY

Computational Lab:

I. Development of algorithms and computer programs using C, MATLAB.

II. Programming assignments on the following topics

- Roots of algebraic and transcendental equations
- Solution of simultaneous algebraic equations
- Curve fitting and optimization
- Numerical integration of ordinary differential equations: Initial value problems
- Numerical Solution of ordinary differential equations: Boundary value problems
- Numerical solution of partial differential equations

III. Hands-on Training on the following Softwares:
a. Design, modeling and analysis: using I-DEAS, ANSYS, PRO-E
b. Computational fluid dynamics and heat transfer: FLUENT

Thermal Measurements Lab:

I.Temperature Measurement
II. Pressure Measurement
III.Flow measurement
IV.Process Control
V.Instrumentation and control Systems in Power plant