

ANNA UNIVERSITY COIMBATORE
M.E. THERMAL ENGINEERING
CURRICULAM AND SYLLABUS

Semester: 01

Code No.	Course title	L	T	P	M
Theory					
	Advanced Mathematics	3	1	0	100
	Advanced Heat and Mass Transfer	3	1	0	100
	Measurements and Control	3	0	0	100
	Advanced Thermodynamics	3	1	0	100
	Fuels and Combustion	3	0	0	100
	Elective – I	3	0	0	100
Practical					
	Thermal Engineering Laboratory	0	0	3	100

Semester: 02

Code No.	Course title	L	T	P	M
Theory					
	Advanced fluid mechanics	3	1	0	100
	Computational Fluid Dynamics	3	1	0	100
	Design of Thermal Power equipments	3	1	0	100
	Thermal Turbo machines	3	1	0	100
	Elective – II	3	0	0	100
	Elective – III	3	0	0	100
Practical					
	Computational Fluid Dynamics Laboratory	0	0	3	100

Semester: 03

Code No.	Course title	L	T	P	M
Theory					
	Elective – IV	3	0	0	100
	Elective – V	3	0	0	100
	Elective – VI	3	0	0	100
	Project work phase - I	-	-	-	100

Semester: 04

Code No.	Course title	L	T	P	M
	Project work phase - I	-	-	-	100

Note: L – Lecture T – Tutorial P – Practical M – Total Marks

ELECTIVE SUBJECTS

- 01.** Gas Turbine
- 02.** Advanced Internal Combustion Engines
- 03.** Numerical methods in Heat Transfer and Fluid Flow
- 04.** Cryogenic Engineering
- 05.** Refrigeration system Design
- 06.** Nuclear Power Plant
- 07.** Advanced Power Plant Engineering
- 08.** Environmental Engineering and Pollution Control
- 09.** Renewable Energy System
- 10.** Cogeneration and Waste Heat Recovery System
- 11.** Refrigeration machinery and components

07TE101 ADVANCED MATHEMATICS

(Syllabus common to ME - Thermal Engg., Energy Engg., R&AC, IC Engg.,)

L T P M

3 1 0 100

UNIT I

9hrs

Fourier Transforms, Complex, Sine and Cosine Transforms, Finite Fourier Transforms. Applications – One dimensional heat conduction problem, Laplace Equation, Poisson Equation.

UNIT II

9hrs

Variation and its properties – Euler's equation – Functionals dependent on first and higher order derivatives – Functionals dependent on functions of several independent variables – Some applications – Direct methods – Ritz and Kantorovich methods.

UNIT III

9hrs

The Schwarz – Christoffel transformation – Transformation of boundaries in parametric form – Physical applications – Application to fluid flow – Application to heat flow.

UNIT IV

9hrs

Matrix transformations – Direct methods – Gaussian Elimination method, Gauss modern method, Factorisation method. Iterative methods – Jacobi, Gauss Seidely and SOR methods.

UNIT V

9hrs

Solution of Laplace's and Poisson equation on a rectangular region by Liebmann's method – Diffusion equation by the explicit and Crank Nicolson – Implicit methods – Stability and Convergence criterion – Solution of wave equation by explicit scheme.

Tutorials

- 15hrs

Total Hours - 60hrs

REFERENCES

- 1.Sneddon,I.N., Elements of partial differential equations, McGraw-Hill, 1986.
- 2.Spiegel, M.R., Theory and problems of complex variables with an introduction to conformal mapping and its applications, Schaum's outline series, McGraw-Hill Book Co.,1987.
- 3.Sankara Rao, K., Introduction to partial differential equations,Prentice-Hall of India,New Delhi, 1995
- 4.Elsgolts, L., Differential equation and calculus of variations, Mir Publishers, Moscow, 1996.
- 5.Carnanan. B., Luther. H.A., and Wilkes, J.O., Applied Numerical Methods, Wiley and Sons,1976

07TE102 ADVANCED HEAT AND MASS TRANSFER

(Use of approved handbook permitted)

(Syllabus common to ME - Thermal Engg., Energy Engg., R&AC, IC Engg.,)

L T P M
3 1 0 100

UNIT I

9hrs

One dimensional study and transient heat transfer equations and boundary conditions, 2D, 3D heat conduction equations-varying thermal conductivity-Analytical and semi-analytical solutions, -Lumped Analysis-Heisler's chart, extended surface-geometric non linear heat transfer-Bessel function.

UNIT II

9hrs

Conduction with moving boundaries, Radiation in gases and vapour. Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection.

UNIT III

9hrs

Momentum and Energy Equations, Turbulent Boundary Layer Heat Transfer, Mixing length concept, Turbulence Model – K ϵ Model, Analogy between Heat and Momentum Transfer – Reynolds, Colburn, Prandtl Turbulent flow in a Tube, High speed flows.

UNIT IV

9hrs

Condensation with shear edge on bank of tubes, Boiling – pool and flow boiling, Heat exchanger, ϵ – NTU approach and design procedure, compact heat exchangers.

UNIT V

9hrs

Mass Transfer, Vaporization of droplets, combined heat and mass transfer, Heat Transfer Correlations in various applications like I.C. Engines, Compressors & turbines.

Tutorials

- 15hrs

Total Hours - 60hrs

REFERENCES

1. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 1996.
2. Ozisik. M.N., Heat Transfer – Basic Approach, McGraw-Hill Co., 1985
3. Schlichting, Gersten, Boundarylayer Theory, Springer, 2000
4. P.K. Nag, Heat Transfer, Tata McGraw-Hill, 2002
5. Rohsenow. W.M., Harnett. J.P., and Ganic. E.N., Handbook of Heat Transfer Applications, McGraw-Hill, NY1985
6. [Anthony F. Mills](#), Basic Heat and Mass Transfer, Irwin Publishers

07TE103 MEASUREMENTS AND CONTROL
(Syllabus common to ME - Thermal Engg., Energy Engg., R&AC, IC Engg.,)

L T P M
3 0 0 100

UNIT I

12hrs

Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments Reliability of instruments.

UNIT II

5hrs

Data logging and acquisition, use of intelligent instrument for error reduction, elements of micro-computer interfacing, intelligent instruments in use.

UNIT III

10hrs

Measurement of thermo-physical properties, instruments for measuring temperature pressure and flow, use of intelligent instruments for the physical variables. Chemical. Thermal, magnetic and optical gas analysers, measurement of smoke, dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

UNIT IV

8hrs

Techniques, shadow graph, Schlieren, interferometer, Laser Doppler anemometer, heat flux measurement, Telemetry in engines.

UNIT V

10hrs

Digital Transducers – Interface system and Standards – Computer automated measurements and controls (CAMAC) standards – IEEE 488 standard interface – Remote monitoring and control of boiler houses – D-DAC (Distributed Data acquisition and Control Systems) – Microprocessor based temperature control system – Introduction to Microcontrollers – Process control system – Pneumatic control systems.

Total Hours - 45hrs

REFERENCES

1. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1958.
2. Barney, Intelligent Instrumentation, Prentice Hall of India, 1988.
3. Prebrashensky. V., Measurement and Instrumentation in Heat Engineering, Vol.1 and 2 MIR Publishers, 1980.
4. Raman, C.S. Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems, Tata McGraw-Hill, New Delhi, 1983.
5. Doebelin, Measurement System Application and Design, McGraw-Hill, 1978.
6. Morris. A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 1998.
7. George C barney, Intelligent Instrumentation Microprocessor and Applications in Measurements and Control, Prentice Hall, New Delhi, 1995.

07TE104 ADVANCED THERMODYNAMICS

*(Use of approved charts and Data Book permitted)
(Syllabus common to ME - Thermal Engg., and R&AC)*

L T P M
3 1 0 100

UNIT I

10hrs

Availability, Irreversibility and Second-Law Efficiency for a closed System and steady-state Control Volume. Availability Analysis of Simple Cycles. Thermodynamic Potentials, Maxwell relations, Generalised relation for changes in Entropy, Internal Energy and Enthalpy, Generalised Relations for Cp and Cv Clausius Claypeyron Equation, Joule-Thomson Coefficient, Bridgman Tables for thermodynamic relations.

UNIT II

10hrs

Different Equations of State, Fugacity, Compressibility, Principle of Corresponding States, Use of generalized charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition, partial molar prosperities, Real gas mixtures, Ideal solution of real gases and liquids, Equilibrium in multi phase systems, Gibbs phase rule for non-reactive components.

UNIT III

10hrs

Thermo chemistry, first Law analysis of reacting systems, Adiabatic Flame temperature, Entropy change of reacting systems, Second Law analysis of reacting systems, Criterion for reaction equilibrium composition.

UNIT IV

8hrs

Microstates and Macrostates, Thermodynamic probability, Degeneracy of energy levels, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein Statistics, Microscopic Interpretation of heat and work, Evaluation of entropy, Partition function, Calculation of the Microscopic properties from partition functions. Collision Theory and Transport properties.

UNIT V

7hrs

Conjugate Fluxes and Forces, Entropy Production, Onsager's Reciprocity relations, thermo-electric phenomena and formulations. Thermodynamics of High-Gas flow.

Tutorials

- 15hrs

Total Hours - 60hrs

REFERENCES

- 1.Kenneth Wark Jr., Advanced Thermodynamics for Engineers, McGraw-Hill Inc., 2001..
- 2.Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 1998.
- 3.Holman, J.P., Thermodynamics, Fourth Ediction, McGraw-Hill Inc., 1998.
- 4.Smith, J.M and Van Ness., H.C., Introduction to chemical Engineering Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1987.
- 5.Sonntag, R.E., and Vann Wylen, G, Introduction to Thermodynamics, Classical and Statistical, third Edition, John Wiley and Sons, 1991.
- 6.Sears, F.W. and Salinger G.I., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, third Edition, Narosa Publishing House, New Delhi, 1993.

7. DeHoff, R.T. Thermodynamics in Materials Science, McGraw-Hill Inc., 1993.
8. Rao, Y.V.C., Postulational and Statistical thermodynamics, Allied Publisher Limited, New Delhi, 1994.

07TE105 FUELS AND COMBUSTION

L T P M
3 0 0 100

UNIT I

8hrs

Fuels-Types And Characteristics Of Fuels-Determination Of Properties Of Fuels-Fuels Analysis-Proximate And Ultimate Analysis-Moisture Determination-Calorific Value-Gross & Net Calorific Values – Calorimetry - Dulong's Formula For Cv Estimation-Flue Gas Analysis –Orsat Apparatus-Fuel & Ash Storage & Handling – Spontaneous Ignition Temperatures.

UNIT II

10hrs

Solid fuels Types – Coal Family – Properties – Calorific Values – ROM, DMMF, DAG AND Bone Dry Basis – Ranking – Bulk & Apparent Density – Storage – Washability – Coking & Caking Coals – Renewable Solid Fuels – Biomass – Wood Waste – Agro Fuels – Manufactured Solid Fuels. Liquid Fuels Types – Sources – Petroleum Fractions-Classification – Refining – Properties Of Liquid Fuels – Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number Etc, - Alcohols – Tar Sand Oil – Liquefaction Of Solid Fuels.

UNIT III

7hrs

Classification – Composition & Properties – Estimation Of Calorific Value – Gas Calorimeter. Rich & Lean Gas – Wobbe Index – Natural Gas – Dry & Wet Natural Gas Stripped NG – Foul & Sweet NG – LPG – CNG – Methane – Producer Gas Gasifiers Water Gas – Town Gas – Coal Gasification – Gasification Efficiency – Non – Thermal Route – Biogas – Digesters – Reactions – Viability – Economics.

UNIT IV

12hrs

Stoichiometry – Mass Basis & Volume Basis – Excess Air Calculation – Fuel & Flue Gas Compositions – Calculations – Rapid Methods – Combustion Processes – Stationary Flame Combustion Explosive Combustion. Mechanism Of Combustion – Ignition & Ignition Energy – Spontaneous Combustion- Flame Propagation – Solid, Liquid & Gaseous Fuels Combustion – Flame Temperature – Theoretical, Adiabatic & Actual – Ignition Limits – Limits Of Inflammability.

UNIT V

8hrs

Coal Burning Equipments – Types – Pulverized Coal Firing – Fluidized Bed Firing – Fixed Bed & Recycled Bed – Cyclone Firing – Spreader Stokers – Vibrating Grate Stokers Sprinkler Stokers, Traveling Grate Stokers. Oil Burners – Vaporizing Burners – Air Aspiration Gas Burners – Burners Classification According To Flame Structures – Factors Affecting Burners & Combustion.

Total Hours - 45hrs

REFERENCES

- 1.Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Logman,latest Edition
- 2.Bhatt,Vora Stoichiometry,2nd Edition, tata Mcgraw Hill, 1984
- 3.Blokh AG, Heat Transfer in Steam Boiler Furance, Hemisphere Publishing Corpn,1988
- 4.Civil Davies, Calculations in Furance Technology, Pergamon Press,Oxford,1966
- 5.Sharma SP,Mohan Chander,Fuels & Combustion, Tata Mcgraw Hill,1984

07TE106 THERMAL ENGINEERING LABORATORY

L T P M
0 0 3 100

Experiments:

1. Performance test on Spark Ignition engines.
2. Emission measurement in Spark Ignition and Compression Ignition Engines.
3. Performance study in a cooling tower
4. Performance study in a refrigeration and heat pump systems
5. Performance study in a solar water heater
6. Properties of fuel oils.
7. Solar radiation measurement
8. Boiler efficiency testing
9. Performance of Heat Exchangers
10. Study on Fuel Cell Systems
11. Study on Thermal Storage Systems

Equipments Required:

1. Multicylinder Automotive Engine
2. CO/HC/NO_x Analysers
3. Smoke meter
4. Cooling tower test rig
5. Refrigeration cum Heat Pump test rig
6. Solar flat plate water heater test rig
7. Instruments for measuring solid / liquid / gas fuels properties
8. Solar Radiation measuring instruments
9. Non-IBR Boiler test rig
10. Heat exchanger test rig.

07TE201 ADVANCED FLUID MECHANICS
(Syllabus common to ME - Thermal Engg., R&AC)

L T P M
3 1 0 100

UNIT I

9hrs

Ideal and non-ideal flows, continuum view point and general equations of fluid motion, Newtonian fluids, Navier - stokes equations and their exact solutions. Boundary layer theory, wedge flows, laminar flow over plates and through cylinders.

UNIT II

9hrs

Two dimensional flow – subsonic flow, physical significance of irrotational motion – Kelvin’s theorem – Differential equation in terms of velocity Potential and stream function – Flow with small perturbation – flow past a wave shaped wall – Gothert’s rule – Prandtl Glanert rule – Hodograph method

UNIT III

9hrs

Turbulence, models, and flow equations: steady and unsteady turbulent boundary layers

UNIT IV

9hrs

Introduction to compressible viscous flow, governing equations, flow with friction – Fanno flow, flow with heat transfer- Rayleigh flow, flow through nozzle and diffusers .

UNIT V

9hrs

Normal and oblique shocks – Prandtl – Meyer expansion – Rankine – Hugoniot relation, Application of method of characteristics applied to two dimensional cases – simple supersonic wind tunnel -Design of supersonic wind tunnel and nozzle

Tutorials

- 15hrs

Total Hours - 60hrs

REFERENCES

- 1.T Radhakrishnan Gas Dynamics Prentice Hall, New Delhi
- 2.Mohanty A K Fluid Mechanics, Prentice Hall of India, 1986
- 3.Shapiro A F The Dynamics of Compressible flow Vd 1, The Ronald Press Company 1963
- 4.Shames, Mechanics of Fluids, MC grow Hill 1962 Book Company 1962
- 5.Schlichting H Boundary layer theory MC Grow Hill Book company 1979
- 6.S M Yahya, Compressible Fluid Flow

07TE202 COMPUTATIONAL FLUID DYNAMICS
(Syllabus common to ME - Thermal Engg., Energy Engg., R&AC, IC Engg.,)

L T P M
3 1 0 100

UNIT I

9hrs

Continuum hypothesis, Lagrangian and Eulerian formulation, Governing equations-continuity equation, momentum equation, energy equation, boundary conditions-classification, initial and boundary value problems-Finite difference schemes-forward, central and backward difference, basics of Finite volume schemes, Implicit and explicit approaches.

UNIT II

9hrs

FDM for Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems, Finite Volume formulation for 1D heat transfer. Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT III

9hrs

Governing Equations, Stream Function – Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach, Unstructured Grids for Viscous Flows.

UNIT IV

9hrs

Steady One-Dimensional and Two-Dimensional Convection – Diffusion, Unsteady one-dimensional convection – Diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – Solution of steady one dimensional heat conduction by FEM – Incompressible flow – Simulation by FEM.

UNIT V

9hrs

Turbulence, Effect of Turbulence and time averaged Navier Stokes Equation, Algebraic Models – One equation model, $k - \epsilon$ Models, k - ω model, Algebraic stress model, Reynolds stress equation model, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

Tutorials

- 15hrs

Total Hours - 60hrs

REFERENCES

- 1.Muralidhar, K., and 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.Subas, V.Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing corporation 1980.
- 4.Taylor, C and Hughes, J.B. “Finite Element Programming of the Navier Stock Equation”, Pineridge Press Limited, U.K

5. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer" Hemisphere Publishing Corporation, Newyork, USA,.
6. Fletcher, C.A.J. Computational Techniques for Fluid Dynamics 1(Fundamental and General Techniques), Springer – Verlag,
7. Bose, T.X., Numerical Fluid Dynamics, Narosa Publishing House, 1997.
8. H.K. Versteeg and W. Malalasekara, An Introduction to CFD, The Finite Volume Method, Addition Wesley Longman ltd.

07TE203 DESIGN OF THERMAL POWER EQUIPMENTS

L T P M
3 1 0 100

UNIT I

9hrs

Heat transfer in furnaces – Furnace heat balance – Design of furnaces – Blast furnace – Electric furnace – Fluidized bed combustion furnace. Circulation – Positive and Natural circulation – Circulation ratio.

UNIT II

9hrs

Types of Condensers – Design of condensers – Surface area calculation – Air leakage and its effects – Methods of removal of air leakage – condenser water cooling systems – Air pump – Wet and Dry capacity and dimensions of air pumps.

UNIT III

9hrs

Types of Super heaters – Location – Performance – Radiation and Convection Characteristics – Design of super heater – Super heater temperature control. Types of Evaporators – Details of submerged types of evaporator – Single effect and Double effect evaporators – Steam requirements.

UNIT IV

9hrs

Advantages – Disadvantages – Recuperative and Regenerative air preheaters –Design Considerations – High temperature and Low temperature limitations. Power required for draught fan – Pressure losses – Diameter and Height of the Chimney – Chimney design.

UNIT V

9hrs

Mechanical carry over – Silica carry over – Gravity separator – Typical separate economizer arrangement – Design of an economizer suitable for a power plant.

Tutorials

- 15hrs

Total Hours - 60hrs

REFERENCNS

1. Arora S.C. and Domkundwar, S, Power Plant Engineering, Dhanpat Rai & Co., New Delhi, 2002.
2. Vopat and Skrotzhi, Power Plant Engineering, Tata McGraw Hill Book Co., New Delhi, 1972.
3. Oliver Lyle, the efficient use of steam, Her Majesty's Stationery Office, London, 1962.
4. Potter, Power Plant Theory and Design, the Ronald Press Co., New Delhi, 1972.

07TE204 THERMAL TURBO MACHINES

L T P M
3 1 0 100

UNIT I

7hrs

Introduction to Turbo machines, Principles of operation, Energy transfer in turbo machines, Classification of turbo machines, Losses and efficiencies – performance characteristics

UNIT II

9hrs

Review of flow through nozzle and diffuser – flow over immersed bodies – flat plate, sphere and air foil – pressure distribution over a symmetrical and inclined air foil – blade technology, blade cascades and nomenclature – lift and drag coefficients – elementary concept of three dimensional flow – free and forced vortex

UNIT III

10hrs

Steam turbines, types – impulse turbine – compounding of impulse turbines – Velocity triangles – reaction turbines – Velocity diagrams – degree of reaction – governing of turbines – Gas turbine classification – Cycle analysis – simple cycle – improvements – effect of operating variables on thermal efficiency – application of gas turbine.

UNIT IV

10hrs

Axial flow fans – construction and operation – types of stages – performance of fans – applications - Centrifugal fans – Construction and operation – types – fan stage parameters – drum type and partial flow fans – losses .

UNIT V

10hrs

Axial flow Compressor – Construction and operating principles – Stage Velocity triangles – Enthalpy Entropy diagram – stage losses and efficiency – Work done factor – Performance Characteristics. Centrifugal Compressors – Construction and operation principle. – Stage Velocity triangles – Enthalpy Entropy diagram – stage losses and efficiency – Slip factor – Performance Characteristics.

Tutorials

- 15hrs

Total Hours - 60hrs

REFERENCES

1. Turbines Compressors and Fans – S.M.Yahya – Tata McGraw-Hill company 2002
2. Principles of Turbo machines by – D.G.Shephard Macmillan company 1984
3. Gas Turbine Theory – Cohen Rogers, Saravana Muttoo, Long man Publishing 2004
4. Steam Turbine - Theory and Practice – William J. Kerten, CBS Publishing 1988

07TE205 COMPUTATIONAL FLUID DYNAMICS LABORATORY

L T P M
0 0 0 100

Softwares: Fluent /Star CD/ ANSYS/CFX / user defined codes.

1. Steady State Conduction in Solid
2. Steady State Convection in Solid
3. Steady State Radiation in Solid
4. Combined conduction and convection
5. Unsteady state conduction and convection
6. Unsteady state conduction and radiation
7. Steady state conduction in Fluids
8. Steady state convection in Fluids
9. Two-phase flows
10. Condensation and boiling heat transfer

07TE001 GAS TURBINE

(Syllabus common to ME- Thermal Engg., IC Engines and Energy Engg.,)

L T P M

3 0 0 100

UNIT I

9hrs

Cycle arrangements – open and closed cycle – working media – application. Ideal cycles and their analysis – simple cycle – heat exchange cycle – reheat cycle – intercooled cycle – combination of cycles – comparison of various cycles – Ericsson cycle. Practical cycles and their analysis – compressor and turbine efficiency – pressure losses – cycle efficiency – polytrophic efficiency – performance of practical cycle.

UNIT II

9hrs

Centrifugal compressors – essential parts – principle of operation – blade shapes and velocity triangles – flow through compressor – inlet casings – inducer – impeller – effect of blade shape on performance – slip factor – diffuser – volute casings – losses in centrifugal compressors – compressor characteristics. Axial flow compressors – geometry and working principle – Stage velocity triangles – work input – work done factor – compressor stage efficiency – performance coefficients – degree of reaction – flow through blade rows – flow and stage losses – performance characteristics.

UNIT III

9hrs

Impulse and reaction turbines – single impulse and reaction stage – multistage – velocity triangles – work output – blade loading and flow coefficients – blade and stage efficiencies- velocity, pressure compounding of multistage impulse turbines – The reaction turbine – multistage reaction turbine – degree of reaction – Zero, fifty and hundred percent reaction stage – blade to gas speed ratio – losses and efficiencies – performance characteristics.

UNIT IV

9hrs

Combustion system – factors affecting combustion chamber design and performance – pressure losses – combustion intensity – combustion efficiency – requirements of combustor – process of combustion – combustor geometry – combustor arrangements – fuel injection – ignition. Inlet and nozzles – subsonic inlets – diffusers – supersonic inlet – exhaust nozzles – engine back pressure control – thrust reversing and thrust vectoring – nozzle coefficients – nozzle performance - Blade – blade materials – manufacturing technique – blade fixing – blade cooling – fabricated designs.

UNIT V

9hrs

Component matching and performance evaluation – performance characteristics – equilibrium running diagram – performance evaluation of single spool turbojet engine – general matching procedure – transient operation. - Typical applications of gas turbines – small gas turbine applications – electric power generation applications – Marine application – locomotive applications – Automotive applications – Aircraft applications – Process applications – Additional features of gas turbine engines – Trends in future development.

Total Hours - 45hrs

REFERENCES

1. “Gas turbines” – Second edition by V.Ganesan, Tara McGraw hill, New Delhi 1999.
2. “Fundamentals of Gas turbines” – Second edition by William W. Bathe John Wiley 1996.
3. “Elements of gas turbine propulsion” by Jack D. Mattingly McGraw hill Inc – 1996.
4. “Gas turbine theory” by Cohen H, Rogers G and Saravanamuthu H, John Wiley & sons,– 2005.

07TE002 ADVANCED INTERNAL COMBUSTION ENGINES

L T P M
3 0 0 100

UNIT I

9hrs

Spark Ignition Engines, mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – factors affecting knock – Combustion chambers.

UNIT II

9hrs

Compression ignition engines, Stages of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behaviour – spray structure, spray penetration and evaporation – air motion – Introduction to Turbo charging and supercharging.

UNIT III

9hrs

Combustion modeling, Basic concepts of engine simulation, governing equations, simulation of various engine processes for SI and CI Engines. Thermodynamic and fluid mechanic based models.

UNIT IV

9hrs

Alternative fuels, Alcohol, Hydrogen, Natural Gas Bio diesel, fuel cell. Other possible fuels and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications. Dual fuel operation

UNIT V

9hrs

Recent trends, Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Zero Emission Vehicles, Engines for special applications – Mining, Defence, Off-highway -Tractor, Bulldozer etc. Submarines, Race car Engine systems, Flexible fuel systems. Surface ignition,

Total Hours - 45hrs

REFERENCES

- 1 K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2002.
- 2 John B Heywood, Internal Combustion Engine Fundamentals, McGraw Hill
- 3 M.L. Mathur and R.P.Sharma, A course in internal Combustion Engines, Dhanapat Rai Publications, New Delhi.
- 4 R.B.Mathur and R.P. Sharma, Internal combustion Engines.
- 5 V. Ganesan, Int. Combustion Engines, II Edition, TMH, 2002.
- 6 Duffy Smith, Auto fuel Systems, The Good Heart Willox Company, Inc.
- 7 Ganesan V. Computer simulation of spark ignition process: University process. Hyderabad 1993.
- 8 Ganesan V. Computer simulation of compression ignition engine. Orient Long man 2000.

07TE003 NUMERICAL METHODS IN HEAT TRANSFER AND FLUID FLOW

L T P M
3 0 0 100

UNIT I

9hrs

Overview of numerical methods – Finite Element Methods, Finite Difference Methods, Finite Volume Methods in heat transfer and Fluid Flow. Discretised representation of physical systems - thermal resistance, flow resistance networks, thermal capacitance - Governing equations and Boundary conditions for thermal and flow systems

UNIT II

9hrs

FEM in one dimensional heat conduction, Principles of variations calculus - applications of variational approach to one dimensional heat conduction - element matrix contribution and assembly.

UNIT III

9hrs

Heat functions and analysis, Weighted residual methods - Galerkin's approach - Shape functions and interpolations - Application of Galerkin's weighted residual approach to one dimensional heat conduction - Three noded triangular elements, 2 D steady state state conduction using triangular elements - Radiation and natural convective boundary conditions.

UNIT IV

9hrs

Convective heat transfer, Higher order elements and numerical integration solution of heat conduction and creeping flow using higher order element - Solution of convective heat transfer.

UNIT V

9hrs

FEM and FDM in flow problems, Incompressible laminar flow simulation - Stream function / Vorticity methods, Velocity Pressure formulation, mixed order interpolation for incompressible flow, modifications for turbulent flow.

Total Hours - 45hrs

SOFTWARE CODES

Description of programs for heat conduction, fluid flow, Assignment problems using these codes.

REFERENCES

1. S.S.Rao Pergamon ,The Finite Element Method in Engg., 2nd ed, Pergamon Press,
2. Larry Segerlind, Applied Finite Element Analysis, 2nd ed John Wiley & Sons, 1988.
3. J.N.Reddy ,Finite Elements Methods, , McGraw-Hill 1988.
4. Daryl L. Logan, A First Course in the Finite Element Method, Thomsen Education
5. Comini, Gianni, Nonino, Car, Finite Element Analysis in Heat Transfer: Basic Formulation and Linear Problems, Taylor & Francis
6. Ghoshdasdidar, P.S., “Computer Simulation of flow and heat transfer” Tata McGraw-Hill Publishing Company Ltd., 1998.

07TE004 CRYOGENIC ENGINEERING

(Syllabus common to ME – R & AC, Energy and Thermal Engineering)

L T P M
3 0 0 100

UNIT I

8hrs

Introduction to Cryogenic systems- Present areas involving Cryogenic Engineering, Low temperature properties of materials- Mechanical properties, Thermal properties, Electrical and Magnetic Properties, Properties of Cryogenic Fluids.

UNIT II

10hrs

Liquefaction Systems - Production of Low temperatures- Joule Thomson effect, adiabatic expansion, Liquefaction systems for gasses other than neon, Hydrogen and Helium and for hydrogen neon and helium, Comparison of Liquefaction systems, Critical components involved in Liquefaction systems.

UNIT III

11hrs

Separation and Purification systems - Properties of mixtures - characteristics- Temperature composition diagrams- Enthalpy Composition diagrams, Enthalpy Composition diagrams, Principles of gas separation-Rectification principles-Flash calculations-Theoretical plate Calculations for columns-Minimum number of theoretical plates-Rectification column types. Air Separation systems, Hydrogen Separation, Helium Separation and Gas Purification systems.

UNIT IV

8hrs

Cryogenic Refrigeration Systems- Ideal Refrigeration systems - Joule Thomson Refrigeration systems, Philips refrigerator, Solvay refrigerator, Mac Mohan Refrigerator, Regenerator. Refrigerators above 2K and below 2K. Magnetic cooling, Thermodynamics of Magnetic cooling, Magnetic moment and Entropy of Paramagnetic materials, Magnetic refrigeration systems, thermal valves, Dilution refrigerators.

UNIT V

8hrs

Instrumentation, measurement systems – Temperature, Pressure, Flow rate, Fluid quality, Liquid level measurement systems. Cryogenic fluid storage systems - Cryogenic transfer systems - Cryogenic insulation, Radiation shield, Vacuum technology - Applications of cryogenics in various fields.

Total Hours - 45hrs

REFERENCES

1. Arkharov and others – Theory and design of cryogenic systems. MIR Publishers, 1981.
2. Randall F. Barron – Cryogenic systems. Oxford University Press 1985.
3. Marshall Sitting – Cryogenic research and application.
4. Scott R.B. – Cryogenic Engineering. Van Nostrand, 1959.
5. Richard J. Allen - **Cryogenics**, University of London Press.

07TE005 REFRIGERATION SYSTEM DESIGN

L T P M
3 0 0 100

UNIT I

10hrs

1. Refrigeration Cycles, Unconventional Refrigeration Cycles

Carnot cycle, Air refrigeration cycles, Comparison of Vapor compression cycle with Carnot cycle, Multipressure systems, Cascade systems, Vapor Absorption systems – Aqua Ammonia System & LiBr system, Steam Jet refrigeration, Thermoelectric Refrigeration.

UNIT II

9hrs

2. System components and Selection

Compressors, Condensers-Evaporators-Types and Performance, Expansion devices-types and their selection Refrigerants Classification of Refrigerants, Refrigerant properties, Oil compatibility, Environmental Impact- ODP, GWP, Montreal/Kyoto protocols-cofriendly Refrigerants

UNIT III

8hrs

3. System Balancing and Controls

System Equilibrium, Balancing and matching of components and cycling controls, Electric circuits in – Refrigerators, Window A/C, Packaged Air Conditioners, Types of Motors, Relays, Different types of Refrigerant tools, Evacuation and Charging unit, Recovery and Recycling unit, Vacuum pumps

UNIT IV

10hrs

4. Cooling and Heating load Calculations

Selection of design temperatures, sources of load, capacity of refrigeration systems, cooling load calculation, Apparatus Selection, Design of Vapor compression system, Duct design, Methods of Duct design.

UNIT V

8hrs

5. Applications

Food Preservation, food spoilage, Methods of Freezing, Cold Storage-Economic Consideration, Refrigerators and freezers, Ice Cream Manufacture, Water Coolers, Liquefaction, Heat pump, Metal Manufacture and Cold treatment, Premature Baby Clinic, Breweries, Fishery Products, Photographic Processing.

Total Hours - 45hrs

REFERENCES

1. Dossat R.J., Principles of Refrigeration, John Wiley, S.I. Version (1989)
2. W.F. Stoecker, Refrigeration and Air Conditioning, McGraw-Hill Book Company, 1989
3. Jordan and Priester, Refrigeration and Air conditioning, 1985
4. Goshnay W.B., Principles and Refrigeration, Cambridge, University Press, 1982.
5. Langely, Billy C., 'Solid state electronic controls for HVACR' Prentice- Hall 1989

07TE006 NUCLEAR POWER PLANT

L T P M
3 0 0 100

UNIT I

7hrs

NUCLEAR PHYSICS

Review of Nuclear Physics – Nuclear equations – Energy from nuclear reactions – Fission and Fusion – Thermal Neutrons – Nuclear cross sections.

UNIT II

8hrs

NEUTRON LIFE CYCLE AND REACTIVITY

Neutron flux distribution in cores – Slowing down of Neutrons – Neutron life cycle – Thermal reaction equations – buckling factors – Reactivity and reactor period – Void and Pressure coefficients of reactivity.

UNIT III

10hrs

HEAT TRANSFER IN REACTORS

Reactor heat generations and removal – Volumetric thermal source strength – Heat flow in and out of solid fuel elements – Axial temperature distribution of coolant and fuel element – Coolant chemical orificing – Hot spot factors – Absorption of core radiation. Heat removal in slabs subjected to radiation – Thermal Shields – Quality and void fractions in non-flow and flow systems – Boiling reactor hydraulics.

UNIT IV

10hrs

NUCLEAR REACTORS

Boiling water reactors – Controlled recirculation fluidized bed reactors – Gas cooled reactors – Radioactivity of gas coolants – Analysis of gas cycle – Steam cycle – Simple and dual pressure cycle – Pebble bed reactors. Liquid metal cooled reactors – Compatibility with materials – Fast reactors – Fluid fuel reactors – types – Corrosion and Erosion characteristics,

UNIT V

10hrs

RADIOACTIVE WASTE MANAGEMENT AND NUCLEAR SAFETY

High, intermediate and low level wastes – Disposal – Return of wastes – liquid discharge – Aerial discharge. Introduction about radiation – Radiation effects and dose limits – Nuclear accidents – Ensuring nuclear safety.

Total Hours - 45hrs

REFERENCES

1. El-Wakil M.M., Nuclear Power Engineering, McGraw Hill Co., New York, 2000
2. Loftness, Nuclear Power Plants
3. P. K. Nag, Power Plant Engineering, Tata Mcgraw Hill Book Co., New Delhi, 2005..

07TE007 ADVANCED POWER PLANT ENGINEERING

(Use of Steam Tables and Thermodynamics Tables are Permitted)

L T P M
3 0 0 100

UNIT I

8hrs

1. INTRODUCTION

Energy reserves and Energy utilization the world– Electrical Power Generation & Consumption in India. Types of Power Plants Merits and Demerits – Criteria for Selection of Power Plants.

UNIT II

10hrs

2. STEAM POWER PLANT

Layout – Super Heaters, Reheaters, Condensers Economizers and Feed Water heaters -Operation and performance – Rankine cycle with Super Heat, Reheat and Regeneration – Fluidized Bed combustion boiler – Advantages – waste heat Recovery boilers – Co – generation Power Plant - Emissions and their controls.

UNIT III

10hrs

3. NUCLEAR POWER PLANT

10

Overview of Nuclear Power Plant – Nuclear physics Radio activity – fission process Reaction Rates – diffusion theory – Critical heat flux –Nuclear Power Reactors– different types – advantages and limitations – Materials used for Reactors. Hazards in Nuclear Power Plant – Remedial Measures - Safety precautions – Methods of Waste disposal Different form of Waste from Power Plant.

UNIT IV

9hrs

4. GAS TURBINE AND MHD POWER PLANT

Layout of Gas Turbine - Basic Gas turbine cycle – cycle improvements – Intercoolers, Reheaters and regenerators, Thermodynamic analysis of Gas turbine –Operations and performance of Gas Turbine Layout of MHD Power Plant – Principles of Working – Function and Importants of Individual Component - salient features.

UNIT V

8hrs

5.COMBINED CYCLE POWER PLANT:-

Binary vapour cycles – Coupled cycles – Combined Power cycle Plants – Advantages and Limitations, Gas turbine – Steam turbine Power Plant And MHD – Steam Power Plant.

Total Hours - 45hrs

REFERENCES

1. Power Plant Engineering – by P, K, Nag – Mc Graw – Hill
2. Power Plant Engineering Technology – M.M. Wakil – Mc Graw - Hill
3. Steam Plant operation – by Everett B. Woodruff Lammers, Thomas F. Lammers – McGraw – Hill
4. Standard Hand Book of Power Plant Engineering – by Thomas C. Elliott, Kao Chen and Robert C.Swamekamp – Mc Graw - Hill

07TE008 ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

L T P M
3 0 0 100

UNIT I

9hrs

INTRODUCTION

Global atmospheric change – Green house gases and effect –Global warming–Ozone Depletion –Acid rain, Natural Cycles - Mass and Energy Transfer – Material balance – Environmental chemistry and biology – Impacts – Environmental legislations.

UNIT II

9hrs

AIR POLLUTION

Pollutants - Sources and Effect – Air Pollution meteorology - natural purification process -Diffusion Theories – Modeling- dispersion and plume raise and numerical problems - Air sampling and measurement - Control Methods and Equipments - Issues in Air Pollution control

UNIT III

9hrs

WATER POLLUTION

Water resources - Water Pollutants – Composition, Characteristics and analysis of waste water, Advanced Wastewater treatment - unit operation- physical, chemical, biological, Disposal of Sludge - Monitoring compliance with Standards

UNIT IV

9hrs

WASTE MANAGEMENT

Sources and Classification – Solid waste – Hazardous waste - Characteristics, Collection and Transportation - Disposal – Reuse and recycling - Biogas and Energy Recovery Processes– Waste minimization

UNIT V

9hrs

POLLUTION FROM INDUSTRIES AND INSTRUMENTATION

Noise Pollution and its impact - Oil Pollution - Pesticides - Instrumentation for EIA test - Instrumentation related with parameter of pollutants, – Environment Impact assessment for various projects – Case studies

Total Hours - 45hrs

REFERENCES

- 1.G.Masters (2003): Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi.
- 2.H.S.Peavy, D.R..Rowe, G.Tchobanoglous (1985): Environmental Engineering - McGraw- Hill BookCompany, NewYork.
- 3.H.Ludwig, W.Evans (1991): Manual of Environmental Technology in Developing Countries, . International Book Company, Absecon Highlands, N.J.
- 4.Arcadio P Sincero and G. A. Sincero, (2002): Environmental Engineering – A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi.

07TE009 RENEWABLE ENERGY SYSTEM

L T P M
3 0 0 100

UNIT I

7hrs

INTRODUCTION

World energy use – Reserves of energy resources – Environmental aspects of energy utilisation – Renewable energy scenario in India – Potentials – Achievements – Applications.

UNIT II

10hrs

SOLAR ENERGY

Solar thermal – Flat plate and concentrating collectors – Solar heating and cooling techniques – Solar desalination – Solar Pond – Solar cooker – Solar thermal power plant – Solar photo voltaic conversion – Solar cells – PV applications.

UNIT III

8hrs

WIND ENERGY

Wind data and energy estimation – Types of wind energy systems – Performance – Details of wind turbine generator – Safety and Environmental Aspects.

UNIT IV

8hrs

BIOMASS ENERGY

Biomass direct combustion – Biomass gasifier – Biogas plant – Ethanol production – Bio diesel – Cogeneration – Biomass applications.

UNIT V

12hrs

OTHER RENEWABLE ENERGY SOURCES

Tidal energy – Wave energy – Open and closed OTEC Cycles – Small hydro – Geothermal energy – Fuel cell systems.

Total Hours - 45hrs

REFERENCE

- 1.G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.
- 2.S.P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Ltd., NewDelhi, 1997.
- 3.Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.
- 4.Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 1986.
- 5.G.N. Tiwari, Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002.
- 6.L.L. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990.
- 7.Johnson Gary, L., Wind Energy Systems, Prentice Hall, New York, 1985

07TE010 COGENERATION AND WASTE HEAT RECOVERY SYSTEMS

(Syllabus common to ME- Thermal, IC Engg., and Energy Engg.,)

L T P M
3 0 0 100

UNIT I

9hrs

INTRODUCTION

Introduction - Principles of Thermodynamics - Cycles-Topping -Bottoming – combined cycle - Organic Rankine Cycles – Performance indices of cogeneration systems – waste heat recovery – sources and types – Concept of trigeneration

UNIT II

9hrs

COGENERATION TECHNOLOGIES

Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – Advanced cogeneration systems: fuel cell, Stirling Engines

UNIT III

9hrs

ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES

Cogeneration plants electrical interconnection issues – Utility and cogeneration plant interconnection issues – Applications of Cogeneration in utility sector – Industrial sector – building sector – rural sector – Impacts of cogeneration plants – fuel, electricity and environment

UNIT IV

9hrs

WASTE HEAT RECOVERY SYSTEMS

Selection criteria for waste heat recovery technologies - Recuperators - Regenerators - Plate Heat Exchangers - thermic fluid heaters- Waste Heat Boilers- classification, Location, Service Conditions, Design Considerations - heat pipe exchangers - heat pumps –sorption systems

UNIT V

9hrs

ECONOMIC ANALYSIS

Economic analysis for cogeneration and waste heat recovery systems-Investment cost – economic concepts – measures of economic performance – procedure for economic analysis – examples – procedure for optimized system selection and design – load curves - sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems

Total Hours - 45hrs

REFERENCE

- 1.EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001
- 2.Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987
- 3.Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
- 4.Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
5. Sengupta Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
- 6.De Nevers, Noel., Air Pollution Control Engineering, McGrawHill, New York,1995
- 7.www.cogeneration.net
- 8.www.energ.co.uk
- 9 www.cogenindia.org

07TE011 REFRIGERATION MACHINERY AND COMPONENTS

L T P M

3 0 0 100

UNIT I

9hrs

REFRIGERANT COMPRESSORS

Hermetic compressors - Reciprocating, Rotary, Scroll Compressors, Open type compressors - Reciprocating, Centrifugal, Screw Compressors. Semi hermetic compressors - Construction, working and Energy Efficiency aspects. Applications of each type.

UNIT II

10hrs

DESIGN OF CONDENSERS

Estimation of heat transfer coefficient, Fouling factor, Friction factor. Design procedures, Wilson plots, Designing different types of condensers, BIS Standards, Optimisation studies.

UNIT III

10hrs

DESIGN OF EVAPORATORS

Different types of evaporators, Design procedure, Selection procedure, Thermal Stress calculations, Matching of components, Design of evaporative condensers.

UNIT IV

9hrs

REFRIGERATION SYSTEM COMPONENTS

Evaporators and condensers - Different types, capacity control, circuitry, Oil return, Oil separators - Different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers, Air Washers, Spray ponds.

UNIT V

7hrs

SYSTEM ACCESSORIES AND CONTROLS

Refrigerant Pumps, Cooling Tower fans, Compressor Motor protection devices, Oil equalising in multiple evaporators. Different Defrosting and capacity control methods and their implications - Testing of Air conditioners, Refrigerators, Visicoolers, Cold rooms, Calorimetric tests.

Total Hours - 45hrs

REFERENCES

- 1) Chlumsky "Reciprocating & Rotary compressors", SNTL Publishers for Technical literature, 1965.
- 2) Hains, J.B, " automatic Control of Heating & Airconditioning" Mc Graw Hill, 1981.
- 3) Althose, A.D. & Turnquist, C.H. " Modern Refrigeration and Airconditioning" Good Heart - Wilcox Co. Inc., 1985.
- 4) Recent release of BIS Code for relevant testing practice.
- 5) ASHRAE Hand book : Equipments, 1998
- 6) Cooper &Williams, B. " Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting " Eagle Wood Cliffs (NT) Prentice Hall, 1989.
- 7) <http://www.chensources.com/ctowers22.shtml>
- 8) <http://www.fortunecity.com/campus/german/201/ctowers.html>
- 9) <http://www.aquasystemsinsc.com/metric-files.html>
- 10) <http://www.ori.org>
- 11) <http://confex.com/store/ashrae/index-features.html>