**VINAYAKA MISSIONS UNIVERSITY: SALEM**

**VINAYAKA MISSIONS KIRUPANANDA VARIYAR ENGINEERING COLLEGE,**

**SALEM & AARUPADAI VEEDU INSTITUTE OF TECHNOLOGY, CHENNAI**

**REGULATIONS - 2015**

**CURRICULUM AND SYLLABUS - FULL TIME**

# M.E. THERMAL ENGINEERING

**SEMESTER I**

| SL.NO | COURSE CODE | COURSE TITLE | DEPT | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | |
| 1 | | ADVANCED ENGINEERING MATHEMATICS | MATHS | 3 | 1 | 0 | 4 |
| 2 | | ADVANCED HEAT AND MASS TRANSFER | MECH | 3 | 0 | 0 | 3 |
| 3 | | MEASUREMENTS AND CONTROL | MECH | 3 | 1 | 0 | 4 |
| 4 | | ADVANCED THERMODYNAMICS | MECH | 3 | 0 | 0 | 3 |
| 5 | | FUELS AND COMBUSTION | MECH | 3 | 1 | 0 | 4 |
| 6 | | ELECTIVE – I | MECH | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | |
| 7 | | THERMAL ENGINEERING LABORATORY | MECH | 0 | 0 | 3 | **2** |
| **TOTAL** | | | | **18** | **3** | **3** | **23** |

**SEMESTER II**

| SL.NO | COURSE CODE | COURSE TITLE | DEPT | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | |
| 1 | | ADVANCED FLUID MECHANICS | MECH | 3 | 1 | 0 | 4 |
| 2 | | THERMAL TURBO MACHINES | MECH | 3 | 1 | 0 | 4 |
| 3 | | DESIGN OF THERMAL POWER EQUIPMENTS | MECH | 3 | 0 | 0 | 3 |
| 4 | | COMPUTATIONAL FLUID DYNAMICS | MECH | 3 | 1 | 0 | 4 |
| 5 | | ELECTIVE – II | MECH | 3 | 0 | 0 | 3 |
| 6 | | ELECTIVE - III | MECH | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | |
| 7 | | COMPUTATIONAL FLUID DYNAMICS LABORATORY | MECH | 0 | 0 | 3 | **2** |
| **TOTAL** | | | | **18** | **3** | **3** | **23** |

## SEMESTER III

| SL.NO | COURSE CODE | COURSE TITLE | DEPT | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | |
| 1 | | ELECTIVE- IV | MECH | 3 | 0 | 0 | 3 |
| 2 | | ELECTIVE –V | MECH | 3 | 0 | 0 | 3 |
| 3 | | ELECTIVE- VI | MECH | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | |
| 4 | | PROJECT PHASE- I | MECH | 0 | 0 | 12 | 6 |
| TOTAL | | | | 9 | 0 | 12 | **15** |

## SEMESTER IV

| SL.NO | COURSE CODE | COURSE TITLE | DEPT | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **PRACTICAL** | | | | | | | |
| 1 | | PROJECT PHASE- II | MECH | 0 | 0 | 24 | 12 |
| TOTAL | | | | **0** | **0** | **24** | **12** |

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 73**

## LIST OF ELECTIVES

| SL. No | COURSE CODE | COURSE TITLE | DEPT | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | | GAS TURBINE | MECH | 3 | 0 | 0 | 3 |
| 2 | | ADVANCED INTERNAL COMBUSTION ENGINES | MECH | 3 | 0 | 0 | 3 |
| 3 | | NUMERICAL METHODS IN HEAT TRANSFER AND FLUID FLOW | MECH | 3 | 0 | 0 | 3 |
| 4 | | CRYOGENIC ENGINEERING | MECH | 3 | 0 | 0 | 3 |
| 5 | | REFRIGERATION SYSTEM DESIGN | MECH | 3 | 0 | 0 | 3 |
| 6 | | NUCLEAR POWER PLANT | MECH | 3 | 0 | 0 | 3 |
| 7 | | ADVANCED POWER PLANT ENGINEERING | MECH | 3 | 0 | 0 | 3 |
| 8 | | ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL | MECH | 3 | 0 | 0 | 3 |
| 9 | | RENEWABLE ENERGY SYSTEM | MECH | 3 | 0 | 0 | 3 |
| 10 | | COGENERATION AND WASTE HEAT RECOVERY SYSTEM | MECH | 3 | 0 | 0 | 3 |
| 11 | | REFRIGERATION MACHINERY AND COMPONENTS | MECH | 3 | 0 | 0 | 3 |
| 12 | | FANS, BLOWERS & COMPRESSORS | MECH | 3 | 0 | 0 | 3 |
| 13 | | QUANTITATIVE AND QUALITATIVE RESEARCH | MECH | 3 | 0 | 0 | 3 |
| 14 | | FOOD PROCESSING, PRESERVATION & TRANSPORT | MECH | 3 | 0 | 0 | 3 |

**ADVANCED ENGINEERING MATHEMATICS**

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**UNIT – I CALCULUS OF VARIATIONS** **12**

Concept of variation and its properties- Euler's Equation-Functional dependant on first and higher order derivatives - Functional dependant on functions of several independent variables- Isoperimetric problems – Direct methods-Ritz and Kantrovich methods

**UNIT – II TRANSFORM METHODS** **12**

Laplace transform methods for one dimensional wave equation – Displacements in a long string – Longitudinal vibration of an elastic bar - Fourier Transform methods for one dimensional heat conduction problems in infinite and semi-infinite rod

**UNIT – III ELLIPTIC EQUATIONS** **12**

Laplace equation – Properties of Harmonic functions – Solutions of Laplace equation by means of Fourier transform in a half plane in an infinite strip and in a semi-infinite strip

**UNIT – IV N UMERICAL SOLUTION OF PARTIALDIFFERENTIAL EQUATIONS** **12**

Solution of Laplace and Poisson equation on a rectangular region by Lieebmann's method – Diffusion equation by the explicit and Crank Nicolson – Implicit methods – Solution of wave equations by explicit scheme Cubic spline interpolation

**UNIT – V CONFORMAL MAPPING AND APPLICATIONS** **12**

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

**Total – 60 PERIODS**

**REFERENCE BOOKS**

1. Gupta, A.S. – Calculus of Variations with Applications, Prentice Hall of India(P) Ltd.,New Delhi, 6th print, 2006

2. Sankara Rao, .K. – Introduction to Partial Differential Equations, Prentice Hall of India(P) Ltd., New Delhi, 5th print, 2004

3. Jain.R.K, Iyengar.S.R.K. - Advanced Engineering Mathematics, Narosa publications 2nd Edition, 2006

4. Grewal, B.S – Numerical Methods in Science and Engineering, Kanna Publications, New Delhi.

5. Kandasamy.P , Thilagavathy. K and Gunavathy, K – Numerical Methods, S Chand and Co., Ltd., New Delhi, 5th Edition, 2007

6. Spiegel , M. R – Theory and problems of Complex Variables with an Introduction to Conformal Mapping and Its applications, Schaum's outline series, Mc Graw Hill Book Co., 1987.

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**ADVANCED HEAT AND MASS TRANSFER**

**L T P C**
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**UNIT – I CONDUCTION AND RADIATION HEAT TRANSFER 12**

One dimensional energy equations and boundary condition, three-dimensional heat conduction equations, Extended surface heat transfer, Conduction with moving boundaries, Radiation in gasesand vapour. Gas radiation and radiation heat transfer in enclosures containing absorbing andemitting media – interaction of radiation with conduction and convection.

**UNIT – II TURBULENT FORCED CONVECTIVE HEAT TRANSFER 12**

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

**UNIT – III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 12**

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

**UNIT – IV N UMERICAL METHODS IN HEAT TRANSFER 12**

Finite difference formulation of steady and transient heat conduction problems – Discretization schemes – Explicit, Crank Nicolson and Fully Implicit schemes, Control volume formulation Steady one dimensional convection and Diffusion Problems, Calculation of the flow field – SIMPLERAlgorithm.

**UNIT – V MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION 12**

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

**TOTAL: 60 PERIODS**

**REFERENCES**

1. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons,
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. Ghoshdasdidar. P.S., Compiler simulation of flow and Heat Transfer, Tata McGraw-Hill, 1998
7. Patankar. S.V.Numerical heat Transfer and Fluid flow,Hemisphere Publishing Corporation,1980

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Prof.N.Rajan Prof.J.Sathees babu

## MEASUREMENTS AND CONTROL

**L T P C**
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### UNIT I 12

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 5**

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

**UNIT III 10**

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 pf pH, Review of basic measurement techniques.

**UNIT IV 8**

Techniques, shadow graph, Schileren, interferometer, Laser Doppler anemometer, hear flux measurement, Telemetry in engines.

**UNIT V 10**

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 - 45 PERIODS**

**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.Doeblin, 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.

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Prof.N.Rajan Prof.J.Sathees babu

**ADVANCED THERMODYNAMICS**

**L T P C**
**3 1 0 4**

**UNIT – I A VAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS 12**

Availability, Irreversibility and Second-Law Efficiency for a closed System and steady-stateControl Volume. Availability Analysis of Simple Cycles. Thermodynamic Potentials, Maxwellrelations, Generalised relation for changes in Entropy, Internal Energy and Enthalpy, GeneralisedRelations for Cp and Cv Clausius Claypeyron Equation, Joule-Thomson Coefficient, BridgmanTables for thermodynamic relations.

**UNIT – II R EAL GAS BEHAVIOUS AND MULTI - COMPONENT SYSTEMS 12**

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 CHEMICAL THERMODYNAMICS AND EQUILIBRIUM 12**

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

**UNIT – IV STATISTICAL THERMODYNAMICS 12**

Microstates and Macrostates, Thermodynamic probability, Degeneracy of energy levels,Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein Statistics, Microscopic Interpretation of heatand work, Evaluation of entropy, Partition function, Calculation of the Microscopic properties frompartition functions.

**UNIT – V IRREVERSIBLE THERMODYNAMICS 12**

Conjugate Fluxes and Forces, Entropy Production, Onsager’s Reciprocity relations, thermoelectricphenomena and formulations.

**TOTAL - 60 PERIODS**

**REFERENCES**

1. Kenneth Wark Jr., Advanced Thermodynamics for Engineers, McGraw-Hill Inc.,1995.

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. DeHoft, R.T. Thermodynamics in Materials Science, McGraw-Hill Inc., 1993.

**FUELS & COMBUSTION**

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**UNIT – I CHARACTERIZATION** **9**

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 SOLID FUELS & LIQUID FUELS** **9**

**(a) Solid Fuels**

Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking Coals – Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels - Manufactured Solid Fuels.

**(b) 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 GA SEOUS FUELS** **9**

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 - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non Thermal Route - Biogas - Digesters – Reactions - Viability - Economics.

**UNIT – IV COMBUSTION : STOICHIOMETRY & KINETICS** **9**

Stoichiometry - Mass Basis & Volume Basis - Excess Air Calculation - Fuel & Flue Gas Compositions - Calculations - Rapid Methods - Combustion Processes - Stationary Flame - Surfaceor Flameless Combustion - Submerged Combustion - Pulsating & Slow Combustion, ExplosiveCombustion.Mechanism of Combustion - Ignition & Ignition Energy - Spontaneous Combustion - FlamePropagation - Solid, Liquid & Gaseous Fuels Combustion - Flame Temperature - Theoretical,Adiabatic & Actual - Ignition Limits - Limits of Inflammability.

**UNIT – V COMBUSTION EQUIPMENTS** **9**

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, Atomizing Burners - Design of Burners.Gas Burners -Atmospheric Gas Burners - Air Aspiration Gas Burners - Burners Classification according to FlameStructures - Factors Affecting Burners & Combustion.

**TOTAL - 45 PERIODS**

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Prof.N.Rajan Prof.J.Sathees babu

**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

**THERMAL ENGINEERING LABORATORY**

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**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. Mutlicyclinder Automotive Engine
2. CO/HC/NOx 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.

**ADVANCED FLUID MECHANICS**

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**UNIT – I INTRODUCTION** **12**

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

**UNIT – II TWO DIMENSIONAL FLOW** **12**

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

**UNIT – III TURBULENT FLOW** **12**

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

**UNIT – IV COMPRESSIBLE FLOW THROUGH DUCTS** **12**

Introduction to compressible viscous flow, governing equations, flow with friction flow with heat transfer flow though nozzle and diffusers

**UNIT – V SHOCK WAVE** **12**

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

**TOTAL: 60 PERIODS**

**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 Vol 1, The Ronald Press company 1963
4. Shames- Mechanics of Fluids, Megraw-Hill Inc
5. Schlichting H - Boundary layer theory, McGraw Hill-Inc
6. Yahya S.M, "Fundamentals of Compressible flow", New Age International (P) Ltd.New Delhi,1996.

## THERMAL TURBO MACHINES

**L T P C**
**3 1 0 4**

**UNIT I** **6**

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

**UNIT II** **9**

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** **10**

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** **10**

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** **10**

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.

**TOTAL HOURS - 60 PERIODS**

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Prof.N.Rajan Prof.J.Sathees babu

**REFERENCES**

1. Turbines Compressors and Fans – S.M.Yahya – Tata McGraw-Hill company2002

2. Principles of Turbo machines by – D.G.Shephard Macmillan company 1984

3. Gas Turbine Theory – Cohen Rogers , Saravana Muttoo, Long man Publishing2004

4. Steam Turbine - Theory and Practice – William J. Kerten, CBS Publishing 1988

## DESIGN OF THERMAL POWER EQUIPMENT

**L T P C**
**3 0 0 3**

**UNIT I** **9**

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** **9**

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** **9**

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** **9**

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** **9**

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

**TOTAL HOURS - 45 PERIODS**

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**REFERENCS**

1. AroraS.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 Majestry's Stationery Office, London,1962.

4. Potter, Power Plant Theory and Design, the Ronald Press Co., New Delhi, 1972.

## COMPUTATIONAL FLUID DYNAMICS

**L T P C**
**3 1 0 4**

**UNIT I** **9**

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** **9**

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** **9**

Governing Equations, Stream Function – Verticity 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** **9**

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** **9**

Turbulence, Effect of Turbulence and time averaged Navier Stokes Equation, Algebraic Models – One equation model, K - □ Models, K-W model, Algebric stress model, Reynolds stress equation model, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

**TOTAL - 45 PERIODS**

**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

## COMPUTATIONAL FLUID DYNAMICS LABORATORY

**L T P C**
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**Software's: 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

# LIST OF ELECTIVE SUBJECTS

## GAS TURBINE

**L T P C**
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**UNIT I** **9**

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** **9**

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** **9**

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** **9**

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** **9**

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 - 45 PERIODS**

**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

## ADVANCED INTERNAL COMBUSTION ENGINES

**L T P C**

**3 0 0 3**

**UNIT I** **9**

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** **9**

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** **9**

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** **9**

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** **9**

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 - 45 PERIODS**

Dr.K.G.Muthurajan Dr.M.Venkataraman Prof.J.Senthil Prof.G.Nagarajan

Prof.N.Rajan Prof.J.Sathees babu

**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.

## NUMERICAL METHODS IN HEAT TRANSFER AND FLUID FLOW

**L T P C**

**3 0 0 3**

**UNIT I** **9**

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** **9**

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

**UNIT III** **9**

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 nodded triangular elements, 2 D steady state state conduction using triangular elements - Radiation and natural convective boundary conditions.

**UNIT IV** **9**

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** **9**

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 - 45 PERIODS**

**SOFTWARE CODES**

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

Dr.K.G.Muthurajan Dr.M.Venkataraman Prof.J.Senthil Prof.G.Nagarajan

Prof.N.Rajan Prof.J.Sathees babu

**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.

## CRYOGENIC ENGINEERING

**L T P C**

**3 0 0 3**

**UNIT I** **8**

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** **10**

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** **11**

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** **8**

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** **8**

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 - 45 PERIODS**

**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.

## REFRIGERATION SYSTEM DESIGN

**L T P C**

**3 0 0 3**

**UNIT I** **10**

**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** **9**

**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** **8**

**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** **10**

**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** **8**

**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 - 45 PERIODS**

**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

## NUCLEAR POWER PLANT

**L T P C**

**3 0 0 3**

**UNIT I** **7**

**NUCLEAR PHYSICS**

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

**UNIT II** **8**

**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** **10**

**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** **10**

**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** **10**

**RADIOACTIVE WASTE MANAGWMENT AND NUCLEAR SAFETY**

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

**TOTAL - 45 PERIODS**

**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..

## ADVANCED POWER PLANT ENGINEERING

**L T P C**

**3 0 0 3**

**UNIT I** **8**

### 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** **10**

### 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** **10**

### 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** **9**

### 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** **8**

## 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 - 45 PERIODS**

**REFERENCES**

1. Power Plant Engineering – by P, K, Nag Mc Grraw – 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

## ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

**L T P C**

**3 0 0 3**

**UNIT I** **9**

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** **9**

**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** **9**

**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** **9**

**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** **9**

**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 - 45 PERIODS**

Dr.K.G.Muthurajan Dr.M.Venkataraman Prof.J.Senthil Prof.G.Nagarajan

Prof.N.Rajan Prof.J.Sathees babu

**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 Enginering - 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 Apporach, Prentice Hall of India Pvt Ltd, New Delhi.

## RENEWABLE ENERGY SYSTEM

**L T P C**

**3 0 0 3**

**UNIT I** **7**

**INTRODUCTION**

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

**UNIT II** **10**

**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** **8**

**WIND ENERGY**

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

**UNIT IV** **8**

**BIOMASS ENERGY**

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

**UNIT V** **12**

**OTHER RENEWABLE ENERGY SOURCES**

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

**TOTAL - 45 PERIODS**

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Prof.N.Rajan Prof.J.Sathees babu

**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

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# COGENERATION AND WASTE HEAT RECOVERY SYSTEMS

**L T P C**

**3 0 0 3**

**UNIT I** **9**

**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** **9**

**COGENERATION TEHNOLOGIES**

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** **9**

**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** **9**

**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** **9**

**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 - 45 PERIODS**

Dr.K.G.Muthurajan Dr.M.Venkataraman Prof.J.Senthil Prof.G.Nagarajan

Prof.N.Rajan Prof.J.Sathees babu

**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 Polllution Control Engineering, McGrawHill, New York,1995

*7.www.**cogeneration**.net*

*8.www.energ.**co**.uk*

*9 www.**co**genindia.org*

## REFRIGERATION MACHINERY AND COMPONENTS

**L T P C**

**3 0 0 3**

**UNIT I** **9**

**REFRIGERANT COMPRESSORS**

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

**UNIT II** **10**

**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** **10**

**DESIGN OF EVAPORATORS**

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

**UNIT IV** **9**

**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** **7**

**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 - 45 PERIODS**

Dr.K.G.Muthurajan Dr.M.Venkataraman Prof.J.Senthil Prof.G.Nagarajan

Prof.N.Rajan Prof.J.Sathees babu

**REFERENCES**

1) Chlumsky “Reciprocating & Rotary compressors”, SNTL Publishers for Technical literaure, 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.

**FANS, BLOWERS & COMPRESSORS**

L T P C

3 0 0 3

**UNIT I PRINCIPLES OF TURBO MACHINERY 9**

Introduction to turbo machines – Transfer of energy to fluids – Performance characteristics– Fan laws – Dimensionless parameters – Specific speed – Selection of centrifugal, axial, mixedflow, Axial flow machines.

**UNIT II ANALYSIS OF CENTRIFUGAL BLOWERS 9**

Centrifugal Blowers: Theoretical characteristic curves, Eulers characteristics and Eulersvelocity triangles, losses and hydraulic efficiency, flow through impeller casing inlet nozzle volute,diffusers, leakage disc friction, mechanical losses, multivane impellers, of impulse type, crossflowfans.

**UNIT III ANAL YSIS OF AXIAL FLOW** 9

Axial flow fans: Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction,blade twist stage design, surge and stall, stator and casing, mixed flow impellers.

**UNIT IV TESTING AND CONTROL OF FANS 9**

Fan testing, noise control, materials and components blower regulation, speed control, throttling, control at discharge and inlet.

**UNIT V D ESIGN AND APPLICATIONS OF BLOWERS 9**

Special design and applications of blowers, induced and forced draft fans for air conditioning plants, cooling towers, ventilation systems, booster systems.

**TOTAL - 45 PERIODS**

**REFERENCES**

1. Stepanoff A.J., Turboblowers, John Wiley & Sons, 1970.
2. Brunoeck, Fans, Pergamon Press, 1973.
3. Austin H. Church, Centrifugal pumps and blowers, John Wiley and Sons, 1980.
4. Dixon, Fluid Mechanics, Thermodynamics of turbomachinery Pergamon Press, 1984.
5. Dixon, Worked examples in turbomachinery, Pergamon Press, 1984.

Dr.K.G.Muthurajan Dr.M.Venkataraman Prof.J.Senthil Prof.G.Nagarajan

Prof.N.Rajan Prof.J.Sathees babu

**QUANTITATIVE AND QUALITATIVE RESEARCH**

LT P C

3 0 0 3

**UNIT – I R ESEARCH METHODOLOGY** **9**

Types of research- Literature survey- Patent survey- literature review reporting- ethicsand interventions of research- planning for research- research tools- seven management toolsgraphicalrepresentations – Codes – Standards.

**UNIT – II QUANTITATIVE METHODS** 9

Descriptions-statistics-distribution-sampling-hypothesis testing- regression-ANOVA-reliabilityvalidity-uncertainty - sensitivity analysis- use of SPSS.

**UNIT – III QUALITATIVE METHODS** 9

Historical analogy-market research- survey analysis - delphi methodology-determination of index-life cycle analysis - modeling and simulation.

**UNIT – IV MEASUREMENT IN RESEARCH** **9**

Need for measurement- types of measuring instruments- Configurations and functionaldescriptions of instruments- Performance characteristics- Static and dynamic characteristicsmanipulation,Transmission and recording of data- Data acquisition and processing systems-Computer aided experimentation.

**UNIT – V RESEARCH REPORT PREPARATION** 9

Principles of Written communication- Content preparation- Synopsis writing- Result analysis-Discussion section - Case studies.

**TOTAL - 45 PERIODS**

**REFERENCES**

1. Robert B. Burns, Introduction to Research methods, SAGE Publications London- 2000

2. Herman J. Ader, Gidon J. mellenbergh, Research Methodology, SAGE Publications London-1999

3. Jeremy Miles& Mark Sherlin, Applying Regression and Correlation, A Guide for students and researchers SAGE Publications London- 2001

4. Ernest O. Doebelin, Measurement Systems- Application and Design IV Edition McGraw-Hill International Edition NY-1990.

**FOOD PROCESSING, PRESERVATION AND TRANSPORT**

**L T P C**

**3 0 0 3**

**UNIT I INTRODUCTION** 9

Microbiology of Food Products, Mechanism of Food Spoilage, Refrigeration Technologies ofFood Products. Thermodynamic Properties, Cooling Process and Heat Transfer, Parameters ofFood Products and their Effect on Quality. Moisture Losses from Respiration of Food Products,Optimum Cold Storage Conditions.

**UNIT II PROCESSING AND PRESERVATION** 9

Food Processing Techniques, Standard Norms for Processing, Plant Layout, Preservation ofMilk, Butter, Fruits, Vegetables, Meat Products. Environment Friendly Food Processing Techniques,Cryofreezing, Energy Conservation in Food Industries.

**UNIT III FREEZING AND DRYING** 9

Precooling, Quick Freezing, Freeze Drying Principles, Techniques and Equipments, ColdStorage and Freezers. Freezing and Drying Limitations. Irradiation Techniques. Food PreservingTechniques for Remote Areas.

**UNIT IV COLD STORAGE DESIGN AND INSTRUMENTATION** 9

Design, Selection, Matching, Installation and Maintenance of Cold Storages & Freezers. Insulation, Instrumentation and Control. Energy Conservation Techniques for Freezers and ColdStorages.

**UNIT V TRANSPORT** **9**

Refrigerated Transportation, Refrigerated Containers and Trucks. Design Features, Pipingand Role of Cryogenics in Freezing and Transport.

**TOTAL - 45 PERIODS**

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Prof.N.Rajan Prof.J.Sathees babu

**REFERENCES**

1. Alan Rodes, Principles of Industrial Microbiology, Pregmon International Pub., 1989.

2. Ibraham Dincer, Heat Transfer in Food Cooling Applications, Tailor & Francis Pub., 1997.

3. Stanley E. Charm, Fundamentals of Food Engineering, III Ed. AVI Pub. Company Inc. 1989.

4. Clive V.I. Dellino, Cold and Chilled Storage Technology, Van Nostrand Reinhold Pub. New York, 1991.

5. Arora C.P., Refrigeration and Air conditioning II Ed. McGraw-Hill, Pub., 2000.

6. ASHRAE Handbook, Cold Storage Application – Collection of papers from ASHRAE Winter meeting at Delirious and Chicago, Jan 1988 and 1989.