EY141 Energy Conservation and Management	**3**	**0**	**0**	**100**

1. INTRODUCTION **8**

Energy Scenario - Principles and Impeartives of Energy Conservation - Energy Consumption Pattern - Resource Availability - Role of Energy Managers in Industries

2. THERMAL ENERGY AUDITIING **12**

Energy Audit-Purpose, Methodology with respect to process Industries - Power plants, Boilers etc., - Characteristic method Employed in Certain Energy Intensive Industries - Various Energy Conservation Measures in Steam System - Losses in Boiler, Methodology of Upgrading Boiler Performance
Energy conservation in pumps, Fans & Compressors, Air conditioning and refrigeration systems, Steam Traps-Types, Function, Necessity

3. ROLE OF INSTRUMENTATION IN ENERGY CONSERVATION **10**

Total Energy systems - Concept of Total Energy - Advantages & Limitations - Total Energy system & Application - Various Possible Schemes Employing Steam Turbines Movers Used in Total Energy Systems - Potential & Economics of Total Energy Systems

4. ELECTRICAL ENERGY AUDITING **10**

Potential Areas for Electrical Energy Conservation in Various Industries-Energy Mangement Opportunities in Electrical Heating, Lighting system, Cable selection - Energy Efficient Motors - Factors involvesd in Determination of Motor Efficiency
Adjustable AC Drives, Applications & its use variable speed Drives/Belt Drives

5. ENERGY MANAGEMENT **5**

Importance of Energy Management, Energy Economics - Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing

Total No of periods: 45

EY141 Energy Conservation and Management **3 0 0 100**

References:

1. *CB Smith, Enegy Management Principles, Pergamon Press, NewYork, 1981*
2. *Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case study, Hemisphere, Washington, 1980*
3. *Trivedi, PR, Jolka KR, Energy Managemnent, Commonwealth Publication, NewDelhi, 1997*
4. *Witte, Larry C, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington,1988*
5. *Diamant, RME, Total Energy, Pergamon, Oxford, 1970.*

IC131 Advanced Thermodynamics **3 1 0 100**

1. AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS 10

Reversible work, 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 relations for changes in Entropy, Internal Energy and Enthalpy, Generalised Relations for Cp and Cv Clausius Clayperon Equation, Joule-Thomson Coefficient, Bridgman Tables for Thermodynamic relations.

2. REAL GAS BEHAVIOUS AND MULTI-COMPONENT SYSTEMS 10

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

3. CHEMICAL THERMODYNAMICS AND EQUILIBRIUM 10

Thermochemistry, First Law analysis of reacting systems, Adiabatic Flame temparture, Entropy change of reacting systems, Second Law analysis of reacting systems, Criterion for reaction equilibrium composition, Chemical availabilty, Availability of reacting systems.

4. STATISTICAL THERMODYNAMICS 8

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 Macroscopic properties from partition functions, Equilibrium constant statistical thermodynamic approach.

5. IRREVERSIBLE THERMODYNAMICS 7

Conjugate Fluxes and Forces, Entropy Production, Onsager's Reciprocity relations, Thermo-electric phenomena, formulations, Power Generation, Refrigeration.

6. TUTORIAL 15

Total No of periods: 60

References:

1. Kenneth Wark Jr.,Advanced Thermodynamics for Engineers, McGraw-Hill Inc., 1995.
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 1988.
3. Holman, J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc.,1988.
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 Van 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. DeHotf,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.

IC132	**Advanced Heat Transfer**	**3**	**1**	**0**	**100**

1. CONDUCTION AND RADIATION HEAT TRANSFER **10**

One dimensional energy equations and boundary condition, three dimensional heat conduction equations, Extended surface heat transfer, Conduction with moving boundaries, Porous-media heat transfer, Radiation in gases and vapor.

2. TURBULENT FORCED CONVECTIVE HEAT TRANSFER **12**

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

3. PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER **8**

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

4. NUMERICAL METHODS IN HEAT TRANSFER **10**

Finite difference formulation of steady and transient heat condition 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 - SIMPLER Algorithm.

5. MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION **5**

Mass Transfer, Vaporization of droplets, Combined heat and mass transfer problems, Heat Transfer Correlations in I.C. Engines.

6. TUTORIAL **15**

Total No of periods: 60

IC132 Advanced Heat Transfer **3 1 0 100**

References:

1. *Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 1996.*
2. *Eckert. E.R.G., and Drake.R.M., Analysis of Heat and Mass Transfer, McGraw Hill Co., 1980.*
3. *Ozisik. M.N., Heat Transfer - Basic Approach, McGraw-Hill Co., 1985.*
4. *Bejan. A., Convection Heat Transfer, John Wiley and Sons, 1984.*
5. *Rohsenow. W.M., Harnett. J.P., and Ganic. E.N., Handbook of Heat Transfer Applications, McGraw-Hill, NY1985.*
6. *Patankar. S.V. Numerical heat Transfer and Fluid flow, Hemisphere Publishing Corporation, 1980.*
7. *Carnahan.B., Luther.H.A., and Wilkes, J.O., Applied Numerical Methods, Wiley and Sons, 1976.*

MA148 Applied Mathematics for Mechanical Engineers 3 1 0 100

1. TRANSFORM METHODS 9

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

2. ELLIPTIC EQUATIONS 8

Laplace equation - Properties of harmonic functions - Fourier transform methods for Laplace equation. Solution for Poison equation by Fourier transform method.

3. CALCULUS OF VARIATIONS 9

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.

4. NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 10

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.

5. CONFORMAL MAPPING AND APPLICATIONS 9

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

6. TUTORIAL 15

Total No of periods: 60

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 confomal 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, 1966.

RA042	**Refrigeration Systems Design**	**3**	**0**	**0**	**100**

1. REFRIGERATION CYCLES **10**

Evolving Vapor Compression Cycle from Basic Carnot Cycle - Analysis. Multipressure Systems, Cascade Systems. Air Refrigeration Cycles.

2. SYSTEM COMPONENTS & ACCESSORIES **12**

Types of Evaporators, Compressors, Condensors, Expansion Devices, Driers/ Filters, Receiver, Accumulator. Functional Aspects of the above components & accessories.

3. SYSTEM BALANCING & CONTROLS **8**

Estimation of Cooling Load, system Equilibrium and Cycling Controls, Capacity Control in Compressors.

4. REFRIGERANTS **6**

Classification of Refrigerants, Refrigerant Properties, Oil Compatibility, Blends, Eco Friendly Refrigerants.

5. UNCONVENTIONAL REFRIGERATION CYCLES **6**

Vapor Absorption Systems - Aqua Ammonia & LiBr Systems, Steam Jet Refrigeration, Thermo Electric Refrigeration.

6. ELECTRICAL COMPONENTS & CONTROLS **3**

Starting and Running Circuits, Relay Types and Controls.

Total No of periods: 45

RA042 Refrigeration Systems Design **3** **0** **0** **100**

References:

1. Dossat R.J., Principles of refrigeration, John Wiley, 1984.
2. W.F. Stoecker, Refrigeration and Air conditioning, McGraw Hill Book Company, 1985.
3. Jordan and Priester, Refrigeration and Air conditioning, 1985.
4. Goshnay W.B., Principles and Refrigeration, Cambridge, University Press, 1982.
5. Langley, Billy C., 'Solid state electronic controls for HVACR' pentice-Hall 1989.
6. http://gort.ucsd.edu/newjour/i/msg02859.html
7. http://www.brazeway.com/refrigeration.
8. http://Progdev.sait.ab.ca/pwen220/119/ref-com.htm
9. http://147.46.94.112/journal/sej
10. http://www.iifir.org

EY143	**Environmental Engineering and Pollution Control**	**3**	**0**	**0**	**100**

1. AIR POLLUTION **10**

Sources and Effect - Acid Rain - Air Sampling and Measurement - Analysis of Air Pollutants - Air Pollution Control Methods and Equipments - Issues in Air Pollution control.

2. SOLID WASTE MANAGEMENT **10**

Sources and Classification - Charecteristics of solid waste-Potential methods of solid waste Disposal - Process and Equipments for Energy Recovery from Municipal Solid Waste and Industrial Solid Waste.

3. WATER POLLUTION **10**

Sources and Classification of Water Pollutants - Charecteristics - Waste Water Sampling Analysis - Waste Water Treatment - Monitoring compliance with Standards - Treatment, Utilization and Disposal of Sludge.

4. OTHER TYPES OF POLLUTION **7**

Noise Pollution and its impact - Oil Pollution - Pesticisdes - Radioactivity Pollution Prevention and Control

5. POLLUTION FROM THERMAL POWER PLANTS AND CONTROL METHODS **8**

Instrumentation for pollution control - Water Pollution from Tanneries and other Industries and their control

Total No of periods: 45

EY143 Environmental Engineering and Pollution Control 3 0 0 100

References:

1. Environmental Considerations in Energy Development, Asian Development Bank (ADB), Manilla(1991)
2. G.Masters (1991): Introduction to Environmental Enginering and Science, Prentice -Hall International Editions.
3. H.S.Peavy, D.R..Rowe, G.Tchobanoglous (1985):Environmental Enginering - McGraw- Hill Book Company,
NewYork.
4. H.Ludwig, W.Evans (1991): Manual of Environmental Technology in Developing Countries, W.Y. Brockelman
and B.N.Lohani, International Book Company, Absecon Highlands, N.J.

IC038	**Instrumentation in Thermal Engineering**	**3**	**0**	**0**	**100**

1. MEASUREMENT CHARACTERSTICS **12**

Instrument classification, Characteristics of Instruments - Static and dynamic, experimental error analysis, systematic and random errors, Statistical analysis, Uncentainity, Experimental planning and selection of measuring instruments, Reliability of instruments.

2. MICROPROCESSORS AND COMPUTERS IN MEASUREMENT **5**

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

3. MEASUREMENT OF PHYSICAL QUANTITIES **10**

Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of intelligent instruments for the physical variables.

4. FLOW VISUALILSATION **8**

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

5. MESUREMENT ANALYSIS **10**

Chemical, thermal, magnetic and optical gas analysers, measurement of smoke, dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

Total No of periods: 45

IC038 Instrumentation in Thermal Engineering 3 0 0 100

References:

1. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1988.
2. Barney, Intelligent Instrumentation, Prentice Hall of India, 1988.
3. Prebrashensky, V., Measurements and Instrumentation in Heat Engineering, Vol.1 and 2, MIR Publishers, 1980.
4. Raman, C.S., Sharma, G.R., Mani, V.S.V., Instumentation Dervices and systems, Tata McGraw Hill, New Delhi, 1983.
5. Doeblin, Measurements System Application and Design, McGraw Hill, 1978.
6. Morris. A.S, Principles of Measurements and Instrumentation, Prentice Hall of India, 1998.

IC141 Internal Combustion Engine Design **3 0 0 100**

1. GENERAL CONSIDERATIONS IN ENGINE DESIGN **6**

Principle of similitude, choice of cycle, speed, fuel, bore and stroke, cylinder arrangement, choice of material, stress and fatigue considerations, design for manufacture.

2. DESIGN OF MAJOR COMPONENTS **12**

Piston sytem, connecting rod assembly, crankshaft system, valve gearing ,stress analyses.

3. DESIGN OF OTHER COMPONENTS **16**

Inlet and exhaust manifolds, cylinder block, cylinder liner, cylinder head, crankcase, Engine foundations and mountings, gaskets, bearings, flywheel. Turbocharger, supercharger,computer controlled fuel injection system.

4. DESIGN OF TWO-STROKE ENGINES **6**

Arrangement and sizing of ports, piston assembly, intake and exhaust system, scavenging, application to automotive gasoline and marine diesel engines.

5. CONCEPTS OF COMPUTER AIDED DESIGN **5**

Preparation of working drawings of designed components using CAD system.

Total No of periods: 45

IC141 Internal Combustion Engine Design **3 0 0 100**

References:

1. Gordon P.Blair, Basic design of Two-stroke Engines, S.A.E., 1992.
2. Gordon P.Blair, Advanced Concepts of Two-stroke Engines, S.A.E., 1990.
3. Pounder, C.C., Marine Diesel Engines, Butterworths, 1981.
4. A.Kolchin and V.Demidov, Design of Automotive Engines, Mir Publishers, Moscow, 1984.
5. Gordon P.Blair, Design and Simulation of Four-Stroke Engines, Society of Automotive Engineers, Inc., USA, 1999.
6. D.E. Winterbone and R.J.Pearson, Design Techniques for Engine Manifolds, Wave action methods for I.C Engines, Professinal Engineering Publishing Ltd., UK, 2000.

RA141	**Design of Condensers Evaporators and Cooling Towers**	**3**	**0**	**0**	**100**

1. INTRODUCTION **5**

Principles of heat transfer, Types of heat exchangers, Standard representation, Parts description, TEMA Classifications, Applications.

2. DESIGN OF CONDENSERS **10**

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

3. DESIGN OF EVAPORATORS **10**

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

4. DESIGN OF COOLING TOWERS **15**

Types of cooling towers, Analytical and graphical design procedures, Tower characteristics, Parametric analysis, Packaging, Water treatment, Selection of pumps and fans, Energy conservation.

5. COMPUTER AIDED DESIGN OF THERMAL SYSTEMS **5**

Principles of CAD, Drafting, Flowcharting, Computer programming, Packages, Case analysis

Total No of periods: 45

RA141 Design of Condensers Evaporators and Cooling Towers 3 0 0 100

Text Books:

Ozisik, M.N. Design of Heat exchangers, condensers and evaporators, John Wiley, New York, 1985.

References:

1. Kern K.H. Process heat transfer, McGraw-Hill,1984.
2. Ozisik M.N., Heat transfer, McGraw-Hill,1988.
3. Nicholas Cheremisioff, Cooling tower, Ann Arbor Science pub.1981.
4. TEMA Hand book, Tubular Exchanger Manufacturer Association, New York,1981.
5. www.nyserda.org/459sp.pdf
6. www.poolpak.com/mcdual.htm
7. www.ashrae.org/RESEARCH/1205trp.htm
8. www.trane.com

TE143	**Thermal Engineering laboratory**	**0**	**0**	**3**	**100**

. PART - A PERFORMANCE TESTS

1. Performance test on Spark Ignition engines using Alternate fuels such as ethanol and LPG.
2. Emission measurement in Spark Ignition and Compression Ignition Engines.
3. Performance test using pressure transducers in SI Engines.
4. Performance test using pressure transducers in CI Engines.1. Performance test on Spark Ignition engines using Alternate fuels such as ethanol and LPG.
2. Emission measurement in Spark Ignition and Compression Ignition Engines.
3. Performance test using pressure transducers in SI Engines.
4. Performance test using pressure transducers in CI Engines.
5. Performance test on variable compression ratio petrol and diesel engines.
6. Performance test on Solar Collector.

. PART - B SIMULATION STUDIES

7. Simulation studies of Vapour Absoroption System.
8. Simulation studies of Petrol and Diesel engine cycles.
9. Simulation of Gas Turbine Cycles.
10. Simulation of Adiabatic flame temperature in constant volume heat addition process.
11. Simulation of Adiabatic flame temperature in constant pressure heat addition process.
12. CFD analysis for a fluid flow problem with heat transfer.

Note : The end semester examination shall be conducted in both Part - A and Part - B.

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Total No of periods: 45

TE143	**Thermal Engineering laboratory**	**0**	**0**	**3**	**100**

Equipments needed for Part - A:

1. Eddy current / Hydraulic Dynamometer with reasonably good accuracy.
2. Piezoelectric pick up with charge amplifier and data acquisition card to be interfaced to a PC.
3. Exhaust Gas Analyser for measuring exhaust gas Constituents in SI Engine.
4. Diesel Smoke Meter and Diesel Emission Measuring Equipment.
5. Variable Compression Radio Petrol and Diesel Engines.
6. Well instrumented Solar Collector.

Equipments needed for Part - B:

7. Personal Computers - 10 Nos.
8. Workstation with any CFD Software / Fluent / Star CD / CFX - 10 Nos.

EY035 Solar Energy and Wind Energy **3 0 0 100**

1. SOLAR RADIATION **9**

Availiabilty - Measurement and Estimation - Isotropic and an Isotropic Models - Introduction to Solar Collectors (Liquid Flat - Plate Collector, Air Heater and Concentrating Collecter) and Thermal Storage - Steady State Transient Analysis - Solar Pond - Solar Refrigeration.

2. MODELING OF SOLAR THERMAL SYSTEMS AND SIMULATIONS IN PROCESS DESIGN **9**

Design of Active Systems by f-chart and Utilizability Methods - Water Heating Systems - Active and Passive - Passive Heating and Cooling of Buildings - Solar Distillation - Solar Drying.

3. PHOTOVOLTAIC SOLAR CELL **9**

P:N Junction - Metal - Schottky Junction, Electrolyte - Semiconductor Junction, Types of Solar Cells - their Appllications - Experimental Techniques to determine the Chatarcteristics of Solar Cells - Photovoltaic Hybird Systems Photovoltaic Thermal Systems - Storage Battery - Solar Array and their Characteristics Evaluation - Solar Chargeable Battery.

4. WIND **9**

Its Structure - Statistics - Measurements and Data Presentation - Wind Turbine Aerodynamics - Momentum Theories - Basics Aerodynamics - Airfoils and their Characteristics - HAWT - Blade Element Theory - Prandtl's Lifting Line Theory (prescribed wake analysis) - VAWT Aerodynamics - Wind Turbine Loads - Aerodynamic Loads in Steady Operation - Wind Turbulence - Yawed Operation and Tower Shadow.

5. WIND ENERGY CONVERSION SYSTEM (WECS) **9**

Siting - Rotor Selection - Annual Energy Output - Horizontal Axis Wind Turbine (HAWT) Vertical Axis Wind Turbine - Rotor Design Considertions - Number of Blades - Blade Profile -2/3 Blades and Teetering - Coning - Upwind/Downwind - Power Regulation - Yaw System - Tower - Synchronous and Asynchronous Generators and Loads - Integration of Wind Enengy Converters to Electrical Networks - Inverters - Testing of WECS - WECS Control System - Requirements and Startegies - Miscellaneous Topics - Noise etc - Other Applications.

Total No of periods: 45

EY035 Solar Energy and Wind Energy **3** **0** **0** **100**

Refernece books:

1. L.L.Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.
2. D.A.Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.
3. S.P.Sukhatme-Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).
4. J.A.Duffie and W.A.Beckman-Solar Engineering of Thermal Processes-John Wiley (1991).
5. J.F.Kreider and F.Kreith-Solar Energy Handbook McGraw-Hill (1981).

Websites
1. http://www.ises.ors
2. http://www.windpower-monthly.com
3. www.solarpv.com

EY038 Waste Management and Energy Generation Technologies 3 0 0 100

1. SOLID WASTE **8**

Definitions - Sources, Types, Compositions, Properties of Solid Waste - Municipal Solid Waste - Physical, Chemical and Biological Property - Collection - Transfer Stations - Waste Minimization and Recycling of Municipal Waste

2. WASTE TREATMENT **8**

Size Reduction - Aerobic Composting - Incineration - Furnace Type & Design, Medical / Pharmaceutical Waste Incineration - Environmental Impacts - Measures of Mitigate Environmental Effects due to Incineration

3. WASTE DISPOSAL **8**

Land Fill Method of Solid Waste Disposal - Land Fill Classficaition, Types, Methods & Siting Consideration - Layout & Preliminary Design of Land Fills - Composition, Characteristics, generation, Movement and Control of Landfill Leachate & Gases - Environmental Monitoring System for Land Fill Gases

4. HAZARDOUS WASTE MANAGEMENT **10**

Definition & Identification of Hazardous Waste - Sources and Nature of Hazardous Waste - Impact on Envirnoment - Hazardous Waste Control - Minimization and Recycling - Assessment of Hazardous Waste Sites - Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation & Closure

5. ENERGY GENERATION FROM WASTE **11**

Types - Biochemical Conversion - Sources of Energy Generation - Industrial Waste, Agro Residues - Anaerobic Digestion - Biogas Production - Types of Biogas Plant Thermochemical Conversion - Sources of Energy Generation - Gasification - Types of Gasifiers - Briquetting - Industrial Applications of Gasifiers - Utilization and Advantages of Briquetting - Environment Benefits of Biochemical and Thermochemical Conversion

Total No of periods: 45

EY038 Waste Management and Energy Generation Technologies 3 0 0 100

Reference books:

1. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985
2. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Printice Hall, 2000
3. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997
4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987
5. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC New Delhi, 1983.

Websites:
1. http://www.bical.net
2. http://www.volund.dk
3. http://www.iswa.org
4. www.wmrc.uiuc.edu

EY040	**Cogeneration and Waste Heat Recovery Systems**	**3**	**0**	**0**	**100**

1. COGENERATION **6**

Introduction - Principles of Thermodynamics - Combined Cycles-Topping -Bottoming - Organic Rankine Cycles - Advantages of Cogeneration Technology

2. APPLICATION & TECHNO ECONOMICS OF COGENERATION **12**

Cogeneration Application in various industries like Cement, Sugar Mill, Paper Mill etc. Sizing of waste heat boilers - Performance calculations, Part load characteristics selection of Cogenerationl Technologies - Financial considerations - Operating and Investments - Costs of Cogeneration.

3. WASTE HEAT RECOVERY **8**

Introduction - Principles of Thermodynamics and Second Law - sources of Waste Heat recovery - Diesel engines and Power Plant etc.

4. WASTE HEAT RECOVERY SYSTEMS, APPLICATIONS & TECHNO ECONOMICS **17**

Recuperators - Regenerators - economizers - Plate Heat Exchangers - Waste Heat Boilers-Classification, Location, Service Conditions, Design Considerations, Unfired combined Cycle - supplementary fired combined cycle - fired combined cycle applications in Industries - fluidised bed heat exchangers - heat pipe exchangers - heat pumps -thermic fluid heaters selection of waste heat recovery technologies - financial considerations - operations and investment costs of waste heat recovery.

5. ENVIRONMENTAL CONSIDERATIONS **2**

Environmental considerations for cogeneration and waste heat recovery - Pollution.

Total No of periods: 45

EY040 Cogeneration and Waste Heat Recovery Systems **3** **0** **0** **100**

Reference Books:

1. Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
2. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987.
3. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
4. Sengupta Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
5. De Nevers, Noel., Air Polllution Control Engineering, McGrawHill, New York,1995.
Websites:
1. http ://www.sicom.nl
2. http ://www.jenbacher.com
3. www.cogen.com
4. www.energypubs.com

EY041 Boiler Technology **3 0 0 100**

1. INTRODUCTION **10**

Parameter of a Steam Generator-Thermal Calculations of a Modern steam Generator - Tube Metal Temperature Calculation and choice of Materials - Steam Purity Calculations and Water Treatment

2. HEAT BALANCE **10**

Heat transfer in Furnace - Furnace Heat Balance - Calculation of Heating Surfaces - Features of Firing Systems for solid -Liquid and Gaseous Fuels-Design of Burners

3. BOILER DESIGN **10**

Design of Boiler Drum - Steam Generator Configurations For Industrial Power and Recovery Boilers - Pressure Loss and Circulation in Boilers

4. DESIGN OF ACCESORIES **8**

Design of Air Preheaters - Economisers and Superheater for high Pressure Steam Generators - Design Features of Fuel Firing Systems and Ash Removing Systems

5. BOILER CODE **7**

IBR and International Regulations - ISI Code's Testing and Inspection of Steam Generator - Safety Methods in Boilers - Factor of Safety in the Design of Boilers Drums and Pressure Parts - Safety of Fuel Storage and Handling - Safety Methods for Automatic Operation of Steam Boilers

Total No of periods: 45

EY041 Boiler Technology **3 0 0 100**

References:

1. David Gunn, Robert Horton, Industrial Boilers - Longman Scientific & Technical Publication, 1986
2. Carl Schields, Boilers - Type, Charecteristics and Functions, McGraw Hill Publishers, 1982
3. Modern Power Station Practice(8 vol) - Central Electricity Generation Board, 1980
4. Large Boiler Furnaces, Richard Dolezal Elsevier Publishing Company, 1980

Websites:
1.http://www.volund.uk
2. http://www.aee.vatech.co.at
3. http://www.thermomax.com
4.http://www.pages.hotbot.com

EY042 Fluidised Bed Systems **3 0 0 100**

1. FLUIDIZED BED BEHAVIOUR **9**

Fluidization Phenomena - Regimes of Fluidized Bed Behaviour - Charecterisation of Fluidized Particles - Two Phase and Well Mixed Theory of Fluidization - Solids Mixing Particle Entrainment and Carryover

2. HEAT TRANSFER **9**

Different modes of Heat Transfer in Fluidized Bed-Use of Immersed Tubes - Finned Tubes - Heat Recovery Systems

3. COMBUSTION AND GASIFICATION **9**

Fluidized Bed Combustion and Gasification, Pressurised Systems, Sizing of Combustion and Gasification Systems, Start-up Methods, Fast Fluidized Beds, Different Modes of Heat Transfer in Fluidized Beds

4. SYSTEM DESIGN **9**

Design of Distributors, Fluidized Bed Furnaces for fossil and Agricultural Fuels, Fluidized Bed Heat Recovery Systems, Fluid Bed Dryers

5. INDUSTRIAL APPLICATIONS **9**

Sulphur Retention - Nitrogen Emission Control - Furnaces, Dryers, Heat Treatment, etc, Pollution control and Environmental Effects-Cost Analysis

Total No of periods: 45

EY042 Fluidised Bed Systems **3 0 0 100**

References:

1. Howard, J.R., Fluidized Bed Technology: Principles and Applications, Adam Hilger, NewYork, 1983
2. Geldart, D, Gas Fluidization Technology, John Wiley & Sons, NewYork, 1986
3. Howard, J.R. (Ed), Fluidized Beds: Combustion and Applications, Applied Science Publishers, NewYork, 1983
4. Yates, J.G.Fundamentals of Fluidized bed Chemical Processes, Butterworths, 1983
5. Reed, T.B., Biomass Gasification: Principles and Technology, Noyes Data Corporation, New Jersey, 1981

Websites:
1. http://www.energyproducts.com
2. http://www.cotene.co.nz
3. http://www.thermomax.com
4. www.minerals.csiro.au

EY043 Design of Heat Exchangers **3 0 0 100**

1. CONSTRUCTIONAL DETAILS AND HEAT TRANSFER **8**

Types - Shell and Tube Heat Exchangers - Regenerators and Recuperators - Industrial Applications Temperature Distribution and its Implications - LMTD - Effectiveness

2. FLOW DISTRIBUTION AND STRESS ANALYSIS **7**

Effect of Turbulence - Friction Factor - Pressure Loss - Channel Divergence Stresses in Tubes - Heater sheets and Pressure Vessels - Thermal Stresses - Shear Stresses - Types of Failures

3. DESIGN ASPECTS **10**

Heat Transfer and Pressure Loss - Flow Configuration - Effect of Baffles - Effect of Deviations from Ideality - Design of Typical Liquid - Gas-Gas-Liquid Heat Exchangers

4. CONDENSORS AND EVAPORATORS DESIGN **10**

Design of Surface and Evaporative Condensors - Design of Shell and Tube - Plate Type Evaporators

5. COOLING TOWERS **10**

Packings - Spray Design - Selection of Pumps - Fans and Pipes - Testing and Maintenance - Experimental Methods

Total No of periods: 45

EY043 Design of Heat Exchangers **3 0 0 100**

References:

1. T. Taborek, G.F. Hewitt and N.Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980
2. Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 1980
3. Nicholas Cheremisioff, Cooling Tower, Ann Arbor Science Pub 1981
4. Arthur P. Fraas, Heat Exchanger Design, John Wiley & Sons, 1988

Websites:
1. http://www.thermomax.com
2. http://www.tata.com
3. http://www.altalevel.com

EY056 Renewable Energy Systems **3 0 0 100**

1. INTRODUCTION **9**

World energy use-reserves of energy resources-energy cycle of the earth-environmental aspects of energy utilisation-renewable energy resources and their importance.

2. SOLAR ENERGY **9**

Introduction -extraterrestrial solar radiation - radiation at ground level-collectors-solar cells-applications of solar energy-Biomass Energy-Introduction-Biomass Conversion-Biogas Production-Ethanol Production-Pyrolysis and Gasification-Direct Combustion-Applications.

3. WIND, GEO THERMAL AND HYDRO ENERGY SOURCES **12**

Introduction-basic theory-types of turbines-applications-Geothermal Energy-Introduction-geothermal resource types-resource base-applications for heating and electricity generation-Hydropower-introduction-basic concepts-site selection-types of turbines-small scale hydropower.

4. TIDAL ENERGY **6**

Introduction-origin of tides-power generation schemes-Wave Energy-Introduction-basic theory-wave power devices

5. OTHER RENEWABLE ENERGY SOURCES **9**

Introduction-Open and Closed OTEC cycles-biophotolysis-Ocean Currents-Salinity Gradient Devices-Environmental Aspects-Potential impacts of harnessing the different renewable energy resources.

Total No of periods: 45

EY056 Renewable Energy Systems **3** **0** **0** **100**

References:

1. A.Duffie and W.A.Beckmann, Solar Engineering of Thermal Processes-John Wiley (1980)
2. F.Kreith and J.F.Kreider, Principles of Solar Engineering , McGraw-Hill (1978)
3. T.N.Veziroglu, Alternative Energy Sources, Vol 5 and 6, McGraw-Hill (1978)

Websites:

1. http ://www.solstice.crest.orgl
2. http ://www.res-.ltd-com
3. http ://www.mnes.mic.in
4. http ://www.ireada.org
5. http://sundancepower.com

EY057 Fuels and Combustion **3 0 0 100**

1. INTRODUCTION **9**

General, Conventional Energy Sources, Solar Energy, Nuclear Power, Energy from Biomass, Wind Power, Tidal Power, Geothermal Energy, Energy Survey of India, Rocket Fuels

2. SOLID, LIQUID & GASEOUS FUELS **12**

General, Family of Coal, Origin of Coal, Gasification of Coal, Analysis and Properties of Coal, Action of Heat on Coal, Classification of Coal, Oxidation of Coal, Hydrogenation of Coal, Efficient use of Solid Fuels. Manufactured Fuels, Agro Fuels, Solid Fuel Handling, Properties Related to Combustion, Handling Storage

Origin and Classification of Petroleum, Refining and Other Conversion Processes, Composition of Petroleum with respect to Combustion, Property & Testing of Petroleum Products, Various Petroleum Products, Nature of Indian Crudes & Petroleum Refining in India, Liquid Fuels from Other Sources, Storage and Handling of Liquid Fuels, Liquid Fuels Combustion Equipment

Types of Gaseous Fuels, Natural Gases, Methane from Coal Mines, Manufactured Gases, Producer Gas, Water Gas, Carburetted Water Gas, Blast Furnace Gas

Fuels, Through Non-Thermal Route - Biogas, Refinery Gas, LPG, Cleaning and Purification of Gaseous Fuels.

3. THEORY OF COMBUSTION PROCESS **9**

Stoichiometry and Thermodynamics, Combustion Stoichiometry General, Rapid Methods of Combustion Stoichiometry, Combustion Thermodynamics, Problem, Combustion Problems with Chemical Reactions Burners

4. STOICHIOMETRY **7**

Stoichiometry Relations, Theoretical Air Required for Complete Combustion, Calculation of Minimum Amount of Air Required for a Fuel of known Composition, Calculation of Dry Flue Gases if Fuel Composition is Known, Calculation of the Composition of Fuel & Excess Air Supplied,from Exhaust Gas Analysis, Dew Point of Products, Flue Gas Analysis (O 2, CO 2, CO, NO x, SO x).

5. BURNER DESIGN **8**

Ignition, Concept of Ignition, Auto Ignition, Ignition Temperature. Flame Propagation, Various Methods of Flame Stabilization, Incorporation in Burner Design, Basic Features and Types of Solid, Liquid and Gaseous Fuel Burner, Design Consideration of Different Types of Coal - Oil and Gas Burners, Recuperative & Regenerative Burners

Total No of periods: 45

EY057 Fuels and Combustion **3** **0** **0** **100**

References books:

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
2. Bhatt ,vora Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 1984
3. Blokh AG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988
4. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966
5. Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984

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1. http ://shop.ieee.org.
2. http ://opus.utah.edu
3. http ://www.creada..org

IC034	**Computational Fluid Dynamics**	**3**	**0**	**0**	**100**

1. GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

2. CONDUCTION HEAT TRANSFER 10

Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

3. INCOMPRESSIBLE FLUID FLOW 10

Governing Equations, Stream Function - Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite deference approach.

4. CONVECTION HEAT TRANSFER AND FEM 10

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 heat conduction by FEM - Incompressible flow - Simulation by FEM.

5. TURBULENCE MODELS 5

Algebraic Models - One equation model, K-I Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

Total No of periods: 45

References:

1. Muralidhar, K.,and Sundararajan,T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House ,New Delhi1995.
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 Ltd.,U.K.1981.
5. Anderson, D.A.,Tannehill, I.I., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, Hemishphere Publishing Corporation, New York, USA, 1984.
6. Fletcher, C.A.J.,"Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer-Verlag,1987.
7. Flectcher, C.A.J., "Computational Techniques for Different Flow Categories, Springer-Verlage 1987.
8. Bose,T.K.,"Numerical Fluid Dynamics" Narosa Publishing House, 1997.

IC036 Finite Element Methods in Thermal Engineering 3 0 0 100

1. INTRODUCTION 5

Overview of numerical methods - Discretised representation of physical systems - thermal resistance, flow resistance networks, thermal capacitance - Governing equations and Boundary conditions for thermal and flow systems.

2. ONE DIMENTIONAL HEAT CONDUCTION 7

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

3. HEAT FUNCTIONS AND ANALYSIS 8

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 - incorporation of variations in thermal properties.

4. CONVECTIVE HEAT TRANSFER 10

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

5. HEAT EXCHANGER APPLICATIONS 10

Incompressible laminar flow simulation - Stream function/Vorticity methods,Velocity Pressure formulation, mixed order interpolation for incompressible flow,modifications for turbulent flow. Application to heat exchanger.

6. SOFTWARE CODES 5

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

Total No of periods: 45

IC036 Finite Element Methods in Thermal Engineering 3 0 0 100

References:

1. The Finite Element Method in Engg., 2nd ed. S.S.Rao Pergamon Press, 1990.
2. Applied Finite Element Analysis, 2nd ed, Larry Segerlind John Wiley & Sons, 1988.
3. Finite Element Analysis Theory and Programming 2nd ed, C.S.Krishnamoorthy, Tata McGraw-Hill 1991.
4. Finite Elements Methods, J.N.Reddy, McGraw-Hill 1988.
5. Finite Element Methods O.C.Zienkiewiez, McGraw-Hill 1980.
6. Introduction to Finite Elements in Engg., T.R.Chandrapatla and Belegundu, Prentice Hall of India.
7. Finite Element Computational Fluid Mechanics - A.J.Baker, McGraw-Hill.

IC037 Gas Turbines **3 0 0 100**

1. INTRODUCTION **12**

Power plant cycles for stationary and aerospace applications, component behaviours, analysis of ramjet, turbojet and turbo-propeller. Inlets and nozzels.

2. COMPRESSORS **10**

Centrifugal and axial flow compressors momentum and energy transfer in rotors, velocity diagrams, stage performance, compressibility effects, cascade testing and characteristics.

3. AXIAL AND RADIAL FLOW TURBINE **10**

Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics.

4. COMBUSTORS **8**

Different types and flow pattern, material requirement and cooling systems, air pollution and reduction.

5. MATCHING **5**

Matching procedure of power plant components, engine off-design performance.

Total No of periods: 45

IC037 Gas Turbines **3 0 0 100**

References:

1. Cohen, H., Rogers, G.E.C., and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman Group Ltd, 1989.
2. Gordon C, Dates, Aero-thermodynamics of Gas Turbine and Rocket Propulsion AIAA Education Series, NY 1984.
3. Kerrebrock, J.L., Aircraft Engines and gas turbines, The MIT Press.
4. Yahya, S.H. Turbines, compressors and Fans, Tata McGraw-Hill, 1983.
5. Earl Logan, Jr., Handbook of Turbomachinery, Marcel Dekker, Inc., USA, 1992.
6. Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbomachinery, Pergamon Press, 1978.
7. Ganesan, V., Gas Turbines, Tata McGraw-Hill Pub.Co.Ltd., New Delhi, 1999.

IC039	**Jet and Rocket Propulsion**	**3**	**0**	**0**	**100**

1. THERMODYNAMICS OF AIRCRAFT JET ENGINES **10**

Theory of Jet Propulsion - Thrust and efficiency - Ram Jet - Turbojet and Turbofan engines - Turboprop and Turboshaft Engines - Thrust augmentations - Typical engine performance - Engine - Aircraft matching.

2. AERO-THERMODYNAMICS OF JET PROPULSION SUBSYSTEMS **10**

Subsonic inlets - Supersonic inlets - Gas turbine combustors - After burners and Ramjet Combustors - Supersonic Combustion - Exhaust Nozzles.

3. PERFORMANCE OF ROCKET VEHICLES **8**

Static performance - Vehicle acceleration - Chemical rockets - Electrical rocket vehicles - Space missions.

4. CHEMICAL ROCKET THRUST CHAMBERS **7**

Performance Characteristics - Nozzles - Rocket Heat Transfer - Liquid Propellant Rocket Performance.

5. CHEMICAL ROCKET PROPELLANT COMBUSTION & EXPANSION **10**

Liquid propellants - Equilibrium composition - Non equilibrium expansion - Liquid - Propellant combustion chambers - Combustion Instabilities.

Total No of periods: 45

IC039 Jet and Rocket Propulsion **3 0 0 100**

References:

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition - Wesley Publishing Company, New York, 1992.
2. Zucrow N.J. Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons Inc, New York, 1970.
3. Zucrow N.J. Aircraft and Missile Propulsion, Vol.I and Vol.II, John Wiley and Sons Inc, New York, 1975.
4. Bonney E.A. Zucrow N.J. Principles of Guided Missile Design, Van Nostranc Co., 1985.
5. S.M. Yahya, Gas Dynamics and Jet Propulsion.

IC042 Simulation of I.C. Engine Processes **3 0 0 100**

1. INTRODUCTION **5**

Simulation principles - Simulation exercises using computers. Validation of models.

2. COMBUSTION PROCESS - GENERAL **10**

Heat of reaction - Adiabatic flame temperature - Temperature change due to fuel vapourisation.

3. COMBUSTION AND HEAT TRANSFER IN ENGINES **10**

Combustion in diesel engines - Heat transfer in engines -Heat transfer correlations.

4. S.I. ENGINE SIMULATION **10**

Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Exhaust and intake process analysis.

5. TWO STROKE ENGINE SIMULATION **10**

Engine and porting geometry, gas flow, Scavenging.

Total No of periods: 45

IC042 Simulation of I.C. Engine Processes **3 0 0 100**

References:

1. Ashley S.Campbell, Thermodynamic Analysis of Combustion Engines, John Wiley and Sons, 1980.
2. V.Ganesan, Computer Simulation of Spark Ignition Engine Processes, Universities Press, 1995.
3. Gordon P.Blair, The Basic Design of two-stroke engines, SAE Publication, 1990.
4. Horlock and Winterbone, The Thermodynamics and Gas Dynamics of Internal Combustion Engines, Vol.I & II, Clarendon Press, 1986.
5. J.I.Ramos, Internal Combustion Engine Modeling. Hemisphere Publishing Corporation, 1989.
6. J.N.Mattavi and C.A.Amann, Combustion Modeling in Reciprocating Engines, Plenum Press, 1980.

IC043	**Speciality Engines**	**3**	**0**	**0**	**100**

1. INTRODUCTION **10**

The design features of Automotive, Locomotive, Marine, Stationary and Generator - set engines.

2. S.I.ENGINE SYSTEMS **10**

Spark ignition engine system variants - Stoichiometric, Lean-burn, port injected/direct injected, carburetted, Air assisted fuel injection engines, HEV Engines. IIIustrations - Honda CVCC, Toyota Prius, Orbital Engine etc. Rotary Piston Engines, Dedicated alternative fueled engine sytems - CNG, LPG, H2, Alcohols.

3. C.I.ENGINE SYSTEMS **10**

Compression ignition engines system variants - Low, Medium and High speed sytem characteristics, High pressure fuel injection systems, Homogeneous Charge Compression Ignition systems, Dual and dedicated alternate fueled engine systems, coal and producer gas fueled engine systems, cogeneration system, Total engine systems.

4. SPECIAL PURPOSE ENGINE SYSTEMS **10**

Engines for special applications - Mining Defence, Off-highway -Tractor, Bulldozer etc. Submarines, Race car engine systems, Flexible fueled systems.

5. LIFE CYCLE ANALYSES OF ENGINE SYSTEMS **5**

Endurance Tests - Continous and Intermittent Tests - Full and Part Throttle Testing of Engines - Simulation of life cycle Analysis using computer system softwares.

Total No of periods: 45

IC043 Speciality Engines **3 0 0 100**

References:

1. The Wankel Engine - Design, Development, Application, Jan P.Norbye, Chilton Book Company, USA, 1971.
2. Introduction to Internal Combustion Engines, Richard Stone, Third Edition , Society of Automotive Engineers Inc, USA, 1999.
3. Diesel Engine References Book, Bernard Challen and Rodica Baranescu (Editors) 2nd Edition, R - 183, SAE International, 1999.
4. Some Unusual Engines, L.J.K.Setright, Mechanical Engineering Publication Ltd., UK, 1975.
5. The Wankel R C Engine, R.F.Ansdale, A.S.Barnes & Co., USA, 1969.
6. Bosch Technical Instruction Booklets,Robert Bosch Gmbh, Germany, 1985.

IC045 Diesel Emission Characteristics **3 0 0 100**

1. DIESEL EMISSION CHARACTERISTICS **9**

Vehicle emission Test Programme - Effect of ambient Temperature on "HC" , "OC" and emission - Different fuel system.

2. EFFECT OF HIGH PRESSURE INJECTION ON SOOT FORMATION PROCESS **9**

High Pressure Injection - Experimental apparatus and measuring principles - Measurement of Non-Evaporating spray - Measurement of Evaporating spray and flame.

3. DIESEL SOOT SUPPRESSION **9**

Soot Suppression by kind and content of fuel additives - Under various operating conditions - Effect of combustion chamber type and swirl ratio.

4. SIMULTANEOUS REDUCTION OF SOOT AND NOx **9**

Experimental procedure - Steady state and test cycle - Transient test cycle.

5. EFFECTS OF DIESEL FUEL PROPERTY ON EXHAUST VALVE STICKING **9**

Test engine bench - Test fuel engine - ignition limit test - Investigation of white smoke - Measurement of valve sticking force - Valve Train fracture test.

Total No of periods: 45

IC045 Diesel Emission Characteristics **3 0 0 100**

References :

1. Satora, Yasuhiro Iton Gutaka Higuchi and Tateo Nagai, SAE - 901608.
2. SW Cootes and G.G.Lassanska, SAE - 901597.
3. G.Greeves and CHT Wang, SAE - 810260
4. Yuzo.Aoyagi, Takeyuki Kamimoto Yokio Matsui and Shim Matsuoka, SAE - 800254.
5. Jeggetg cinoebtes and John H.Johnson, SAE - 790815
6. Harvet A. Bybket and Thoedore L.Rjosebrock, SAE - 790923
7. Charles M.Urban and Robert D.Waner, SAE - 850147.

IC046 Modelling of C.I.Engine Processes **3 0 0 100**

1. GENERAL CONSIDERATIONS OF MODELING **5**

Governing equations, conservation of mass, conservation of energy, second law Analysis, Numerical methodology, computing mesh, Discretisation, Grid Formation.

2. SPRAY MODELING **5**

Spray equation Models, Thin spray models, Thick Spray Models, Droplet turbulence interactions, Droplet impingement on walls.

3. IN-CYLINDER FLOW MODELING **10**

Full Field Model, K-e Model, laminar flow modeling, probability density functions, Ekman layers roll-up vortex, vortex structures. Compression generated turbulence, effective viscosity, turbulent diffusivity.

4. INTRODUCTION TO COMBUSTION MODELING **10**

Classification, zero-dimensional modeling, quasi-dimensional modeling, multidimensional modeling, comparison of different combustion systems, combustion efficiency, applications

5. COMBUSTION MODELS **15**

Multi zone Models, Kono's model, Cummins engine model, Hiroyasu's model,. Single zone models, Premixed diffusive models, Heat Transfer Cp-relations, Weibe's function analysis, Whitehouse-way model, Two zone models, Mathematical modeling of Catalytic converters, one dimensional model- 2D axi-symmetric model of monolithic reactor, Computation of chemical reactions, two dimensional transient temperature field.

Total No of periods: 45

IC046 Modelling of C.I.Engine Processes **3 0 0 100**

References :

1. *J.I.Ramos "Internal Combustion Engine Modeling" Hemisphere Publishing Corporation, 1989.*
2. *James N.Mattavi and Charles A.Amann "Combustion Modeling in Reciprocaating Engines". Plenum Press - 1980.*
3. *John.B.Heywood, "Internal Combustion Engine Fundamentals" McGraw-Hill International Editions, Automotive technology Series, 1988.*
4. *Pkandylas,G.C.Koltsakis and A.M.Stamatelos "Mathematical Modeling of Precious Metals Catalytic Converters for Diesel Nox Reduction". Proc.Institution of Mechanical Engineers Vol. 213 Pard D.*
5. *Sandeep Maju, Robert I.Sager.Jr., and Benny J.Srider, "Predicting Durability" Mechanical Engineering Vol. 64, March 1999.*
6. *A.J.Baxendale "Computational Fluid Dynamics in Exhaust System Design and Development", SAE Paper No. 931072, 1993.*

RA032 Cryogenic Engineering **3 0 0 100**

1. INTRODUCTION **5**

Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures.

2. LIQUEFACTION CYCLES **10**

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle, Dual Cycle, Helium Regrigerated Hydrogen Liquefaction Systems. Crtical components in Liquefaction Systems

3. SEPARATION OF CRYOGENIC GASES **10**

Binary Mixtures, T-C and H-C. Diagrams, Principle of Rectification, Rectification Column Analysis - McCabe Thiele Method. Adsorption Systems for purification

4. CRYOGENIC REFRIGERATORS **10**

J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators.

5. HANDLING OF CRYOGENS **5**

Cryogenic Dewar Construction and Design, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Different Types of Vacuum Pumps, Instrumentation to measure Flow, Level and Temperature.

6. APPLICATIONS **5**

Applications of Cryogenics in Space Programmes, Superconductivity, Cryo Metallurgy, Medical applications.

Total No of periods: 45

RA032 Cryogenic Engineering **3 0 0 100**

References :

1. *Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.*
2. *Randall F.Barron, Cryogenic Systems, McGraw Hill, 1985.*
3. *Scott R.B., Cryogenic Engineering, Van Nostrand and Co., 1962.*
4. *Herald Weinstock, Cryogenic Technology, 1969.*
5. *Robert W.Vance, Cryogenic Technology, Johnwiley & Sons, Inc., New York, London.*
6. *http://www.wiley-vch.de/contents/ullmann/ull_10211.html.*
7. *http://www.onecryo.com*
8. *http://www.caddet-ee.org/search/produce.cfm?ID=R072*
9. *http://www.sumkasons.20m.com/In2.htm*
10. *http//www.thtcryogenics.freeserve.co.uk/cryogenics.htm*

RA033	**Sorption Refrigeration Systems**	**3**	**0**	**0**	**100**

1. INTRODUCTION **10**

Carnot Cycle - Abosrption Refrigeration System - Heat Pump - Heat Transformer - Working Fluids - Analytical Perspective-Graphical Perspective-Thermodynamic Processes with Mixtures.

2. LIQUID SORPTION SYSTEMS **12**

Single Effect/Double Effect Systems - Types - Analysis - Advanced Cycles

3. SOLID SORPTION SYSTEM **10**

Diffusion Absorption Cycle - Solid Sorption Systems - Working Fluids - Single and Multi Effect Systems - Metal Hydride Heating and Cooling Systems

4. COMPONENTS DESIGN **8**

Generator - Absorber - Condenser - Evaporator - Solution Heat Exchanger - Reactors - System Balance

5. APPLICATIONS **5**

Energy Storage - Cogeneration - Solar Cooling - Low Level Heat Utilisation - Economics of Sorption Systems - Environmental Factors in Sorption Refrigeration Systems.

Total No of periods: 45

RA033 Sorption Refrigeration Systems **3 0 0 100**

REFERENCES:

1. K.E.Herold, R.Radermacher and S.A.Klein, Absorption Chillers and Heat Pumps, CRC Press, London (1996).
2. G.Alefeld and R.Radermacher, Heat Conversion Systems, CRC PRess, London (1994)
3. www.ashrae.org
4. www.iir.org

RA034 Food Processing Perservation and Transport **3 0 0 100**

1. INTRODUCTION **12**

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

2. PROCESSING AND PRESERVATION **10**

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

3. FREEZING AND DRYING **8**

Precooling, Quick Freezing, Freeze Drying Principles, Techniques and Equipments. Cold Storage and Freezers. Freezing and Drying Limitations. Irradiation Techniques. Food Preserving Techniques for Remote Areas.

4. COLD STORAGE DESIGN AND INSTRUMENTATION **10**

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

5. TRANSPORT **5**

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

Total No of periods: 45

RA034 Food Processing Perservation and Transport 3 0 0 100

REFERENCES :

1. *Alan Rodes, Principles of Industrial Microbiology, Pregmon International Pub., 1989.*
2. *Ibrahim 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 Airconditioning 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.
7. *http://microbiol.org/vlmicro/vl_food.htm*
8. *http://www.howstuffowrks.com/food-preservation.htm*
9. *http://www.fao.org.wfs/final/e/volumed/t/a-e.htm*
10. *http://www.iifiir.org*

RA035	**Refrigeration Machinery and Components**	**3**	**0**	**0**	**100**

1. REFRIGERATION SYSTEM COMPONENTS **12**

Refrigeration Compressors, Different Types, Performance, Capacity Control - Evaporators, Evaporator Circuitry, Applications and Different Types - Condensers, Types, Evaporative Condenser, Optimum Cooling Water Rate and Velocity, Cooling Towers, Range and Approach, Air Washers, Spray Ponds, Natural and Induced Draught System-Expansion Devices.

2. COMPONENTS TESTING AS Per (BIS CODES) **10**

Testing of Condensers and Evaporators, Testing of Cold Storages - Code of Practice for Fire Safety in General Storage. Specification and Testing of Room Airconditioners.

3. AIR CONDITIONING EQUIPMENTS & ACCESSORIES **6**

Construction Details of Room Air Conditioner - Window Type, Package Type, Split Type, Central Units - Air Distribution Devices - Air Circuits - Air Supply System .

4. APPLICATIONS OF AIR CONDITIONING **9**

Air Conditioning in Automobiles, Railway Wagons, Marine Vessels, Aircraft and other Commercial Applications.

5. REFRIGERATION ACCESSORIES & CONTROL **8**

Piping System, Valves, Receivers, Oil Trap, Oil Regenerators, Driers and Strainers. Control System of Temperature, Pressure, Oil Flow, Compressor Motor - Protection Devices.

Total No of periods: 45

RA035 Refrigeration Machinery and Components 3 0 0 100

REFERENCES:

1. Dossat, R.J. "Principles of Refrigeration", John Wiley & Sons, 1989.
2. Hains, J.B. "Automoatic Control of Heating & Airconditioning" Mc Graw Hill, 1981.
3. Althouse, 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 (Fundamentals & Equipments)
6. Cooper & Williams, B. "Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting" Eagle Wood Cliffs (NT) Prentice Hall, 1989.
7. htt://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://www.confex.com/store/ashrase/index-features.html

RA036	**Thermal Energy Systems**	**3**	**0**	**0**	**100**

1. DESIGN OF THERMAL SYSTEM **5**

Design Principles, Workable systems, Optimal systems, Matching of system components, Economic analysis, Depreciation, Gradient present worth factor

2. MATHEMATICAL MODELLING **5**

Equation fitting, Nomography, Emperical equation, Regression analysis, Different modes of mathematical models, selection, computer programmes for models.

3. MODELLING THERMAL EQUIPMENTS **10**

Modelling heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

4. SYSTEMS OPTIMIZATION **20**

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

5. DYNAMIC BEHAVIOUR OF THERMAL SYSTEM **5**

Steady state simulation, Laplace transformation, Feedback control loops, Stability analysis, Non-linearties.

Total No of periods: 45

RA036 Thermal Energy Systems **3 0 0 100**

References :

1. *J.N.Kapur, Mathematical Modelling, Wiley Eastern Ltd., New York, 1989.*
2. *W.F. Stoecker, Design of Thermal Systems, McGraw Hill, 1980.*
3. *W.F. Stoecker, Refrigeration and Airconditioning, TMH, 1985.*
4. *Fanger P.O., Thermal Comport, McGraw Hill, USA 1972.*
5. *McQuiston FC & Parker TD, Heating, Ventilating and Air conditioning, Analysis and Design, John Wiley & Sons, USA 1988.*
6. *http;//www.engr.usak.ca/dept/mee/research/thermal_fluid.html*
7. *http://at.yorku.ca/cgi-bin/amca/cadl-26*
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RA039	**Fans, Blowers and Compressors**	**3**	**0**	**0**	**100**

1. PRINCIPLES OF TURBO MACHINERY **10**

Introduction to turbo machines - Transfer of energy to fluids - Performance charcteristics - fan laws - Dimensionless parameters - Specific speed - selection of centrifugal, axial, mixed flow, Axial flow machines.

2. ANALYSIS OF CENTRIFUGAL BLOWER **10**

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

3. ANALYSIS OF AXIAL FLOW **10**

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.

4. TESTING AND CONTROL OF FANS **5**

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

5. DESING AND APPLICATIONS OF BLOWERS **10**

Special design and applications of blower, induced and forced draft fans for airconditioning plants, cooling towers, ventilation systems, booster sytems.

Total No of periods: 45

RA039 Fans, Blowers and Compressors **3** **0** **0** **100**

References:

1. Stepanoff A.J. Turboblowers, John Wiley & sons, 1970.
2. Brunoeck, Fans, Pergamon Press, 1973.
3. Austin H. Chruch, 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.
6. http://www.petropager.com
7. http://www.tami.org
8. http://www.erichson.com
9. http://www.apgate.com