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

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

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

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

IC131 Advanced Thermodynamics **3 1 0 100**

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

MA148 Applied Mathematics for Mechanical Engineers 3 1 0 100

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.

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.*

EY142 Energy Modelling, Economics and Project Management 3 0 0 100

1. MODELS AND MODELING APPROACHES 7

Macroeconomic Concepts - Measurement of National Output - Investment Planning and Pricing - Economics of Energy Sources - Reserves and Cost Estimation.

2. INPUT OUTPUT ANALYSIS 10

Multiplier Analysis - Energy and Environmental Input / Output Analysis - Energy Aggregation -Econometric Energy Demand Modeling - Overview of Econometric Methods.

3. ENERGY DEMAND ANALYSIS AND FORECASTING 8

Methodology of Energy Demand Analysis - Methodology for Energy Technology Forecasting -Methodology for Energy Forecasting - Sectoral Energy Demand Forecasting.

4. ECONOMICS OF STANDALONE POWER SUPPLY SYSTEMS 10

Solar Energy - Biomass Energy - Wind Energy and other Renewable Sources of Energy -Economics of Waste Heat Recovery and Cogeneration - Energy Conservation Economics.

5. PROJECT MANAGEMENT-FINANCIAL ACCOUNTING 10

Cost Analysis - Budgetary Control - Financial Management - Techniques for Project Evaluation.

Total No of periods: 45

EY142 Energy Modelling, Economics and Project Management 3 0 0 100

References:

1. *M.Munasinghe and P.Meier (1993): Energy Policy Analysis and Modeling, Cambridge University Press.*
2. *W.A.Donnelly (1987): The Econometrics of Energy Demand: A Survey of Applications, New York.*
3. *S.Pindyck and Daniel L.Rubinfeld (1990): Econometrics Models and Economic Forecasts, 3rd edition MC Graw -Hill, New York.*
4. *UN-ESCAP (1991): Sectoral Energy Demand Studies: Application of the END-USE Approach to Asian Countries, New York.*
5. *UN-ESCAP (1996): Guide Book on Energy -Environment Planning in Developing Countries: Methodological Guide on Economic Sustainability and Environmental Betterment Through Energy Savings and Fuel Switching in Developing Countries, New York.*
6. *S.Makridakis , Wiley(1983): Forecasting Methods and Applications.*

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.

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

EY036	**Bio-Energy Conversion Technologies**	**3**	**0**	**0**	**100**

1. INTRODUCTION **5**

Bio Energy - Bio Conversion Mechanism - Utilization of Photosynthate

2. THERMAL BIOMASS CONVERSION **10**

Combustion, Pyrolysis, Gasification and Liguefaction - Biological Conversion - Methoanl, Ethanol Production - Fermention - Anaerobic Digestion Biodegradation and Biodegradability of Substrate - Hydrogen Generation from Algae - Biological Pathways

3. POWER GENERATION TECHNIQUES **20**

Through Fermentation and Gasification - Biomass Production from differnet Oragnic Wastes - Effect of Additives on Biogas Yield - Biogas production from Dry Dung Cakes - Industrial Application - Viability of Energy Production - Wood Gasifier System, Operation of Spark Ignition and Compression Ignition with Wood Gas. Operation and Maintenance

4. ECONOMICS AND ENVIRONMENTAL ASPECTS **10**

Energy Effectives and Cost Effectiveness - History of Energy Consumption and Cost - Environmental Aspects of Bioenergy Conversion.

Total No of periods: 45

EY036 Bio-Energy Conversion Technologies **3** **0** **0** **100**

Reference books:

1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood, Chichester, 1984
2. Khandelwal KC, Mahdi SS, Biogas Technology - A Practical Handbook, Tata McGraw Hill, 1986
3. R.C.Maheswari, Bio Energy for Rural Energisation , Concepts Publication, 1997
4. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, New York, 1980
5. EL - Halwagi MM, Biogas Technology : Transfer & Diffusio, Elsevier Applied SC, London 1986

Websites
1. http://www.bio-energy.at
2. http://www.abchansen.dk.
3. www.soest.hawaii.edu/csf

EY037 Nuclear Engineering	**3**	**0**	**0**	**100**

1. NUCLEAR REACTIONS **9**

Mechanism of Nuclear Fission - Nuclides - Radioactivity - Decay Chains - Neutron Reactions - the Fission Process - Reactors - Types of Fast Breeding Reactor - Design and Construction of Nuclear reactors - Heat Transfer Techniques in Nuclear Reactors - Reactor Shielding.

2. REACTOR MATERIALS **9**

Nuclear Fuel Cycles - Characteristics of Nuclear Fuels - Uranium - Production and Purification of Uranium - Conversion to UF4 and UF6 - Other Fuels like Zirconium, Thorium - Berylium.

3. REPROCESSIG **9**

Nuclear Fuel Cycles - Spent Fule Characteristics - Role of Solvent Extraction in Reprocss ing - Solvent Extraction Equipment.

4. SEPARTION OF REACTOR PRODUCTS **9**

Processes to be Considered - 'Fuel Element' Dissolution - Precipitation Process - Ion Exchange - Redox - Purex - TTA - Chelation -U235 -Hexone - TBP and Thorax Processes - Oxidative Slaging and Electro - Refinng - Isotopes - Principles of Isotope Separation.

5. WASTE DISPOSAL AND RADIATION PROTECTION **9**

Types of Nuclear Wastes - Safety Control and Pollution Control and Abatement - International Convention on Safety Aspects - Radiation Hazards Prevention.

Total No of periods: 45

EY037 Nuclear Engineering **3 0 0 100**

Reference books:

1. J.R.Lamarsh, Introduction to Nuclear Reactor Theroy, Wesley, 1966
2. J.J.Duderstadt and L.J.Hamiition, Nuclear Reactor Analysis - John Wiley 1976
3. A.E.Walter and A.B.Reynolds Fast Breeder Reactor, Pergamon Press - 1981
4. S.Glasstone and A.Sesonske, Nuclear Reactor Engineering (3 rd Edition), Von Nostrand, 1981.
5. R.H.S.Winterton, Thermal Design of Nuclear Reactors - Pergamon Press - 1981.

Websites
1. http://www.min.uc.edu
2. http://www.huc.Berkeley.edu
3.www.ne.doe.gov/

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

EY039 Hydropower Systems	3	0	0	100

1. INTRODUCTION **9**

Overview of Hydropower systems-Preliminary Investigation-Determination of Requirements-preparation of Reports and Estimates-Review of World Resources-Cost of Hydroelectric Power-Basic Factors in Economic Analysis of Hydropower projects-Project Feasibility-Load Prediction and Planned Development

2. DEVELOPMENT OF PROTOTYPE SYSTEMS **9**

Advances in Planning,Design and Construction of Hydroelectric Power Stations-Trends in Development of Generating Plant and Machinery-Plant Equipment for pumped Storage Schemes-Some aspects of Management and Operations-Uprating and Refurbishing of Turbines

3. POWER STATION OPERATION AND MAINTENANCE **9**

Governing of Power Turbines-Functions of Turbine Governor-Condition for Governor Stability-Surge Tank Oscillation and Speed Regulative Problem of Turbine Governing in Future

4. RESERVOIRS **9**

Problem of management-Maintenance of Civil Engineering works-Maintenance of Electrical Engineering works

5. DEVELOPMENT OF SOFTWARE **9**

Computer aided Hydropower System Analysi-Design-Execution-Testing-Operation and control of Monitoring of Hydropower Services

Total No of periods: 45

EY039 Hydropower Systems **3** **0** **0** **100**

References:

1. L.Monition,M.Lenir and J.Roux,Micro Hydro Electric Power Station(1984)
2. AlenR. Inversin,Micro Hydro Power Source Book(1986)
3. Tyler G.Hicks(1988),Power Plant Evaluation and Design

websites:
1. http://www.digiserve.com/inship
2. http://www.siemens.de
3. www.tva.gov/power

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

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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

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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

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

EY044 Power Generation, Transmission and Utilization **3 0 0 100**

1. CONVENTIONAL POWER GENERATION **10**

Steam power plant-Selection of site-Generated Layout-coal and Ash Handling-Steam Generating Plants-Feed Make Circuit-Cooling Towers-Turbine Governing-Hydro Power Plant-Selection of Site -Classification Layout Governing of Turbines-Nuclear Power Plants-Selection of Site -Classification Layout Governing of Turbines-Nuclear Power Plants-Selection of Site-Nuclear Fuels-nuclear reactors-nuclear disposal-Gas Turbine Plants

2. NON CONVENTIONAL POWER GENERATION **8**

Wind power generation-charecteristics of wind power-design of wind mills-Tidal power generation-Single and two basin systems-Turbines for tidal power -Solar power generation-Energy from biomass

3. ECONOMICS OF POWER GENERATION **8**

Daily load curves-load factor-diversity factor-load deviation curve-load management-number and size of generating unit cost of electrical energy-tariff-power factor improvement

4. ELECTRICAL POWER TRANSMISSION **9**

Online diagram of transmission-sub transmission and distribution systems-comparison of systems(DC and AC)-EHVAC and HVDC transmission-layout of substations and bus bar arrangements-Equivalents circuit of short,medium and large lines-Transmission efficiency-regulation-reactive power-compensation-transmission-loss minimisation

5. UTILISATION OF ELECTRICAL ENERGY **10**

Selection of Electrical Drives-Electrical charecteristics and mechanical considerations-size,rating and cost0-Transformer charecteristics-illumination-laws of ilumination-polar curve-incandascent-fluoroscent and vapour lamps-Design of OLTC lighting Scheme of industry-electrical welding-energy efficient aspects of devices

Total No of periods: 45

EY044 Power Generation, Transmission and Utilization 3 0 0 100

REFERENCES:

1. C.L.Wadhwa,Generation Distribution and utilization of Electrical Energy,Wiley Eastern Ltd.,India(1989)
2. V.A.Venikov and B.V. Put Yatin,Introduction of Energy Technology,Electric power Engineering,MIR Publishers,Moscow(1984)
3. M.L.Soni,P.VGupta and V.S.A.Bhatnagar,Course in Electrical Power,Dhanbat Rai & Sons,NewDelhi(1983)
4. J.W.Twidell and A.D.Weir,Renewable Energy Sources,ELBS Edition(1986)
5. A.J.Wood and B.F. Wallenberg(1986):Power Generation,Operation and Control,2nd Edition,JohnWiley &Sons,Newyork
6. E.Khan(1988):Electrical Utility Planning and Regulation,American Council for a n Energy Efficient Economy,Washington D.C

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2. http://www.igc.apc.org/awea
3. http://www.siemens.com
4. http://www.research.psu.edu

EY045 Electrical Drives and Controls	**3**	**0**	**0**	**100**

1. REVIEW OF CONVENTIONAL MOTOR DRIVES **10**

Characteristics of DC and AC motors for various applications-starting and speed control-methods of breaking.

2. PHYSICAL PHENOMENA IN ELECTRICAL MACHINES **10**

Various losses in motors-Saturation and Eddy current effects-mmf harmonics and their influence of leakage-stray losses-vibration and noise.

3. INTRODUCTION TO SOLID STATE POWER CONTROLLERS **10**

Power devices-Triggering Circuits-Rectifiers-Choppers-Inverters-AC Controllers

4. SUPERCONDUCTIVITY **9**

Super conducting generators-motors and magnets-Super conducting magnetic energy storage (SMES).

5. SOLID STATE MOTOR CONTROLLERS **6**

Single and Three Phase fed DC motor drives-AC motor drives-Voltage Control-Rotor resistance control-Frequency control-Slip Power Recovery scheme.

Total No of periods: 45

EY045 Electrical Drives and Controls **3 0 0 100**

Reference Books:

1. S.K. Pillai, A First Course on Electrical Drives, Wiley Eastern Ltd (1982).
2. S.B. Devwan, G.R. Slevnon, A.Strangher, Power Stream and Control Drives, John Wiley & Sons (1984).
3. Eedam subramanyan, Thyristor Control of Electrical Drives, Tata McGraw-Hill Co.Ltd.,(1988).
4. J.M.D. Murphy, F.G. Turnbull, ;Power Electronics: Control of AC Motors-Pergamon Press(1988).
5. C.G. Say-Introduction to the Theories of Electromagnetic Machines, Pitman (1971).
6. Rakesh Dal Begamudre-Electro Mechanical Energy Conversion with Dynamics of Machines - Wiley Eastern (1988).

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1. http://www.ascorinc.com
2. http://wwwsoltek.ca
3. http://www.siemens.com

EY046 Energy Conservation in Buildings and HVAC	**3**	**0**	**0**	**100**

1. CLIMATES AND BUILDINGS **9**

Thermal Properties and Energy content of Building materials - Psychrometry-Comfort conditions - Air conditioning Systems.

2. ESTIMATION OF BUILDING LOADS **9**

Steady state method-Network method- Numerical method-correlations-computer packages for carrying out thermal design of lbuildings and predicting performance.

3. EFFICIENT LIGHTING AND DAYLIGHTING **9**

Lighting and Visual ability-Light sources and Luminaries - Lighting System Design-Daylighting-Lighting Economics and aesthetics-Impacts of Lighting efficiency.

4. INDOOR ENVIRONMENTAL REQUIREMENT AND MANAGEMENT **9**

Thermal comfort-Ventilation and air quality-Air conditioning requirement- visual perception - illumination Requirement-Auditory requirement-Energy Management Options-Energy Audit and Energy Targeting-Technological Options for Energy Management.

5. ENERGY CONSERVATION IN AIR CONDITIONING SYSTEMS **9**

Cycles-Energy Conservation in pumps/fan/blowers-Refrigerating machines -Heat Rejection Equipment-Energy efficient motors-insulation.

Total No of periods: 45

Reference Books:

1. J.Krieder and A.Rabi (1994): Heating and Cooling of Buildings: Design for Efficiency McGraw-Hill.
2. M.S.Sodha, N.K. Bansal,P.K.Bansal, A.Kumar and M.A.S. Malik, Solar Passive Building, Science and Design, Pergamon Press (1986).
3. J.R. Williams, Passive Solar Heating, Ann Arbar Science (1983).
4. R.W. Jones, J.D. Balcomb, C.E. Kosiewiez, G.S. Lazarus, R.D.Mc Farland and W.O. Waray (1982),Passive Solar Design Handbook,Vol 3,Report of U.S. Department of Energy (DOE/CS-0127/3)
5. J.L.Thrikeld, Thermal Environmental Engineering, Prentice Hall (1976).
6. (1993):IES Lighting Handbook, Reference and Application Volume, IESNA.
7. Thumann (1992): Lighting Efficiency Applications, Fairmont Press.

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1. http ://www.climat.arch.ucl.ac.be
2. http ://www.21design.com
3. http ://www.ashrae.org
4. www.log-one.com

EY047	**Chemical Process Technology**	**3**	**0**	**0**	**100**

1. INTRODUCTIN **8**

Raw Materials and Energy Supply for Chemical Process Industries - Principal Chemical Conversion Processes & General Characteristics, Units Operations, Flow Charts, Plant Layout, Mass and Energy Balances

2. PROCESS INDUSTRY **5**

Chlor - Alkali Industries, Electro Chemical Industries & Cement Industries

3. FERTILIZER INDUSTRY **9**

Feed stocks for the production of ammonia, nitrogenous fertilizers, Phosphatic Fertilizers, Potassium Fertilizers, NPK Fertilizer

4. ORGANIC INDUSTRY **15**

Phosphoric & Phosphoric Acid, Ammonia & Nitric Acid, Sulphuric and Hydrochlonic Acid Industries. Food Processing, Oil and Fats, Sugar ans Starch, Alcohol, Pulp & Paper Industries, Paints & Varnishes

5. PETROLEUM TECHNOLOGY **8**

Key Petroleum Products, Crude Oil Fractionations, Destructive Petroleum Processing Purification of Petroleum Products - Environmental Abatement in Petroleum Refining

Total No of periods: 45

EY047 Chemical Process Technology **3 0 0 100**

Reference books:

1. Austin GT and Shrerve Chemical Process Industries V - Edition, McGraw Hill (1984)
2. Hand Book of Fertilizer Technology - Rantumen Associates of India New Delhi - 1997
3. CE Dryden and GN Pandey - Outlines of Chemical Technology for the 21 st Century, Afffiliated East West Process, New Delhi (1973)
4. Van Den Berg, Introduction to Chemical Process Technology, Univ Press, Delft, 1980
5. James G, Chemistry & Technology of Petroleum, Marcel Dekker, New York, 1999

Wbsites:

1. http://www.chemicalprocessing.com
2. http://www.psicorp.com

EY048 Unit Operations in Chemical Engineering **3 0 0 100**

1. SIZE SEPERATION **5**

Introduction - Characterization of solid particles - Standard Screens - Screen Analysis - Types of screening Equipements - Air Separation Methods - Cyclone and Bag Filters - Size Separation by Setting - Laws of Setting - Classifers - Material Separation by difference in Density - Hindered Setting - working of a Thickener.

2. CRUSHING, GRINDING AND CONVEYING **10**

Various Laws of Crushing - Classification of Crushing and Grinding Machinery - coarse Crushers - Intermediate Crushers - fine Grinder - Jaw Crusher - Gyrator Crusher - Crushing Rolls - Hammer Mills - Ball and Tube Mills - Ultra Fine Grinders - closed circut Grinding - Grindibility Index - conveyors.

3. MIXING & FILTERATION **10**

Introduction - Mixing of Liquids/Liquids, Liquids/Gases, Liquids/Solids - Types of Mixers - Various Mixing Equipements - Power Requirments for an Impeller Mixer - Theory of Industrial Filteration - Constant Preassure and Constant Rate Filteration - Filter Aids - Filteration Equipments classification - Filter Presses - Heat Filters Rotary Drum Filter - Centrifuges.

4. EVAPORATION & HUMIDIFICATION **10**

Introduction - Diihrings Chart - Boiling Point Elevation - Capacity and Economy of Evaporators - Evaporators Classification - Short Tube and Long Tube Evaporators - Forced Circulation Evaporators - Forced Circulation Evaporators, Climbing and Falling Film Evaporators - Multiple Effect Evaporators - Evaporator Accessories - Defination - Adiabatic Saturation Temperature Humidity Chart - Wet Bulb Temperature and Measurment of Humidity - Spray Ponds and coling Tower Design.

5. DRYING & DISTILLATION **10**

Introduction - Drying Theory - Eqiuilibrium Moisture Content - Bound, Unbound, Free Moisture - Drying rate Curves - Constant Drying Rate - Falling Rate Period - Classification of Dryers - Tray Dryers - Rotary Dryer - Turbo Dryer - Cylinder Dryer - Festoon Dryer - Drum Dryer - Spray Dryer - Fluid Bed Dryer - Distillation Methods - Minimum Reflux Ratio - Total Reflux - Optimum Reflux Ratio - Steam Distillation Calculations - Ideal Plate - Actual Plate - Plate Efficiency Distillition column internals - Concept of Azeotropic and Extractive Distillation - Enthalpy Balance for a Continous Distillation - Enthalpy Balance for a Continuous Distillation column(for Binary Systems).

Total No of periods: 45

EY048 Unit Operations in Chemical Engineering **3** **0** **0** **100**

References:

1. *W.L.M.C. CABE and JC.SMITH - " Unit Operation of Chemical Engg. " - McGraw Hill, 1980.*
2. *W.L.BADGER and JT.BANCHERO, " Introduction to Chemical Engg. ", McGraw Hill, 1955.*
3. *J.M.COULSON and J.F.RICHARDSON - " Chemical Engg., Vol.2 and Vol.3 ", Oxford, 1996.*
4. *ALAN S.FOUST - " Principles of Unit Operations ", John Wiley, 1980.*

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1. *http://www.Chemisoft.on*
2. *http://www.Chemicalonline.com*

EY049 Transport Phenomena **3 0 0 100**

1. BASIC EQUATIONS OF FLOW **6**

Pressure - Kinetic & Datum Energy - Bernoulli's Theorem - Deduction of Bernoulli's Theorem - Eulers Equations for motion - Limitations of Bernoulli's Theorem - Practical Applications of Bernoulli's Theorem - Liquid jet & syphon - Momentum Equation - Forced and Free Vortex

2. REYNOLD'S ANALYSIS & BOUNDARY LAYER CONCEPT **13**

Reynold's Experiment - Laminar and Turbulent Flow -Reynold's Number - Navier Stoke's Equation of Motion - Laminar Flow between Parallel Plates - Waojuen - Poiseuille's Equation for Flow through Circular Pipes - Turbulence - Darcy Weisbach Equation for Flow Through Circular Pipe - Friction Factor - Smooth and Rough Pipes - Moody Diagram - Uses due to Contraction / Expansion etc., Pipes in Series & Parallel - Economical Diameter of Pipe Transmission of Power.

Boundary Layer - Displacement & Momentum Thickness - Laminar & Turbulent Boundary Layers in Flat Plates - Velocity Distribution in Turbulent Flows in Smooth and Rough Boundaries - Laminar Sub Layer

3. TRANSPORTATION OF FLUIDS, INTERPHASE AND MULTIPHASE MOMENTUM TRANSFER **12**

Types of Centrifugal and Reciprocating Pumps - Comparision of Centrifugal and Reciprocating Pumps. Industrial Pipe Systems - Selection of Fans, Blowers, Pumps and Compressors - Efficiency Prediction - Pressure Drop Characteristics - Friction Factor, Fluid - Fluid System Flow Patterns in Vertical and Horizontal Pipes. Formation of Bubbles and Drops and their Size Distribution, Solid - Fluid Systems - Forces acting on Stagnant and Moving Solids. Flow through Porous Medium. Capillary Tube Model and its Applications for Packed Bed and Filters, Fluidised Bed, Solid Fluid Conveying Settling and Sedimentation

4. INTERPHASE TRANSPORT IN NON-ISOTHERMAL SYSTEMS AND RADIATION HEAT TRANSFER **6**

Heat Transfer Co-efficient, Forced Convection in Tubes, around Submerged Objects, through Packed Beds. Heat Transfer by Free Convection, Film Type and Dropwise Condensation Equations for Heat Transfer Coefficients for both, Heat Transfer in Boiling Liquids

5. INTERPHASE MASS TRANSPORT AND MACROSCOPIC BALANCES FOR MULTICOMPONENT SYSTEM **8**

Mass transfer coefficient in one and two phases at low and high mass transfer rates, film theory penetration theory, boundary layer theory, fixed bed catalytic, reactor, macroscopic balances to solve steady and unsteady state problems

Total No of periods: 45

EY049 Transport Phenomena **3 0 0 100**

References:

1 .Bansal, Fluid Mechanics, Saurabh & Co., New Delhi, 1985
2. Arora KR, Fluid Mechanics, Hydraulics & Hydraulic Machines, Standard Publishers, New Delhi, 1976
3. Jagadish Lal, Hydraulics & Fluid Mechanics, 2nd Edition Revised & Enlarged, Metropolitan Book Co, New Delhi
4. P.N. Modi & SM Seth, Hydraulics & Fluid Mechanics, 8th Edition, Standard Book House, 1987
5. Natarajan MK, Principles of Fluid Mechanics, Oxford & IBH Publishers, 1984

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1. http ://www.gbhp.com
2. http ://www.owlnet.rice.edu

EY050	**Energy Conversion Techniques**	**3**	**0**	**0**	**100**

1. INTRODUCTION **5**

Enenrgy classification - sources - utilization - principle of energy conversion - biomass - solar energy

2. PRODUCTION OF THERMAL ENERGY AND MECHANICAL ENERGY **10**

Conversion of mechanical, electrial, electro magnetic and chemical energy - conversion of thermal energy - turbines - electromechanical conversion

3. PRODUCTION OF ELECTRICAL ENERGY **10**

Conversion of thermal energy into electricity - chemical energy into electricity - electro-magnetic energy into electricity - mechanical energy into electricity.

4. ENERGY STORAGE SYSTEMS **10**

Intoduction - storage of mechanical energy, electrical energy, chemical energy, thermal energy.

5. FUEL CELLS **10**

Thermodynamic and Kinetics of fuel cell processes - fuel cell performance - types of fuel cells - Advantages - fuel cell applications.

Total No of periods: 45

EY050 Energy Conversion Techniques **3 0 0 100**

References:

1. Archie.W.Culp,Principles of Energy Conversion,McGraw Hill Inc.,(1991),Singapore
2. K.Kordesch,G.Simader,Fuelcell and Their Applications,Wiley-Vch,Germany(1996)
3. M.A.Kettari,Direct Energy Conversion,Addison Wesley Pub.Co.(1997)
4. A.B. Hart and G.j.Womack,Fuel cells:Theory and Application,Prentice Hall,Newyork Ltd.,London(1989)

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2. http://www.iiec.org
3. http://www.alternativepower.com

EY051 Thermal Energy Systems **3 0 0 100**

1. REVIEW OF THEMAL PROCESS AND APPLICATIONS **9**

First and second law of thermodynamics-cycles-ideal gas mixtures and psychometry-Energy analysis and its use in design of energy system-Dead states and energyn components-Exergy balance for closed and control volume systems-applications of exergy analysis for selected energy system design

2. DESIGN OF WORKABLE SYSTEMS **9**

Methodology of engineering undertakings-distinction between workable and optimum systems-examples-Equation Fitting for charecterization of energy Equipments-Applications of equation fitting techniques for charecterization of energy proceses and techniques

3. MODELLING OF ENERGY EQUIPMENTS BASED UPON PHYSICAL LAWS **9**

Heat Exchanger -Solar collectors-Distillation and Rectifications-Information flow diagrams-Application of successive method and Newton Raphson Method to Energy Systems

4. OPTIMIZATION TECHNIQUES FOR ENRGY SYSTEMS AND HEAT EXCHANGE NETWORKS **9**

Selection of Mathematical Representation for Optimization Problems in Energy Systems-Applications ofmLagrange's Multipliers and Various search methods to Energy Systems,such as Waste Heat Recovery System-Refrigeration System s,etc.,Basic concepts of pinch technology & Stream Network-composite curves-maximum energy recovery-design of energy recovery systems

5. ENGINEERING ECONOMICS **9**

Cost analysis by present worth-annual cost-Evaluating potential Investments-Forecasting Techniques-Economic Factors in Energy Systems-Examples

Total No of periods: 45

EY051 Thermal Energy Systems **3** **0** **0** **100**

References:

1. W.F.Stocker(1989):Design of Thermal Systemas,McGraw Hill
2. B.Linhoff et al.(19840,User Guide on process intergration for the efficient use of energy
3. M.J.Moran and H.N.Shapiro(1988):Fundamentals of Enginering Thermodynamics
4. A.Bejan,G.Tsatsaronis and M.Moran (1996):Thermal Design and Optimization John Wiley & Sons

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1. http://www.ciemat.es
2. http://www.solrwall.com
3. www.tesgary.com

EY052 IT in Energy Management **3 0 0 100**

1. INTRODUCTION TO COMPUTER APPLICATION **9**

Programming languages - Introduction to Visual C++, C-Programming Design - Computer Organization.

2. INTRODUCTION TO COMPUTER BASED INFORMATION SYSTEM **9**

Types of CBIS - Relationship among CBIS system concepts and CBIS - general systems theory - Energy Management concepts and CBIS.

3. DATA BASE MANGEMENT SYSTEM **9**

Intelligence based system - energy data bases - networking - time sharing concepts.

4. SOFTWARE ENGINEERING **9**

The need for the scope of software engineering - survey of software life cycle models- Transform theory of software performance - network model of structured programs.

5. COMPUTER BASED MONITORING AND ONLINE CONTROL SYSTEM **9**

Data acquisition systems - expert based systems for energy management - Parallel Processing Concepts - Typical applications in energy managemnt area.

Total No of periods: 45

EY052 IT in Energy Management **3 0 0 100**

REFERENCE BOOKS:

1. Herbert Schildt-C/C++ Programmer's reference (2000), McGraw-Hill, New York.
2. David McMahon, Rapid Application Development with Visual C++(1999), McGraw-Hill, New York.
3. Gerrit Blaauw, Frederick Brooks, (1997), Computer Architecture:Concepts and Evolution, Addison Wesley.
4. Ian Sommerville, Software Engineering, 5/e, University of Lancaster, England (1996), Addison Wesley.
5. Peter Jackson, Introduction to Expert Systems, 3/e, addison Wesley(1998).
6. Peter Rob, Databases: Design, Development and Deployment with student CD (Pkg), McGraw-Hill, New York (1999).

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1. http://www.emd.dk
2. http://www.esd.uk
3. www.energymanagementsys.com

EY053 Computational Heat Transfer **3 0 0 100**

1. MATHEMATICAL DESCRIPTION OF PHYSICAL PHENOMENA **5**

Governing Differential Equation - Energy Equation - Momentum Equation - Nature of Co-ordinates - Discretization Methods

2. FINITE DIFFERENCE METHODS IN PARTIAL DIFFERENTIAL EQUATIONS **8**

Parabolic Equations - Explicit, Implicit and Crank Nicholson Methods. Finite Differences in Cartesian and Polar Co-ordinates. Local Truncation Error - Consistency Convergence - Stability - ADI Methods. Elliptic Equations - Laplace's Equation. Laplace's Equation in a Square - Non-rectangular Regions - Mixed Boundary Condition - Jacobi - Gauss-siedel and SOR Methods. Necessary and Sufficient Conditions for Iterative Methods

3. FINITE DIFFERENCE APPLICATIONS IN HEAT CONDITION AND CONVECTION **8**

Control Volume Approach - Steady and Unsteady One Dimensional Conduction - Two and Three Dimensional Situations - Solution Methodology. Convection and Diffusion : Upwind Scheme - Exponential Scheme. Hybrid Scheme - Power Law Scheme : Calculation of the Flow Field - Simpler Algorithm

4. FINITE ELEMENT METHOD CONCEPT **9**

General Applicability of the Method using one dimensional heat transfer equation - Approximate Analytical Solution - Raleigh's Method. Galerikin Method, Solution Methods

5. FINITE ELEMENT METHOD PACKAGES **15**

General Procedure - Discretisation of the domain - Interpolation Polynomials - Formulation of Element Characteristic Matrices and Vectors - Direct, Variational and Weighted - Residual Approach - Higher Order Isoparametric Element Formulations Conduction and Diffusion Equations - Heat Transfer Packages - Heat 2, HEATAX, RADIAT, ANSYS

Total No of periods: 45

EY053 Computational Heat Transfer **3** **0** **0** **100**

References:

1. *Suhas V.Patnakar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 1980*
2. *Jaluria and Torrance, Computational Heat Transfer - Faluria and Torrance, Hemisphere Publishing Corporation, 1986*
3. *A.R.Mitchell and D.F.Grifths, Finite Difference Method in Partial Differential Equations, John Wiley & Sons, 1980*
4. *S.S.Rao, The Finite Element Methode in Engineering, Pergamon Press - 1989*
5. *O.C. Zienkiewicz & R.L.Taylor, The Finite Element Method IV Edition - Vol. I & II, McGraw Hill International Edition, 1991*

Websites:

1 .http://www.fluent.com
2. http://chtol.mech.unsw.edu.au

EY054 Optimisation of Power Systems **3 0 0 100**

1. INTRODCUTION **9**

Operational problems of power systems-review of economic dispatch and loss formula calculations.

2. OPTIMAL POWER FLOW **9**

Formulation of OPF Problem-cost minimization-loss minimization-solution using NLP methods-successive LP methods.

3. HYDROTHERMAL COORDINATION **9**

Long Range and Short Range hydro scheduling-Short Term hydrothermal Scheduling-a gradient approach-solution method using iteration and dynamic programming.

4. UNIT COMMITMENT **9**

Constraints in Unitcommitment-thermal unit constraints-hydro constraints-solution methods-priority list methods-dynamic programming solution.

5. MAINTENANCE SCHEDULING **9**

Preparation of maintenance schedules for generating units-turbines-boilers-taking into account forced outages and normal outages-optimal maintenance scheduling using mathematical programming.

Total No of periods: 45

EY054 Optimisation of Power Systems **3 0 0 100**

REFERENCE BOOKS:

1. *Allen J.Wood and Bruce F.Wollenberg, "Power Generation Operation and Control", John Wiley & Sons NY & Singapore, (1984).*
2. *Murthy P.S.R., Power System Operation and Control, Tata McGraw-Hill Publishing Co., Ltd., New Delhi(1984)*

Web Sites :

1. *http://www.powerlight.com*
2. *http://www.tecsol.fr.*

EY055 Thermal Storage Systems **3 0 0 100**

1. INTRODUCTION **5**

Necessity of thermal storage-Energy storage devices-Types of storage system-Specific areas of application-Heat transfer enhancement methods.

2. SENSIBLE HEAT STORAGE SYSTEM **10**

Basic concepts and modeling of heat storage units Modeling of simple water and rock bed storage system-Use of TRNSYS-Pressurized water storage system for power plant applications-packed beds.

3. REGENERATORS **10**

Parallel flow and Counter flow Regenerators-Finite Conductivity model-Non-linear model-Transient performance-Step changes in inlet gas temperature-Step changes in gas flow rate-Parameterization of transient response-Heat storage exchangers.

4. LATENT HEAT STORAGE SYSTEMS **10**

Storage materials Modeling of phase change problems and solution methodologies-Enthalpy modeling-Heat transfer enhancement configuration-Parameterization of rectangular, cylindrical geometric problems.

5. APPLICATIONS **10**

Specific areas of application of energy storage-food preservation-waste heat recovery-Solar energy Storage-Green house heating-power plant applications-Drying and heating for process industries.

Total No of periods: 45

EY055 Thermal Storage Systems **3** **0** **0** **100**

References:

1. *F.W.Schmidt and A.J.Willmott, Thermal Storage and Regeneration, Hemisphere Publishing Corporation (1981).*
2. *V.J.Lunardini, Heat Transfer in Cold Climates, D.Van Nostrand,Reinhold,N.Y(1981).*
3. *Proc.1 st IEA Workshop on Phase Change Materials and Chemical Reaction for Thermal Energy Storage,Adana,Turkey,1998.*

Websites:

1. *http ://www.arcon.dk*
2. *http ://www.tata.com*

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.