M. Tech. DEGREE

ENERGY ENGINEERING

SYLLABUS

FOR

CREDIT BASED CURRICULUM

(2014 -2015)

CENTRE FOR ENERGY & ENVIRONMENTAL SCIENCE AND TECHNOLOGY (CEESAT)

NATIONAL INSTITUTE OF TECHNOLOGY

TIRUCHIRAPPALLI – 620 015

M.TECH. (ENERGY ENGINEERING)

The total credits required for completing the M.Tech Programme in Energy Engineering is 66

SEMESTER-I

Code	Course of Study	L	T	P	C
EN601	Energy Audit & Management	3	0	0	3
EN603	Environmental Engineering And Pollution Control	3	0	0	3
EN605	Solar Energy Utilization	3	0	0	3
	Elective-I	3	0	0	3
	Elective-II	3	0	0	3
	Elective-III	3	0	0	3
EN607	Environmental Engineering Laboratory	0	0	6	2
					20

SEMESTER-II

Code	Course of Study	L	T	P	C
EN602	Bio-Energy Technologies	3	0	0	3
EN604	Computational Fluid Dynamics	3	0	0	3
EN606	Wind Energy and Hydro Power Systems	3	0	0	3
	Elective-IV	3	0	0	3
	Elective-V	3	0	0	3
	Elective-VI	3	0	0	3
EN608	Computational Fluid Dynamics Laboratory	0	0	6	2
EN610	Solar Energy Engineering Lab	0	0	6	2
					22

SEMESTER-III

Code	Course of Study	L	T	P	C
EN667	Project Work Phase-I	0	0	24	12

SEMESTER-IV

Code	Course of Study	L	T	P	C
EN668	Project Work Phase-II	0	0	24	12

Elective I

Code	Course of Study	L	T	P	C
EN609	Energy Systems Modeling & Analysis	3	0	0	3
EN611	Fuels And Combustion Technology	3	0	0	3
EN613	Heat and Mass Transfer	3	0	0	3

Elective II

Code	Course of Study	L	T	P	C
EN615	Air Conditioning and Refrigeration	3	0	0	3
EN617	Thermal Engineering	3	0	0	3
EN619	Power Plant Technology	3	0	0	3

Elective III

Code	Course of Study	L	T	P	C
EN621	Electrical Energy Technology	3	0	0	3
EN623	Power Generation, Transmission and Distribution	3	0	0	3
EN625	Power Systems Planning & Operation	3	0	0	3
EN627	Instrumentation and Control in Energy Systems	3	0	0	3

Electives IV,V&VI*

Code	Course of Study	L	T	P	C
EN612	Batteries and Fuel Cells	3	0	0	3
EN614	Design of Heat Transfer Equipments	3	0	0	3
EN616	Direct Energy Conversion	3	0	0	3
EN618	Energy Efficient Buildings	3	0	0	3
EN620	Optimum Utilization of Heat and Power	3	0	0	3
EN622	Power Generation & Systems Planning	3	0	0	3
EN624	Renewable Power Generation Sources	3	0	0	3

***Reserved Electives**

Code	Course of Study	L	T	P	C
EN626	Advanced Heat Transfer	3	0	0	3

EN628	Advanced Thermodynamics	3	0	0	3
EN629	Advanced Reaction Engineering	3	0	0	3
EN630	Computational Heat Transfer	3	0	0	3
EN631	Energy Resources, Economics & Environment	3	0	0	3
EN632	Environmental Impact Assessment And Economic	3	0	0	3
EN633	Nuclear, Hydel&Otec Power Plants	3	0	0	3
EN634	Nuclear Reactor Theory	3	0	0	3
EN635	Optimization	3	0	0	3
EN636	Power Sources For Electric Vehicles	3	0	0	3
EN637	Technology Management	3	0	0	3
EN638	Thermal Environmental Engineering	3	0	0	3
EN639	Unit Operations In Industries	3	0	0	3
EN640	Waste Management And Energy Generation Technologies	3	0	0	3
EN641	Waste To Energy	3	0	0	3
EN642	Applied Probability and Statistics for analyzing occupational	3	1	0	4
EN643	Fundamentals of occupational health, physiology and Industrial	3	0	0	3
EN644	Environmental Microbiology and Industrial Ecology	3	0	0	3
EN645	Environmental Quality Management – Policies and	3	0	0	3
EN646	Fire and Safety Engineering	3	0	0	3
EN647	Capacity Building for Industrial Pollution Management	3	0	0	3
EN648	Environmental Management Systems and Auditing	3	0	0	3
EN649	Safety, Health and Environmental Management in Process Industries	3	0	0	3
EN650	Introduction to Sustainable Development and Corporate	3	0	0	3

EN651	Environmental Monitoring and Management	3	0	0	3
EN652	Indoor Air quality	3	0	0	3

EN601 ENERGY AUDIT AND MANAGEMENT

Energy Scenario - Role of Energy Managers in Industries – Energy monitoring, auditing & targeting – Economics of various Energy Conservation schemes. Total Energy Systems

Energy Economics - Simple Payback Period, Time Value of Money, IRR, NPV, Life Cycle Costing, Cost of Saved Energy, Cost of Energy generated, Examples from energy generation and conservation

Steam engineering, steam traps and various Energy Conservation Measures in Steam; Boilers - types, losses and efficiency calculation methods. Boiler controls.

Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor – energy consumption & energy saving potentials – Design consideration.

Refrigeration & Air conditioning - Heat load estimation -Energy conservation in cooling towers & spray ponds – Case studies Electrical Energy -Energy Efficiency in Lighting – Case studies.

Organizational background desired for energy management motivation, detailed process of M&T; Specific energy consumption and energy cost calculation methodologies - CUSUM, balanced ratio etc. Case studies across industries. Visit to energy generation / consumption facility.

TEXT BOOKS

1. *Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists,.Logman Scientific & Technical, ISBN-0-582-03184, 1990.*
2. *Reay D.A, Industrial Energy Conservation, 1stedition, Pergamon Press, 1977.*
3. *Bureau of Energy Efficiency - Energy Management Series, 2006*

REFERNECES

1. *Larry C Whitetal, Industrial Energy Management & Utilization.*
2. *Power System Engineering 2nd Ed. D P Kothari, I J Nagrath, Tata McGraw-Hill Co 2008*

EN602 BIO ENERGY TECHNOLOGIES

Sources and Classification. Chemical composition, properties of biomass. Energy plantations.Size reduction, Briquetting, Drying, Storage and handling of biomass

Feedstock for biogas, Microbial and biochemical aspects - operating parameters for biogas production. Kinetics and mechanism- High rate digesters for industrial waste water treatment

Incineration- Processing for liquid fuel production. Pyrolysis - Effect of particle size, temperature, and products obtained. Gasification - Effect of pressure, temperature, steam and oxygen.

Industrial effluents [Food waste, Textile, Distilleries, Glue, paper and pulp, Dairy and miscellaneous]; Waste to Energy [Domestic sewage, Municipal solid wastes]; Biorefineries; Biohydrogen production.

Combustion of rice husk and woody biomass. Life Cycle Analysis of biofuels - Environmental aspects of biofuel utilization - Techno-economic features of bio-fuels

TEXT BOOKS:

1. *Chakraverthy A, "Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.*
2. *Mital K.M, "Biogas Systems: Principles and Applications", New Age International publishers (P) Ltd., 1996.*
3. *Nijaguna, B.T., Biogas Technology, New Age International publishers (P) Ltd., 2002 VVN Kishore, Renewable energy engineering and Technology, Principles and Practices, TERI, 2009*

REFERENCES:

1. *Venkata Ramana P and Srinivas S.N, "Biomass Energy Systems", Tata Energy Research Institute, 1996.*
2. *Rezaiyan. J and N. P. Cheremisinoff, "Gasification Technologies, A Primer for Engineers and Scientists", Taylor & Francis, 2005*

3. *Khandelwal. K. C. and Mahdi S. S, "Bio-Gas Technology", Tata McGraw-Hill Pub. Co. Ltd, 1986.*

4. *Bioenergy and Biofuel from Biowastes and Biomass edited by Samir Kumar Khana, ASCE Publications, 2010*

EN603 ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

Environmental Pollution- units of measurements, material balance and energy fundamentals, classification of pollution

Air Pollution Control Methods & Equipment- sources and effects of air pollution –Sampling measurement and analysis of air pollutants- Control

Solid Waste Management-Sources & Classification –Solid Waste Disposal Options - Toxic Waste Management

Water Pollution - sources of water pollutants– Classification and effects of Water Pollutants – Water pollution Laws and Standard

Environment For Comfort Living & Working - Comfort & Climate –Temperature, humidity and ventilation Control– AC load, Natural & Artificial Lighting, Noise Sources, control.

TEXT BOOKS

1. *Rao C .S. "Environmental Pollution Control Engineering," 2nd Edition, New AgeInternational Publishers, 2006*
2. *. Gilbert M. Masters, "Introduction to Environmental Engineering and Science", 2nd Edition, Prentice Hall, 1998.*

REFERENCES

1. *A. P. Sincero and G.A. Sincero , Environmental Engineering: A Design Approach,Prentice Hall of India pvt Ltd, N.Delhi.1996m*

2. *Pandey G.N and Carney G.C., "Environmental Engineering", Tata McGraw HillPublishing Co., 1989.*

3. *Bishop P., Pollution Prevention: Fundamentals and Practice, McGraw-Hill InternationalEdition, McGraw-Hill book Co, Singapore, 2000*

EN604 COMPUTATIONAL FLUID DYNAMICS

Governing Equations of Fluid Flow, Finite Difference, Finite Volume, Finite Element Methods, Laplace Equation, Diffusion Equation or Wave Equation

Application of Finite Volume Method to Fluid Flow problems - Pressure Correction Techniques-Gauss Siedel, Gauss Jordan.Introduction to Multi grid Methods. Boundary Conditions

Structured and Unstructured Mesh- Introduction to CAD systems and Different Standards used for DATA Exchange. Governing Equations for Turbulent Flow, Rotating Machinery, Combusting Flow, Multiphase Flow.

Simple Internal Flows: T-Junction, Driven Cavity, Manifold, Valves, External Flows: Flow Over Ahmed Body, Car-Reacting Flow in a Gas Burner, Multiphase Flow in an Air Lift Reactor.

TEXT BOOKS

1. *H.K. Versteeg& W. Malalasekera, "An Introduction to Computational Fluid Dynamics -The finite volume approach" Longman, 1995*

2. *Segerlind .L. J., "Applied finite Element Analysis", 2nd edition, John Wiley, 198*

REFERENCS

1. *Anderson, "Computational Fluid Dynamics" McGraw Hill Company, 1995*
2. *D.A. Caughey and M.M.Hafez, "Frontiers of Computational Fluid Dynamics 1994" JohnWiley & Sons, 1994*

EN605 SOLAR ENERGY UTILIZATION

Solar radiation, availability, measurement and estimation; Isotropic and anisotropic models; empirical relations, solar collectors and types: flat plate, concentrating solar collectors, advanced collectors and solar concentrators, Selective coatings

Solar water heating, Solar cooking, Solar drying, Solar distillation and solar refrigeration, Active and passive heating and cooling of buildings, Solar Chimney, Solar drying

Solar thermal power generation, Home lighting systems, Solar lanterns, Industrial process heat systems, Solar thermal power generation and sterling engine, Solar economics.

Photo-voltaic cell – characteristics- cell arrays-power electric circuits for output of solarpanels-choppers-inverters-batteries-charge regulators, Construction concepts.

Energy Storage - Sensible, latent heat and thermo-chemical storage-pebble bed etc. materialsfor phase change-Glauber's salt-organic compounds. Solar ponds.

TEXT BOOKS

1. *D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003*
2. *Edward E. Anderson, "Fundamentals for solar energy conversion", Addison WesleyPubl. Co., 1983.*

REFERENCES

1. *Duffie J. A and Beckman, W .A., "Solar Engineering of Thermal Process", John Wiley,1991.*
2. *G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable energy Sources", NarosaPublishing House, New Delhi, 2007*
3. *Energy Studies, Second Edition, by W. Shepherd and D. W. Shepherd, Imperial CollegePress, London, 2004.*
4. *S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hil, New Delhi, 1996*
5. *M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive*

Building: science and design, Pergamon Press, New York, 1986

6. *M. A. S. Malik, G. N. Tiwari, A. Kumar and M.S. Sodha, Solar Distillation. Pergamon Press, New York, 1982.*

EN606 WIND ENERGY AND HYDRO POWER SYSTEMS

Measurement and instrumentation – Beau fort number -Gust parameters – wind type – power law index -Betz constant -Terrain value.

Energy in wind– study of wind applicable Indian standards – Steel Tables, Structural Engineering.Variables in wind energy conversion systems – wind power density – power in a wind stream– wind turbine efficiency – Forces on the blades of a propeller – Solidity and selection curves.

HAWT, VAWT– tower design-power duration curves- wind rose diagrams- study of characteristics- actuator theory- controls and instrumentations.

Grid-combination of diesel generator, Battery storage – wind turbine circuits- Wind farms—fatiguestress.

Overview of micro mini and small hydro, Site selection and civil works, Penstocks and turbines, Speed and voltage regulation, Investment issues, load management and tariff collection

Distribution and marketing issues, case studies, Wind and hydro based stand-alone / hybrid power systems, Control of hybrid power systems, Wind diesel hybrid systems.

TEXTBOOKS

1. *S. Rao& B. B. Parulekar, "Energy Technology", 4th edition, Khanna publishers, 2005.*
2. *Wind energy Handbook, Edited by T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, John Wiley & Sons, 2001*
3. *Wind and Solar Power Systems, Mukund. R. Patel, 2nd Edition, Taylor & Francis, 2001*

4. *L .L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.*
5. *D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press*

REFERENCS

1. *Anna Mani &Nooley, "Wind Energy Data for India", 1983.*
2. *IS 875 Part IV and IS 1893 semics D+STDS mareials STDS IS 226 (IS 2862, ASTMS 36, BS 4360 GR 43D and A).*
3. *Logan (EARL),"Turbo Machinery Basic theory and applications", 1981.*

EN609 ENERGY SYSTEMS MODELING & ANALYSIS

Overview of technologies and conventional methods of energy conversion, Workable andoptimum systems, Steps in arriving at a workable system, Creativity in concept selection

Mathematical modeling, Exponential forms- Method of least squares - Counter flow heatexchanger, Evaporators and Condensers, Effectiveness, NTU, Pressure drop and pumping Power

Classes of simulation, flow diagrams, Sequential and simultaneous calculations, Newton-Raphson method- Optimization procedure, mathematical statement of the problem

The Lagrange multiplier equations, Sensitivity coefficients- Single variable – Exhaustive,Dichotomous and Fibonacci, Multivariable unconstrained - Lattice, Univariable and Steepestascent

Dynamic Programming-Geometric Programming-Linear Programming- Linear regressionanalysis, Internal energy and enthalpy, Pressure temperature relationship at saturatedconditions

TEXTBOOKS

1. *W.F. Stoecker: "Design of Thermal Systems", 3rd Ed., McGraw Hill,1989.*
2. *B.K.Hodge: "Analysis and Design of Thermal Systems", Prentice Hall Inc., 1990.*

REFERENCES

1. *J. Nagrath& M .Gopal: "Systems Modelling and Analysis", Tata McGraw Hill.*
2. *D.J. Wide: "Globally Optimal Design", Wiley- Interscience, 1978*

EN611 FUELS AND COMBUSTION TECHNOLOGY

Fuels & Fuel Analysis-Combustion Stoichiometry, theoretical & actual combustion processes –Air fuel ratio.

Combustion Thermodynamics- calculation of heat of formation & heat of combustion – First law analysis of reacting systems

Heat Treatment Furnaces- Industrial furnaces – process furnaces – Kilns – Batch & continuous furnaces

Flame, Flame Structure, Ignition and Igniters – flame propagation – deflagration – detonations- flame front – Ignition – self & forced ignition – Ignition temperature

Combustion Appliances- Gas burners- Functional requirement of burners – Gas burner Classification –Stoker firing –pulverized system of firing

TEXT BOOKS

1. *S.P. Sharma &Chander Mohan, "Fuels & Combustion", Tata McGraw Hill PublishingCo. Ltd., 1984*
2. *Dr. Samir Sarkar, "Fuels & Combustion", Orient Longman, Second edition, 1990.*

REFERENCES

1. *Blokh A.G, "Heat Transmission in Steam Boiler furnaces", Hemisphere PublishingCorpn.ISBN-089-116-626-2*

2. *Gupta O.P, "Elements of Fuels, Furnaces & Refractories", 3rd edition, KhannaPublishers, 1996.*
3. *Combustion Fundamentals by Roger A. Strehlow – McGraw-Hill*
4. *Combustion Engineering and Fuel Technology by Shaha A.K. – Oxford and IBH.*
5. *Principles of Combustion by Kenneth K. Kou – John Wiley & Sons.*

EN612 BATTERIES & FUEL CELLS

Basic concepts – Components of cells and batteries, Classification of cells and batteries, Operation of a cell, Specifications – Free energy, theoretical cell voltage, specific capacity, specific energy, energy density, memory effect, cycle life, shelf life, state of charge (SOC) and depth of discharge (DOD), internal resistance and coulombic efficiency.

Electrochemical principles and reactions – electrical double layer, discharge characteristics of cell and polarization, Electrode processes and Tafel polarization, thermodynamic background and Nernst equation.

Primary and secondary batteries – Zn/C, Zn/air, alkaline cells, lithium primary batteries, lead-acid, Ni/Cd, Ni/MH and Lithium secondary batteries (Components, Chemistry and Performance characteristics). Applications of storage batteries.

Fuel cell fundamentals, The alkaline fuel cell, Acidic fuel cells, SOFC (components, chemistry and challenges) - Emerging areas in Fuel cells

Fuel cell outlook, Applications of fuel cells – Industrial and commercial.

Text Books

1. Hand Book of Batteries and Fuel cells, 3rd Edition, Edited by David Linden and Thomas. B. Reddy, McGraw Hill Book Company, N.Y. 2002.
2. Modern Electrochemistry 2A, Fundamentals of Electrodics, 2nd Edition, John O'M Bockris, Amulya K. N. Reddy and Maria Gamboa-Aldeco, Kluwer Academic Publishers, Newyork.
3. Principles of Fuel Cells, by Xianguo Li, Taylor & Francis, 2006
4. Fuel Cells, Principles and Applications, Viswanathan, B. and Scibioh, Aulice M, Universities Press, 2006

EN613 HEAT AND MASS TRANSFER

Flow classifications, mass, momentum and energy relations in differential form.

Exact and approximate solutions to forced convection in laminar and turbulent,internal and external flow.Solution to natural convection problems.

Heat transfer at high velocity and incompressible fluid. Liquid metal heat transfer.

Convective mass transfer. Reacting flows. Mass transfer. Transport equations. Mass transfer across interface. Heat and mass transfer in separated flows.

TEXT BOOKS

1. W.M. Rays, Convective Heat and Mass Transfer, McGraw Hill, 1966. E.R.G.
2. Eckert R.M. Drake Jr., Analysis of Heat Transfer, McGraw-Hill, 1972.

EN614 DESIGN OF HEAT TRANSFER EQUIPMENTS

Types – Details –Specifications for heat exchangers – Standards of heat exchangers Study of different methods used for design of heat exchangers, classification, design methodology, LMTD and NTU methods.

Design of double pipe heat exchanger-study and performance- Design of shell and tube heat exchanger.

Extended surfaces, fin design, longitudinal and transverse fins.

Regenerators - Plate type heat exchangers - Compact heat exchangers- Cross flow heat exchangers

TEXT BOOKS

1. *D. G. Kern: "Process Heat Transfer," McGraw-Hill Book Co., N.Y. 1997.*

2. *W.L.McCabe, J.C. Smith, P. Harriott, "Unit Operations of Chemical Engineering*

   SixthEdition, McGraw Hill Company, 2001.

3. *M. NecatiOzisik "Heat Transfer A Basic Approach", International Edition, McGraw- Hill Company, 1985.*

REFERE NCES

1. *S. Kokac: "Heat Exchangers-Thermal Hydraulic Fundamentals and Design",*

   McGrawHill.

2. *J .P. Gupta: "Heat Exchanger Design".*

3. *A Heat Transfer Textbook, by J.H. Lienhard IV and J.H. Lienhard V, Phlogiston*

   Press,Cambridge, Massachusetts, 2005

EN615 AIR CONDITIONING AND REFRIGERATION

Thermodynamic concepts, Thermodynamic systems and postulates, thermodynamic equilibrium, thermodynamic relations, stability and phase transition.Principles of air conditioning, methods of refrigeration.

Vapour and combined power cycles : Simple steam power cycle-Rankine cycle-comparison of Rankine& Carnot Cycle- reheat cycle-regenerative cycle-direct contact and surface contact regenerators- characteristics of an ideal working fluid in vapor cycle-binary vapor cycle thermodynamics of combined cycles.

Refrigeration cycle : Refrigerators - Heat pumps - Thee reversed Carnot cycle - Refrigeration by non-cyclic process - Reversed heat engine cycle - Ideal & actual vapor compression Refrigeration cycle-absorption refrigeration cycle - gas refrigeration cycle - Absorption refrigeration systems - Liquefaction of gases.

Air Compressor : Reciprocating air compressors. Types.Construction. Work of compression without clearance. Effect of clearance.Multistaging. Optimum intermediate pressure for perfect inter cooling. Compressor efficiencies and mean effective pressure

Vapour compression system adsorption and adsorption cycles, Air-cycle steam jet. Refrigeration systems and their performances: compressors, expansion devices, evaporators, condensers, absorbers, Cooling towers etc.

Comfort factors-specifications –Limits for humidity, temperature etc Heat load estimation, air distribution,ventilation,instrumentation.

TEXT BOOKS

1. *Stoecker W.F. "Refrigeration and Air Conditioning", TMH edition, McGraw Hill*

   publication, (1980).

2. *Ballaney P.L. "Refrigeration and Air Conditioning" V Ed. Khanna Publishers (1980)*

REFERE NCES

1. *Trott A.R." Refrigeration and Air Conditioning" 2nd Ed. Butterworth Publishers.1980*

EN616 DIRECT ENERGY CONVERSION

Energy conversion process, indirect and direct energy conversion. Preview of semiconductor physics: Basic ideas of quantum physics, Fermi Energy, band diagram, Intrinsic and extrinsic semiconductors, p-n junction Introduction to irreversible thermodynamics.

Thermoelectric conversion: thermoelectric effects, analysis of thermoelectric generators and coolers, figure of merit, device configuration

Photovoltaic conversion, Optical effects of p-n junction, design and analysis of PV cells. PV cell fabrication, System design

Thermionic conversion: thermionic effects, analysis of converters, application of heat pipes. Magneto hydrodynamic conversion: gaseous conductors, analysis of MHD generators.

Batteries and fuel cell: Thermodynamic analysis, design and analysis of batteries and fuel cells. Other modes of direct energy conversion.

TEXT BOOKS

1. *Kettani, M.A., Direct energy conversion, Addison-Wesley, Reading, Mass, 1970*
2. *AngristS.W. ,Direct Energy Conversion. 4th Ed. Allyn And Bacon, Boston, 1982*

REFERE NCES

1. *Green M.A. ,Solar Cells, Prentice-Hall, Englewood Cliffs, 1982*
2. *Hand book Batteries and Fuel Cells. Linden, McGraw Hill, 1984.*

EN617 THERMAL ENGINEERING

Air Compressor : Reciprocating air compressors. Types.Construction. Work of compression without clearance. Effect of clearance.Multistaging. Optimum intermediate pressure for perfect inter cooling. Compressor efficiencies and mean effective pressure.

Vapour and combined power cycles : Simple steam power cycle-Rankine cycle-comparison of Rankine& Carnot Cycle- reheat cycle-regenerative cycle-direct contact and surface contact regenerators- characteristics of an ideal working fluid in vapor cycle-binary vapor cycle thermodynamics of combined cycles.

Gas power cycles : Carnot cycle - Stirling cycle - Ericsson cycle - Air standard cycle – Otto cycle - Diesel Cycle-limited pressure cycle - Dual cycle - Comparison of Otto, diesel & dual cycles - Brayton cycle - Air standard cycle for jet propulsion - Brayton cycle with intercooling, reheating & regeneration - Second law analysis of gas power cycles.

Refrigeration cycle : Refrigerators - Heat pumps - Thee reversed Carnot cycle – Refrigeration by non-cyclic process - Reversed heat engine cycle - Ideal & actual vapor compression Refrigeration cycle-absorption refrigeration cycle - gas refrigeration cycle - Absorption refrigeration systems - Liquefaction of gases.

Steam turbines : Principles of operation - Classification of turbines - Simple impulse turbine - Velocity, Pressure compounded impulse turbine - Impulse reaction turbine velocity diagrams for flow of steam thro turbine blades - Forces on the blades & work done - Blade or diagram efficiency - Stage efficiency of reaction turbine - Degree of reaction - Steam turbine performance - Reheat factor - Descriptive examples.

Internal combustion engines : Classification of IC engine components - Four stroke cycles, valve timing - Spark ignition - Air Fuel mixtures - Mixture requirements of automotive engines Four stroke engine - Comparison of two stroke with four stroke engines – Engine power - Indicated power - Break horse power - Engine efficiency - Performance analysis of IC engine - Heat balance - Solved problems - Cooling system of IC engines.

TEXT BOOKS

1. *Nag. P.K., " Engineering Thermodynamics ",Tata McGraw-Hill Publishing Co., Ltd.,1994*

2. *Moran, Shapiro, Munson and Dewitt, "Introduction to Thermal Systems Engineering:Thermodynamics, Fluid Mechanics and Heat Transfer", John Wiley, N. Y 2000*

3. *Sonntag, R.E and Van Wylen, G.J.., "Fundamentals of Thermodynamics", Sixth Edition,2003.*

REFERE NCES

1. *Bacon, D.H., "Engineering Thermodynamics ", Butterworth & Co., London, 1989.*

2. *Saad, M.A., "Thermodynamics for Engineers ", Prentice-Hall of India Pvt. Ltd., 1989.*

3. *Mayhew, A. and Rogers, B., " Engineering Thermodynamics ", Longman Green & Co.Ltd., London, E.L.B.S. 4th Edition, 1994*

4. *Ganesan, Y.,* Internal Combustion Engines, *Tata McGraw-Hill, 2003.*

5. *Heywood, J.B.,* Fundamentals of Internal Combustion Engines, *McGraw-Hill, 1988*

6. *Ballaney, P.L.,* Thermal Engineering, *Khanna Publishers, 1996.*

EN618 ENERGY EFFICIENT BUILDINGS

Architecture- Building Science and its significance.Indoor Environment.Components ofIndoor Environment.Quality of Indoor Environment.

Human Comfort-Thermal, Visual, Acoustical and Olfactory comfort. Concept of Sol- airtemperature and its significance. Ventilation and is significance.

Cooling and heating concepts, Passive concepts appropriate for the various climatic zones inIndia. Classification of building materials based on energy intensity.

Energy Management of Buildings and Energy Audit of Buildings. - Energy managementmatrix monitoring and targeting.

Energy Efficient Landscape Design -Modification of microclimate through landscapeelements for energy conservation.

TEXT BOOKS

1. *Sodha M.,Bansal, N.K., Bansal,P.K., Kumar, A.. and Malik, M.A.S.,"SolarPassiveBBuildings", Pergamon Press, 1986.*

2. *Koenigsberger, O.H., Ingersoll, T.G., Mayhew Alan and Szokolay, S. V., "Manual of*

3. *Tropical Housing and Building part 1: Climatic Design", OLBN 0 002120011,OrientLongman Limited, 1973.*

EN619 POWER PLANT TECHNOLOGY

Thermodynamic concepts, Thermodynamic systems and postulates, thermodynamic equilibrium, thermodynamic relations, stability and phase transition

Power Plants - Features, Components and Layouts - Working of Power Plants, Power Plant Economics

Boiler Classification - Boiler Types - Fire Tube & Water Tube Boilers - Fluidized Bed Boilers - Positive Circulation Boilers - Thermal Liquid Heaters & Vaporizers

Classification - Features - Working - Performance of Steam Turbines - Losses in Steam Turbines - Trouble Shooting - Classification and Comparison of Different Types Gas Turbine Power Plants Components - Economics & Future of Combined Cycles

Integrated Gasification Combined Cycle (IGCC) – Indirect Fired Combined Cycle (IFCC) – Magneto Hydrodynamics (MHD) – Fuel Cells – Micro turbines– RDF based power plants.

TEXT BOOKS

1. *Thomas C. Elliott ,"Standard Hand Book of Power Plant Engineering"*

REFERE NCES

1. *E L Wakil, "Power Plant Engineering", McGraw-hill Book Co, N.Y. 2001*

2. *Arora and Domkundwar, A course in Power Plant Engineering, Dhanpat Ra, N.Delhi.2003*

3. *Nag, P.K., "Power Plant Engineering", 2nd Edition, TMH, 2001*

EN620 OPTIMUM UTILIZATION OF HEAT AND POWER

Energy Economics - Simple Payback Period, Time Value of Money, IRR, NPV, Life Cycle Costing, Cost of Saved Energy, Cost of Energy generated, Examples from energy generation and conservation

Basic concepts of CHP- The benefits and problems with CHP -Balance of energy demand– Types of prime movers –Economics– CHP in various sectors.Application & techno economics of Cogeneration- Cogeneration - Performance calculations, Part load characteristics- financial considerations - Operating and Investments

Pinch Technology–significance– Selection of pinch temperature difference – Stream splitting – Process retrofit – Installation of heat pumps, heat engines - Grand composite curve.

Insulation – Recuperative heat exchanger – Run –around coil systems – Regenerative heat exchangers – Heat pumps – Heat pipes –. Waste Heat Recovery -Cogeneration Technology

Sources of waste heat, Cogeneration - Principles of Thermodynamics - Combined Cycles- Topping -Bottoming - Organic Rankine Cycles- Advantages Of Cogeneration Technology

TEXT BOOKS

1. *Eastop, T.D. & Croft D.R, "Energy efficiency for engineers and Technologists", 2nd edition, Longman Harlow, 1990.*

2. *O"Callaghan, Paul W, "Design and Management for energy conservation", Pergamon,1993.*

REFERE NCES

1. *Osborn, peter D, "Handbook of energy data and calculations including directory of products and services", Butterworths, 1980.*

2. *Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.*

3. *Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987*

EN621 ELECTRICAL ENERGY TECHNOLOGY

Transformers – Parallel operation, auto transformers DC machines - generator characteristics- motor characteristics – applications Synchronous machines - permanent magnet alternators– Induction machines.

Transmission line – power flow study – power factor improvement, faults on power systems, symmetrical components, introduction to HVDC systems

Controlled rectifiers, choppers, inverters, voltage regulators and cycloconverters. Speed control of dc motors – converter –fed and chopper –fed control. Speed control of ac motors – Inverter –fed and ac voltage controller –fed schemes

Wind-driven induction generators, grid connected Photo-voltaic systems, Steady state performance, integration issues, principles of energy auditing

TEXT BOOKS

1. *John F. Walker and Jenkins N., "Wind energy technology", John Wiley and sons, NChichester U.K, 1997*

2. *Syed A Nasar, "Electric energy conversion and transmission", Macmillan Publishing company, New York, 1985*

REFERE NCES

1. *Sen P.C. "Power Electronics", NBT Code no (45-36/1980), Tata McGraw – HillPublishing company, 1993.*

2. *John J. Graigner and W.D. Stevenson, "Power system analysis", McGraw- Hillpublishing company, 1994.*

EN622 POWER GENERATION & SYSTEMS PLANNING

Overview of the Indian power sector, Thermodynamic analysis of Conventional Power Plants. Advanced Power Cycles, Kalina (Cheng) Cycle, IGCC, AFBC/PFBC

Steam Turbine - Superheater, reheater and partial condenser vacuum. Combined Feed heating and Reheating. Regenerative Heat Exchangers, Reheaters and Intercoolers in Gas Turbine power plants.

Hydro power plants - turbine characteristics. Auxiliaries - Water Treatment Systems, Electrostatic Precipitator / Flue gas Desulphurisation, Coal crushing / Preparation - Ball mills / Pulverisers, ID/FD Fans, Chimney, Cooling Towers.

Power plant control systems- Review of control principles, Combustion control, pulveriser control, control of air flow, Furnace pressure and feed water, steam temperature control, Safety provisions / Interlocks

Analysis of System load curve -plant load factor, availability, Loss of load Probability calculations for a power system, Maintenance Scheduling Pricing of Power - Project

cost components, Analysis of Power Purchase Agreements (PPA), Debt/Equity Ratio and effect on

Return on Investment, Environmental Legislations/Government Policies Optimal Dispatch Scheduling of Hydro-Thermal plants. Load Forecasting - Time series, Econometric, end use techniques. Least Cost Power Planning - Integration of DSM, Renewable into supply.

TEXT BOOKS

1. *R.W.Haywood, Analysis of Engineering Cycles, 4th Edition, Pergamon Press, Oxford, 1991.*
2. *D. Lindsay, Boiler Control Systems, Mcgraw Hill International, London, 1992.*
3. *H.G. Stoll, Least Cost Electrical Utility / Planning, John Wiley & Sons, 1989.*

REFRE NCES

1. *T.M. O' Donovan, Short Term Forecasting: An introduction to the Box Jenkins Approach, Wiley, Chichester, 1983.*
2. *A.B.Gill, Power Plant Performance, Butterworths, 1984.*
3. *Wood, A.J., Wollenberg, B.F., Power Generation, operation & control, John Wiley, New York, 1984.*

EN623 POWER GENERATION, TRANSMISSION AND DISTRIBUTION

Generation: Synchronous generator operation, Power angle characteristics and the infinite bus concept, Dynamic analysis and modeling of synchronous machines, Excitation systems, Prime-mover governing systems, Automatic generation control, Auxiliaries, Power system stabilizer, Artificial intelligent controls,

Power quality of AC Transmission: Overhead and cables, Transmission line equations, Regulation and transmission line losses, Reactive power compensation, Flexible AC transmission, HVDC Transmission: HVDC converters, Advantages and economic considerations converter control characteristics, Analysis of HVDC link performance, Multi terminal DC system, HVDC and FACTS,

Distribution: Distribution systems, Conductors size, Kelvin's law performance calculations and analysis, Distribution inside and commercial buildings entrance terminology, Substation and feeder circuit design considerations, Distributions automation, Futuristic power generation

TEXT BOOKS

1. *Wadhawa, C.L. „Electrical Power Systems", New Age International Publishers, 6th edition, 2009*

2. *D. P. Kothari and IJ Nagrath, „Power System Engineering" Tata Mcgraw – Hill, 2nd edition, 2008*

3. *Gupta B.R.,' Power system Analysis & Design', S. Chand and Company Ltd.,2nd edition, 2008*

REFERE NCES

1. *Padiyar, K.R., „HVDC transmission systems", Wiley Eastern Ltd., New Delhi, 1992.*

2. *Allen J.Wood and Wollenberg B.F., „Power Generation Operation and control", JohnWiley & Sons, Second Edition,1996.*

3. *Pabla, A.S., „Electrical Power Distribution System", 5th edition,Tata McGraw hill, 2004.*

EN624 RENEWABLE POWER GENERATION SOURCES

Basic characteristics of sunlight – solar energy source- photovoltaic - characteristics – equivalent circuit – photo voltaic for battery charging – charge regulators

Source –energy in the wind- aerodynamics – rotor types – forces developed by blades braking systems - control and monitoring system – power performance

Wind driven induction generators– steady state performance – modeling –integration issues impact on central generation-transmission and distribution systems.

Wind – diesel system– permanent magnet alternators-modeling- steady state equivalent circuit-self – excited induction generators-integrated wind – solar systems.

Micro-hydel electric systems- isolated and parallel operation of generators- geothermal operation of generators – geothermal – tidal and OTEC systems.

TEXT BOOKS

1. *John F. Walker & Jenkins. N., "Wind Energy Technology", John Wiley and sons,Chichester, 1997.*

2. *Van Overstraeton. R. J. and Mertens R. P., "Physics Technology and use ofPhotovoltaic" Adam Higher, Bristol, 1996.*

REFERE NCES

1. *Freris LL, "Wind Energy Conversion Systems", Prentice Hall, U.K., 1990.*

2. *Imamura M S .et.al "Photovoltaic System Technology. European hand book" H.S.Stephen & Associates.1992*

EN625 POWER SYSTEM PLANNING & OPERATION

Generation system capacity adequacy planning: Probabilistic models of generating unit outage performance and system load-evaluation of loss of load and loss of energy indices, Probabilistic production costing

Inclusion of power generation from renewable energy sources in the reliability analysis, Interconnected systems: multi-area reliability analysis, power pool operation and power/energy exchange contracts

Quantification of economic and reliability benefits by pool operation, Demand / energy forecasting: sector-wise peak demand and energy forecasting by trend and econometric projection methods

Optimal power system expansion planning: formulation of least cost optimization problem incorporating the capital, operating and maintenance costs of candidate plants of different types (thermal, hydro, nuclear, non conventional etc.) and minimum assured reliability constraint-optimization techniques for solution by linear and dynamic programming approaches-case studies.

TEXT BOOKS

1. *Sullivan, R.L., „Power System Planning", Heber Hill, 1987.*
2. *Roy Billington, „Power System Reliability Evaluation", Gordan& Breach ScainPublishers, 1990.*
3. *Allen J.Wood and Wollenberg B.F., „Power Generation Operation and control", JohnWiley & Sons, Second Edition,1996.*

REFERE NCES

1. *. Kirchmayer L.K., „Economic Control of Interconnected Systems", John Wiley &Sons,n1959.*
2. *Nagrath, I.J. and Kothari D.P., „Modern Power System Analysis", TMH, New Delhi,2006.*
3. *Eodrenyi, J., „Reliability modelling in Electric Power System" John Wiley, 1*

EN626 ADVANCED HEAT TRANSFER

Heat conduction - basic law, governing equations in differential form, solution methods, steady state, unsteady state problems-fins, moving boundaries.

Convective heat transfer - conservation equations, boundary layer approximations.Forced convective laminar and turbulent flow solutions.

Natural convection solutions, correlations. Radiation heat transfer mechanism; properties; exchange between black and non black surfaces, condensation - mechanism, controlling parameters.

Nusselt Theory; solution to laminar film modifications, influence of other parameters, correlations for single horizontal tube, vertical bank of horizontal tubes, other configurations.

Dropwise condensation.Boiling mechanisms regimes.Basic models, correlations.Mass Transfer- governing laws, transfer coefficients; application.Heat exchangers. Design principles.

TEXT BOOKS

1. *E.R.G. Eckerst and R.M. Drake Jr, Analysis of Heat Transfer, McGraw-Hill, 1972.*

2. *W.M. Roshenow and P. Choi, Heat, Mass and Momentum Transfer, Prentice - Hall, 1961.*

REFERE NCE

1. *B. Gebhart, Heat Transfer, McGraw-Hill, 1971.*

EN627 INSTRUMENTATION AND CONTROL IN ENERGY SYSTEMS

Measurement Errors - Materials, radiant storage- Transducer classification- Static anddynamic characteristics of transducers, Transient analysis of a control system.

Temperature Measurement - Bimaterials, Pressure thermometers, Thermocouples, RTD,Thermisters, and Pyrometry, pyrometers- Calibration of Pressure measuring equipment.

Flow Measurement- Variable head flow meters- Rota meters, Electromagnetic flow

meters,Hot wire anemometers, Hot film transducers, Ultrasonic flow meters.

Air pollution and Miscellaneous Measurements- Particulate sampling techniques, SO_2,Combustion Products, Opacity , odour measurements - Measurement of liquid level,Humidity, O_2, CO_2 in flue gases- pH measurement

Moving Iron/coil, Energy measurement, power factor meter-Analog signal conditioning, Amplifiers, Instrumentation amplifier, A/D and D/A converters, Digital data processing and display, Computer data processing and control, Feedback control system, Stability and transient analysis of control systems, Application of PID controllers, General purpose control devices and controller design

TEXT BOOKS

1. A. K. Sawhney. PuneetSawney: A course in Mechanical Measurements and Instrumentation.DhanpatRai&Co 2002

2. Bechwith. Marangoni.Lienhard: Mechanical Measurements Fifth edition. Addison-Wesley 2000

REFERENCES

1. J.P. Holman: Experimental methods for engineers Sixth edition, McGraw-Hill .1994.

EN628 ADVANCED THERMODYNAMICS

Review of Basic Postulates, Maxwell`s relations, Legendre Transformation, Pure Component properties, Theory of corresponding states, real fluids Equilibrium, Phase Rule, Single component phase diagrams, Introduction to Multicomponent Multiphase equilibrium

Introduction to Classical Mechanics, quantum Mechanics, Canonical Ensemble, Microcanonical Ensemble, Grand Canonical Ensemble, Boltzmann, Fermi-dirac and Bose Einstein Statistics,Fluctuations,Monoatomic and Diatomic Gases

Introduction to Classical StatisticalMechanics, phase space, liouville equation, Crystals, Intermolecular forces and potential energy functions, imperfect Monoatomic Gases, Molecular theory of corresponding states, introduction to Molecular Simulations, Mixtures, partial molar properties, Gibbs Duhems equations, fugacity and activity coefficients,

Ideal and Non-ideal solutions, Molecular theories of activity coefficients, lattice models, multiphase Multicomponent phase equilibrium, VLE/SLE/LLE/VLLE, Chemical Equilibrium and Combined phase and reactionequilibria.

TEXT BOOKS

1. *McQuarrie D.A, Statistical Mechanics, Viva Books Private Limited, 2003.2. Hill Terrel, An Introduction to Statistical Thermodynamics, Dover, 1960.3.*
2. *Allen MP, Tildesley DJ, Computer simulation of liquids, Oxford, 1989.4. Callen, HB. Thermodynamics and an Introduction to Thermodstatics, 2nd Edition, John Wiley and Sons, 1985.5.*

REFERENCES

1. *Prausnitz, J.M., Lichtenthaler R.M. and Azevedo, E.G., Molecularthermodynamics of fluid-phase Equilibria (3rd edition), Prentice Hall Inc., New Jersey,1996.6.*
2. *J.M. Smith. H.C.Van Ness and M.M.Abott. "Introduction to ChemicalEngineering Thermodynamics:. McGraw Hill International edition (5th ed.). 1996*

EN629 ADVANCED REACTION ENGINEERING

Homogeneous reactor design and analysis-I: Ideal reactors, Review of isothermal design for batch, semi-batch and flow reactors, Multiple reactions and reaction networks: Yield-selectivity concepts.

Wei-Prater analysis for first order networks, reaction networks of general order, Reactor energy balance and its applications to reactor design and analysis. Homogeneous reactor design and analysis-II: Non-ideal reactors- Review of the basic concepts of residence time distributions, single parameter models for real reactor behavior

Macromixing and micromixing, segregated flow model and Zweitering`s analysis of maximum mixedness, IEM and other models for micromixing. Heterogeneous reactors-I: Gas-solid systems- Review of kinetics of gas-solid catalytic reactions with and without diffusion limitation

Reactor design for fixed and fluidized bed reactors, Selected case studies, Non-catalytic gas-solid reactions: review of kinetics; reactor design case studies.Heterogeneous reactors-II:

Gas-liquid systems- Basic theories of mass transfer with chemical reaction model systems and model reactors, Reactor design for mechanically agitated and bubble column reactors. Selected case studies.

TEXT BOOKS

1. *Froment, F.G. and Bischoff, K.B., Chemical Reactor Analysis and Design,Wiley, 1990.*
2. *Rawlings, J.B. and Ekerdt, J.G., Chemical Reactor Analysis and Design Fundamentals, Nob Hill, 2002.*
3. *Carberry, J.J., Chemical and Catalytic Reaction Engineering, McGraw Hill, 1976.*

REFERENCES

1. *Levenspiel, O., Chemical Reaction Engineering, Third edition, Wiley, 1999.*
2. *Smith, J.M., Chemical Engineering Kinetics, McGraw Hill, 1981. Doraiswamy, L.K*
3. *Sharma, M.M., Heterogeneous Reactions, Vol. I and II, Wiley,1984. Danckwerts, P.V., Gas-Liquid Reactions, McGraw Hill, 1970.*

EN630 COMPUTATIONAL HEAT TRANSFER

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

Parabolic Equations - Explicit, Implicit and Crank Nicholson Methods. Cartesian and Polar Co-ordinates - Mixed Boundary Condition -Jacobi - Gauss-siedel and SOR Methods.

Heat Condition And Convection Control Volume Approach - Steady and Unsteady One Dimensional Conduction - Two and Three Dimensional -Power Law Scheme – Simpler Algorithm.

General Applicability of the Method - Approximate Analytical Solution - Raleigh's Method.Galerikin Method, Solution Methods.

Isoparametric Element Formulations Conduction and Diffusion Equations - Heat Transfer Packages - Heat 2, HEATAX, RADIAT, ANSYS

TEXT BOOKS

1. *SuhasV.Patnakar, Numerical Heat Transfer and Fluid Flow, Hemisphere PublishingCorporation, 1980*
2. Jaluria and Torrance, Computational Heat Transfer - Hemisphere PublishingCorporation, 1986

REFERENCES

1. *R. Mitchell and D.F. Grifths, Finite Difference Method in Partial DifferentialEquations, John Wiley & Sons, 1980*

EN631 ENERGY RESOURCES, ECONOMICS & ENVIRONMENT

Overview of World Energy Scenario – Dis-aggregation by end-use, by supply Fossil Fuel Reserves - Estimates, Duration Overview of India's Energy Scenario - Dis-aggregation by end-use, by supply, reserves Country Energy Balance Construction - Examples Trends in energy use patterns, energy and development linkage.

Energy Economics - Simple Payback Period, Time Value of Money, IRR, NPV, Life Cycle Costing, Cost of Saved Energy, Cost of Energy generated, Examples from energy generation and conservation.

Energy Chain, Primary energy analysis Life Cycle Assessment, Net Energy Analysis. Environmental Impacts of energy use - Air Pollution - SOx, NOx, CO, particulates Solid and Water Pollution, Formation of pollutants, measurement and controls.

Sources of emissions, effect of operating and design parameters on emission, control methods, Exhaust emission test, procedures, standards and legislation.

Environmental audits; Emission factors and inventories Global Warming, CO2 Emissions, Impacts, Mitigation Sustainability, Externalities, Future Energy Systems.

TEXT BOOKS

1. *Energy and the Challenge of Sustainability, World energy assessment, UNDP New York, 2000.*
2. *AKN Reddy, RH Williams, TB Johansson, Energy after Rio, Prospects and challenges, UNDP, United Nations Publications, New York, 1997.*

REFERENCES

1. *NebojsaNakicenovic, ArnulfGrubler and Alan McDonald Global energy perspectives, Cambridge University Press, 1998*
2. *Fowler, J.M., Energy and the environment, 2nd Edn., McGraw Hill, New York, 1984*

EN632 ENVIRONMENTAL IMPACT ASSESSMENT AND ECONOMIC ANALYSIS

Principles, Production and assessment of impacts due to air and water pollution on the environment. Environment Impact Assessment in the land and biological environment

Methodologies for Environmental Impact Assessment – Case studies Assessing Impacts and Setting Priorities – Economic Measurement of Environmental Impacts – Theoretical Basis and Practical Applications.

Selectively Applicable Techniques of Valuing Environmental Impacts – Potentially Applicable Techniques of Valuing Environmental Impacts.The limits of Economic Measurement of Environmental Impacts – case studies

TEXT BOOK

1. Barthwal, R. R., Environmental Impact Assessment, New Age International publishers (P) Ltd., 2002

2. Adaptive environmental assessment and Management Ed. C. S. Holling, John Wiley and Sons, 2000

REFERENCE

1. Environmental Impact Assessment L.W .Canter, McGraw Hill Book Company, 1977.

2. Energy Sources and their Environmental Impact, S.A.Abbasi, N.Abbasi, Prentice Hall of India, New Delhi, 2006

EN633 NUCLEAR, HYDEL & OTEC POWER PLANTS

Nuclear Power–Radioactivity & Radioactive charge, Types of reaction – General problem of reactor operation.

Current Generation power reactors- Pressurized water reactors – Boiling water reactors – Gas-cooled reactors – Advanced Design

Hydrology & Hydro - Electric Power Plants- Hydrographs – Flow duration curve – Mass curve & storage. Site selection for hydroelectric power plants.

Design Construction & Operation Of Hydro-Electric Power Plants- Components – Advantages & Disadvantage of under ground power station

Ocean Thermal Energy conversion -Operational problem – Ecological & environmental impacts. Water power – Tidal power – wave power – geothermal power

TEXT BOOKS

1. *Black and Veatch, "Power Plant Engineering", ISBN 0-412-06401-4, CBS Publishersand Distributors, Chapter 23424.*
2. *S .Rao&Dr .B. B. Parulekar, "Energy Technology" , Third Edition, Khanna Publishers .*

REFERENCES

1. *Samuel Glasstone and Alexander Sesonske "Nuclear Reactor Engineering" ThirdEdition.*

EN634 NUCLEAR REACTOR THEORY

Radioactivity, Nuclear reactions, Cross sections, Nuclear fission, Power from fission,

Conversion and breeding, Neutron transport equation, Diffusion theory approximation, Fick's law, Solutions to diffusion equation for point source, Planar source, etc. Energy loss in elastic collisions,

Collision and slowing down densities, Moderation in hydrogen, Lethargy.concept, Moderation in heavy nucleus.

Moderation with absorption, Resonance absorption, NR and NRIM approximations.Multi-region reactors, Multigroup diffusion methods, Thermal reactors, Heterogeneous reactors.

Reactor kinetics.in hour equation, Coefficients of reactivity, Control, Fission product poison. Perturbation theory

TEXT BOOKS

1. *J.R. Lamarsh, Introduction to Nuclear Reactor Theory, Wesley, 1966*
2. *J.J. Duderstadt and L.J. Hamilton, Nuclear Reactor Analysis, John Wiley, 1976*

EN635 OPTIMIZATION

Introduction to Process Optimization; Formulation of Various Process Optimization Problems and their Classification;

Basic Concepts of Optimization-Convex and Concave Functions, Necessary and sufficient conditions for Stationary Points; Optimization of one-dimensional Functions.

Unconstrained Multivariable Optimization- Direct Search Methods. Indirect First Order and Second Order Methods; Linear Programming and its Applications; Constrained Multivariable

Optimization-Necessary and Sufficient Conditions for Constrained Optimum, Quadratic Programming, Generalized Reduced Gradient Method, Successive Linear and Quadratic Programming; Optimization of Staged and Discrete Processes, Dynamic Programming, Integer and Mixed Integer Programming.

TEXT BOOKS

1. *T.F.Edgar and D.M.Himmelblau, Optimization of Chemical Processes, McGraw Hill International Editions, Chemical Engineering Series (1989)*
2. *G.S.Beveridge and R.S.Schechter, Optimization Theory and Practice, McGraw Hill, New York l970.*

REFERENCES

1. *G.V.Rekllaitis, A.Ravindran, and K.M.Ragsdell, "Engineering Optimization-Methods and Applications", John Wiley, New York (1983)*

EN636 POWER SOURCES FOR ELECTRIC VEHICLES

The Electric Vehicle Debate, Primary Energy Sources and Alternative Fuels for Transportation, History of Electric Vehicles, Electrochemical Power Sources – Secondary

Batteries and Fuel Cells Sources- Aqueous Electrolyte Batteries –Lead Acid, Nickel – Iron, Nickel – Zinc, Metal – Air Zinc – Halogen Non Aqueous Electrolyte Batteries- High Temperature Batteries, Organo Electrolyte and
Solid State Batteries

Overview of Performances of Candidate Secondary Battery Systems-Fuel Cells – Acid Systems, Direct Methanol / Air Systems ,Alkaline Systems-Overview of Performances of candidate Fuel Cell Systems, Battery / Fuel cell / Internal

Combustion Engine Hybrid Electric Vehicles, Laboratory Test of Electric Vehicle Batteries, Vehicle tests with Electric Vehicle Batteries, Future of Electric Vehicles

TEXT BOOKS

1. *Power Sources for Electric Vehicles, Edited by B.D. McNicol and D.A.J. Rand, ElsevierPublications.1998Lithium Batteries for Hybrid Cars By John Voelcker, IEEE Spectrum, 1990*

REFERENCES

1. *Hand Book of Batteries and Fuel cells, 3rd Edition, Edited by David Linden and Thomas.B. Reddy, McGraw Hill Book Company, N.Y. 2002*
2. *Fuel Cells, Principles and Applications, Viswanathan, B. and Scibioh, Aulice M,Universities Press, 2006*
3. *The Essential Hybrid Car Handbook: A Buyer's Guide (Paperback) by Nick Yost, TheLyons Press, N.Y. 2006*

EN637 TECHNOLOGY MANAGEMENT

PASTER program aimed at technological self-reliance-– Strategy Evaluation & Correction, Strategy Implementation - Business Ethics, Knowledge Management, Bench Marking.

Invention, Innovation, Industrial & IPR, Patents, Copyrights, Trademarks, Design Registration, Trade Secrets, WTO, Trade, Patent Specifications, Patent Search Websites.

Technology Transfer Model, Technology Search Strategy, Dimensions of Technology Transfer, Features of Technology Package, Routes of Technology Transfer, Techno market Survey, Technology Evaluation Parameters, Identification of Core

Competence- Constraints in Technology Absorption, Importance of Diffusion Exploratory Method of TF – Delphy Technique, Cross Impact Matrix, Curve Fitting, Morphological Methods, Trend Extrapolation, Regression Analysis

TEXT BOOKS

1. *Wright, Peter, Kroll, Mark J. and Parnell, John A: Strategic Management Concepts andCases, Prentice – Hall, N. J. 1996.*
2. *Coates, V.T.:"A Handbook of Technology Assessment", U.S. Department of Energy,Washington D.C., 1988.*
3. *Ayres, Robert U: "Technologies forecasting and Long Range planning".*

REFERENCES

1. *Intellectual Property Protection in India: A Practical Guide for Scientists, Technologiesand Other Users, Delhi, TIFAC / CSIR, 1993.*
2. *H. Ansoff "Implementing Strategic Management" by Englewood Cliffs, New Jersey.*
3. *Michael E. Porter, "Corporate Strategy" – New York Free Press.*

EN638 THERMAL ENVIRONMENTAL ENGINEERING

Refrigeration cycles: need for refrigeration, various refrigeration cycles, vapour compression cycles, single-stage, two-stage and cascade

Vapour absorbtion cycles, LiBr/H2O and NH3/H2O, gas cycles and air liquifaction cycles, selection of refrigerants and refrigerant/absorbent combination

Advanced psychometrics: psychometric charts, thermodynamic properties of moist air, typical air conditioning processes and associated energy calculations.

Introduction to advanced refrigeration cycles: vapour compression cycles with solution circuits, cogeneration of power and refrigeration, refrigeration using solar energy and waste heat.

TEXT BOOKS

1. *1993 ASHRAE Handbook - Fundamentals. J.L. Threlkeld, Thermal Environmental Engineering, Prentice Hall, 1970. Manufacturers literature and handouts.*

EN639 UNIT OPERATIONS IN INDUSTRIES

Crushing, Grinding Size Separation & Conveying Of Bulk Solids Various Laws of Crushing - Classification of Crushing and Grinding Machineries -

Mixing of Liquids / Liquids, Liquids / Gases, Liquids / Solids - Types of Mixers - Industrial Filtration

Evaporator- Duhrings Chart - Boiling Point Elevation - Capacity and Economy of Evaporators - Evaporators Classification – Economy and capacity

Humidity Chart - Wet bulb Temperature and Measurement of Humidity Equilibrium Moisture Content - Bound, Unbound, Free Moisture - Drying Rate Curves Classification of Dryers

Distillation Methods - Minimum Reflux Ratio - Total Reflux - Optimum Reflux Ratio - Steam Distillation Calculations Concepts of Azeotropic and Extractive Distillation –

TEXT BOOKS

1. *P Chattopadhyay, "Unit operations of Chemical Engineering", 2nd edition, KhannaPublishers, 1996.*
2. *W. L. McCabe and J.C. Smith and P. Harriot, "Unit operations of ChemicalEngineering", 6th edition, McGraw Hill International editions, 2001.*

REFERENCES

1. *Alan S Foust, "Principles of Unit Operations", Second Edition, Wiley InternationalEdition, 1960.*
2. *J.M. Coulson & Richardson, Chemical Engineering,, 5th edition, Butterworth Heinemann,1996.*

EN640 WASTE MANAGEMENT AND ENERGY GENERATION TECHNOLOGIES

Sources, Types, Compositions, Properties Physical, Chemical and Biological - Collection - Transfer Stations – Waste minimization and recycling of Municipal Waste.

Size Reduction - Aerobic Composting - Incineration for Medical /Pharmaceutical Waste - Environmental Impacts -Environmental Effects due to Incineration.

Land Fill Method- Types, Methods & Siting Consideration - Composition, Characteristics, generation, Control of Landfill Leachate & Gases – Environmental monitoring System for Land Fill Gases.

Sources and Nature of Hazardous Waste - Impact on Environment - Hazardous Waste - Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation & Closure

Biochemical Conversion - Industrial , Agro Residues - Anaerobic Digestion – Biogas Production

Types of Biogas Plant-Thermochemical Conversion -Gasification - Types – Briquetting

Industrial Applications of Gasifiers - Environment Benefits

TEXT BOOK

1. *Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, PrinticeHall, 2000*

REFERENCES

1. *Parker, Colin, & Roberts, Energy from Waste - An Evaluation of ConversionTechnologies, Elsevier Applied Science, London, 1985*

EN641 WASTE TO ENERGY

Introduction to energy from waste: characterisation and classification of waste as fuel – agrobased, forest residues, industrial waste, Municipal solid waste.

Waste to energy options: combustion (unprocessed and processed fuel), gasification, anaerobic digestion, fermentation, pyrolysis.

Conversion devices: combustors (Spreader Stokes, Moving grate type, fluidized bed), gasifier, digesters. Briqueting technology: Production of RDF and briquetted fuel. Properties of fuels derived from waste to energy technology: Producer gas, Biogas, Ethanol and Briquettes,

Comparison of properties with conventional fuels. Power generation using waste to energy technologies: Cl and Sl engines.

IGCC and IPCC concepts. Landfills: Gas generation and collection in land fills, Introduction to transfer stations. Comparison with non-energy options like Vermiculture, Composting.

TEXT BOOKS

1. *M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.*
2. *D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.*

EN607 ENVIRONMENTAL ENGINEERING LABORATORY

1. Pollutant analysis using orsat apparatus
2. Air pollution analysis using flue gas analyzer
3. Measurement of COD for liquid effluents
4. Settling studies
5. Study of aerator design on water treatment
6. Study on noise pollution of various devices
7. Gas absorption using foam bed
8. Hydrocylones for removing suspended particles
9. Cyclones to remove dust particles

EN608 COMPUTATIONAL FLUID DYNAMICS LABORATORY

1. Flow in static mixer
2. Flow in a process injection-mixing pipe
3. Flow from a circular vent
4. Flow in an Axial rotor /stator arrangement
5. Multiphase flow in mixing vessel
6. External flow over Ahmed body

7. Supersonic flow in a Laval nozzle

8. Flow through a butterfly valve

9. Flow through an automatic catalytic converter

10. Flow through an engine inlet valve

11. Conjugate heat transfer in a process-heating coil

12. Combustion and radiation in a Can Combustor

EN610 SOLAR ENERGY LABORATORY

1. Study of direct and diffused beam solar radiation

2. Study of green house effect

3. Performance evaluation of solar flat plate collector

4. Study the effect of solar flat plate collector in parallel combination

5. Performance evaluation of concentrating solar collector

6. Performance evaluation of solar cooker

7. Performance evaluation of a solar PV panel

8. Performance of PV panel in series and parallel combination

EN642 APPLIED PROBABILITY AND STATISTICS FOR ANALYZING OCCUPATIONAL ACCIDENTS

Course Objectives:

To provide an insight to safety management in the workplace, a statistical approach has been applied to realize practical techniques, such as the prediction of time intervals of accident occurrence

Probability and Statistics

Introduction to probability and random variables,Correlation and Regression, Distributions - Binomial, Poisson, Normal, Exponential, Geometric, Gamma – Mean and Variance – Problems

Estimation Theory

Principle of least squares – Regression – Multiple and Partial correlations – Estimation of Parameters – Maximum likelihood estimates – Method of moments

Testing of Hypothesis

Sampling distributions – Test based on Normal, t-distribution, chi-square, and Fdistributions– Analysis of variance – One-way and two way classifications

Reliability

Basics concepts of reliability - Failure rate analysis – Reliability of systems – Series, Parallel– Maintenance - Preventive and corrective – Maintainability equation – Availability – Quality and Reliability.

Accident Analysis

Accident Analysis - Compilation of Accident Rates – Frequency Rate, Severity Rate, Incident Rate, Lost time injury, Classification of Accidents, Body Parts, Nature of Injury, Unsafe Actions, Unsafe Conditions as per IS 3786 – 1983.

TEXT BOOKS:

Gupta, S.C. and Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand and Sons

Trivedi K.S., Probability and Statistics with Reliability and Queuing and Computer Science Applications, Prentice Hall of India

Applied Statistics in Occupational Safety and Health By Christopher A. Janicak

REFERENCES:

Jay, L.Devore, "Probability and Statistics for Engineering and Sciences", Brooks Cole Publishing Company, Monterey, California, 5th Edition, 2002

Spiegel, Murray R., Probability and Statistics, Schaum"s series

EN643 FUNDAMENTALS OF OCCUPATIONAL HEALTH, PHYSIOLOGY AND INDUSTRIAL TOXICOLOGY

Course Objectives:

To introduce major concepts and issues in occupational health and safety and to provide a unique assessment of the more extensive factors that influence the management of work place health and safety

Physical Hazards

Noise, Ionizing radiation, non-ionizing radiations, microwaves and radio-waves, lasers, radar hazards, vibration, occupational damage, risk factors, over all monitoring and measurement, properties of sound and light, Threshold limit value (TLV) –cold environments, hypothermia, wind chill index, control measures–hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control

Chemical Hazards

Recognition of chemical hazards -dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs.dose, TLV –Methods of Evaluation, process or operation description, field survey, sampling methodology, Industrial hygiene calculations, Comparison with OSHAS Standard. Measurement Procedures and Methods of Control –training and education

Biological and Ergonomical Hazards

Classification of Biohazardous agents - infectious diseases –Biohazard control Programmes, employee health Programmes-laboratory safety programmes -animal care and handling-biological safety cabinets – building design, Work Related Musculoskeletal Disorders –carpal tunnel syndrome (CTS) –Tendon pain-disorders ofthe neck– back injuries

Occupational Physiology

Man as a system component -allocation of functions -efficiency -occupational work capacity – aerobic and anaerobic work -evaluation of physiological requirements of jobs -parameters of measurements –categorization of job heaviness -work organization -stress -strain -fatigue -rest pauses – shift work – personal hygiene

Occupational Toxicology

Concept and spectrum of health –functional units and activities of occupational health services, pre and post-employment medical examinations –occupational related diseases, levels of prevention of diseases, gas poisoning their effects and prevention - Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects

TEXT BOOKS:

"Hand book of Occupational Safety and Health", National Safety Council, Chicago, 1982

Goetsch D.L., (1999), "Occupational Safety and Health for Technologists", Engineers and Managers", Prentice Hall

REFERENCES:

"Encyclopedia of Occupational Health and Safety", Vol.I and II, InternationalLabour Office, Geneva
1985

Della D.E., and Giustina, (1996), "Safety and Environmental Management", Van Nostrand Reinhold International Thomson Publishing Inc

EN644 ENVIRONMENTAL MICROBIOLOGY AND INDUSTRIAL ECOLOGY

Course Objectives:

This course envisages the diverse roles of microorganisms in natural and artificial environments and introduces major concepts and issues related to industrial ecology

Introduction to microbiology

Classification of microorganisms, prokaryotic cells, eukaryotic cells; Characterization of microorganism, microorganism of importance;Bacteria, Algae, Fungi, Protozoa and viruses; Bacteriology of water, Microbiology of food, Fresh water biology

Air and wastewater microbiology

Types of microorganisms, Air and wastewater borne diseases, sampling of air and wastewater, microbialcontent of air and wastewater, control of airborne and wastewater borne diseases; theory of microbial operations in various wastetreatment methods, oxygen requirements and associated environmental factors

Control of microorganisms

Death of bacteria, Pattern of death, effect of temp pH, toxicsubstances on growth of bacteria, Antagonism and synergism; Control of microorganisms byphysical agents, Control of microorganisms by chemical agents

Principles of Industrial Ecology

The astrosphere and industrial ecology, Industrial metabolism and biological analogies,

material and energy flow in industrial metabolism, industrial metabolism, internalization of materials cycle, system integration and industrial metabolism, Eco-efficiency, Components of the industrial ecosystem, Examples

Life Cycles: Products, Processes and Facilities Life Cycles

Expanding and Closing the Materials Loop, Life Cycle Assessment, Materials and Product

Budgets, Consumable, Recyclable and Service Products, Design for Environment, Design for Recycling, Kinds of Materials Recycled, Efficient use of materials through Industrial Ecology

TEXT BOOKS:

Pelczar Jr., M.J., Chan, E.C.S. and Kreig, N.R., Microbiology, 5th Edition, McGraw- Hill

Publishing Co. Ltd., New Delhi, 1993

Stanley E Manahan, Industrial Ecology: Environmental Chemistry and Hazardous Wastes, (1999) Lewis, New York, USA

REFERENCES:

Bitton, G., Wastewater Microbiology, Wiley-Liss Inc., New York, 1994

T. E. Graedel and B. R. Allenby, Industrial Ecology., (2003), Printice Hall, New Jersey, USA

EN645 ENVIRONMENTAL QUALITY MANAGEMENT - POLICIES AND LEGISLATION

Course Objectives:

This course provides indispensable guidance regarding statutory requirements and compliance with SHEM Acts

Environmental Management and Impact Assessment

Environmental management, problems and strategies; Review of political, ecological and

remedial actions; Future strategies; multidisciplinary environmental strategies, the human, planning, decision-making and management dimensions; Fundamental Rights – Directive Principles of State Policy – Article 48 (A) and 51-A(g) Judicial enforceability – Constitution and Resources management and pollution control – Indian Forest Policy (1990) – Indian Environmental Policy (1992)

Administrative Regime and Legal Regime

Administrative regulations – constitution of Pollution Control Boards Powers, functions,

Accounts, Audit etc. – Formal Justice Delivery mechanism Higher and Lower of judiciary – Constitutional remedies writ jurisdiction Article 32, 226 136 special reference to Mandamus and Certiorari for pollution abatement – Equitable remedies for pollution control

Pollution Control Laws

Administrative regulation under recent legislations in air, water and soil pollution control;

Water (prevention and control of pollution) Act 1974 as amended by Amendment Act 1988; Water (prevention and control of pollution) Rules 1975 Water (prevention and control or Pollution) Cess Act. 1977 as amended by Amendment Act 1987 and relevant notifications. Relevant notifications in connection with Hazardous Wastes (management and handling) Biomedical wastes (management and handling), Noise pollution, Eco-labelling, and E.I.A. Air quality requirements, legislation, emission standards and management for air pollution control

Environmental Economics, Legislation & Social Impact

Broad aspects of environmental economics; society and environment, sustainable

development, management of environmental strategies, environmental movements; Environmental legislation; role of UN and its associate bodies, role of world bank, administrating global environmental funds, environmental programmes and policies in developed and developing countries, environmental programmes and policies of the government of India, structural changes for environmental managements, sectoral policies regarding land, water, forestry, energy, industrial pollution and human resources development

Environmental Quality and Pollution Monitoring Techniques

General principles of sample collection and data analysis; Gravimetric methods for solids

analysis in water and wastewater, determination of acidity, alkalinity and turbidity, analysis of common cations and anions in water/wastewater through various chemical techniques, determination of nitrogen, phosphorus and chemical oxygen demand (COD). Titrimetric methods; acid-base titrations, precipitation titrations, complexometric titrations, oxidation-reduction titrations

TEXT BOOKS:

Handbook on Pollution Control Acts, Central Pollution Control

Board, New Delhi. "Constitution of India", 12th Edition, Eastern Book Company, 1997.

REFERENCES:

Divan, A., and Noble M., "Environmental Law and Policy in India (cases, Materials and

Statutes)", Tripathi, 1991 Relevant Indian Acts and rules, Government of India

EN 646 FIRE AND ELECTRICAL SAFETY ENGINEERING

Course Objectives:

To offer a thorough understanding in regard with principles of fire management systems in order to provide a fire free environment and to realize the electrical causes of fire and explosion

Fire chemistry

Fire properties– Firespread – Toxicity of products of combustion– Theory of combustion and explosion – Vapour clouds – Flash fire – Jet fires – Pool fires – Unconfined vapour cloud explosion, Shock waves – Auto ignition– Boiling liquid expanding vapour explosion

Industrial fire protection systems

Sprinklers – Hydrants– Stand pipes – Special fire suppression system like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, Evaluation and standards – Alarm and detectionsystems, Portable extinguishers and Other suppression systems – Smoke venting– Flammable liquids – Tank farms – Indices of inflammability

Building evaluation for fire safety

Fire load – Fire resistance materials and fire testing – Structural Fire protection – Exits and egress– Width calculations – Fire certificates – Fire safety requirements for high rise buildings
– Snookers

Explosion protection systems

Explosion parameters – Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure – explosion venting– inert gases, plant for generation of inert gas – rupture disc in process vessels and lines explosion, Explosion suppression system basedon CO_2 and Halon– Hazards in L.P.G handling

Statutory rules and Electrical safety

Indian Explosive acts and rules – Techniques of fire fighting and demonstration, Electrical hazards– Electrical causes of fire and explosion – National electrical safety code – statutory requirements from Electrical inspectorate

TEXT BOOKS:

Derek James, Fire Prevention Hand Book, Butter Worths and Company, London Fordham Cooper W., Electrical Safety Engineering, Butter Worths and Company, London Gupta, R.S., Hand Book of Fire Technology, Orient Longman, Bombay

REFERENCES:

Accident Prevention manual for industrial operations, N.S.C., Chicago
DinkoTuhtar, Fire and explosion Protection
Fire fighters hazardous materials reference book Fire Prevention in Factories, Van Nostrand ReinHold, New York

EN647 CAPACITY BUILDING FOR INDUSTRIAL POLLUTION MANAGEMENT

Course Objectives:

To provide an insight to the necessity of pollution prevention approaches to achieve

sustainability at industrial level without compromising on environmental issues along with the best available technologies for pollution prevention

Industrial Wastewater

Sources and types of industrial wastewater – Environmental impacts – Regulatory requirements – generation rates – characterization – Toxicity and Bioassay tests, Prevention vs Control of Industrial Pollution– Source reduction techniques – Waste Audit– Evaluation of pollution prevention options

Air Pollution

Air Pollution Control Methods & Equipment– sources and effects of air pollution – Sampling measurement and analysis of air pollutants– Control concept of clean coal combustion technology – Evaluation of pollution prevention options

Solid and Hazardous Waste Management

Solid and Hazardous waste management in India – waste identification, characterization and classification – technological options for collection, treatment and disposal of hazardous waste – selection charts for the treatment of different hazardous wastes – methods of collection and disposal of solid wastes – health hazards – Toxic and radioactive wastes incineration and vitrification– recycling and reuse

Pollution Control in Process Industries

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper –metal finishing – Petrochemical – Pharmaceuticals – Sugar and Distilleries – Food Processing – fertilizers – Thermal Power Plants and Industrial Estates, ISO 14000:2003 – Waste Audit

Capacity Building

Evaluation of pollution prevention options in industrial wastewater, air and hazardous waste – Technology Assessment – Implementation practices – case studies

TEXT BOOKS:

Bishop P., Pollution Prevention: Fundamentals and Practice, McGraw-Hill International

Edition, McGraw-Hill book Co, Singapore, 2000

S.P.Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 1993

REFERENCES:

Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001

A text book of environmental chemistry and pollution control, Dara S S,.(1998), S. Chand & Company Ltd, New Delhi

EN648 ENVIRONMENTAL MANAGEMENT SYSTEMS AND AUDITING

Course Objectives:

This course provides indispensable guidance regarding statutory requirements and compliance with Environmental Management Systems and introduces the procedures involved in environmental auditing

Environmental Management Standards

Environmental guidelines - National policies on environment, abatement of pollution and conservation of resources - Environmental quality objectives – Environmental standards - Concentration and Mass standards- Effluent and stream standards – Emission and ambient standards -Minimum national standards - Measuring performance evaluation: Indicators, Benchmarking - Systems approach to environmental management

Preventive Environmental Management

Pollution control vis a vis Pollution Prevention - Opportunities and Barriers – Cleaner production and Clean technology, closing the loops, zero discharge technologies - source reduction, raw material substitution, toxic use reduction and elimination, process modification – Cleaner Production Assessment- Material or resource balance – CP option generation and feasibility analysis

Environmental Management System (EMS)

Introduction; Principles & elements of successful EMS; ISO principles; EMS; Creating an EMS in line with ISO: 14000; Benefits of an EMS; Principles & elements of successful environmental management: leadership, environmental management planning,

implementation, measurement & evaluations required for an EMS, environmental management reviews & improvements; Legal and regulatory concerns; Integrating ISO 9000 & ISO 14000.

Environmental Audit

EMS audits as per ISO 19011 – Roles and qualifications of auditors - Concepts of environmental audit, objectives and Types of audit; Features of Effective auditing; Programme Planning; Organisation of Auditing Programme, pre-visit data collection. Audit Protocol; Onsite Audit; Data Sampling - Inspections - Evaluation and presentation; Exit Interview; Audit Report - Action Plan - Management of Audits; Waste Management Contractor Audits. Life Cycle Approach

Applications

Applications of EMS , Waste Audits and Pollution Prevention opportunities in Textile , Sugar, Pulp & Paper, Electroplating, Mining, petroleum refining, Tanning industry, Dairy, Cement, Chemical industries, etc

TEXT BOOKS:

"The ISO: 14000 Handbook" - Joseph Caseio (Ed), Published - CEEM Information Services. 2000

INSIDE ISO: 14000 – The Competitive Advantage of Environmental Management - Don Sayre, Vinity Books International, New Delhi, 2001

A Guide to the Implementation of the ISO: 14000 Series on Environmental Management – Ritchie, I and Hayes W, Prentice Hall, New Jersey, 1998

REFERENCES:

Christopher Sheldon and Mark Yoxon, "Installing Environmental management Systems – a step by step guide" Earthscan Publications Ltd, London, 1999

ISO 14001/14004: EMS – Requirements and Guidelines – ISO 2004

ISO 19011: 2002, "Guidelines for quality and/or EMS auditing, BIS, New Delhi, 2002

EN649 SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT IN PROCESS INDUSTRIES

Course Objectives:

To detect and eliminate the unsafe practices in process industries and to enhance the safety, health and environmental management at industry

Safety in Process Design

Design process, conceptual design and detail design, assessment, inherently safer design – chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipments, utilities.

Plant Commissioning

Commissioning phases and organization, pre and post – commissioning documents, process commissioning, problems, Plant inspection, pressure vessel, pressure piping system, non-destructive testing, pressure testing, leak testing and monitoring – plant monitoring, performance monitoring, condition, vibration, corrosion, acoustic Emission-pipe line inspection.

Plant Operations

Operating discipline, operating procedure and inspection, format, emergency procedures – hand over and permit system–start up and shut down operation, refinery units –operation of fired heaters, driers, storage -operating activities and hazards –trip systems–exposure of personnel

Plant Maintenance

Management of maintenance, hazards–preparation for maintenance, isolation, purging, cleaning, confined spaces, permit system–maintenance equipment–hot works–tank cleaning, repair and demolition–online repairs–maintenance of protective devices modification of plant, problems–controls of modifications, Emergency planning, disaster planning, onsite and offsite emergency

Storages

General consideration, petroleum product storages, LPG storages, LNG storages, hydrogen storages, toxic storages, chlorine storages, ammonia storages, other chemical storages – underground storages–loading and unloading facilities–drum and cylinder storage – ware house, storage hazard assessment of LPG and LNG.

TEXT BOOKS:

Lees F.P., "Loss Prevention in Process Industries", Butter and worths Company, 1996

REFERENCES:

"Quantitative Risk Assessment in Chemical Process Industries" American Institute of Chemical Industries, Centre for Chemical Process safety

Fawcett, H.h. and Wood, "Safety and Accident Prevention in Chemical Operations" Wiley inters, Second Edition

"Accident Prevention Manual for Industrial Operations" NSC, Chicago, 198

EN650 INTRODUCTION TO SUSTAINABLE DEVELOPMENT AND CORPORATE SUSTAINABILITY

Course Objectives:

To explore the concept of prosperity and conventional view of development and corporate sustainability in the context of environmental limitations

Sustainable Development

Defining the Concept, The Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture, Current environmental issues in India – Case studies: Narmada Dam, There Dam, Almetti Dam

Environmental Economics

Valuing the Environment: Concepts, Methods, Property Rights, Externalities, and Environmental Problems, Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg

Environmental sustainability

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming, Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary-Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

Corporate social and environmental responsibility

Triple bottom line approach, Bottom of the pyramid opportunities, Issues and opportunities for business in socially and environmentally sensitive world, influence of social and environmental problems in shaping markets, Reducing socio-environmental costs and risks: managing the downside

Corporate sustainable development strategies

Social and environmental risk/liability management, Creating firm capabilities: Social and environmental management tools, technologies andsystem concepts, Environmental Managements Systems, ISO 14001 and the Natural Step, ISO 26000: Social responsibility guidance standard, Global Compact Principles, Environmental Impact Assessment, Life Cycle Analysis, Social Impact Assessment, Trends and opportunities in green energy technologies

TEXT BOOKS:

Andrew Hoffman, Competitive Environmental Strategy -A Guide for the Changing Business Landscape, Island Press

Andy Wales, Matthew Gorman & Dunstan Hope, Big Business, Big Responsibilities

REFERENCES:

Krebs, Charles J. 2001, Ecology: The Experimental Analysis of Distribution and Abundance, 5thedition

Aron Cramer & Zachary Karabell, "Sustainable Excellence"

Herman Daly, For the Common Good: redirecting the economy toward community, the environment and a sustainable future

Our Common Future by the World Commission on Environment and Development (Brundtland Commission)

EN651 ENVIRONMENTAL MONITORING AND MANAGEMENT

Course Objectives:

To introduce the techniques commonly utilized for the analysis of environmental samples and to understand the principles of environmental management

Environmental Monitoring Techniques

Overview of field sampling methods/plans –statistical sampling, representative sampling, Techniques and Technologies, Monitoring of ambient environment, including air, water and land, noise, liquid and solid waste management

Environmental Standards

Standards for discharge of treated liquid effluent into water bodies, including inland water bodies, and sea, standards for disposal of air emissions (SO_2, SPM, NH_3, H_2S and HC) into atmosphere

Environmental Legislations

Environmental Legislations in India related to environment -Development of Legislations, Standards and Guidelines Factory Act 1987 of India, Occupational health and safety requirements and standards of ILO, Compliance of rules and guidelines of Factory Act applicable to industries.

Principles of Environmental impact assessment

Principles of Environmental impact assessment and audit guidelines, legislature requirements for siting of industrial units in estates/complex, Preparatory procedures for EIA study, Evaluation of impact on air, water and land environment

Principles of Environmental Auditing

Principles of Environmental Auditing, Cleaner Technologies in Industrial Processes and evaluation of processes, Auditing techniques in Preparing Environmental Audit

TEXT BOOKS:

Canter, W.L., Environmental Impact Assessment, McGraw-Hill Inc., 1992

O'Riordan, T. 2000, Environmental Science for Environmental Management, Prentice Hall

REFERENCES:

Jones, A., Duck, R., Reed, R., and Weyers, J. 2000, Practical Skills in Environmental Science.

Pearson Prentice Hall

Vijay Kulkarni and Ramachandra T.V., 2006, Environmental Management, Commonwealth

Of Learning, Canada and Indian Institute of Science, Bangalore

Jain, R.K., Urban, L.V., Stacey, G.S. and Balbach, H.E., Environmental Assessment, McGraw-Hill, 1993

UNEP/IED Technical Report Serial No.2., Environmental Auditing, 1990

EN652 INDOOR AIR QUALITY

Course Objectives:

This course explores the physical nature of gaseous and particulate air contaminants, their occurrence inworkplaces, the principles underlying industrial hygiene measurement techniques andscenarios linking exposure with pollutants related ill-health

Indoor Air Pollution

Air pollutants -Sources and classification of pollutants and their effect on human health vegetation and property–Effects –Reactions of pollutants and their effects, Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapour monitors, dust sample collection devices, personal sampling

Indoor sources of indoor air pollution

Indoor activities of inhabitants –Levels of pollutants in indoor and outdoor air–Design and operation of buildings for improvements of public health–Indoor Air Quality policy issues–sustainability

Outdoor sources of indoor air pollution

Indoor air pollution from outdoor sources–particulate matter and ozone–Combustion by products–Radon and its decay products–Volatile organic compounds–odors and sick building syndrome–Humidity–Bio aerosols–infectious disease transmission–Special indoor environments–A/C units in indoor–Measurement methods–Control technologies–Control strategies

Control of indoor air pollution

Air pollutants in indoor environments–private residences–offices–schools-public buildings, industries, ventilation, Control of several pollutant classes–radon–toxic organic gases–combustion by products microorganisms such as molds and infectious bacteria

Modeling of indoor air pollution

Concepts and tools–exposure–material balance models–statistical models

TEXT BOOKS:

Thaddes Godish, Indoor air and Environmental Quality, CRC press, 2000

Nazaroff W.W. and L. Alvarez-Cohen, Environmental Engineering Science, Wiley sons, Newyork, 2001

REFERENCES:

Jonathan M. Samet, John D. Spengler, Indoor Air Pollution: A Health Perspective (The Johns Hopkins Series in Environmental Toxicology)

H. E. Burroughs, Shirley J. Hansen, Managing Indoor Air Quality, The Fairmont Press, Inc.,