ANNA UNIVERSITY TIRUCHIRAPPALLI
Tiruchirappalli – 620 024

Regulations 2008

Curriculum

M.TECH. ENERGY CONSERVATION AND MANAGEMENT

SEMESTER I

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	**CH5130**	Advanced Heat Transfer	3	1	0	4
2	**EM5101**	Advanced Thermodynamic	3	1	0	4
3	**EM5102**	Renewable Energy Systems	3	0	0	3
4	**EM5103**	Fuels and Combustion Technology	3	1	0	4
5	**CH5131**	Process Instrumentation and Control	3	1	0	4
6	**EM5104**	Nuclear, Hydel and Other Power Plants	3	0	0	3

SEMESTER II

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	**CH5170**	Design of Heat Exchangers	3	0	0	3
2	**EM5151**	**Cogeneration and Waste Heat Recovery Systems**	**3**	**1**	**0**	**4**
3	**EM5152**	Power Plant Technology	3	0	0	3
4	**EM5153**	Optimum Utilization of Heat and Power	3	0	0	3
5	**E1******	Elective I	3	0	0	3
6	**E2******	Elective II	3	0	0	3
Practical						
7	**EM5154**	Energy Engineering Laboratory	0	0	12	3

SEMESTER III

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	**EM5201**	Energy Conservation and Management	3	1	0	4
2	**E3******	Elective III	3	0	0	3
3	**E4******	Elective IV	3	0	0	3
Practical						
4	**CH5220**	Visual Basic Programming Laboratory	0	0	12	3
5	**EM5251**	Project Work (Phase I)	0	0	12	3

SEMESTER IV

S.No.	Subject Code	Subject	L	T	P	C
Practical						
1	**EM5251**	Project Work (Phase II)	-	-	24	12

LIST OF ELECTIVES

S.No.	Subject Code	Subject	L	T	P	C
ELECTIVE I						
1	**CH5030**	Refrigeration and Air Conditioning	3	0	0	3
2	**CH5031**	Unit Operations in Industries	3	0	0	3
ELECTIVE II						
1	**CH5032**	Applied Mathematics for Engineers	3	0	0	3
2	**CH5033**	Environmental Engineering and Pollution Control	3	0	0	3
3	**EM5001**	Sustainable Development	3	0	0	3
4	**EM5002**	Energy Efficient Buildings and HVAC	3	0	0	3
5	**EM5003**	Carbon Sequestration and Trading	3	0	0	3
ELECTIVE III						
1	**CH5034**	Fluidized Bed Systems	3	0	0	3
2	**CH5035**	Computational Fluid Dynamics	3	0	0	3
3	**CH5036**	Transport Phenomena	3	0	0	3
4	**CH5037**	Process Modeling, Simulation and Optimization	3	0	0	3
5	**EM5004**	Waste Management and Energy Conversion Technologies	3	0	0	3
ELECTIVE IV						
1	**EM5005**	Power Generation, Transmission and Utilization	3	0	0	3
2	**EE5030**	Electrical Energy Technology	3	0	0	3
3	**CH5038**	Technology Management	3	0	0	3
4	**EM5005**	Demand side Management of Power	3	0	0	3
5	**CH5039**	Safety and Hazards Control in Industries	3	0	0	3

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Regulations 2008

Syllabus

M.TECH. ENERGY CONSERVATION AND MANAGEMENT

CH5130 – ADVANCED HEAT TRANSFER

L	T	P	C
3	1	0	4

UNIT I CONDUCTION AND EXTENDED SURFACES 9

Conduction: Steady state one-dimensional law of heat conduction – Fourier heat conduction – heat conduction through a plane wall-radial conduction in long hollow cylinders – Radial conduction through hollow sphere – General three dimensional heat conduction equation – Transient heat conduction in plane walls, cylinders and spheres with convective boundary conditions – Transient heat flow in semi-infinite bodies – Finite – Difference methods for solving heat conduction problems.

Extended Surfaces: Extended surface heat transfer – Conduction and convection systems in fin – rectangular fin of constant cross section – Heat transfer from rectangular, triangular and circumferential fins – Fin efficiency.

UNIT II CONVECTION 9

Fundamental laws of convection – The governing equations of free convection – Working correlations for free convection – Mixed, free and forced convection – Forced convection heat transfer co-efficient – Heat transfer for laminar flow in circular tubes – Heat transfer for turbulent flow in circular tubes – Analogy between heat and momentum transfer – Reynolds, Colburn, Van kerman analogy – Forced convection heat transfer coefficient for flow over bodies – Heat transfer co-efficient for turbulent flow over flat plates.

UNIT III RADIATION 9

Thermal radiation – Introduction – Stefan – Boltzmann Law, the black body and emissive power – Basic radiation properties – Radiation shape factors and their relationships – Radiant heat transfer between two black bodies forming an enclosure shields – Directional aspects of emitted radiation – Radiation shape factor –Radiation in gases.

UNIT IV BOILING AND CONDENSATION 9

Boiling Liquids: Regimes of boiling – Free convection regime, Nucleate boiling regime – Mechanism of nucleate boiling – Peak heat flux and critical ΔT – Nucleate surface boiling of sub-cooled liquids – Forced convection boiling inside tubes – Heat transfer relations.

Condensing Vapors: Condensation theory – Condensation on vertical surfaces, inclined surfaces, Horizontal tube banks – Drop wise condensation of pure vapors – Film wise condensation both inside and outside horizontal tubes – Effect of non-condensable gases in condensers.

UNIT V NUMERICAL METHODS IN HEAT TRANSFER 9

Finite difference formulation of steady and transient heat conduction problems – Discretization schemes – Explicit, Crank Nicolson and fully implicit schemes – Control volume formulation – Steady one dimensional convection and diffusion problems – Calculation of the flow field – SIMPLER Algorithm

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Knudsen, J.G. and Katz, D. L., "Fluid Dynamics and Heat Transfer", Mc Graw Hill Publishers, 1958.
2. Mc William Adams, H., "Heat Transmissions", McGraw Hill Intl, 2001.
3. Chattopadhyay, P., "Problems in Heat Transfer", 3rd Edition, Khanna Publishers, 2003.

REFERENCES

1. Nag, P.K., "Heat Transfer", Tata McGraw Hill, 2002.
2. Chuen, Yen Chow., "An Introduction to computational Fluid Mechanics", John Wiley and Sons,2005.
3. Kollmann, W.,"Computational Fluid Dynamics", A Von Karman Inst. Book Mc Graw Hill Intl, 2001.
4. Patankar, S.V., "Numerical heat transfer and Fluid Flow", Hemisphere Publishing Corporation, 1980.

EM5101 – ADVANCED THERMODYNAMICS

L	T	P	C
3	1	0	4

UNITI AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS 9

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 – Generalized relations for changes in entropy, internal energy and enthalpy – Generalized relations for C_p and C_v – Clausius clayperon equation – The Joule-Thomson coefficient – Bridgman tables for thermodynamic relations.

UNIT II REAL GAS BEHAVIOURS AND MULTICOMPONENT SYSTEMS 9

Different equations of state – Fugacity – Compressibility – Principle of corresponding states – Use of generalized charts for enthalpy and entropy departure – Fugacity coefficient – Lee-Kesler generalized three parameter tables – Fundamental property relations for systems of variable composition – Partial molar properties – Real gas mixtures – Ideal solution of real gases and liquids – Activity – Equilibrium in multi phase systems – Gibbs phase rule for nonreactive components.

UNIT III VAPOUR AND COMBINED POWER CYCLES 9

Simple steam power cycle – Rankine cycle – Comparison of Rankine and 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.

UNIT IV REFRIGERATION CYCLE 9

Refrigerators and heat pumps – The reversed carnot cycle – Ideal and actual vapor compression Refrigeration cycle – Selection of refrigerants – Multistage compression refrigeration systems – Absorption refrigeration cycle – Gas refrigeration cycle – Absorption refrigeration systems.

UNIT V STATISTICAL AND IRREVERSIBLE THERMODYNAMICS 9

Statistical Thermodynamics: 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 – Calculation of statistical thermodynamic approach.

Irreversible Thermodynamics: Conjugate fluxes and forces – Entropy production – Onsager's reciprocity relations – Thermo-electric phenomena formulations – Power generation – Refrigeration.

L: 45 T:15 Total: 60

TEXT BOOKS

1. Nag, P.K., “Engineering Thermodynamics”, 3rd Edition, Tata McGraw Hill, 2005.
2. Gordon Van Vylan., “Applied Thermodynamics for Engineers”, 3rd Edition, John Wiley International Edition, 2004.
3. Holman, J.P., “Thermodynamics”, 4th Edition, McGraw Hill Inc., 1988.

REFERENCES

1. Ballaney, P.L., “Thermal Engineering”, Khanna Publishers, 2005.
2. Natarajan, M.K., “Thermodynamic analysis of energy systems”, Khanna Publishers, 2006.
3. Smith, J.M. and Van Ness., “Introduction to Chemical Engineering Thermodynamics”, 5th Edition, McGraw Hill, 1996.

EM5102 – RENEWABLE ENERGY SYSTEMS

L	T	P	C
3	0	0	3

UNIT I SOLAR ENERGY 9

Introduction – Solar radiation – Measurement, data estimation – Design of flat plate water heater and solar air heater – Performance analysis – Applications – Economic feasibility – Selective coatings – Concentrating collectors – Characteristics of cylindrical / parabolic / compound parabolic collectors – Central receiver tower – Introduction to solar ponds – Merits and demerits of solar pond – Economics of solar pond.

UNIT II SOLAR ENERGY APPLICANCES 9

Solar energy storage – Types of storage systems – Characteristics and limitation of storage systems with respect to sensible heat and latent heat – Thermo chemical storages – Economic feasibility of solar cookers – Types – Working principle –Efficiency prediction – Comparison of various models – Economic aspect – Photovoltaics – Introduction – Principle of operation – Performance prediction – Solar lanterns – Solar powered vehicles.

UNIT III BIOMASS ENERGY 9

Introduction – Origin – Types of biomass – Availability data – Characteristic of biomass – Classifications – Biomass utilization – Pretreatment processes – drying – Size reduction – Densification – Pelletization – Baling – Briquetting – Merits and demerits of biomass utilization as fuel – Transportation – Pollution aspects – Types of combustion in boilers – Gasification of biomass – Principle of gasification – Type of gasifiers – Utility of gasification process – Problems encountered in gasification – Pyrolysis of biomass – Principle – Production of charcoal – Economics.

UNIT IV BIO GAS TECHNOLOGY 9

Historical background of biomethanation – Aerobic fermentation – Properties of biogas – Biogas plant designs construction, operation and maintenance – Factors affecting biogas yield – Biogas from different organic waste – Types of biogas reactors – Biogas reactor design, case studies and its economics – Applications and usage of biogas.

UNIT V WIND ENERGY 9

Uses of wind energy – Betz limit – Classification of wind machines – Features and comparison horizontal and vertical axis wind machines – Application of wind mill for water pumping – Types of wind energy systems, wind – diesel and wind solar combinations – Battery storage – Limitations of wind energy – Wind mill design, case studies and economic aspects.

Total: 45

TEXT BOOKS

1. Rai, G.D., “Non-conventional energy sources”, Khanna Publishers, 2005.
2. Sukhatme, S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill, 1984.

REFERENCES

1. Pachauri, R K., “Global Energy Interactions”, Energy Policy Issues, Volume 1, Allied Publishers, 1985**.**
2. Duffie, J.A. and Beckmann W.A., “Solar Engineering of Thermal Processes”, John Wiley, 1980.
3. Kreith, F. and Kreider J.F., “Principles of Solar Engineering”, McGraw Hill, 1978.
4. Kreider, J.F. and Kreith F., “Solar Energy Handbook”, McGraw Hill, 1981.

EM5103 – FUELS AND COMBUSTION TECHNOLOGY

L	T	P	C
3	1	0	4

UNIT I FUELS, FUEL ANALYSIS and COMBUSTION STOICHIOMETRY 9

Fuels and Fuel Analysis: Solid fuels – Coal – Origin of coal – Analysis of coal – Composition and properties of coal – Coal Petrology – Coal classification – Other solid fuels – Classification and analysis of other solid fuels – Storage and handling of solid fuels – Liquid fuels – Origin of petroleum – Classification and composition of petroleum – Petroleum processing – Other liquid fuel – Storage and handling of liquid fuel – Gaseous fuels – Types of gaseous fuels – Natural gas, coal gas, manufactured gases – Cleaning and purification of gaseous fuel – Properties and testing of fuel gases.

Combustion Stoichiometry: Stoichiometry relations – Conservation of mass principles – Theoretical and actual combustion processes – Calculation of air fuel ratio for a fuel of known composition – Calculation of flue gas composition of fuel and excess air supplied from exhaust gas analysis – Combustion calculation with sub-stoichiometric air – Calculation of atmospheric air moisture – Dew point temperature of the combustion products – Flue gas analysis and Calorific value determination.

UNIT II THERMODYNAMICS OF COMBUSTION PROCESSES 9

Combustion Thermodynamics: Enthalpy of formation – Enthalpy of combustion – Calculation of heat of formation and heat of combustion – First law analysis of reacting systems – Adiabatic flame temperature calculation – Entropy change of reacting systems – Second law analysis of reacting systems.

Combustion Kinetics: Reversible reactions – equilibrium – Criteria of equilibrium – Laws of mass action – Gibbs free energy – equilibrium constant – Vant Hoffs isotherm – Rate of reaction – Factors affecting rate of reaction – Calculation of equilibrium constant and composition of reacting systems.

UNIT III HEAT TREATMENT FURNACES 9

Industrial furnaces – process furnaces – Kilns – Batch and continuous furnaces – Advantages of ceramic coating – Heat source – Distributions of heat source in furnaces – Blast furnace – Open health furnace – Pot and crucible furnace – Waste heat recovery in furnaces – Recuperator – Regenerators – Furnace atmospheres – Furnace Heat balance calculations.

UNIT IV FLAME, FLAME STRUCTURE, IGNITION, IGNITORS 9

Flame – Flame structure – Flame propagation – Deflagration – Detonations – Flame front – Ignition – Self and forced ignition – Ignition temperature and ignition limits – Factors influencing ignition – SIT – Ignition lag – Limits of inflammability and its determination – Factors affecting inflammability limits – Calculation of inflammability limits – Flame blow off, blow out and flash back –Flame quenching, Flame structure – Flame stability – Premixed and diffused flames – Velocity of flame propagation – Various methods of flame stabilization.

UNIT V COMBUSTION APPLIANCES 9

Gas burners: Functional requirement of burners – Gas burner classification -Premix burners – Aerated gas burners – Air aspiration gas burners – Diffusion flame burners – Radiant or tile port burners – Atmospheric gas burners.

Liquid fuel burners: Pressure jet atomization – Air blast atomizers – Steam atomizers – Rotary cup atomizers – Vaporizing burners – Low NO_X burners – Swirl number and its significance – Selection of appropriate type of burners.

Coal burning equipments: Coal burning methods – Over feed and underfeed supply of coal – Mechanical Stokers – Traveling grate and spreader stoker – Vibrating grate stoker – Advantages and disadvantages of stoker firing over pulverized systems of firing – Problems encountered with burning of high ash coal – Pulverized fuel burners – Streamlined burner – Turbulent burners – Tangential burner – Cyclone burner.

L: 45 T:15 Total: 60

TEXT BOOKS

1. Sharma, S.P. and Chander Mohan., "Fuels and Combustion", Tata Mc Graw Hill, Publishing Co.Ltd, 1984.
2. Samir Sarkar.S., "Fuels and Combustion", 2nd Edition, Orient Longman, 1990.

REFERENCES

1. Blokh, A.G., "Heat Transmission in Steam Boiler furnaces", Hemisphere Publishing Corporation, 1994.
2. Gupta, O.P., "Elements of Fuels, Furnaces and Refractories", 3rd Edition, Khanna Publishers, 1996.
3. Gilchrist, J. D., "Fuels, Furnaces and Refractories", Pergamom Press, 1999.

CH5131 – PROCESS INSTRUMENTATION AND CONTROL

L	T	P	C
3	1	0	4

UNIT I INTRODUCTION TO MEASUREMENT TECHNIQUES 9

General concepts of measurements, static and dynamic characteristics, Introduction to calibrations, calibration standards – characteristics of instruments – Definition – True value – Accuracy – Precision – Sensitivity –Resolution – errors and its measurements.

UNIT II MEASUREMENT OF PRESSURE AND TEMPERATURE 9

Measurement of Pressure: Different units of pressure – Classification of pressure gauges – Manometers – Pressure balance gauges – Force balancing gauges – Elastic deformation – Commercial pressure gauges using the above principles – Ring balance type elements. Measurement of vacuum – Mcleod gauge – Pirani gauge – Measurement using strain gauges. Measurement of Pressure using electronic/micro processor based transmitter.

Measurement of Temperature: Different temperature scales – Non-electrical methods – Change in volume of liquid – Change in pressure of gas – Change in vapour pressure. Electrical methods – Thermocouple – Resistance temperature detector – Radiation pyrometer – Optical pyrometer – Thermistors – Temperature measurement using electronic/micro processor based transmitter – Measurement of electrical energy – Voltage – Current – Power Factor.

UNIT III MEASUREMENT OF FLOW, LEVEL, HUMIDITY AND OTHER MISCELLEANEOUS PARAMETERS 9

Flow measurement – Types – Differential pressure type flow meter – Orifice meter – Ventury tube – Flow nozzle – Pitot tube – Positive displacement type flow meter – Inferential flow meter – Turbine flow meter – Variable area flow meter (rotameter) – Mass flow meter – Low flow measurement using pizzo ring – Ultra Sonic flow meter for high flow.

Level measurement – Basic methods – Measuring hydrostatic pressure – Measuring the movement of the float – Electric conduction method – Sight glass – Non-contact measurement techniques –Level measurement by DP transmitter.

Definition of humidity – Hygrometer and psychrometer – Humidity measurement measurement of pH-pH scale – Methods of pH measurements – Mass spectrometer and chromotograph. Hazardous area and its classification.

UNIT IV TRANSDUCERS 9

Classification of Transducers – Active and passive transducers – Analog and digital transducers. Advantages of electrical transducers over mechanical transducers – Different type – Resistance – Inductance – Capacitance – Piezo electric transducers.

UNIT V PROCESS CONTROL 9

Functional block diagram of a process control loop and their elements – Definition of set point, controlled variable, measured variable, manipulated variable, dead zone, dead time, disturbance, deviation, (definitions only) – Basic definition of control system – Open and closed loop control system – feed forward control – Ratio control – Cascade control – Basic control actions and applications – Characteristics of on-off, proportional, integral and derivative control modes – Composite control actions – PI, PD and PID control modes – Examples of control loops – Boiler controls – Combustion control, Drum level control and steam temperature control – Programmable logic controllers and Distributed controlled system – Computer control using supervisory computer.

L: 45 T:15 Total: 60

TEXT BOOKS

1. Bentley, J. P., "Principles of Measurement Systems", 3rd Edition, Addison Wesley Longman Ltd, 2000.
2. Neubert, H.K.P., "Instrument Transducers An introduction their performance and Design", 2nd Edition, Oxford University Press, 1999.
3. Patranabis, D., Sensors and Transducers, Wheeler Publishing Co., 1997.

REFERENCES

1. Liptak, B. G., "Process Control ", 3rd Edition, Chilton Book Company, 1995.
2. Liptak B. G., "Measurement and Analysis", 3rd Edition,Chilton Book Company 1995.
3. Noltingk, B.E., "Instrumentation", 2nd Edition, Butterworth Heinnemann, Oxford, 1996.
4. Stephanopoulos., "Chemical Process Control – An Introduction to Theory and practice", PHI, 1999.

EM5104 – NUCLEAR, HYDEL AND OTHER POWER PLANTS

L	T	P	C
3	0	0	3

UNIT I NUCLEAR POWER 9

Introduction –Nuclear power for developing countries – Role of nuclear power – Radioactivity and radioactive charge – Unit of radioactivity – Mass energy equivalence – Usefulness of einstein theory – Types of nuclear reaction – Nuclear fission and fusion – Fertile materials and breading – Location of nuclear power plants – General components of nuclear reactors – Fuel – Moderator – Reflector – Coolant – Control rods – Shielding – Reflector vessel – General problem of reactor operation.

UNIT II NUCLEAR REACTORS 9

Current Generation power reactors – Pressurized water reactors – Boiling water reactors – Gas – cooled reactors – Advanced design – Advanced boiling water reactors – Modular pressurized – heavy water reactors – Advanced passive reactors – Gas turbine modular helium reactor – Breeder reactors – Commercial design – Comparison of nuclear plants with thermal plants.

UNIT III HYDROLOGY AND HYDRO – ELECTRIC POWER PLANTS 9

Rainfall and its measurements – Hydrographs – Flow duration curve – Mass curve and storage – Site selection for hydroelectric power plants – Environmental aspects of site selection – Classification of hydro – electric power plants – Storage type hydro-electric plant and its operation – Advantage and disadvantages of hydro-electric power plant.

UNIT IV DESIGN CONSTRUCTION AND OPERATION OF HYDRO-ELECTRIC POWER PLANTS 9

Reservoirs – Dam – Spillway – Surge tank – Power house and turbine setting – Arrangement of reaction and impulse turbine – Advantages and disadvantage of under ground power station – Prime movers – Pelton turbine – Francis Turbine – Kaplan turbine – Specific speed of turbine – Draft tubes – Moody draft tube – Selection of turbines – Covering of water turbines – Advantages of hydro power plants.

UNIT V OTHER TYPES OF POWER PLANTS 9

Ocean thermal energy conversion – Concept – History of OTEC development – Constructions operational problem – Ecological and environmental impacts – Tidal and water power – Tidal power – Wave power – Geothermal power – Potential – Geothermal power – History of geothermal power – Environment and ecologic consideration.

Total: 45

TEXT BOOKS

1. Black and Veatch., “Power Plant Engineering”, CBS Publishers and Distributors, 2004.
2. Rai, G.D., “Renewable energy sources**,** 4th Edition, Khanna Publishers, 1997.

REFERENCES

1. Boyle, G., “Renewable Energy Power for Sustainable Future”, Oxford University Press, 1996.
2. Twidell, J. W. and Weir. A., “Renewable Energy Sources”, EFN Spon Ltd., 1986.

II SEMESTER

CH5170 – DESIGN OF HEAT EXCHANGERS

L	T	P	C
3	0	0	3

UNIT I DOUBLE PIPE AND COMPACT HEAT EXCHANGERS 9

Equipment classification – Study of film coefficients in pipes / annuli – Fouling factors – Pressure drop in pipes / annuli – Design factors and approach – Typical industrial systems – Series / Parallel flow arrangements – Design of double pipe heat exchangers – Compact heat exchangers – Plate and frame heat exchangers – Advantages – Design considerations – Spiral plate and spiral tube heat exchangers – Its Comparison – Other common heat exchange devices – Applications and case studies.

UNIT II SHELL AND TUBE HEAT EXCHANGERS 9

Basic design procedure and theory – Overall heat transfer coefficient – Fouling factors (Dirt Factors) – Shell and tube exchanger – Construction details – General design considerations – Fluid allocation – Shell and tube fluid velocities – Fluid physical properties – Shell side and Tube side heat transfer coefficients / pressure Drop – Design of liquid-liquid, gas-gas, liquid-gas heat exchangers (with no Phase Change – E-NTU method of heat exchanger analysis).

UNIT III CONDENSER DESIGN 9

Heat transfer fundamentals – Condenser design – Condensation outside horizontal tubes – Condensation inside/outside vertical tubes – Condensation inside horizontal tubes – De-super heating and sub cooling – Pressure drop in condensers – Advantages of condenser – weighted mean temperature difference calculations – Types of steam condensers – Jet type – surface condensers – Air cooled condensers – requirement of modern surface condensers – Evaporative condensers – Air leakage and its effects on the condenser performance – Scale formation and its prevention – Various types of condenser design.

UNIT IV COOLING TOWERS AND SPRAY PONDS 9

Types of cooling towers and its selection – Packings – Spray design – Selection of pumps and fans – Cooling tower blow down – Spray ponds – Testing and maintenance – Energy conservation in cooling towers and spray ponds.

UNIT V HEAT PIPE HEAT EXCHANGERS 9

Types and classification of heat pipes – HEHP design – Thermal and pressure drop design – HEHP design optimization – Working fluid selection – Wick structure – Modeling heat pipe performance – HEHP applications.

Total: 45

TEXT BOOKS

1. Kern, D.Q., “Process Heat Transfer”, McGraw Hill, 1999.
2. G. P. Peterson., “An Introduction to Heat Pipes: Modeling, Testing and Analysis, McGraw Hill, 1994.

REFERENCES

1. Coulson, J.M. and Richardson, J.F., “Chemical Engineering”, Vol. 6, Tata McGraw Hill, 2006.
2. Ludwig, E.D., “Chemical Processing Equipment Design”, Gulf Publishing Company, 2005.

EM5151 – COGENERATION AND WASTE HEAT RECOVERY SYSTEMS

L	T	P	C
3	1	0	4

UNIT I COGENERATION 9

Introduction – Principles of thermodynamics – Combined cycles – Topping and bottoming – Organic ranking cycles – Advantages of cogeneration technologies.

UNIT II APPLICATIONS AND TECHNOECONOMICS OF COGENERATION 9

Cogeneration applications in various industries like cement, sugar mill, paper mill etc., – Sizing of waste heat boilers – Performance analysis of cogeneration schemes – Economic analysis of cogeneration systems.

UNIT III WASTE HEAT SOURCES AND CLASSIFICATION 9

Sources of waste heat – Diesel engines, power plants – High, medium and low temperature heat recovery – Total, available, returnable and recoverable heat in combustion gases – Waste heat potentials – Waste heat recovery applications and calculations.

UNIT IV WASTE HEAT RECOVERY SYSTEMS 9

Heat pipe heat exchangers – Heat pumps – Thermic fluid heaters – Waste heat recovery Systems – Recuperators – Regenerators – Economisers – Plate heat exchangers.

UNIT V WASTE HEAT BOILERS AND COMBINED CYCLES 9

Waste heat boilers – Classification – Location – Service conditions – Design considerations – Sizing of waste heat boilers – Performance calculations – Part load characteristics – WHR industrial application – Materials of construction – Unfired combined cycle – Supplementary fired combined cycle – Fired combined cycle.

L: 45 T:15 Total: 60

TEXT BOOKS

1. Kern, D.Q., "Process Heat Transfer", McGraw Hill, 1999.
2. Reay**,** D.A.**,** "Heat Recovery Systems", 2nd Edition, John Wiley and Sons, 1979.
3. Beckett, Ardell., **"**Waste Heat Recovery System**",** John Wiley and Sons, 1983.

REFERENCES

1. Subrata. S. and Lee, S.S., "Waste Heat Utilization and Management", Volume 1, 2 and 3, Hemisphere, 1983.
2. Butler, C.H., "Cogeneration", McGraw Hill Book Co., 1984.
3. Horlock, J.H.,"Cogeneration-Heat and Power, Thermodynamics and Economics", Oxford Press,1987.
4. Anonymous, "Waste Heat Recovery", Institute of Fuel, Chapman and Hall Publishers, 1963.

EM5152 – POWER PLANT TECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I POWER PLANT FEATURES and POWER PLANT ECONOMICS 9

Power plants – Features, components and layouts – Working of power plants, power plant economics – Essentials of power plant equipments – Power station design – Fuel – Preparation and handling – Storage – Feeding – Burning of fuels – Ash handling – Dust collections – Control of power plant stack emissions – Draught system.

UNIT II BOILER and ACCESSORIES 9

Boiler classification – Boiler types – Fire tube and water tube boilers – Fluidized bed boilers – Positive circulation boilers – Thermal liquid heaters and vaporizers – Waste heat boilers – Boiler design principles – Furnace and fire side design – Design considerations for utility and Industrial boilers – Input data and its significance for design of steam generators – Boiler furnaces – Type of furnace walls – Factors influencing furnace design – Plan area loading – EPRS loading – Volumetric loading – Furnace exit gas temperature estimation – Design consideration for evaporator/super heater / reheater / economizer and air heater – Steam temperature control – Boiler blow down and steam purification – Super heaters, re-heaters and attemperators, economizers and air heaters – Soot blowers – Design considerations for modern boilers.

Heat balance for boilers and power plants – Boiler efficiency calculations – Boiler regulations – Codes and standards – Boiler ratings and performance fluidised bed combustion systems (FBC) – Principles of FBC and CFBC – Types and arrangements – FBC for low grade fuels – Corrosion of FBC systems – Starting and control of FBC – Advantages and disadvantages.

UNIT III STEAM CYCLE APPLIANCES 9

Classification – Features – Working – Performance of steam turbines – Losses in steam turbines – Governing of steam turbines – Trouble shooting – Stem turbines for industrial purposes – Cycles for steam power plants – Steam turbine efficiency parameters – Power plant auxiliaries – Condensers – Cooling towers – Feed water treatment – Steam piping.

UNIT IV GAS CYCLE APPLIANCES 9

Gas turbine power plant: Classification and comparison of different types gas turbine power plants – Analysis of closed cycle and open cycle gas turbine plants – Methods to improve thermal efficiency – Components of gas turbine power plant – Advantages of gas turbine plant over diesel and thermal power plants.

Gas and Steam Turbine Combined Cycle: Simple gas-steam combined cycles – Repowering cycles – Coal gasification – Integrated combined cycles – Combined cycles with PFBC and PFBG systems – Thermodynamic analysis for optimum design – Advantages of combined cycles – Performances, economics and future of combined cycles.

UNIT V EMERGING TECHNOLOGIES 9

Integrated gasification combined cycle (IGCC) – Indirect fired combined cycle (IFCC) – Magneto hydrodynamics (MHD) – Fuel cells – Micro turbines –Co-generation plants – RDF based power plants.

Diesel electric power plants : Field of use – Outline of diesel electric power plant – Different types of engine and their working – Different systems of diesel power plant – Performance of diesel engines – Comparison of diesel plant with steam power plants.

Total: 45

TEXT BOOKS

1. Elliott,T.C.**, "**Standard Hand Book of Power Plant Engineering", McGraw Hill Book Co, 2001.
2. Wakil, E L., "Power Plant Engineering", McGraw Hill Book Co, 2001.
3. Black and Veatch., "Power Plant Engineering"**,** CBS Published and Distributors, 2004.

REFERENCES

1. Wood, A. J., Wollenberg, B.F., "Power Generation, Operation and Control," John Wiley, 1984.
2. Arora and Domkundwar., "A Course in Power Plant Engineering", Danpat Rai and Co., 2004.
3. Nag, P. K., "Power Plant Engineering," Tata McGraw Hill publishing Co. Ltd.,1998.

EM5153 – OPTIMUM UTILIZATION OF HEAT AND POWER

L	T	P	C
3	0	0	3

UNIT I ENERGY CONVERSION AND ITS USE 9

The energy problem – Energy scenario – Yesterday, today – Future energy perspective – World experience – Energy conversion – Efficient combustion – Waste as a fuel – Selection of energy Recovery methods – Utility system optimization and cogeneration – Heat rate calculation – Case studies.

UNIT II TARGETING AND ΔT_{min} OPTIMIZATION 9

Energy targeting – Area targeting – Unit targeting – Shell targeting – Cost targeting – ΔT_{min} optimization – Continuous targeting – Overall pinch targeting and continuous targeting.

UNIT III PROCESS INTEGRATION and PINCH TECHNOLOGY 9

Basic concepts of pinch technology – Stream networks – The signification of the pinch – Design of energy recovery systems – Selection of pinch temperature difference – Tabular method – Stream splitting – Process retrofit – Installation of heat pumps – Installation of heat engines – The grand composite curve – General comments about process integration.

UNIT IV TOTAL ENERGY SYSTEMS AND SCHEMES 9

Total Energy Systems : Concept of total energy – Advantages and limitations – Total energy system and application – Various possible schemes employing steam turbines movers used in total energy systems – Potential and economics of total energy systems.

Total Energy Schemes: Basic concepts of CHP – Benefits of CHP – Problems associated with CHP – Economics of CHP generations – CHP in the industry, commercial and domestic sector.

UNIT V THE ECONOMICS OF ENERGY SAVING SCHEMES 9

Costs – Types of costs associated with energy usage – Simple pay back analysis – Effective method of inventing capital in energy saving projects – ARR, DCF, NPV and IRR methods – Factors affecting project appraisal – Life cycle cost – Impact of fuel inflation on the life cycle analysis – Case studies – Pinch technology – Basic concepts and its significance – Selection of pinch temperature difference – Pinch methodology – Pinch design and optimization – Design of energy recovery systems

Total: 45

TEXT BOOKS

1. Eastop,T.D. and Croft, D.R., "Energy Efficiency for Engineers and Technologists" Longman and Scientific and Technical, 2002.
2. O'Callaghan**,** Paul W**.**, "Design and Management for Energy Conservation**",** Pergamon**,** 1993.

REFERENCE

1. Peter, O. D., "Handbook of Energy Data and Calculations Including Directory of Products and Services", Butterworths, 1980.

EM5154 – ENERGY ENGINEERING LABORATORY

L	T	P	C
0	0	12	3

LIST OF EXPERIMENTS

1. Proximate Analysis of Solid Fuels
2. Ultimate Analysis of Solid Fuels
3. Determination of Calorific Value of Solid/liquid Fuels using Bomb Calorimeter
4. Determination of Calorific Value of gaseous Fuels using Junker's gas Calorimeter
5. Emission Test Using Combustion Gas Analyzer
6. Energy balance test on given steam boiler
7. Performance analysis of heat transfer equipments
8. Determination of heating/cooling load for the given space to be air – conditioned
9. Performance Analysis of Air conditioning / Refrigeration System
10. Solar Radiation – Measurement and Analysis
11. Determination of dissolved Oxygen, suspended, volatile and fixed Solids
12. Determination of B.O.D and C.O.D
13. Control valve characteristics of flow co-efficient and range ability
14. Effect of P, PI, and PID controller on pressure control loop
15. Verifying the response of Interacting and Non – Interacting level systems

Total: 45

III SEMESTER

EM5201 – ENERGY CONSERVATION AND MANAGEMENT

L	T	P	C
3	1	0	4

UNIT I ENERGY CONSERVATION PRINCIPLES and PRACTICES 9

Energy scenario – Principles and imperatives of energy conservation – Energy consumption pattern – Resource availability – Why save energy – Reasons to save energy – An over view of energy consumption and its effects – Current energy consumption in India – Role of energy managers in industries.

UNIT II THERMAL ENERGY AUDITING AND CO-GENERATION 9

Energy audit – Purpose – Methodology with respect to process indstries, power plants, boilers etc., – Characteristic methods employed in certain energy intensive industries – Various energy – Conservation measures in steam system – Losses in boiler – Methodology of upgrading boiler performance – Boiler blow down control – Excess air control – Pressure reducing stations – Energy conservation in steam systems – Importance of correct pressure, temperature, and quality of steam – Condensate recovery – Condensate pumping – Thermo compressors – Recovery of flash steam – Air removal and venting – Moisture removal – Steam Traps – Types – Function – Necessity – Selection and application – Co-generation – in-plant power generation systems – Co-generation schemes and configuration – Design considerations – Heat rate improvement – Case studies.

UNIT III ENERGY CONSERVATION IN FLUID MOVING MACHINES, AND COOLING TOWERS 9

Centrifugal pumps – Energy consumption and energy saving potentials – Design consideration – minimizing over design – Case studies – Fans and blowers – Specification, safety margin, choice of fans, controls and design considerations – Air compressor and compressed air systems – selection of compressed air layout – Encon aspects to be considered at design stage – Case studies.

UNIT IV ELECTRICAL ENERGY AUDITING 9

Potential areas for electrical energy conservation in various industries – Conservation methods – Energy management opportunities in electrical heating, lighting system, cable selection – Energy efficient motors – Factors involved in determination of motor efficiency – Adjustable AC drives – Application and its use – Variable speed drives / belt drives – Energy efficiency in electrical systems – Energy efficiency in lighting – Case Studies.

UNIT V ENERGY MANAGEMENT, MONITORING and TARGETING 9

Organizational background desired for energy management persuasion / motivation / publicity role – Tariff Analysis – Industrial energy management systems – Energy monitoring, auditing and targeting – Economics of various energy conservation schemes – Energy policy and energy labeling.

L: 45 T:15 Total: 60

TEXT BOOKS

1. Reay, D. A., "Industrial energy conservation", Pergamon Press, 1979.
2. White, L. C., "Industrial Energy Management and Utilization", Hemisphere Publishers, 1988.
3. Eastop, T.D. and Croft, D.R., "Energy Efficiency for Engineers and Technologists" Longman and Scientific and Technical, 1988.

REFERENCES

1. Smith, C.B., "Enegy Management Principles", Pergamon Press,1981.
2. Hamies, "Energy Auditing and Conservation; Methods, Measurements, Management and Case study", Hemisphere, 1980.
3. Trivedi, P.R. and Jolka K.R., "Energy Management", Common Wealth Publication, 1997.
4. Diamant, R.M.E., "Total Energy", Pergamon, Oxford Press, 1970.

CH5220 – VISUAL BASIC PROGRAMMING LABORATORY

L	T	P	C
0	0	12	3

1. Fundamental of VB Programming
2. VB Programme to Evaluate Thermodynamic Properties
3. VB Programme to Generate Steam Tables
4. VB Programme to Generate VLE Data
5. VB Programme to find theoretical air required and flue gas composition for a fuel of given composition
6. VB Programme to Evaluate performance of pumps and compressors
7. VB Programme to Evaluate performance of Cooling Towers
8. VB Programme to Evaluate performance of Heat Exchangers
9. Development of VB Programme for the design of Heat Exchangers
10. Development of VB Programme for the design of Distillation Columns

Total: 45

II SEMESTER ELECTIVE SUBJECTS

ELECTIVE I

CH5030 – REFRIGERATION AND AIR CONDITIONING

L	T	P	C
3	0	0	3

UNIT I BASIC CONCEPTS AND TYPES OF REFRIGERATION 9

Basic concepts of refrigeration – Types of refrigeration – Application of refrigeration systems for food preservation – Heat pump – Vapor compression and absorption systems and its applications – Refrigerants and their properties selection of refrigerants – Air conditioning systems and concepts.

UNIT II DESIGN FEATURES OF ACCESSORIES 9

Design features of condensers, evaporators and cooling towers – Types of electrical systems for refrigeration – Various of domestic and industrial refrigeration equipment and their design features – Types of expansion devices – Temperature control – De-frosting.

UNIT III PHYCROMETRICS, HEATING, VENTILATION AND AIR - CONDITIONING 9

Properties of moist air – Requirements of comfort air conditioning – Psychometric chart – By-pass factor – Sensible heat factor – Humidification and de-humidification – Heating and humidification – Cooling and de-humidification – Various types of air conditioning and ventilation systems for domestic and industrial applications.

UNIT IV WORKING AND PERFORMANCE ANALYSIS OF REFRIGERATION SYSTEMS 9

Comfort Chart – Cooling load calculations – Different types of heat gains summer – Winter and year round air conditioning systems – Performance calculations for air conditioning system – Working details of air conditioning equipment.

UNIT V DESIGN OF REFRIGERATION EQUIPMENTS AND APPLICATION 9

Types of refrigeration compressors – Fans – Ducting and Insulations – Measurement of performance of refrigeration and air conditioning systems – Instruments for R and A/c applications – Cryogenics – Cascade refrigeration system – Liquefaction of gases.

Total: 45

TEXT BOOKS

1. Arora and Domkundwar, “A Course in Refrigeration and Air Conditioning”, Dhanpat Rai and co, 2002.
2. Stoecker, W.F., “Refrigeration and Air Conditioning”, TMH Edition, McGraw Hill Publication, 1980.
3. Trott, A.R., “Refrigeration and Air Conditioning”, 2nd Edition, Butterworth Publishers Butterworth-Heinemann, 2008.

REFERENCES

1. Arora, C. P., **“**Refrigeration and Air Conditioning”,Tata McGraw Hill, 1984
2. Khurmi, RS.and Gupta,JK., “A Text Book of Refrigeration and Air-Conditioning”, Tata McGraw Hill, 1988.
3. Manohar Prasad, D., “Refrigeration and Air-conditioning Data Book”, Wiley Eastern Ltd, 1989.

CH5031 – UNIT OPERATIONS IN INDUSTRIES

L	T	P	C
3	0	0	3

UNIT I CRUSHING, GRINDING and CONVEYING OF BULK SOLIDS 12

Various laws of crushing – Classification of crushing and grinding machineries – Coarse crushers – Intermediate crushers – Fine grinders – Jaw crusher – Gyratory crusher – Crushing rolls – Hammer mills – Ball and tube mills – Ultra fine grinders – Closed circuit grinding – Grind ability index.

Introduction – Characterization of solid particles – Standard screens – Screen analysis – Types of screening equipments – Air separation methods – Cyclone and bag filters – Size separation by settling – Laws of settling – Classifiers – Material separation by difference in density – Heavy media cyclone – Froth floatation – Hindered settling – Working of a thickener.

Conveying of bulk solids – Conveyor for bulk materials – Screw conveyors – Belt conveyors – Bucket elevators – Pneumatic conveyors.

UNIT II MIXING AND FILTRATION 8

Introduction – Mixing of liquids / liquids, liquids / gases, liquids / solids – Types of mixers – Various mixing equipments – Power requirement for an impeller mixer – Theory of industrial filtration – Constant pressure and constant rate filtration – Filter aids – Filtration equipment classification – Filter presses – Leaf filters – Rotary drum filter – Centrifuges

UNIT III EVAPORATION 8

Introduction – Duhrings chart – Boiling point elevation – Capacity and economy of evaporators – Evaporators classification – Short tube and long tube evaporators – Forced Circulation evaporators – Climbing and falling film evaporators – Multiple effect evaporators – Evaporator accessories.

UNIT IV HUMIDIFICATION AND DRYING 8

Definition – Adiabatic saturation temperature – Humidity chart – Wet bulb temperature and measurement of humidity – Spray ponds and cooling towers – Cooling tower design considerations – Introduction – Drying theory – Equilibrium 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.

UNIT V DISTILLATION 9

Introduction – Various distillation methods – Flash distillation – Batch distillation – Steam distillation – Continuous distillation – Minimum reflux ratio – Total reflux – Optimum reflux ratio – Steam distillation calculations – Ideal plate – Actual plate – Plate efficiency – Distillation column internals – Concepts of azeotropic and extractive distillation – Enthalpy balance for a continuous distillation column (for binary systems)

Total: 45

TEXT BOOKS

1. Chattopadhyay, P., “Unit operations of Chemical Engineering”, 2nd Edition, Khanna Publishers, 1996.
2. McCabe, W.L. and Smith, J.C., “Unit Operations of Chemical Engineering”, 5th Edition, McGraw Hill International Editions, 1993.

REFERENCES

1. Foust, A.S., “Principles of Unit Operations”, 2nd Edition, Wiley International Edition, 1960.
2. Coulson, J.M. and Richardson., “Chemical Engineering”, 5th Edition, Butterworth Heinemann, 1996.

ELECTIVES II

CH5032 – APPLIED MATHEMATICS FOR ENGINEERS

L	T	P	C
3	0	0	3

UNIT I 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 – Dimensional heat conduction problems in infinite and semi-infinite rod.

UNIT II ELLIPTIC EQUATIONS **9**

Laplace equation – Properties of harmonic functions – Fourier transform methods for Laplace equation – Solution for poison equation by fourier transform method.

UNIT III CALCULUS OF VARIATIONS **9**

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

UNIT IV NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS **9**

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.

UNIT V 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.

Total: 45

TEXT BOOKS

1. Sneddon, I.N., "Elements of Partial Differential Equations", McGraw Hill, 1986.
2. Spiegel, M.R., "Theory and Problems of Complex Variables with an Introduction to Conformal Mapping and its Applications", Schaum's Outline Series, McGraw Hill Book Co., 1987.

REFERENCES

1. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India, 1995.
2. Elsgolts, L., "DifferentialEequation and Calculus of Variations", Mir Publishers, 1966.

CH5033 – ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

L	T	P	C
3	0	0	3

UNIT I ENVIRONMENTAL POLLUTION AND AIR POLLUTION 9

Environmental Pollution: Mass and energy transfer – Units of measurements – Material balance and energy fundamentals – Environmental chemistry stoichometry, chemical equilibria. Mathematics of growth – Exponential growth, resource consumption and population growth – problems – Atmosphere – Regions of atmosphere – Earth's natural atmosphere – Consequences of population growth – Classification of pollution – Pollution of air, water and soil – Effect of pollutants on living system – Environmental legislation.

Air Pollution : Sources of air pollution – Classification and properties of air pollutants – Scales of concentration – Effects of air pollution – Meteorological aspects of air pollution – Urban air pollution – Carbon-di-oxide and climate change – Acid deposition – Industrial air pollution – Automobile air pollution – Sampling, measurement and analysis of air pollutants such as Sox, NOx, CO, NH3, CnHn, SPM and trace metals – Environmental policy and eco-labelling.

UNIT II AIR POLLUTION CONTROL METHODS and EQUIPMENTS 9

Dry Techniques: Inertial dust collectors – Cyclone and multiclone separators – Bag filters – Electrostatic precipitators – Relative merits and demerits – High efficiency filters – Candle filter and membrane filter – Selective catalyst reduction – Choice of equipments – Design aspects – Economics.

Wet Techniques : Wet dust collection – Wet cyclone – Column scrubber – Packed column scrubber – Venturi scrubber – Suitability – Merits and demerits – Design aspects – Economics – FGD Systems.

UNIT III SOLID WASTE MANAGEMENT 9

Sources and classification – Potential methods of solid waste disposal –Disposal technique adopted for municipal solids wastes – Composting (Natural) – Accelerated composting with industrial sludge.
Toxic Waste Management – Problems of industrial hazardous solid waste management in india. incineration of industrial wastes – Treatment of radioactive material.
Biomedical wastes – Sources and classification – Various methods of biomedical waste disposal – Biomedical waste rules and regulations – Environmental policy and Eco-labelling.

UNIT IV WATER POLLUTION 9

Water Sources – Origin of waste water – Classification of water pollutants – Effects of water pollutants – Water pollution laws and standards – Water pollution and health – Waste water sampling – BOD – COD analysis – Waste water treatment – Primary treatment – Secondary treatment – Advanced waste water treatment – Anaerobic digestion – Aerobic digestion – Desalination – Micro filtration – Ultra filtration – Reverse osmosis – Environmental policy and Eco-labeling.

UNIT V ENVIRONMENT FOR COMFORT LIVING and WORKING 9

Aeration, Temperature and Humidity : Building heat balance – Comfort and Climate – Humidity effects – Temperature control – Humidity control – Ventilation control.

Lighting : Natural and artificial lighting – Flame based lighting – Electrical lighting – Enhancing lighting sources – Selection and design of lighting system – Lighting economics.

Noise Pollution and its Abatement : Noise criteria – Noise sources – Noise control measures.

Total: 45

TEXT BOOKS

1. Rao,C.S., "Environmental Engineering and Pollution Control", 1st Edition, New Age International Publishers, 1991.
2. James P, Tomany., "Air Pollution, the Emissions, the Regulations and The Controls", American Elsevier Environmental Service Series, 2007.
3. Gillbert, M.Masters., "Introduction to Environmental Engineering and Science", 2nd Edition, prentice Hall, 1998.

REFERENCES

1. Howard, E. Hesketh., "Understanding and Controlling Air Pollution".Hesketh Products. Hardcover, 1972.
2. Pandey, G.N. and Carney G.C., "Environmental Engineering", Tata McGraw Hill, 1989.
3. Veslind, P.A., Hartman G.C. and Skene E.T., "Sludge Management and Disposal for the Practicing Engineers", Lewis Publishers, 2005.

EM5001 – SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION 12

Industrial activity and environment industrialization and sustainable development – Industrial ecology – Prevention versus control of industrial pollution – Regulations to encourage cleaner production based approached.

UNIT II CLEANER PRODUCTION CONCEPT 7

Importance – Historical evolution – Benefits – promotion – barriers – Role of industry, government and institutional – Resume, recovery, recycle, substitution – Internet information and other CP resources.

UNIT III CLEANER PRODUCTION PROJECT DEVELOPMENT 10

Overview of CP assessment steps and skills – Preparing for the site – Material balance – Technical and environmental feasibility analysis – Economic evolution of alternatives – Total cost analysis – CP financing – Established programme – Preparing and programme plan – reset audit – Environmental statement

UNIT IV LIFE CYCLE ANALYSIS and ENVIRONMENTAL MANAGEMENT SYSTEM 8

Elements of LCA – Life cycle costing – ECO labeling – Design for the environment Environmental standards – ISO 14001 – Environmental audit.

UNIT V CASE STUDY 8

Industrial application of CP, LCA, EMS – Environmental audit

Total: 45

TEXT BOOKS

1. Bishap,P.L., "Pollution Prevention Fundamental and Practice", McGraw Hill, INC Waveland Pr Inc, 2004.
2. Anonymous, "Pollution Prevention and Abatement Hand Book Towards Cleaner Production**"** World Bank Group,1998.

REFERENCES

1. Modak, P., "Cleaner Production Audit"., Asian Institute of Technology, 1996.
2. Modak, P., "Cleaner Production Audit", Asian Institute of Technology, 1996.
3. Bishap, P.L., "Pollution Prevention Fundamental and Practice", McGraw hill, INC 1996.

EM5002 – ENERGY EFFICIENT BUILDINGS AND HVAC

L	T	P	C
3	0	0	3

UNIT I INDOOR ENVIRONMENT 9

Introduction to Architecture – Architecture as the art and science of designing buildings – Building science and its significance – Indoor environment – Components of indoor environment – Quality of indoor environment.

UNIT II THERMAL ANALYSIS AND DESIGN FOR HUMAN COMFORT 9

Human Comfort – Thermal, visual, acoustical and olfactory comfort – Comfort, energy and indoor environment – Concept of sol-air temperature and its significance – Calculation of instantaneous heat gain through building envelopes – Calculation of Solar radiation on buildings. Building orientation and its significance . – Introduction to design of shading devices (horizontal, vertical andegg-crate) – Factors that affect energy use in buildings. Ventilation and is significance.

UNIT III SOLAR PASSIVE CONCEPTS FOR COOLING FOR BUILDINGS 9

Passive concepts – Passive heating concepts – Passive cooling concepts and passive heating and cooling concepts . Passive concepts appropriate for the various climatic zones in India – Classification of building materials based on energy intensity.

UNIT IV ENERGY MANAGEMENT AND ENERGY AUDIT OF BUILDINGS 9

Introduction to Energy Management of Buildings and Energy Audit of Buildings – Aims of energy management of buildings – The historical and diagnostic energy audit, their objectives and benefits – Introduction to energy management matrix monitoring and targeting . Building energy survey and audit report form.

UNIT V ENERGY EFFICIENT LANDSCAPE DESIGN 9

Modification of microclimate through landscape elements for energy conservation – Energy conservation through site selection – Sitting and orientation – Energy conservation through integration of buildings and site – Site planning and site design.

Total: 45

TEXT BOOKS

1. Sodha M.,Bansal, N.K., Bansal,P.K., Kumar, A. and Malik, M.A.S.,"Solar Passive Buildings", Pergamon Press, 1986.
2. Koenigsberger,O.H., Ingersoll, T.G., Mayhew Alan.and Szokolay,S.V., "Manual of Tropical Housing and Building part 1Climatic Desing", Orient Longman Limited, 1973.

REFERENCES

1. Bureau of Indian Standards, I.S. 11907 –1986., "Recommendations for Calculation of Solar Radiation Buildings, 1986.
2. Givoni,B., "Man Climate and Architecture", Elsevier, Amsterdam, 1986.

EM5003 – CARBON SEQUESTRATIONS AND TRADING

L	T	P	C
3	0	0	3

UNIT I GREENHOUSE GAS 9

Stabilization of greenhouse gas concentrations – Geenhouse gas risks and reservoirs – Green gas mitigation – Carbon-di-oxide and climate change, acid rain, global warming, impacts of global warming – Kyeto-procal.

UNIT II CARBON 9

Practices for sequester carbon – Carbon sequestration types – Carbon credits – Carbon testing – potential for carbon sequestration.

UNIT III MANAGEMENT 9

Risk management and risk reduction – Carbon economics – Verification of carbon change.

UNIT IV CASE STUDIES 9

Carbon trading model – Century model – Case studies.

UNIT V RULES AND REGULATIONS 9

Implication – Nethanl – Nitrous oxide – Carbon bank – Best Management Practices in Public issues – Policies.

Total: 45

TEXT BOOK

1. Richard F. Kosobud, Douglas L. Schreder., “Emission Trading: Environmental Policies New Approach”, John Wiley and Sons, Holly M. Biggs Published 2000.

REFERENCES

1. John M. Kimble, Rattan Lal., “Agricultural Practices and Policies for Carbon Sequestration in Soil”, CRC Press, Published 2002.
2. David F. Karnosky., “The Impact of Carbon Dioxide and Other Greenhouse Gases on Forest Ecosystems", CABI Publishing, 2001.

III SEMESTER

ELECTIVE III

CH5034 – FLUIDIZED BED SYSTEMS

L	T	P	C
3	0	0	3

UNIT I FLUIDIZED BED BEHAVIOUR 9

Fluidization phenomena – Regimes of fluidized bed behaviour – Characterization of fluidized particles – Two phase and well mixed theory of fluidization – Solids mixing particle entrainment and carryover.

UNIT II HEAT TRANSFER 9

Different modes of heat transfer in fluidized bed – Use of immersed tubes – Finned tubes – Heat recovery systems.

UNIT III COMBUSTION AND GASIFICATION 9

Fluidized bed combustion and gasification – Pressurized systems – Sizing of combustion and gasification systems – Start-up methods – Fast fluidized beds – Different modes of heat transfer in fluidized beds.

UNIT IV SYSTEM DESIGN 9

Design of distributors – Fluidized bed furnaces for fossil and agricultural fuels – Fluidized bed heat recovery systems – Fluid bed dryers.

UNIT V INDUSTRIAL APPLICATIONS 9

Sulphur Retention – Nitrogen Emission Control – Furnaces, dryers, heat treatment, etc, pollution control and environmental effects – Cost Analysis

Total: 45

TEXT BOOKS

1. Howard, J.R., "Fluidized Bed Technology: Principles and Applications", Adam Hilger, 1983.
2. Geldart, D., "Gas Fluidization Technology", John Wiley and Sons, 1986.

REFERENCES

1. Howard, J.R. "Fluidized Beds: Combustion and Applications", Applied Science Publishers, 1983.
2. Yates, J.G., "Fundamentals of Fluidized Bed Chemical Processes", Butter worths, 1983.
3. Reed, T.B., "Biomass Gasification: Principles and Technology", Noyes Data Corporation, 1981.

CH5035 – COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION TO THE THEORY OF CFD 9

Introduction to CFD – Governing Equations of Fluid Flow – Simplified form of governing equations – Finite Difference – Finite Volume – Finite element methods – Application of these methods to simpler equations such as a Laplace Equation – Diffusion equation/ Wave equation.

UNIT II FINITE VOLUME METHOD 9

Application of finite volume method to fluid flow problems – Pressure correction techniques – SIMPLE algorithm and its variants – Coupled solution and its advantages – Various Linear equation solvers – Gauss siedel – Gauss jordan – Introduction to multigrid methods – Boundary conditions and their implementation – Anatomy of a typical CFD code and description of its various parts.

UNIT III GRID GENERATION 9

Structured and unstructured mesh generation – Algebraic and partial differential equations based mesh generation – Typical codes for doing the same – Unstructured mesh generations – Delauny and advancing front techniques – Introduction to CAD systems and different standards used for DATA exchange.

UNIT IV ADVANCED MODELS 9

Governing equations for turbulent flow – Rotating machinery – Combusting flow – Multiphase flow.

UNIT V APPLICATIONS 9

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.

Total: 45

TEXT BOOKS

1. Versteeg, H.K. and Malalasekera W., "An Introduction to Computational Fluid Dynamics – The Finite Volume Approach", Longman, 1995.
2. Segerlind, L.J, "Applied Finite Element Analysis", 2nd Edition, John Wiley, 1984.

REFERENCES

1. Anderson., “Computational Fluid Dynamics”, McGraw Hill Company, 1995.
2. Caughey, D.A. and Hafez, M.M., "Frontiers of Computational Fluid Dynamics 1994", John Wiley and Sons,1994.
3. Chuen-Yen-Chow.G., "An Introduction to Computational Fluid Mechanics”, John Wiley and Sons, 1979.

CH5036 – TRANSPORT PHENOMENA

L	T	P	C
3	0	0	3

UNIT I BASIC EQUATIONS OF FLOW 6

Pressure – Kinetic and 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 and syphon – Momentum equation – Forced and free vortex.

UNIT II REYNOLD'S ANALYSIS and 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 and parallel – Economical diameter of pipe transmission of power – Boundary layer – Displacement and momentum thickness – Laminar and turbulent boundary layers in flat plates – Velocity distribution in turbulent flows in smooth and rough boundaries – Laminar sub layer.

UNIT III TRANSPORTATION OF FLUIDS, INTERPHASE AND MULTIPHASE MOMENTUM TRANSFER 12

Types of centrifugal and reciprocating pumps – Comparison 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, fluidized bed, solid fluid conveying settling and sedimentation.

UNIT IV 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 drop wise condensation equations for heat transfer coefficients for both, heat transfer in boiling liquids

UNIT V INTERPHASE MASS TRANSPORT AND MACROSCOPIC BALANCES FOR MULTICOMPONENTSYSTEM 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: 45

TEXT BOOKS

1. Bird, R.B, Stewart W.E. and Lighfoot E.W., "Transport Phenomena", John Wiley, 1978.
2. Bansal, R.K., "Fluid Mechanics", Saurabh and Co.,1985.
3. Arora, K.R., "Fluid Mechanics, Hydraulics and Hydraulic Machines", Standard Publishers, 1976.

REFERENCES

1. Jagadish Lal, G., "Hydraulics and Fluid Mechanics", 2nd Edition, Revised and Enlarged, Metropolitan Book Co, 1987.
2. Modi, P.N.and Seth SM, Hydraulics and Fluid Mechanics, 8th Edition, Standard Book House, 1987.
3. Natarajan, MK., "Principles of Fluid Mechanics", Oxford and IBH Publishers, 1984.

CH5037 – PROCESS MODELING, SIMULATION AND OPTIMIZATION

L	T	P	C
3	0	0	3

UNIT I BASIC MODELLING 9

Introduction to modeling – Uses of mathematical models – Scope of coverage – Principles of formation – Review on algebraic – Ordinary and partial differential equations – Solutions of the above equations – Linearization – Probabilisation models – Development of models by experiment and statics – Regression and correlation analysis.

UNIT II MATRIX MODELS 9

Elementary matrix concepts – Simple array models – Multi component distillation – Dynamic simulation of distillation column – Solution techniques for matrix – Differential equations – Matrix formation of distributed parameter system – Flow pattern in stirred tanks – Design of mixers.

UNIT III LUMPED PARAMETER MODEL 9

Introduction to lumped parameter system – Mathematical description of multiphase transfer process – Non isothermal reactors etc – Axial dispersion in packed beds – Reactor design from response curves – Reactor effectiveness factor – Computer aided modeling of reaction networks.

UNIT IV DISTRIBUTED PARAMETER MODEL 9

Formation and solution of one dimensional state problem in heat transfer and mass transfer systems – Multi dimensional problems – Application in heat and mass transfer equipments.

UNIT V OPTIMISATION AND SIMULATIONS 9

Introduction – Application – Analytical and numerical techniques for multivariable problems – Techniques for Constrained optimization – Simulation; Introduction – Discrete event and continuous simulation – Dynamic simulation of reactors, distillation columns, absorbers, evaporators and crystallizers – Simulation in process control.

Total: 45

TEXT BOOKS

1 . Edgar, T. F., Himmelblau, D.M., “Optimization of Chemical Processes”, McGraw Hill Book Co, 1989.

2. Luyben, W. L., “Process Modeling Simulation and Control”, McGraw Hill Book Co., 2nd Edition, 1990.

REFERENCES

1. Ramirez, W., “Computational Methods in Process Simulation”, Butterworth Publishers, 1989.

2. Luyben, W. L., “Process Modeling Simulation and Control”, 2nd Edition, McGraw Hill Book Co., 1990.

3. Myers, A. L., Seider, W. D., “Introduction to Chemical Engineering and Computer Calculations”, Prentice Hall Inc., Englewood Cliffs, 1976.

EM5004 – WASTE MANAGEMENT AND ENERGY CONVERSION TECHNOLOGIES

L	T	P	C
3	0	0	3

UNIT I 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.

UNITII WASTE TREATMENT 8

Size reduction – Aerobic composting – Incineration – Furnace type and design, medical / pharmaceutical waste incineration – Environmental impacts – Measures of mitigate environmental effects due to incineration.

UNIT III WASTE DISPOSAL 8

Land fill method of solid waste disposal – Land fill classification – Types, methods and siting consideration – Layout and preliminary design of land fills – Composition, characteristics, generation, movement and control of landfill leachate and gases – Environmental monitoring system for land fill gases.

UNIT IV HAZARDOUS WASTE MANAGEMENT 10

Definition and 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 and closure.

UNIT V 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: 45

TEXT BOOKS

1. Parker., Colin, and Roberts., "Energy from Waste – An Evaluation of Conversion Technologies", Elsevier Applied Science,1985.
2. Shah, Kanti. L., "Basics of Solid and Hazardous Waste Management Technology", Printice Hall, 2000.

REFERENCES

1. Manoj Datta., "Waste Disposal in Engineered Landfills", Narosa Publishing House, 1997.
2. Rich, Gerald et.al., "Hazardous Waste Management Technology", Podvan Publishers, 1987.
3. Bhide AD., Sundaresan BB., "Solid Waste Management in Developing Countries", INSDOC, 1983.

ELECTIVE IV

EM5005 – POWER GENERATIONS, TRANSMISSION AND UTILIZATION

L	T	P	C
3	0	0	3

UNIT I 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.

UNIT II NON CONVENTIONAL POWER GENERATION 8

Wind power generation – Characteristics 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

UNIT III 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

UNIT IV 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 minimization

UNIT V UTILISATION OF ELECTRICAL ENERGY 10

Selection of Electrical Drives – Electrical characteristics and mechanical considerations – Size, rating and cost – Transformer characteristics – Illumination – Laws of illumination – Polar curve – Incandescent – Fluoroscent and vapour lamps – Design of OLTC lighting scheme of industry – electrical welding – Energy efficient aspects of devices.

Total: 45

TEXT BOOKS

1. Venikov V.A. and Put Yatin B.V, “Introduction of Energy Technology, Electric Power Engineering”, MIR Publishers,1984.
2. Soni M.L., GuptaP.V and Bhatnagar V.S.A., “Course in Electrical Power”, Dhanbat Rai and Sons,1983.

REFERENCES

1. Twidell J.W. and Weir A.D., “Renewable Energy Sources, ELBS Edition, 1986.
2. Wood A.J. and Wallenberg B.F., “Power Generation, Operation and Control”, 2nd Edition, JohnWiley and Sons, 1986.
3. Khan E., “Electrical Utility Planning and Regulation”, American Council for an Energy Efficient Economy, 1988.
4. Wadhwa1, C.L,”Generation Distribution and utilization of Electrical Energy”, Wiley Eastern Ltd., 1989.

EE5030 – ELECTRICAL ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I ELECTRIC ENERGY CONVERSION DEVICES 9

Transformers – Parallel operation – Auto transformers DC machines – Performance equation – Generator characteristics – Motor characteristics – Applications synchronous machines – Permanent magnet alternators – Induction machines.

UNIT II POWER SYSTEM FUNDAMENTALS 9

Transmission line representation – Power flow study – Power factor improvement – Faults on power systems – Symmetrical components – Introduction to HVDC systems – Basic ideas about insulation coordination.

UNIT III SOLID STATE POWER CONVERTERS 9

Controlled rectifiers – Choppers – Inverters – Voltage regulators and cycloconverters.

UNIT IV SOLID STATE DC AND AC DRIVES 9

Speed control of DC motors – Converter –Fed and chopper –Fed control – Speed control of AC motors – Inverter – Fed and AC voltage controller –Fed schemes.

UNIT V EMBEDDED GENERATION 9

Wind-driven induction generators – Grid connected Photo-voltaic systems – Steady state performance – Integration issues – Principles of energy auditing

Total: 45

TEXT BOOKS

1. John F. Walker. and Jenkins N., “Wind Energy Technology”, John Wiley and sons,1997.
2. Nasar, S.A., “Electric Energy Conversion and Transmission’, Mac Millan publishing company, 1985.

REFERENCES

1. Sen, P.C. “Power Electronics”, Tata Mc Graw –Hill Publishing Company, 1993.
2. Graigner, J.J. and W.D.Stevenson., “Power System Analysis”, Mc-GrawHill Publishing Company, 1994.

CH5038 – TECHNOLOGY MANAGEMENT

L	T	P	C
3	0	0	3

UNIT I STRATEGIC MANAGEMENT (SM) 9

Scientific organizations under government of India – PASTER program aimed at technological self-reliance – Management strategy – Operational strategy – Strategic Vs Tactical planning – Globalization – Open-economy – Strategic alliances – Enterprise – Resource planning – Mission statement – Environmental appraisal – Opportunities and threats – Organizational appraisal – Strengths and weaknesses, generic strategy alternatives – Stability expansion, modernization / diversification / merger, take over and liquidation strategies – Strategy evaluation and correction, strategy implementation – Business ethics, knowledge management.

UNIT II INTELLECTUAL PROPERTY RIGHTS (IPR) 9

Invention and innovation – Industrial and intellectual property rights – Patents, copyrights – trademarks, design registration – Trade secrets – WTO-Trade related intellectual property rights, patent cooperation treaty (PCT) agreements – Infringement of IPR, patent Specifications, patent search websites.

UNIT III TECHNOLOGY MANAGEMENT (TM) 9

Models of technology transfer – Technology transfer model – Technology search strategy – Dimensions of technology transfer – Features of technology package – Routes of technology transfer – Technology absorption capabilities of recipient enterprise – Competence of know – how supplier – Pricing of technology – Technology transfer agreements – Code of conduct for technology transfer – Government initiative and technology transfer and defence experiences and models.

UNIT IV TECHNOLOGY AQUISITION AND MARKETING (TAM) 9

Technological indicators – Make Vs buy decisions – Techno market survey – Assessment and evaluation of technology – Case studies – Methodology of technology assessment – Technology evaluation parameters – Identification of core competence – Technology absorption and diffusion – Constraints in technology absorption – Management of technology absorption – Importance of diffusion – Knowledge management – New product development strategies.

UNIT V TECHNOLOGY FORECASTING (TF) 9

Exploratory method of TF – Delphy technique – Cross impact matrix – Curve fitting – Morphological methods – Trend extrapolation – Regression analysis – Economic models – Normative methods of TF – Operational research models and simulation – Network techniques, Relevance trees, system dynamics – Qualitative methods and futurology.

Total: 45

TEXT BOOKS

1. Coates, V.T., "A Handbook of Technology Assessment", U.S. Department of Energy, 1978.
2. Wright, Peter, Kroll, Mark J. and John, P.A., "Strategic Management Concepts and Cases", N.J. Prentice Hall, 1996.
3. Ayres, Robert U., "Technologies Forecasting and Long Range planning", John wiley, 1998.

REFERENCES

1. Anonymous "Intellectual Property Protection in India – A Practical Guide for Scientists, Technologies and Other Users, TIFAC / CSIR, 1993.
2. Ansoff, H., "Implementing Strategic Management" by Englewood Cliffs, New Jersy. Prentice Hall Inc, 1990.

EM5005 – DEMAND SIDE MANAGEMENT OF POWER

L	T	P	C
3	0	0	3

UNIT I BASICS OF ELECTRICAL ENERGY CONSERVATION 9

Units of measurement – Measurement of Various Electrical parameters – Electrical Indicating Instruments – Concept of electrical energy audit – Improvement of power factor – Energy accounting – Energy devices – Techniques of electrical load management.

UNIT II POWER DISTRIBUTION SECTOR 9

Types of Distribution systems – A/C single phase and 3 distributions – Kelvin's law of power distribution – Limitations – Types of Sub-stations and their functions – Load optimization in distribution systems – Recent developments.

UNIT III INDUSTRIAL SECTOR 9

Types of Motors fore Industrial Applications, Characteristics – transient and steady state, speed control, load equalization, heating applications – Resistance furnace, Arc furnace and Induction furnace – performance and energy efficiency, Welding Applications – resistance and arc type – performance analysis, recent developments.

UNIT IV TRACTION, ILLUMINATION 9

Types of traction motors – Speed control – Requirements of Ideal traction systems Braking – Law of Illumination – Luminous efficacy – Photometry – Calculation of lumen of flux – Lighting calculations – Types of Illumination equipment – Design of chokes and capacitors – Optimization of Illumination loads – Recent developments.

UNIT V AGRICULTURAL SECTOR 9

Importance of Agricultural and rural loads – Types of agricultural loads – Load characteristics of pumps – Role of alternate energy sources in agricultural and rural energy requirements.

Total: 45

TEXT BOOK

1. Wadhwa, CL., 'Generation Distribution and Utilization of Electrical Energy' Wiley Eastern Limited, 1998.

REFERENCE

1. Theraja, Bl. Theraja, Ak., "A Text Book of Electrical Technology" Volume – I and II S.Chand and Company Ltd, 1999.

CH5039 – SAFETY AND HAZARDS CONTROL IN INDUSTRIES

L	T	P	C
3	0	0	3

UNIT I GENERAL 9

Safety – Total definition and hazard identification – General hazards of plant operation – Transport of hazardous chemical – Planning for safety – Safety based on emergency – Relief systems – Operational safety – safety checks – Check list for safety – Leaks and detections – Introduction to ISO standards (ISO 14001) with reference to chemical industries – Industrial hygiene and safety aspects related to toxicity, noise, radiation – Identification, evaluation and control.

UNIT II HAZARDS AND ITS EFFECTS 9

Hazards of plant operation – Toxic hazards – Fire and explosion hazards – Reaction hazards – Hazard identification – Control and mitigation of gas emissions – Absorption with chemical reaction – Health and enviro effects – Special problems of developing countries – Safety gadgets – Dispersions – Degree of hazards – Hierarchy of operations – ICA applications – Nil hazards and alternate methods – Threshold limits – Laws of safety – Accident reporting.

UNIT III FIRES AND EXPLOSIONS 9

Flammability characteristics of liquids and vapors – Minimum oxygen concentration (MOC) – Ignition energy – Ignition sources – Explosions – Detonation and deflagration – Combined explosions – BLEVE, Blast Damage due to overpressure – Hazard identification – Various techniques, HAZOP – Consequence analysis – Flow of liquid / vapors through hole, flashing liquid, Pool evaporation – Design to prevent fire and explosions – Inerting controlling static electricity – Explosion proof equipments and instruments – Ventilation – Sprinkler systems.

UNIT IV HAZARDS / RISK ASSESSMENT 9

Hazards / Risk Assessment – Event trees, fault trees – Reliability – Probability emergency planning – Elements of emergency planning-on-site/ off-site emergency plans – Risk analysis Evaluation mitigation hazop, hazan quantification methods case histories of accidents – Documentation for hazardous chemical – Formats and methods – Case studies – Bhopal tragedy – Flixborough disaster – Mexico disaster.

UNIT V WASTE MANAGEMENT AND ECONOMICS 9

Storage – Central handling safety – Unintentional spills – Runoff emits – Waste disposal and enviro protection – Incineration and alternatives – Clean technology.

Total: 45

TEXT BOOKS

1. Daniel, A., Crowl, Joseph, F., Lovvar.,"Chemical Process Safety Fundamentals with Application:" , Prentice Hall, Englewood Cliffs, 1990.
2. Wells, G.L ., "Safety in Process Plant Design", John Wiley, 1980.

REFERENCES

1. Lees**,** F.P., "Loss Prevention in the Process Industries", 2nd Edition, Elsevier, 1996.
2. Chan Left**,** ET., "Environmental Protection", McGraw Hill, 1994.
3. Berthouex, P. M., and Rudd D. F**, "**Strategy of Pollution Control", Wiley, 1977.