**AFFILIATED INSTITUTIONS**

**ANNA UNIVERSITY, CHENNAI**

**REGULATIONS - 2009**

**II TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS**

## M.TECH. ENERGY CONSERVATION AND MANAGEMENT

### SEMESTER II

| S.NO. | SUBJECT CODE | SUBJECT | L | T | P | C |
|---|---|---|---|---|---|---|
| **THEORY** | | | | | | |
| 1 | EY9256 | Design of Heat Exchangers | 3 | 0 | 0 | 3 |
| **2** | TE9221 | Cogeneration and Waste Heat Recovery Systems | **3** | **0** | **0** | **3** |
| 3 | EM9323 | Power Plant Technology | 3 | 0 | 0 | 3 |
| 4 | EM9324 | 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 | EM9327 | Energy Engineering Laboratory | 0 | 0 | 3 | 2 |
| | | **TOTAL** | **18** | **0** | **3** | **20** |

### SEMESTER III

| S.NO. | SUBJECT CODE | SUBJECT | L | T | P | C |
|---|---|---|---|---|---|---|
| **THEORY** | | | | | | |
| 1 | EM9331 | 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 | EM9332 | Visual Basic Programming Laboratory | 0 | 0 | 3 | 2 |
| 5 | EM9333 | Project Work (Phase I) | 0 | 0 | 12 | 6 |
| | | **TOTAL** | **9** | **1** | **15** | **18** |

## SEMESTER IV

| S.NO. | SUBJECT CODE | SUBJECT | L | T | P | C |
|---|---|---|---|---|---|---|
| **PRACTICAL** | | | | | | |
| 1 | EM9341 | Project Work (Phase II) | - | - | 24 | 12 |
| | | **TOTAL** | **0** | **0** | **24** | **12** |

## LIST OF ELECTIVES

| S.NO. | SUBJECT CODE | SUBJECT | L | T | P | C |
|---|---|---|---|---|---|---|
| **ELECTIVE I** | | | | | | |
| 1 | EM9001 | Refrigeration and Air Conditioning | 3 | 0 | 0 | 3 |
| 2 | EM9002 | Unit Operations in Industries | 3 | 0 | 0 | 3 |
| **ELECTIVE II** | | | | | | |
| 3 | EM9003 | Applied Mathematics for Engineers | 3 | 0 | 0 | 3 |
| 4 | EM9005 | Sustainable Development | 3 | 0 | 0 | 3 |
| 5 | EM9006 | Energy Efficient Buildings and HVAC | 3 | 0 | 0 | 3 |
| 6 | EM9007 | Carbon Sequestration and Trading | 3 | 0 | 0 | 3 |
| 7 | TE9223 | Environmental Engineering and Pollution Control | 3 | 0 | 0 | 3 |
| **ELECTIVE III** | | | | | | |
| 8 | EM9010 | Transport Phenomena | 3 | 0 | 0 | 3 |
| 9 | EM9011 | Process Modeling, Simulation and Optimization | 3 | 0 | 0 | 3 |
| 10 | EM9012 | Waste Management and Energy Conversion Technologies | 3 | 0 | 0 | 3 |
| 11 | IC9262 | Computational Fluid Dynamics | 3 | 0 | 0 | 3 |
| 12 | TE9272 | Fluidized Bed Systems | 3 | 0 | 0 | 3 |
| **ELECTIVE IV** | | | | | | |
| 13 | EM9014 | Electrical Energy Technology | 3 | 0 | 0 | 3 |
| 14 | EM9015 | Technology Management | 3 | 0 | 0 | 3 |
| 15 | EM9016 | Demand side Management of Power | 3 | 0 | 0 | 3 |
| 16 | EM9017 | Safety and Hazards Control in Industries | 3 | 0 | 0 | 3 |
| 17 | EY9011 | Power Generation, Transmission and Utilization | 3 | 0 | 0 | 3 |

**EY9256 DESIGN OF HEAT EXCHANGERS L T P C**
**3 0 0 3**

**AIM:**
The course is intended to build up necessary background for the design of the various types of heat exchangers.

**OBJECTIVE:**
- To learn the thermal and stress analysis on various parts of the heat exchangers
- To analyze the sizing and rating of the heat exchangers for various applications

**UNIT I FUNDAMENTALS OF HEAT EXCHANGER 9**
Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperators – analysis of heat exchangers – LMTD and effectiveness method.

**UNIT II FLOW AND STRESS ANALYSIS 9**
Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses, types of failures.

**UNIT III DESIGN ASPECTS 9**
Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe, finned tube, shell and tube heat exchangers, simulation of heat exchangers.

**UNIT IV COMPACT AND PLATE HEAT EXCHANGERS 9**
Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters, limitations.

**UNIT V CONDENSERS & COOLING TOWERS 9**
Design of surface and evaporative condensers – cooling tower – performance characteristics.

**TOTAL : 45 PERIODS**

**TEXT BOOK:**
1. Sadik Kakac, Hongtan Liu,Heat Exchangers Selection, Rating and Thermal Design,CRC Press,2002.

**REFERENCES**
1. P Arthur. Frass, Heat Exchanger Design, John Wiley & Sons, 1988.
2. Taborek.T, Hewitt.G.F and Afgan.N, Heat Exchangers, Theory and Practice, McGraw-Hill Book Co. 1980.
3. Hewitt.G.F, Shires.G.L, Bott.T.R, Process Heat Transfer, CRC Press, 1994.

**TE9221 COGENERATION AND WASTE HEAT RECOVERY SYSTEMS L T P C**
**3 0 0 3**

**AIM:**
To detail on the importance of Total Energy Concept, its advantages and cost effectiveness

**OBJECTIVES:**

- To analyze the basic energy generation cycles
- To detail about the concept of cogeneration, its types and probable areas of applications
- To study the significance of waste heat recovery systems and carryout its economic analysis

**UNIT I INTRODUCTION 9**

Introduction - principles of thermodynamics – cycles - topping - bottoming – combined cycle - organic rankine cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of tri generation.

**UNIT II COGENERATION TECHNOLOGIES 9**

Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.,

**UNIT III ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES 9**

Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment

**UNIT IV WASTE HEAT RECOVERY SYSTEMS 9**

election criteria for waste heat recovery technologies - recuperators - Regenerators - economizers - plate heat exchangers - thermic fluid heaters - Waste heat boilers-classification, location, service conditions, design Considerations - fluidized bed heat exchangers - heat pipe exchangers - heat pumps – sorption systems.

**UNIT V ECONOMIC ANALYSIS 9**

Investment cost – economic concepts – measures of economic performance – procedure for economic analysis – examples – procedure for optimized system selection and design – load curves - sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**


1. Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001


**REFERENCES:**


1. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford, 1987.
2. Institute of Fuel, London, Waste Heat Recovery, Chapman and Hall Publishers, London, 1963
3. Seagate Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
4. De Nevers, Noel, Air Pollution Control Engineering, McGrawHill, New York, 1995.

**EM9323 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 PERIODS**

**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.


**EM9324 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 $\Delta T_{min}$ OPTIMIZATION 9**

Energy targeting – Area targeting – Unit targeting – Shell targeting – Cost targeting – $\Delta T_{min}$ 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 PERIODS**

**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.

**EM9327 ENERGY ENGINEERING LABORATORY LT P C**
**0 0 3 2**

**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 PERIODS**

**EM9331 ENERGY CONSERVATION AND MANAGEMENT LT 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 PERIODS**

**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.


**EM9332 VISUAL BASIC PROGRAMMING LABORATORY LT P C**
**0 0 3 2**

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 PERIODS**

**EM9001 REFRIGERATION AND AIR CONDITIONING LT 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 PERIODS**

**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.


**EM9002 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 PERIODS**

**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.


**EM9003 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 PERIODS**

**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.


**EM9005 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 PERIODS**

**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.

**EM9006 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 PERIODS**

**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.

**EM9007 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 PERIODS**

**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.

**TE9223 ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL** **L T P C 3 0 0 3**

**AIM:**

To create awareness among the student community on anthropogenic degradation of environment and technologies available to limit the degradation.

**OBJECTIVES:**

- To impart knowledge on the atmosphere and its present condition, global warming and eco-legislations.
- To detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.
- To elaborate on the technologies available for generating energy from waste.

**UNIT I INTRODUCTION** **9**

Global atmospheric change – green house effect – Ozone depletion - natural cycles - mass and energy transfer – material balance – environmental chemistry and biology – impacts – environmental. Legislations.

**UNIT II AIR POLLUTION** **9**

llutants - sources and effect – air pollution meteorology – atmospheric dispersion – indoor air quality - control methods and equipments - issues in air pollution control – air sampling and measurement.

**UNIT III WATER POLLUTION** **9**

Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.

**UNIT IV WASTE MANAGEMENT** **9**

Sources and Classification – Solid waste – Hazardous waste - Characteristics – Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization.

**UNIT V OTHER TYPES OF POLLUTION FROM INDUSTRIES** **9**

Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control - water pollution from tanneries and other industries and their control – environment impact assessment for various projects – case studies.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**


1. G. Masters: Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi, 2003
2. Peavy, H.S. and D.R. Rowe, G.Tchobanoglous: Environmental Engineering - McGraw- Hill BookCompany, NewYork, 1985


**REFERENCES**


1. Ludwig, H. W.Evans: Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J, 1991
2. Arcadio P Sincero and G. A. Sincero, Environmental Engineering – A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002

**EM9010 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 MULTI COMPONENT SYSTEM 8**

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

**TOTAL: 45 PERIODS**

**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.

**EM9011 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 PERIODS**

**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.

**EM9012 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 PERIODS**

**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", Prentice 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.

**IC9262 COMPUTATIONAL FLUID DYNAMICS L T P C**
**3 0 0 3**

**AIM**

This course aims to introduce numerical modeling and its role in the field of heat and fluid flow, it will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.

**OBJECTIVE :**

- To develop finite difference and finite volume discretized forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns.

**UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10**

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

**UNIT II CONDUCTION HEAT TRANSFER 10**

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

**UNIT III INCOMPRESSIBLE FLUID FLOW 10**

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.

**UNIT IV CONVECTION HEAT TRANSFER AND FEM 10**

Steady One-Dimensional and Two-Dimensional Convection – diffusion, Unsteady one-dimensional convection – diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – solution of steady heat conduction by FEM – Incompressible flow – simulation by FEM.

**UNIT V TURBULENCE MODELS 5**

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

**TOTAL: 45 PERIODS**

**REFERENCES:**


1. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
2. Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier- Stokes Equation", Pineridge Press Limited, U.K., 1981.
5. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer " Hemisphere Publishing Corporation, New York, USA,1984.
6. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.
7. Fletcher, C.A.J. "Computational Techniques for fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag, 1987.
8. Bose, T.X., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.


**TE9272 FLUIDIZED BED SYSTEMS L T P C**
**3 0 0 3**

**AIM:**

To inspire the students with the theories of fluidization, heat transfer and design for various applications.

## OBJECTIVES:

- To introduce the concepts of fluidization and heat transfer in fluidized beds.
- To understand the design principles and apply the same for industrial applications.

**UNIT I FLUIDIZED BED BEHAVIOUR 12**

Characterization of bed particles - comparison of different methods of gas - solid contacts.Fluidization phenomena - regimes of fluidization – bed pressure drop curve.Two phase and well-mixed theory of fluidization.Particle entrainment and elutriation – unique features of circulating fluidized beds.

**UNIT II HEAT TRANSFER 6**

Different modes of heat transfer in fluidized bed – bed to wall heat transfer – gas to solid heat transfer – radiant heat transfer – heat transfer to immersed surfaces.Methods for improvement – external heat exchangers – heat transfer and part load operations.

**UNIT III COMBUSTION AND GASIFICATION 6**

Fluidized bed combustion and gasification – stages of combustion of particles – performance - start-up methods.Pressurized fluidized beds.

**UNIT IV DESIGN CONSIDERATIONS 9**

Design of distributors – stoichiometric calculations – heat and mass balance – furnace design – design of heating surfaces – gas solid separators.

**UNIT V INDUSTRIAL APPLICATIONS 12**

Physical operations like transportation, mixing of fine powders, heat exchange, coating, drying and sizing.Cracking and reforming of hydrocarbons, carbonization, combustion and gasification. Sulphur retention and oxides of nitrogen emission Control.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**


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


**REFERENCES:**


1. Kunii, D and Levespiel, O., Fluidization Engineering, John Wiley and Son Inc, New York, 1969.
2. Howard, J.R. (Ed), Fluidized Beds: Combustion and Applications, Applied Science Publishers, NewYork, 1983.
3. Botteril, J.S.M., Fluid Bed Heat Transfer, Academic Press, London, 1975.
4. Yates, J.G.Fundamentals of Fluidized bed Chemical Processes, Butterworths, 1983.


**EM9014 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 PERIODS**

**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.

**EM9015 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 PERIODS**

**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.


**EM9016 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 PERIODS**

**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.

**EM9017 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 PERIODS**

**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.

**EY9011 POWER GENERATIONS, TRANSMISSION AND UTILIZATION**

| L | T | P | C |
|---|---|---|---|
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**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 PERIODS**

**REFERENCES:**


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