



**M.TECH - RENEWABLE ENERGY
 (TWO YEAR FULL TIME)
 CURRICULUM 2008
 SEMESTER I**

Code No.	Course Title	L	T	P	C
YRE101	Fuels and combustion technology	3	0	0	3
YRE102	Hydro Power Technology	3	0	0	3
YRE103	Solar Energy Engineering	3	1	0	4
YRE104	Wind Energy, Tidal Energy and OTEC	3	0	0	3
YRE105	Fluid Dynamics and Heat Transfer	3	1	0	4
RE106B	Elective – I	3	0	0	3
YRE107	Solar Energy Lab	0	0	6	3

Total Hours:26

Total Credits:23

SEMESTER II

Code No.	Course Title	L	T	P	C
YRE201	Bio-Energy Engineering	3	0	0	3
YRE202	Computational Fluid Dynamics	3	1	0	4
YRE203	Electrical Energy Technology	3	0	0	3
YRE204	Hydrogen and Nuclear Energy	3	0	0	3
YRE205	Statistical Tools For Data Analysis	3	0	0	3
YRE206*	Elective – II	3	0	0	3
YRE207	Bio and Thermal Energy Lab	0	0	6	3

Total Hours:25

Total Credits :22

SEMESTER III

Code No.	Course Title	L	T	P	C
YRE301	Energy Audit and Management	3	1	0	4
YRE302*	Elective – III	3	0	0	3
YRE303*	Elective – IV	3	0	0	3
YRE304	Project work phase - I	0	0	15	8

Total Hours:25

Total Credits:18

SEMESTER IV

Code No.	Course Title	L	T	P	C
YRE401	Project work phase - II	0	0	25	13
	Total	0	0	25	13

Total Hours:25

Total Credits:13

Over all Credits:76

LIST OF ELECTIVES					
Group – 106					
Code No	Course Title	L	T	P	C
YRE106A	Thermal Engineering	3	0	0	3
YRE106B	Energy Conservation in HVAC	3	0	0	3
YRE106C	Unit Operations in Industries	3	0	0	3
Group – 206					
YRE206A	Environmental Engineering	3	0	0	3
YRE206B	Carbon Sequestration And Trading	3	0	0	3
YRE206C	Waste Management and Energy Recovery	3	0	0	3
Group – 302					
YRE302A	Optimum Utilization of heat and power	3	0	0	3
YRE302B	CAD/CAM – Renewable Energy	3	0	0	3
YRE302C	Sustainable Development	3	0	0	3
Group – 303					
YRE303A	Process Control and Instrumentation Technology	3	0	0	3
YRE303B	Energy Efficient building	3	0	0	3
YRE303C	Energy Modeling, Economics and Project Management	3	0	0	3

SYLLABUS

YRE101 - FUELS AND COMBUSTION TECHNOLOGY

3 0 0 3

UNIT - I FUELS, FUEL ANALYSIS & COMBUSTION STOICHIOMETRY

9

FUELS & FUEL ANALYSIS: Types of Fuels-Physical and Chemical characteristic of solid, liquid, and Gaseous fuels- Non conventional fuel-Producer Gas, Hydrogen, Biogas etc..-Determination of Calorific values- Ultimate and proximate analysis-Problems associated with handlings, storage and combustion

COMBUSTION STOICHIOMETRY: Stoichiometry relations – conservation of mass principles – theoretical & actual combustion processes – calculation of air fuel ratio for a fuel of known combustion –calculation of flue gas composition of fuel and excess air supplied from exhaust gas analysis – combustion calculation with sub-stoichiometry air – calculation of atmospheric air moisture – Dew point temperature of the combustion products – Flue gas analysis-Boiler Performance Analysis.

UNIT - II THERMODYNAMICS OF COMBUSTION PROCESSES

9

COMBUSTION KINETICS: Degree of reactions – reactions equilibrium — Laws of mass action – criteria of equilibrium- heat and temperature-**Gibbs** free energy – equilibrium constant – **Vant Hoff's isotherm** – rate of reaction –factors affecting rate of reaction – calculation of equilibrium constant & composition of reacting systems.

COMBUSTION THERMODYNAMICS: Enthalpy of formation – First law analysis of reacting systems -Enthalpy and internal energy of combustion – calculation of heat of formation & heat of combustion — Adiabatic flame temperature calculation – Entropy change of reacting systems – Second law analysis of reacting systems

UNIT- III FLAME, FLAME STRUCTURE, IGNITION AND IGNITORS

9

Flame – flame structure – flame propagation – deflagration – detonations – flame front – Ignition – self & forced ignition – Ignition temperature & ignition limits – Factors influencing ignition – SIT – Ignition lag – limits of inflammability & its determination – factors affecting inflammability limits – calculation of inflammability limits – flame blow off, blow out & flash back – flame quenching, Flame structure – flame stability – premixed & diffused flames – velocity of flame propagation – various methods of flame stabilization – swirl number & its significance – Turndown ratio – Igniters – various types of igniters – NFPA class I, II & III igniters – Eddy plate igniter – plasma igniter – High energy Arc igniter – DIPC igniter

UNIT- IV BASICS OF FURNACES

9

Industrial furnaces – process furnaces- Steam generating furnaces – Kilns – Batch & continuous furnaces – Advantages of ceramic coating – Heat source – Distributions of heat source in furnaces – Blast furnace – open hearth furnace – pot & crucible furnaces – waste heat recovery in furnaces – Recuperator – Regenerators – Furnace atmospheres – Furnace Insulation – Furnace Heat balance calculations, Pipe still Heater.

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 orifice port burners – Atmospheric Gas burners – Flare Stack.

LIQUID FUEL BURNERS: Pressure jet atomization – Air blast atomizers – steam atomizers – rotary cup atomizers – vaporizing burners – Low NO_x burners – swirl number & its significance – selection of appropriate type of burners.

COAL BURNING EQUIPMENTS

Coal burning methods – over feed & underfeed supply of coal – Mechanical Stokers – Travelling grate & spreader stoker – vibrating grate stoker – Advantages & 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 – special type burners.

A compulsory Seminar/ Assignment on Design/Case Study/Analysis/Application in any one the combustion System and Accessories(viz.. Burner, Draught etc.,)

L:30; T:15; Total:45

TEXT BOOKS:

1. Dr. Samir Sarkar, "Fuels & Combustion", Orient Longman, Second edition, 1990.
2. Gupta O.P. "Elements of Fuels, Furnaces & Refractories", 3rd edition, Khanna Publishers, 1996.

REFERENCES:

1. S.P. Sharma and Chander Mohan, "Fuels & Combustion", Tata McGraw Hill Publishing Co.Ltd., 1984.
2. J.D. Gilchrist, "Fuels, Furnaces & Refractories", Pergamon Press, ISBN-008-029430- 9
3. Blokh A.G. "Heat Transmission in Steam Boiler furnaces", Hemisphere Publishing Corpn. ISBN-089-116-626-26

UNIT - I HYDROLOGY**9**

Overview of Hydropower systems-Preliminary Investigation- Rainfall and Run of measurements- Hydrographs- flow duration graph and mass storage graphs- Determination of site selection- types hydro electric power plants- General arrangements and Layouts- Preparation of Reports and Estimates-Review of World Resources-Basic Factors in Economic Analysis of Hydropower projects-Project Feasibility-Load Prediction and Planned Development.

UNIT- II DEVELOPMENT OF PROTO TYPE SYSTEMS**12**

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

UNIT - III SELECTION AND ANALYSIS OF TURBINES**7**

Measurement of pressure head, Velocity- Various parameters for finding out the potential of Hydro Energy- Selection of turbines based on Specific quantities- Case study

UNIT - IV HYDRO POWER STATION OPERATION, MAINTENANCE AND TROUBLE SHOOTING**10**

Governing of Power Turbines-Functions of Turbine Governor-Condition for Governor Stability-Surge Tank Oscillation and Speed Regulative Problem of Turbine Governing in Future Planning, Design and Construction of Hydroelectric Power Stations-Remaining Lifecycle Analysis.

UNIT - V SMALL, MINI AND MICRO HYDRO POWER PLANTS TURBINES**7**

Introduction – Analysis of Small, mini and micro hydro turbines – Economical and Electrical Aspects of Small, mini and micro hydro turbines- potential developments – Design and reliability of Small, mini and micro hydro turbines – Case Study.

A compulsory Seminar/ Assignment on Design/Case Study/Analysis/Application in any one the Small, Mini and Micro Hydro Power Plants and Components(viz.. Turbines, Controls, and Storage etc.,)

L:30 T:15; Total: 45**TEXT BOOKS:**

- 1.P.K Nag “Powerplant Engineering”, TataMcGrawHill, NewDelhi,2004
- 2.Domkundwar and Arora” A Course in Powerplant Engineering”, Khanna Publishers, NewDelhi.

REFERENCES:

1. L.Monition,M.Lenir and J.Roux Micro Hydro Electric Power Station(1984)
2. AlenR. Inversin, Micro Hydro Power Source Book(1986)

YRE 103 - SOLAR ENERGY ENGINEERING

3 1 0 4

(Use of approved data book permitted in the examination)

UNIT - I SOLAR RADIATION

9+3

Source of radiation – Sun earth relationship- extra terrestrial radiation.– Atmospheric attenuation – Terrestrial radiation-radiation on a horizontal surfaces and inclined planes- relations between horizontal radiation and inclined surfaces – relations between monthly, daily and hourly radiation and components of the radiations– solar charts – Critical radiation-Measurement of global, direct and diffuse solar radiation- pyroheliometer, pyranometer, pyrogeometer, net pyradiometer-sunshinerecorder – an overview of solar radiation data in India.

UNIT - II SOLAR COLLECTORS – FLAT PLATE COLLECTORS

12+3

Design considerations – classification- Flat plate collectors- air heating collectors liquid heating –Temperature distributions- Heat removal rate- Useful energy gain – Losses in the collectors-for efficiency of flat plate collectors – selective surfaces – tubular solar energy collectors analysis of concentric tube collector – testing of flat plate collectors. Solar green house.

UNIT - III CONCENTRIC SOLAR COLLECTORS AND THERMAL APPLICATION

9+3

Concentric collectors-Limits to concentration – concentrator mounting – tracking mechanism - performance analysis focusing solar concentrators: Heliostats. Solar powered absorption A/C system (Ammonia/water) solar water pump, solar chimney, solar drier, solar dehumidifier, solar still, solar cooker.

UNIT- iv SIMULATION AND ENERGY STORAGE

9+3

Simulation in Solar Process Design- TRANSYS- Design of active systems- f chart methods for liquid and air heaters- phi bar, of chart method - sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change- Glauber's salt-organic compounds -solar ponds.

UNIT - V SOLAR PV SYSTEM 6+3

Photo-voltaic cell – characteristics-maximum power- tracking-cell arrays-power electric circuits for output of solar panels--inverters-batteries-charge regulators, Construction concepts.

A compulsory Seminar/ Assignment on Design/Case Study/Analysis/Application in any one the Solar thermal Energy System

L:45; T:15; Total:60

TEXT BOOKS:

1. Duffie J.A and Beckman, W.A., "Solar Engineering of Thermal Processes", 2nd Edition, John Wiley & Sons Inc., New York, -1991
2. G.N. Tiwari. "Solar Energy: Fundamentals, Design, Modelling and Applications", Third Reprint, Narosa Publishing House, New Delhi-2006

REFERENCES:

1. Edward E. Anderson, "Fundamentals for Solar Energy Conversion", Addison Wesley pubCO., 1983.
2. Fank Kreith, Jan F. Kreider, "Principles of solar Engg", 1978.
3. Koushika M.D., "Solar Energy Principles and Applications", IBT publications and distributors, 1988.
4. Kaushik S.C, Tiwari G.N and Nayak J.K, "Thermal control in passive solar buildings" .IBT Publishers & Distributors, 1988.

UNIT - I MEASUREMENT TECHNIQUES**12****(Use of approved data book permitted in the examination)**

Introduction-measurement and instrumentation-Beau fort number Guest parameters wind type-power law index betz constant Terrain value. Wind speed characterization-site survey and site analysis -Energy in wind-Highest, lowest wind speeds-wind speed for return periods-study of wind applicable Indian standards-steel Tables, Structural Engineering.

UNIT - II WINDMILL AND WIND TURBINE**10**

Wind mill characteristics – types of wind mills- performance analysis -Merits and limitation-variables in wind energy conversion system-wind power density-power in a wind stream-wind turbine efficiency-power of a wind turbine for given in-coming wind velocity - forces on the blades of a propeller-examples of wind farm site-mean wind velocity-wind velocity duration curve-energy pattern factor-wind power duration characteristics - Tip speed ratios - Solidity curves. Terms-study of all types of turbines (HAWT, VAWT)-typical large capacity wind turbines-sizing-tower design-power duration curves-wind rows diagrams –study of characteristics-actuator theory –analysis of Hourly, daily, monthly, annual, wind behavior-control and instrumentations. synch & power stabilization synchronization & power stabilization.

UNIT - III POWER GENERATION AND HYBRIDISATION**10**

Types of wind energy system-alternatives-Grid-combination of diesel generator, Battery storage-wind turbine circuits-wind map of India-Wind farm-indefinitely developed wind turbine-study of various wind turbines manufactured indigenously - kilowatt rating retrofits- R&M-OP & FC-speed limitation-fatigue stress.

UNIT - IV WAVE AND TIDAL ENERGY**7**

Wave energy -Tidal changes – Ecological changes – Types Tidal Power – Energy from Sea – Tidal Turbines – Tidal Power Generation – Recent Trends and Developments – Problems and solutions – Case Studies.

UNIT - V OTEC**6**

The concepts- construction and operational problems – history of OTEC development Alternative energy technology – Ocean thermal energy conversion – Techniques – Problems and solutions – Case Studies-ecological and environmental aspects.

L:45; Total:45

A compulsory Seminar/ Assignment on Design/Case Study/Analysis/Application in any one of the Wind energy, Tidal And OTEC.

TEXT BOOKS:

1. E.I.Wakil “ Power Plant Technology”, McGraw Hill Publishers, NewYork
2. G.D Rai “ NonConventional Energy Sources”, Khanna Publishers, NewDelhi

REFERENCES:

1. S.Rao & B.B.Parulekar, “Energy Technology”, 3rd edition, Khanna publishers, New Delhi, 1995.
2. Anna Mani & Dr.Nooley, “wind Energy Data for India”, 1983.
3. IS 875 part IV and IS 1893 material STDS IS 226 (IS 2862, ASTM A-36, BS. 4360 Gr 43 D)
4. Logan (EARL), “Turbo Machinery Basic theory and applications”, 1981.

YRE105 - FLUID DYNAMICS AND HEAT TRANSFER

3 0 0 3

UNIT – I FLUID KINEMATICS AND FLUID DYNAMICS

10

Fluid Kinematics – Flow visualization – lines of flow – types of flow – velocity field and acceleration – continuity equation one and three dimensional differential forms – Equation of streamline – stream function – velocity potential function – circulation – flow net – fluid dynamics – equations of motion – Euler's equation along a streamline – Bernoulli's equation – applications – Venturi meter – Orifice meter – Pitot tube – dimensional analysis – Buckingham's π theorem – applications – similarity laws and models.

UNIT - II CONDUCTION AND RADIATION

10

Fourier's law of conduction in simple and composite geometries, types of boundary and initial conditions, contact resistance, conduction with heat generation, extended surface heat transfer, transient and periodic heatconduction, and application of numerical methods. Basic laws of radiation, radiation in ideal and real surfaces, view factor algebra, radiation shields, electrical analogy using radiosity and irradiation, gaseous emission and absorption.

UNIT- III CONVECTIVE HEAT TRANSFER

10

Dimensional analysis, boundary layer concept, basic governing equations, laminar and turbulent external and internal flows, forced and free convections, integral methods, semi-empirical correlations, flows over bank of tubes.

UNIT IV- MASS TRANSFER

5

Rate equations, mass diffusion in binary mixtures, evaporation in a column, forced convective mass transfer, heat and mass transfer analogies- Case Studies

UNIT – V HEAT EXCHANGER

10

Modes of boiling, Nusselt theory of condensation, correlations in boiling and condensation, types of heatexchangers, methods of analysis, fouling factor Recent development in the designing of heat exchanger – Plate heat exchanger – run around coils – heat pipes – regenerators - effectiveness of heat exchanger, and simple design problems.

L:45; Total:45

A compulsory Seminar/ Assignment on Design/Case Study/Analysis/Application in Heat transfer

TEXT BOOK:

1. James G. Knudsen, Donald L. Katz., "Fluid Dynamics and Heat Transfer", 1958, Mc Graw Hill Publishers

2. R.C.Sachdeva, " Fundamentals of Engineering Heat and Mass Transfer ", New Age International Publishers, New Delhi, 1995.

REFERENCES:

1. R.Yadav, " Heat and Mass Transfer ", Central Publishing House, Allahabad, 1995
2. Kern D.C., "Process Heat Transfer", Mc Graw Hill Publishers
3. Frank P. Incropera and David P. DeWitt, " Fundamentals of Heat and Mass Transfer ", John Wiley and Sons, 1998.
4. A.Bejan, " Heat Transfer ", John Wiley and Sons, 1995.
5. M.N.Ozisik, " Heat Transfer ", Mc Graw Hill Book Co., 1994.
6. C.P.Kothandaraman, " Fundamentals of Heat and Mass Transfer ", New Age International Publishers, New Delhi, 1998.
7. James Sucec , " Heat Transfer ", M/s.Jaico Publishing 1998-99 Edition.
8. Nicholas P.C., " Heat Transfer Hand Book ", M/s Jaico Publishing 1998-99 Edition.

YRE106A - THERMAL ENGINEERING**3 1 0 4**

(For Non Mechanical / Chemical Background)

UNIT I GAS POWER CYCLES**9**

Otto - Diesel – Dual – Brayton cycles – calculation of mean effective pressure and air standard efficiency – actual and theoretical PV diagram of four stroke engines – actual and theoretical PV diagram of two stroke engines.

UNIT II INTERNAL COMBUSTION ENGINES**9**

Classification of IC engine – IC engine components and functions – Comparison of two stroke and four stroke engines – Valve and port timing diagram – Fuel supply systems – Ignition Systems – Performance calculation – Comparison of petrol and diesel engine – Fuels – Air-fuel ratio calculation – Knocking and Detonation – Lubrication system and cooling system – Exhaust gas analysis – pollution control norms

UNIT III STEAM NOZZLES AND TURBINES**9**

Flow of steam through nozzles – shapes of nozzles – effect of friction – critical pressure ratio – supersaturated flow – Impulse and reaction principles – compounding – velocity diagrams for simple and multistage turbines – speed regulations – governors and nozzle governors

UNIT IV AIR COMPRESSOR**9**

Classification and working principle – work of compression with and without clearance – Volumetric efficiency – Isothermal efficiency and isentropic efficiency of reciprocating air compressors – Multistage air compressor and inter cooling – work of multistage air compressor – working principle of various types of rotary compressors

UNIT V REFRIGERATION AND AIR-CONDITIONING**9**

Vapour compression Refrigeration cycle – super heat – sub cooling – performance calculations – Working principle of vapour absorption system: Ammonia – water and Lithium bromide – water systems – Comparison between vapour compression and absorption systems – Cooling load calculations – Concept of RSHF, GSHF and ESHF Air conditioning systems.

L: 45; T:15; Total: 60

(Use of standard thermodynamic tables – Mollier chart – Psychometric chart and Refrigerant property tables are permitted in the examination)

TEXT BOOKS:

1. Rajput, "Thermal Engineering", S. Chand publishers, 2000.

REFERENCES:

1. Kothandaraman.C.P., Domkundwar. S and A.V.Domkundwar., "A course in Thermal Engineering", Fifth Edition, Dhanpat Rai & Sons, 2002
2. Holman. J.P., "Thermodynamics", McGraw-Hill, 1985
3. Rogers- Meyhew, "Engineering Thermodynamics", ELBS, 1992

YRE106B - ENERGY CONSERVATION IN HVAC

3 0 0 3

UNIT - I DESIGN OF HVAC SYSTEM COMPONENTS

9

Vapour compression Systems-Refrigerant properties- Energy Efficient compressor- Condensers-Evaporators-expansion devices- Cooling Systems other auxiliaries-Design and Analysis for Energy conservation- Case Studies- VAR Systems- Utilization of Waste heat and other sources- Analysis for Energy Efficiency Ratio.

UNIT – II AIR CONDITIONING SYSTEMS

9

Psychrometry – Comfort conditions -Types of A/c Systems- Energy conservation of Humidifiers, Air Washers- Air distribution and handling systems-Controls for AHU- Passive and Active A/c Systems-Thermal Properties and Energy content of Building materials.

UNIT - III ESTIMATION OF BUILDING LOADS

9

Steady state method – Network method-Numerical method – correlations – computer packages for carrying out thermal design of buildings and predicting performance- Thermal comfort – Ventilation and air quality – Air conditioning requirement – Visual perception – Illumination Requirement – Auditory requirement – Energy Management Options – Energy Audit and Energy Targeting – Technological Options for Energy Management-standards on indoor parameters.

UNIT - IV FACTORS AFFECTING THE ENERGY USE

Factors that affect energy use in building- functional factors, environmental factors- Envelope factors-Air conditioning system factors- Energy source factors and Electrical systems factors- Fenestration design for optimal day lighting- Lighting and Visual ability – Light sources and Luminaries – Lighting System- Design-Day lighting-Day light factors- Luminance Efficacies- CRI for Lighting source and Usage- Economics and Aesthetics.

UNIT-V MODELING AND SIMULATION

9

Evaluation of natural ventilation in buildings, determination of probable indoor wind speed and direction- Ventilation heat transfer - Sol-air temperature-Introduction to Natural and artificial ventilation simulation systems- Energy Calculations- Degree Days procedure- BIN methods-Comprehensive simulation methods

L:45; Total: 45

TEXT BOOKS:

1. Faye C. McQuiston and Jerald D. Parker “ Heating, Ventilating and Air Conditioning –Analysis and Design”, 4th Edition, John-Wiley & Sons, Inc, NewYork.1994.
2. C.P.Arora “ Refrigeration and Air-conditioning”, Tata-McCraw Hill Publishers, New Delhi

REFERENCES:

1. J.Krieder and A.Rabi “Heating and Cooling of Buildings. Design for Efficiency Mcgraw Hill (1994).
2. J.R.Williams, Passive Solar Heating, Ann Arbor Science(1983).
3. R.W.Jones, J.D.Balcomb, C.E.Kosiewiez, G.S.Lazarus, R.D.Mc Farland and
4. W.O.Waray, Passive Solar Design Handbook, Vol.3 Report of U.S. Department of Energy (DOE/CS-0127/3) (1982).

UNIT - I CRUSHING, GRINDINGSIZE SEPARATION & 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 – Ultrafine grinders – Closed circuit grinding – Grindability 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 thickener. Conveying of bulk solids – conveyor of bulk materials – screw conveyors – Belt conveyors – Bucket Elevators – Pneumatic Conveyers.

UNIT - II MIXING AND FILTRATION**8**

Introduction – mixing of liquids/Liquids, Liquids/Gases, Liquids/Solid – 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 Evaporator – 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 Designing 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 Dryers – 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 system)

L:45; Total:45

REFERENCES:

1. P.Chattopadhyay, "Unit operations of chemical Engineering", 2nd edition, Khanna Publishers, 1996.
2. W.L.McCabe and J.C.Smith, "Unit operations of Chemical Engineering", 5th edition, McGraw Hill International editions, 1993.
3. Alan S Foust, "Principles of Unit Operations", 2nd edition, Wiley International Edition, 1960.
4. J.M. Coulson & Richardson, Chemical Engineering, 5th edition, Butterworth Heinemann, 1996.

1. Study of direct and diffused beam solar radiation
2. Study of green house effect
3. Performance evaluation of solar flat plate collector
4. Study the effect of solar flat plate collector in parallel combination
5. Performance evaluation of concentrating solar collector
6. Performance evaluation of solar cooker
7. Performance evaluation air dryer
8. Performance evaluation distillation
9. Performance evaluation of a solar PV panel
10. Performance of PV panel in series and parallel combination
11. Charging characteristics of a battery using PV panel
12. Effect of tilt angle on solar PV panel
13. Effect of shadow on solar PV panel

P:90; Total:90