Department of Chemical Engineering

Proposed Scheme for T Y (Chemical Engineering)-2011-12

(To be introduced in 2011-12)

Semester –V

Code	Course Title	Nature of Sub. Compulsory(C) /Elective(E)	Dept. Offering Sub.	Weekly load (Hour)			Credit
				Lect	Tutorial	Pract.	
CH301	Chemical Engg. Thermodynamics	C	Chemical	3	1	--	04
CH302	Heat Transfer	C	Chemical	3	1	2	05
CH303	Mass Transfer-I	C	Chemical	3	1	2	05
CH304	Process Equipment Design .	C	Chemical	3	1		04
CH305	Chemical Process Industries	C	Chemical	3	-	-	04
Total				**15**	**4**	**4**	**21**

Semester-VI

Code	Course Title	Nature of Sub. Compulsory(C) /Elective(E)	Dept. Offering Sub.	Weekly load (Hour)			Credit
				Lect	Tutorial	Pract.	
CH306	Mass Transfer-II	c	Chem.	3	1	2	05
CH307	Chemical Reaction Engg -I	c	Chem.	3	1	2	05
CH308	Process Control & Instrumentation	c	Chem.	3	1	2	05
CH309	Process Modeling & Simulation	c	Chem.	3	1	2	05
CH310	Elective-I(Safety & Risk Analysis, Renewable Energy Sources, Energy Management	E	Chem.	3	-	-	03
Total				**15**	**4**	**8**	**23**

Semester –V

CH301: Chemical Engineering Thermodynamics (Credit-04)

(Lect-04,Pract.-00)

1 **Introduction To Chemical Engineering Thermodynamic and First Law:**
The scope of thermodynamics, fundamental and derived quantities, first law of thermodynamics: Formation of 1st law of thermodynamics, state and path functions, thermodynamic systems, steady state flow system, phase rule, reversible process heat capacity.

2 **The Second Law of Thermodynamics**: Introduction, Mathematical Treatment of Entropy Concept, Combined form of First and Second Law of Thermodynamics, Thermodynamic Relations based on Second Law of Thermodynamics, Calculations of Entropy Changes, and Third Law of Thermodynamics.

3 **Heat Effects**: Sensible heat effects, Temperature dependence of heat capacity, Evaluation of sensible heat integral, Standard heat of reaction, Standard heat of formation, Standard heat of combustion, Heat effects of industrial reactions, Problems

4 **Solution Thermodynamics & Phase Equilibria**: Chemical potential, partial molar properties, Gibbs/Duhem equation, Ideal gas mixtures, Kay's rule, real gas mixtures, Fugacity coefficient for pure substances & for species in solution, generalized correlation for fugacity, Ideal gas solution

5 **Vapor-Liquid Equilibria (VLE)** : Basic equations for VLE, Reduction of VLE data, VLE at low to moderate pressure, Excess Gibbs free energy Model, Margules Equation & Van Laar Equation, Wilson equation . Thermodynamic consistency test of VLE data.
Phase Equilibria for Single Component System: Gibbs-Helmholtz Equation, The Clapeyron Equation, Clausious-Clapeyron Equation, Application of Clapeyron Equation

6 **Chemical Reaction Equilibria**: The criteria for chemical equilibrium, Equilibrium constant, Law of chemical equilibrium, Thermodynamic treatment of the law of mass action, Van't Hoff reaction isotherm, Relations between equilibrium constant, Homogeneous gaseous equilibria, Temperature dependence of the equilibrium constant (The Van't Hoff Equation), Integrated form of the Van't Hoff equation, Pressure dependence of the equilibrium constant. Applications of Phase Equilibrium in Ideal Solutions: To construct pressure-composition and boiling point diagrams.

Text Book:

1. J.M. Smith and H.C. Van Ness, "Introduction to Chemical Engg.Thermodynamics 6th Edition, International student edition, McGraw Hill publication.

Reference Books:

1.B.F. Dodge, "Chemical Engg. Thermodynamics", International student edition McGraw Hill Publication.
2. D.A. Hougen, K.M. Watson and R.A. Ragatz, "Chemical Process Principles", (Vol. II) 2nd Edn. Asia Publishing House.
3. K.V. Narayanan, "Chemical Engg. Thermodynamics", Prentice Hall India
4. Y.V.C. Rao, Chemical Engineering Thermodynamics, University Press (INDIA) Ltd., Orient Longman Ltd., Hyderabad. Hall India Pvt. Ltd., New Delhi.
5. R.R.Rastogi and R.R.Mishra, An Introduction to Chemical Thermodynamics, Vikas Publishing House Pvt.Ltd, New Delhi.
6. D.Shrinivasan, Chemical Engineering Thermodynamics, New Age International Publisher New Delhi.

7. G.N. Pandey and J.C.Chaudhari, Chemical Engineering Thermodynamics, Khanna Publishers, Delhi.

CH302: Heat Transfer (Credit-5) **(Lect-3,Tut.-1,Pract.-2)**

1 **Basic modes of heat transfer**: Conduction, convection and radiation, Fourier's law Heat conductic Equation at steady state, heat conduction in slabs, cylinders, spheres, heat generation inside solids. Fourier's heat conduction equation in three dimensions , equation for one dimensional conduction heat conduction through a semi infinite slab unsteady state heat conduction,
heat transfer by forced :
convection in laminar and turbulent flow, dimensional analysis method, use of imperials equations heat transfer by forced convection outside tubes, natural convection. Combined heat transfer by conduction, convection, radiation
Radiation heat transfer:
Fundamental of radiation, black body radiation, Kirchoff's law, radiant heat exchange between non black surfaces.

2 **Principles of heat flow in fluids**. . Heat transfer to fluids without phase change. Regimes of heat transfer in fluids, Heat transfer to fluids with phase change. Drop wise and film type condensation, coefficient for film type of condensation, practical use of Nusselt's equations, application to petroleum industries
Heat transfer to boiling liquids: Boiling of saturated liquids maximum flux and critical temperature drop, maximum Flux and film boiling.

3 **Evaporation**: Liquid characteristics, types of evaporators, single evaporator capacity economy ,boiling point elevation and Duhring's rule. Heat transfer co-efficient, Enthalpy balance for single effect evaporator, multiple effect evaporators, types, methods of feeding, enthalpy balance of multiple effect evaporators, problems.

4 **Introduction to heat transfer to packed and fluidized beds**: General heat transfer characteristics, Calculation for Heat transfer co-efficient. Transfer in jacketed vessels, boilers, furnaces and reactors, reboilers, heat transfer in agitated vessels with and without coils, Heat transfer in packed and fluidized beds.

5 **Heat Exchangers:** Typical heat exchange equipment, overall heat transfer coefficient, overall heat transfer coefficient , log mean temperature difference, individual heat transfer coefficient, calculation of overall coefficient from individual coefficients , transfer units in heat exchangers.
Fouling factor LMTD in single pass parallel, counter and cross-flow arrangements. N.T.U – effectiveness method for parallel and counter flow heat exchangers general Design aspect of heat exchangers. Problem based on LMTD AND NTU effectiveness method

Text book: Kern D.Q., Process Heat Transfer, Tata McGraw Hill Book Co., New Delhi, 1990.

References books

1)Arora S.C., Heat Transfer and Mass Transfer, Khanna Published, New Delhi.
2)Coulson J.M., Richardson J.R. Chemical Engineering, Vol. I 5th Edition, Butterworth Heinemann, New Delhi.
3) Dawande S.D., Principles of Heat and Mass Transfer, Central Techno Publications, Nagpur.
4) Eckert E.R.G. and Drake R.M.; 2nd Edition, Heat Transfer and Mass Transfer, McGraw Hill Education,Hollman J.P.; Heat Transfer, McGraw Hill, 1993.

5) Kothandaram C.P., Subramanyan S.; Heat Transfer and Mass Transfer, Databook, 4th Edition, Wiley eastern Ltd., (1989).
6) Kumar D.S., Process Heat Transfer, S.K.Kataria & Sons Publishers, New Delhi.
7) McAdams W.H.; Heat Transmission, McGraw Hill Book Co. New York, 1954.
8) Sukhatme S.P., Text Book on Heat Transfer, Orient Longman Pvt. Ltd.

Lab Work

Perform any eight practical's

1) Determination of Cp of ebonite in Infinite Cylinder.
2) Determination of Thermal Conductivity of a metal rod at different temperatures using Fourier equation.
3) Determination of Heat Transfer Coefficient in Enameled Vessel.
4) Determination of Heat Transfer Coefficient in Jacketed Kettle and natural convention with or without stirring.
5) Determination of Overall Heat Transfer in Shell and Tube Heat Exchanger.
6) Determination of Overall heat transfer coefficient in film condensation and Drop wise condensation.
7) Determination of Overall heat transfer coefficient in a CSTR.
8) Determination of heat transfer coefficient in steam – air heat exchanger / hot oil.
9) Evaluation of Wilson Plot.
10) Verification of Nusselt Equation.
11) Determination of Stefan Boltzmann constant using (dTe/ dθ) from temperature Vs Time plot.
12) Determination of Emissivity of a given plate at various temperatures.
13) Determination of Overall heat transfer coefficient for Concentric Tube heat Exchanger.
14) Determination of heat transfer coefficient in a Finned tube heat Exchanger.
15) Study of temperature distribution along the length of a pin-fin under natural and forced convention conditions.

CH303: Mass Transfer-I(Credit:05) **(Lect:03, Tut:01, Pract:02)**

1 **General principles of Mass Transfer**: Classification of Mass Transfer Operations, choice of separation method, methods of conducting mass transfer operations, design principles.

Diffusion Mass Transfer

Molecular Diffusion in gases and liquids, diffusivities of gases and liquids, types of diffusion, Fick's and Maxwell law of diffusion, diffusion in solids, unsteady state mass transfer.

2 **Mass transfer Coefficients** in laminar flow and turbulent flow, theories of Mass transfer, mass, heat and momentum transfer analogies. Inter-phase mass transfer, equilibrium in mass transfer, the two resistance theory, continuous concurrent, countercurrent and crosscurrent processes, cascades

3 **Distillation**: Vapour – liquid equilibria, Raoult's law, X-Y and H-X-Y diagrams, differential distillation and equilibrium distillation, steam distillation, azeotropic distillation, extractive distillation. Fractionation, binary distillation, plate and packed columns for distillation analytical and graphical methods for estimation of number of stages required in distillation column, minimum reflux ratio, optimum reflux ratio, number of stages at optimum reflux, murphree plate

efficiency and overall plate efficiency, effect of feed conditions on number of plates for separation Concept of HETP, HTU, NTU in distillation, plate and packed columns, packings for packed columns, pressure drop in plate and packed columns, bubble cap, sieve tray, valve tray plate columns

4 **Liquid – Liquid Extraction** fundamentals, selection of solvent for extraction, estimation of mass transfer coefficients, triangular diagram representation, equipments for liquid – liquid extraction, plate and packed columns, spray columns, rotary disc contactors, design procedures and equipment selection criteria. Single stage, multistage operations etc. Solid – Liquid Extraction fundamentals, Solvent selection, equilibrium relationship triangular diagram representation, single stage, multistage concurrent and counter current operation, equipments for solid – liquid extraction, their design procedure and selection criteria.

5 **Solid – Liquid Extraction** fundamentals, Solvent selection, equilibrium relationship, triangular diagram representation, single stage, multistage concurrent and counter current operation, equipments for solid – liquid extraction, their design procedure and selection criteria

6 **Adsorption:** Adsorption isotherms, adsorption agents, equipments for adsorption, pressure swing adsorption technology, adsorption phenomena

Text book: Treybal R.E.; Mass Transfer Operations, Edition 3rd, McGraw Hill Book Co., New York .

References books

1. Arora S.C.; Heat Transfer and Mass Transfer, 3rd Ed., Khanna Publishers, (1986).
2. Badger W.L. and Banchero J.T.; Introduction to Chemical Engineering, Tata McGraw Hill Book Co.
3. Brown G.G.; Unit Operations, John Wiley & Sons, New York.
4. Chattopadyay P.; Unit Operations of Chemical Engineering, Vol. 1 & 2, Khanna Publishers, New Delhi.
5. Coulson J.M. and Richardson J.F.; Chemical Engineering Vol. I, II & III, Pergamon Press, New York 1977.
6. Lyderson A.L.; Mass Transfer in Engineering Practice, John Wiley Co. (1983).
7. McCabe W.L. and Smith J.C. & Harriot; Unit Operations of Chemical Engineering, 5th Edition, McGraw Hill Book Co., New York 1980.
8. Suryanarayana A.; Mass Transfer, New Age International, New Delhi..

Lab Work:

1.Study of adsorption of acetic acid on activated charcoal [To verify adsorption isotherms].
2.Theoretical plate (HETP) of Packed distillation column
3. Diffusion (Liquid – Liquid) –To calculate the diffusion coefficient of vapor in still Air.
4.To study the characteristics of Boiling point diagram
5.Plate Column Distillation: - to study the Performance of a rectification column
6.Liquid – Liquid Extraction– To determine Overall efficiency for a three stage counter Current and cross current system
7.Experiments on Differential Distillation
8.To determine rate of distillation by Steam Distillation

CH304: Process Equipment Design (Credit: 04) (Lect:03,Tut:01, Pract:00)

1 **Design Considerations:** Design codes, Maximum working pressure, Design pressure, Design Temperature, Design stress, Factors of safety, Selection of factor of safety design wall thickness, Corrosion ratio, Poisson ratio, Criteria of failure, Elastic stability. Materials of construction : Mechanical properties, Materials, Corrosion, Protective coating, Corrosion prevention, Choice of materials

2 **Design of Pressure Vessels:** Importance of chemical process equipment design, design procedure for pressure vessels subjected to internal pressure, external pressure and combined loading, closures for pressure vessels, optimum proportions of pressure vessels, optimum sizing of vessels Design of pressure vessels subjected to high pressure, monoblock construction, shrink fit construction. Crystallizer Design: Introduction, Types of Crystallizers, Design of crystallizers

3 **Process Design of Heat Exchanger**: Introduction, Types Of Heat Exchanger, Process Design of Shell and Tube Heat Exchanger.
Process Design of Evaporator: Introduction, Types of Evaporators, Methods of Feeding of Evaporators, Design of Evaporator

4 **Design of Distillation column** :Design of Sieve Tray for Distillation Column Design of Bubble Cap Tray For Distillation Operation
Agitators : Introduction, Types Of Agitators, Baffling, Power Requirements, Design Of Turbine Agitator.

5 **Introduction,** Type of Dryers, Design of Rotary Dryer

Text book: M.V.Joshi, V.V. Mahajan, Process Equipment Design, 3rd Edition, Macmillan India Ltd

References books

1) B. C. Bhattacharya, Introduction to Chemical Equipment Design (Mechanical Aspects) CBS Publisher & Distributors, New Delhi.
2) Coulson & Richardson, Chemical Engineering (Vol VI), Pergamon Press.
3) R.E.Treybal, Mass Transfer Operations, McGraw Hill, New Delhi.
4) S.D. Dawande, Process Design of Equipments (Vol. 1& 2) Central Techno Publications, Nagpur.
5) G.K.Roy, Solved Problems In Chemical Engg., Khanna Publications, NewDelhi.
6) J.H.Perry, Chemical Engineer's Hand Book, McGrawhill, New Delhi.

CH305: Chemical Process Industries (Credit:03) (Lect:03)

1 **Food Industries**: Types of food processing, preservation method, Food Products.
Sugar and Starch Industries: sugar and starch.
Fermentation Industries: Absolute alcohol, Beer, Wines and liquors, vinegar, citric acid lactic a

2 **Oil, Fat and Waxes:** Vegetable oils, animal Fats and oils, Waxes. Soaps and detergents. Pulp and paper industries: Manufacturing of pulp, manufacturing of paper, and structural boards

3 **Agrochemical Industries:** Insecticides, pesticides, Herbicides, plant growth, Nutrients and regulators, compound fertilizers, Bio fertilizers, complex fertilizers, various grades of N.P.K. fertilizer.

4 **Explosives**: Types of Explosives, Explosive characteristics, Industrial explosives, propellants,

rockets, missiles, pyrotechnics, matches, toxic chemical weapons.
Plastic industries: Raw Materials, general polymerization processes, manufacturing processes, compounding and Molding operation

5 **Dyes:** Classification and manufacturing of dyes.

6 **Petroleum and Petrochemical:** Petroleum production and Refining , Manufacturing ofMethanol Formaldehyde , Ethylene and Acetylene , Ethylene dioxide, Isopropanol, Acetone , Isopropyl , Benzene ,Butadiene, Phenol styrene

7 **Pharmaceuticals Industries:** Classification of Pharmaceuticals products. Manufacture of Antibiotics, Isolates from plant and animal, vitamins

Text book: George T. Austin, "Shreeve's Chemical Process Industries", 5th Edition , Mc Graw Hill Book Company.

References books

1) C.E. Dryden, Outline of Chemical Technology, Affiliated East WestPress.1973.

2) S.D.Shukla, G.N.Pandey, A text book of Chemical technology, 3rd Edition.

Semester –VI

CH306: Mass Transfer-II (Credit:05) (Lect:03, Tut:01, Pract:02)

1 **Gas Absorption**
Mechanism of gas absorption, equilibrium in gas absorption, application of mass transfer theories to absorption, absorption in wetted wall columns, values of transfer coefficient, absorption in packed tower and spray tower, calculation of HETP, HTU, NTU,calculation of height of packed and spray tower. Absorption in tray towers, absorption and stripping factors, tray efficiencies, calculation of number of trays for absorption, absorption with chemical reaction.

2 **Drying**
Principles, equilibrium in drying, type of moisture binding, mechanism of batch drying, continuous drying, time required for drying, mechanism of moisture movement in solid, design principles of tray dryer, rotary dryer, drum dryer, spray dryer, fluidized bed and spouted bed dryer, pneumatic dryer and vacuum dryer.Numericals

3 **Introduction to Membranes Separation technology**:

Reverse osmosis, ultra filtration, evaporation, micro filtration, design principles, permeability, desalination technology, dialysis technique, membranes selection and parameters to be considered in design of membranes separation technology

4 **Crystallization** : Theory of Crystallization, saturation, super saturation, nucleation and crystal growth, various equipments for crystallization, their operational and design characteristics, calculation of yield, enthalpy balances, equipment

5 **Humidification and dehumidification** equipments operational characteristics, design procedures and selection criteria along with mass transfer calculations, Types of cooling towers, cooling tower operational characteristics

Text book: Treybal R.E.; Mass Transfer Operations, Edition 3rd, McGraw Hill Book Co., New York .

References books

1. Arora,Heat Transfer and Mass Transfer, Khanna Publishers, New Delhi. .
2. Badger W.L., Banchero J.T.; Introduction to Chemical Engineering,McGraw Hill Book Co., New York. .
3. Brown G.G.; Unit Operations, John Wiley & Sons, New York.
4. Chattopadhyay P., Unit Operations in Chemical Engineering Vol-I & II,Khanna publishers, New Delhi
5. Coulson J.M., Richardson J.F.; Chemical Engineering Vol.II, edition 3rd, Perganon Press, New York (1987).
6. Lyderson A.L.: Mass Transfer In Engineering Practice, John Wiley & Sons. .
7. McCabe W.L., Smith J.M.& Harriot P.; Unit Operations in Chemical Engineering, 5th Edition, McGraw Hill Book Co., New York, 1993.

Mass Transfer Lab-Work:

- Rotary Dryer – To study the Characteristics of Rotary Dryer
- Tray Dryer – To calculate rate of Drying
- Spray Dryer – To study the design and Operating Principles of Spray Dryer

- Mass transfer Coefficient – To determine the Mass Transfer Coefficient for Absorption in a Packed Tower
- Enhancement Factor – To find the enhancement factor for absorption with and without chemical reaction
- To study the characteristics Cooling Tower experiment
- Performance evaluation of fluid bed dryer
- To study the characteristics Cooling Tower experiment
- Experiments on Fractional Crystallization
- Process of Crystallization and its Characteristics Ion Exchange

CH307: Chemical Reaction Engineering –I (Credit:05) (Lect:03 ,Tut:01, Pract:02)

1 Classification of chemical reactions, elementary and non-elementary reactions representation of reaction rate, chain reaction mechanism, kinetics of homogeneous reactions, determination of reaction order, differential and integral methods for reaction. order, half life time of chemical reaction, volume change during reaction

2 Classification of reactors, batch wise Vs. continuous reactor operation, material balance and energy balance equations for reactors, introduction to the steady state behavior of continuous stirred tank and plug flow reactors, semi batch reactors operation at steady state and unsteady state conditions

3 Development of performance expression for batch and continuous reactors, performance evaluation of reactors, arrangement of reactors in series and parallel Reversible reaction kinetics, consecutive reactions, parallel reactions and their performance evaluation

4 Batch recycle reactors, continuous recycle reactors, reactive distillation, multiple reactions in batch and continuous reactors, concept of yield and selectivity of chemical reactions

5 Residence time distribution in reactors, E-curve, F–curve, dispersion model for reactions Dispersion numbers and dispersion model and its effect on reactor performance, introduction to catalysis and the effect on chemical reaction.

Text book: . Levenspiel O.; Chemical Reaction Engineering, 2nd Edition, John Wiley Eastern Singapore

References books

- Fogler W.; Chemical Reaction Engineering, 2nd Edition, Prentice Hall, India. Hills C.G
- Introduction to Chemical Engineering Kinetics and Reactor Design John Wiley & Sons New York.
- Holland C.D. and Rayboard A.G.; Fundamentals of Chemicals Reaction Engineering Prentice Hall India Ltd
- Smith J.M; Chemical Engineering Kinetics, 2nd Edition, Mc Graw Hill, (1970).
- Walas S. M.; Chemical Reaction Engineering, Handbook of solved Problems, Gorden and Breach Publication, (1995).

Mass Transfer Lab-Work:

Minimum of Eight experiments should be performed. Suggested list is as below

1) Study of first order reaction.
2) Inversion of sucrose
3) Study of pseudo first order reaction. Acid catalysed hydrolysis of methyl acetate
4) Study of a second order reaction – Saponification of ethyl acetate.
5) Determination of Arrhenius parameters
6) Study of homogeneous catalytic reaction, decomposition of hydrogen peroxide, acid catalyzed ester hydrolysis.
7) Batch fermentation of sucrose using invertase
9) Study of CSTR
10) Study of CSTR combination in first order reactions
11) Study of F & C curves in CSTR
12) Study of F & C curves in Helical coil reactor

CH308: Process Control & Instrumentation (Credit:05) (Lect:03,Tut:01, Pract:02)

1 Importance, aims and objectives of process control, introduction to system dynamics, concept of dynamic response, first order, second order interacting process gain, overshoot, decay ratio, dead time

2 Introduction to set point, disturbance, closed loop and open loop control feedback and feed forward configurations, dynamics of feed back control system.

3 Types of controllers, P, PI and PID controllers, controller gain, stability analysis, Routh stability criteria

4 Design of controllers using open loop response, Zieler – Nichols controller settings, Bode and Nyquist stability criteria.

5 Control valve and choice of controller settings. Basic design of pneumatic controllers, electric / electronic controllers, discontinuous control modes two position, classical and modern control actions

6 Process instruments used for measurement of pressure, temperature, liquid level, flow rate and compositions, pressure gauge, strain gauge, Mcleod gauge, vacuum measurement, transducers, transmitters, digital signal processing.

7 Introduction to set point, error, accuracy, sensitivity Application of control systems to chemical process equipments such as chemical reactors, heat exchangers, distillation columns, boilers etc

Text book/References books

- Babatunde A., Ogunnaike & Ray W.H.; Process Dynamics, Modeling and Control, Oxford Press, New York, (1994)
- Coughnowr D.R.; Process Systems Analysis and Control: 2nd Edition McGraw Hill Book Co
- Harriot P.; Process Control, McGraw Hill, New Delhi, 1984.
- Perry R.H.; Chemical Engineer's Handbook, 7th Edition
- Radhakrishnan V.R.; Instrumentation and Control for the Chemical Mineral and Metallurgical Processes, Allied Publ ishers Ltd., New Delhi
- Stephanopoulos G., Chemical Process Control, An Introduction to Theory and Practice, PHI Learing Pvt. Ltd. New Delhi.

- Smith Carlos A. & Corrieio A.B.; Principles and Practice of Automatic Process Control: 2nd Edition, John Wiley & Sons, New York

Lab-Work:

- Study of first order system & determination of time constant for a first order syatem.
- Study of second order interacting and non interacting system& determination of time constant, overshoot and decay ratio
- Study of Gain of a proportional controller
- Study of Process simulation
- Study of P–I Controller
- Study of P-I-D Controller.
- Study of Proportional Controller
- Calibration & determination of time lag of various first and second order instruments
- Set point setting and study of operation of a system & set point setting
- Study of Safety valve actuating system
- PC based control of any of the equipment ex. Heat Exchanger /Distillation column
- Flow control study using P, P-I, P-I-D, controllers

CH309: Process Modeling & Simulation (Credit:05) (Lect:03, Tut:01, Pract:02)

1 Differential equation and population balance models: Physical and thermodynamic properties. Numerical methods for digital simulation.
2 Modeling of specific systems with reference to important industries like fertilizer, petrochemicals and petroleum refining. Application of simulation languages. Analysis and design of advanced control systems.
3 Design of control systems for multivariable processes. Process control using digital computers
4 Introduction to process modeling and simulation: Models; Need of models and their classification; Development of detailed mathematical models of evaporators; Distillation columns; Absorption columns and chemical reactors and their simulation and computer program development
5 Introduction of chemical process flow sheeting and industrial simulators.

Text book/References books

- Luyben W.L., Process modeling & Control for Chemical Engineers2nd Edition, Mc Graw Hi1 990
- Babatunde A. Ogunnaike A., Harman Ray W.; Process Dynamics Modeling and Control, Ist Edition, Oxford Press N. (1994).
- Grewal B.S. Engineering Mathematics
- Jenson V.J& Jeffery G.V, Mathematial methods in chemical engineering academic press, London. NY 1977

- Kluwer, Mathematical Modelling of Heat and Mass Transfer Processes Academic Publisher, London
- Mickley H.S, Sherwood I.S., Reed C.E., Applied Mathematics in Chemical Engineering,Tata Mc Graw Hill, New Delhi
- Asghar Husain, Chemical process Simulation, Wiley Eastern Ltd.,New Delhi.

Chemical Process Modeling and Simulation Lab-Work:

The following experiments have t be conducted using C / C++ / Simulink using MATLAB.

1. Gravity Flow tank.
2. Three CSTR's in series – open loop.
3. Three CSTR's in series – closed loop.
4. Non-isothermal CSTR.
5. Binary Distillation Column.
6. Batch Reactor isothermal; Batch reactor non isothermal – closed loop.
7. Isothermal batch reactor – open loop.
8. Heat Exchanger.
9. Interacting system – two tank liquid level.
10. Non-interacting system – two liquid level.
11. Plug flow reactor.
12. Bubble point calculation

CH 310: Elective-I(Safety & Risk Analysis, Renewable Energy Sources, Energy Management) Credit:03 (Lect:03)

Safety And Risk Analysis

1 Introduction to process plant safety, handling of hazardous chemicals Lower flammability limit (LFL), UFL, LEL, UEL, TLV, electrostatic hazards, Hazard code and explosive limit, TWA, Ceiling level, Safety in handling of gases, liquids and solids

2 Flammable liquid hazards, fire and explosion index, fire ball hazards, oil spillage hazards, Bleveuvce, pool fires, jet fires, radiation hazards

3 Explosion, emergency and disasters in chemical process plants, onsite and offsite emergency plan, Fire detectors, smoke detectors Safety audit of chemical process plants, HAZOP studies, fault tree and event tree analysis.

4 Resources for combating fires, dry chemical powders, fire fighting foam fixed and portable fire extinguishers, FMEA Risk analysis of chemical processes, risk management, risk identification, personnel training, risk to environment

5 OSHA standards, importance of plant layout in safety, importance of site selection, personnel safety, role of human error in losses. Case studies of fires, explosions, disasters in chemical process plants

Text / References:

- Dixit ; Safety Evaluation of Environmental Chemicals,.
- Dekkar Marcel; Safety Management and Practices for Hazardous Units, New York1995
- Greene R.; Safe and Efficient Plant Operation and Maintenance McGraw Hill Book Co. New York
- Saxena, Safety and Good House Keeping, 3rd Edition on National Productivity Council, New Delhi (1976).
- Wells G.L.; Safety in Process Plant Design, George Godwin Ltd., (1980).

Energy Management

1 **Energy auditing:** Methodology, analysis of past data, measurements of various parameters, portable and on line instruments
2 **Energy economics:** Payback period, Rate of Return, life cycle costing
3 **Steam Systems:** Boiler-efficiency testing, excess air control, Steam distribution and use, steam traps, condensate recovery, flash steam utilization.
4 **Electrical systems:** Demand control, power factor correction, load scheduling/shifting. Motor drives – motor efficiency testing, energy efficient motors, and motor speed control.

5 **Lighting:** Conservation in Pumps, Fans (flow control), Compressed Air Systems, Refrigeration and conditioning systems, Waste heat recovery, heat pipes**.**

Text / References:

- Callaghan O' Paul; Energy Management, McGraw Hill, 1994
- Dryden I.G.C.; The efficient use of Energy; Ed. Butter worth, London1982
- Murphy W.R., McKay G.A.; Energy Management, Murphy Butterworth-Heinemann Ltd., 2001.
- Turner W.C.; Energy Management Handbook – 2nd Edition, Fairmont Press, Lilburn, Georgia, 1993

New and Renewable Energy Sources

1 **Introduction :** Energy scene of supply and demand in India and the world, Energy consumption in various sectors, potential of non-conventional energy resources,energy needs and energy supply, sources, contribution of non conventional energy
2 **Solar Energy :** Solar radiation and its measurement, characteristics and estimation, limitations in the applications of Solar Energy, Collectors: flat plate and concentrating types, their

comparative study; design and material selection, efficiency, selective paints and surfaces. Solar water heater applications of Solar Energy for heating, drying, water desalination, solar concentrators, photovoltaic power generation using silicon cells. Thermal storages, Solar ponds, Solar pumps, Solar power, Solar cookers etc. Direct conversion of solar energy to electricity and its various uses, materials limitations and costs

3 **Bio- Fuels :** Photosynthesis and generation of bio-gas, digesters and their design, selection of material; feed to digester, pyrolytic gasification production of hydrogen, algae production and their uses

4 **Wind Energy :** Principle of energy from wind, availability, site selection different types of wind turbines, design criteria and material selection economics

5 **Geo-Thermal Energy :** Geo-technical wells and other resources dry rock and hot aquifer analysis , harnessing geothermal energy resources

6 **Tidal Energy** Its meaning, causes of tides and their energy potential enhancement of tides, limitations, different methods of using tidal power Principles of ocean thermal energy conversion (OTEC) analysis and sizing of heat exchangers for OTEC

Ocean Thermal Energy : Principle of utilization and its limitations description of few systems Other Non-conventional Energy Sources ,fluidized bed combustion, heat from waste water and other sources.

7 **Energy Conservation :** Principles of energy conservation. Familiarization with the different energy conservation appliances and practices, improved cooking stoves, benefits of improved cooking stoves over the traditional cooking stoves. Scope of energy conservation in the domestic, commercial and agricultural sector

Text / References:

- Duffie J. A., Beckman W A., Solar Engineering of Thermal Processes, John Wiley1980
- Kreith F. and Kreider J. F., Principles of Solar Engineering, McGraw Hill,1978.
- Rai G.D, Non-Conventional Energy Sources, Khanna Publishers, Delhi
- Sarkar S., Fuels and Combustion, 2nd Edition, Orient Longman1989
- Sukhatme, S. P., Solar Energy, 2nd Edition, Tata McGraw-Hill, 1996
- Twiddle J., Weir T., Renewable Energy Resources, Cambridge University Press, 1986
- Veziroglu, N., Alternative Energy Sources, Volume 5 & 6, McGraw-Hill

****