CM- 501 – Advanced Chemical Engg. Thermodynamics

UNIT-1 Thermodynamic properties of homogeneous mixtures; property relationship for systems of variable compositions, partial molar properties, fugacity & fugacity-coefficient in ideal-solution, concept of fugacity departure

UNIT-2 Change of mixing activity, heat effects in mixing, activity effect in gaseous mixture

UNIT-3 Refrigeration, ideal reversed Carnot cycle, vapour compression refrigeration, component of a vapour compression plant (compressor, condenser, expansion device, evaporator) properties of refrigerant

UNIT-4 Chemical potential & its physical significance, effect of pressure & temperature on heat of reaction, concept of free energy Vant-Hoffs equation, Claussions-Clapeyron equation, Gibbs-Buem relationship of free energy with equilibrium constant, equilibrium & its applications.

UNIT-5 Elements of statistical thermodynamics, counting the number of microstates for a given macro-state, the most probable macrostate, Boltzman distribution, evaluation of Lagrangian constants alpha , statistical interpretation of work & heat.

References:

1. Smith J.M and Van Ness- Introuction to Chemical Engg Thermodynamics – 6th edition
2. Daubert; chemical engg thermodynamic; TMH
3. Rathakrishnan E; Fundamentals of Engg Thermodynamics; PHI
4. Dodge B.F. Chemcail Engineering –Thermodynamics –McGraw Hill
5. Balzhiser Samules and Eliassen-Chemical Engg- Thermodynaics Prentic Hall
6. Sandler S.I Chemical Engg-Thermodynamics-John Wiley and son
7. Rastogi and Mishra-Chemical Engg Thermodynaics

CM- 502 – Inorganic Process Technolgy

Unit I
Salts and sodium compounds, soda ash, caustic soda, chlorine and potassium salts.

Unit II
Hydrochloric acid, Sulphur and sulfuric acid, Phosphoric acid and phosphates

Unit III
Nitrogenous Industries, Ammonia and Nitric acid, Nitrogenous Fertilizer, mixed fertilizers, N-P-K Fertilizers and micronutrients.

Unit IV
Cement industries, Industrial gases: Nitrogen, Oxygen, Hydrogen, Helium and Argon.

Unit V
Inorganic chemicals namely Bromine, Iodine and Fluorine, Alumina and Aluminium chloride, Inorganic pigments.

References:
1. Austine G.T.and Shreeves; Chemicasl Process Industries; Mc GrawHill
2. Dryden C.E., M. Gopala Rao; Outlines Of Chemical Technology. Affiliated East-West Press
3. Pandey G.N.; Chemical Technology Volume- I; Lion Press, Kanpur.

CM- 503 – Computational Methods in Chemical Engineering

Unit I Treatment of engineering data – Graphical representation. Empirical equations, Interpolation, Newton's formula, Lagrange's Interpolation formula, extrapolation, Integration, graphical Integration, Graphical Construction of Integral curves, Numerical Integration.
Unit II Interpretation of Engineering Data- Significant figure, Classification of Measurements, Propagation of Errors, Variation and Distribution of Random Errors, Properties of Variance, Confidence limits for small samples.

Unit III Ordinary Differential Equations – Formulation, Application of Law of Conservation of Mass– Mixing in flow process. Classification of ordinary Differential Equations and its applications to common Chemical Engineering problem

Unit IV Numerical Solutions of Ordinary Different Equations– Linear Second– order Equations with variable coefficients, Numerical solution by Runge Kutta Method. Its application to higher–order equations

Unit V Formulation of partial Different Equations. Finite difference, linear finite difference equations, non-linear difference equations, Optimization, types of methods, its application relating to chemical processes.

References:
1. Mickley HS, Sherwood and Reed; Applied Mathematics In Chemical Engineering;TMH pub.
2. Jenson & Jeffrey's; Mathematical Methods In Chemical Engineering; Mc Graw Hill
3. Luyben WL; Process modeling, simulation and control for chemical engr; Mc Graw Hill

List of Experiment (Pl. expand it):
1. Data representation and treatment by Graphical methods, Pressure- Volume-Temperature and concentration relationships for gases and their mixtures.
2. Integrated methods of data processing. Integral functions and their graphical representation.
3. Estimation of properties from empirical correlations (Nokay)
4. Estimation of critical properties from group contribution method.
5. Redlich-Kwong equation of state and other Virial equations to estimate thermodynamic properties like compressibility factor, molar volume and P-V-T relationships.
6. To study the effect of liquid viscosity and dissolved gases on pump efficiency, reciprocating pump performance.
7. Measurement errors their propagation and minimization of random errors. Selection of confidence limits.
8. Mass balance problems using continuity equation applied to a dynamic system. Formation of differential equations (component balance) and their solution & examples – CSTR and flow through pipes.
9. Numerical Solutions of batch reactor problems. Euler Algorithm
10. Runge-Kutta algorithm and its application in chemical Engineering. Implicit and explicit calculations. Problems related to effect design, optimum liquid concentration.
11. Transient flow of fluid unsteady temperature and varying concentration problems and use of partial differential equation to solve them.
Note: Each student should perform at least eight experiments from the above list.

CM- 504 – Mass Transfer-I

Unit I Fundamentals of Mass Transfer Individual and film coefficients, overall mass transfer coefficient and their inter relationships; Analogies in transfer processes, determination of mass transfer co-efficient; two phase flow in packed beds, co-current and counter current processes flooding loading, column internals: types of trays/ plates and packing, point and plate efficiency.

Unit II Diffusion phenomenon: Molecular and eddy diffusion in gases, liquids and solids, interface mass transfer, Mass transfer theories: film theory Penetration theory and surface renewal theory

Unit III Distillation Vapour liquid Equillibria, Boiling point diagram, Relative volatility, flash and differential distillation for two component mixture, steam distillation, azeotropic distillation, extractive distillation.

Unit IV Continuous and Differential contact Distillation Rectification, reflux ratio, calculation of numbers of plates by NTU, optimum reflux ratio, open steam, multiple feed and multiple product calculations, Enthalpy concentration diagram, Panchon-Savarit method for calculation of number of theoretical plates. Approximate equation; Fensky and undeinrood equation for minimum numbers of plate calculation. Polarison Gilliland method for actual numbers of plate calculation, Batch distillation.

Unit V. Absorption: Absorption and Extraction in continuous contact columns, co-current, counter current and cross current contacting fluids, calculations of NTU and HTU, concept of HETP

References:

1. Mc-Cabe W.L, Smith J.M.; Unit Operation In Chemical Engineering; Tat Mc-GrawHill.
2. Coulson J. M. Richardson; Chemical Engineering – Vol 2; Butserworth Heinmann, Oxford, Delhi
3. Treybal R.E; Mass Transfer Operatio; Mc. Graw Hill.
4. Sherwood, T.K. Pigford R.L. and Wilke, C.R.; Mass Transfer; Mc. Graw Hill.

List of Experiment (Pl. expand it):

1. To study the flooding and loading of packed columns using different types of packing.
2. To study different types of plates and packing.
3. To prepare the vapor-liquid equilibrium and Boiling point diagram for a binary liquid mixture.
4. Determination of relative volatility of a given system of acetic acid water.
5. To verify Rayleigh equation for differential distillation of binary system.
6. To carry out the steam distillation.
7. To study batch distillation.
8. To study continuous distillation.
9. Studies on packed tower distillation unit.
10. Studies on the sieve plate distillation unit.
11. Studies on bubble cap distillation column.
12. To study the absorption of a gas in a packed column and calculation of NTU and HTU.

Note: Each student should perform at least eight experiments out of the above list.

CM- 505 – Heat Transfer

Unit I Conduction: Modes of heat transfer one dimensional and two dimensional, heat rate equations, Theory of insulation, critical radius calculations, types of insulation material, conduction through slab, cylinder and sphere.

Unit II Convective heat transfer, heat transfer in boundary layer and in films, natural and forced convection, co/counter/cross current contacting for heat transfer, individual and overall heat transfer coefficient, fouling factor.

Unit III Radiative heat transfer, Black body radiation, concept of shape factor, methods of determination of shape factor, radiation exchange in enclosure with black surfaces

Unit IV Heat transfer under phase change conditions, boiling and condensation of pure components, heat flux temperature diagram for boiling and condensation under vertical and horizontal surfaces, nucleate & pool boiling, effect of surface condition on condensation, correlation for heat transfer under condensation. Evaporation- Type of evaporators and their applications single and multiple effect evaporators, design and operation of forward– backward and mixed feed operations, effect of boiling point elevation and hydrostatic head vapour recompression.

Unit V Heat Exchange equipment: Introduction to general design of double pipe ,shell and tube exchangers, condensers, extended surface equipments, heat exchanger equation – coil to fluid, jacket to fluid.

References:

1. Donald Q. Kern; Process Heat Transfer; Tata McGraw Hill.
2. Alan J. Chapman; Heat Transfer; Collier McMillan.
3. Rao Y.V.C; Heat Transfer; PHI

List of Experiment (Pl. expand it):

1. To determine the thermal conductivity of metal rod.
2. To determine the equivalent thermal conductivity of composite wall.
3. To determine heat transfer coefficient in force convection.
4. To determine heat transfer coefficient in Natural convection.
5. To determine heat transfer coefficient with the help of Stefan Boltzmann Apparatus.
6. To calculate emissivity of the test plate by emissivity measurement apparatus.
7. To determine heat transfer coefficient in double pipe heat exchanger.
8. To study the heat transfer characteristics of a shell and tube heat exchanger (heating/cooling) of water.
9. To determine heat transfer coefficient in parallel and counter flow heat exchanger.
10. To measure the rate of evaporation using an open pan evaporator.
11. To measure the rate of condensation of pure water vapour and to determine the heat transfer coefficient.
12. Demonstrate the film-wise drop-wise condensation and determination of he heat transfer coefficient.
13. To study the single effect evaporator and find out the heat transfer coefficient.

Note: Each student should perform at least eight experiments out of the above list.

CM- 506 – Chemical Process Plant Simulation Lab -I

Simulation Study of Various chemical Process with the help of following Softwares :

MATLAB , Chemcad , Pro – Simulator .