अनुसंधान प्रबंधन और राष्ट्रीय प्रौद्योगिकी संस्थान

RESEARCH MANAGEMENT AND NATIONAL INSTITUTE OF TECHNOLOGY

(An Autonomous institution under Ministry of HRD, Govt. of india)

(A 9001-2008 ISO CERTIFIED INTERNATIONAL B-SCHOOL)

SYLLABUS

Bachelor of Chemical Engineering

3rd Year (V & VI Semester)

On

UGC Model Curriculum

Name of Course: B. Tech. (Chemical Engineering)

Uttar Pradesh Technical University

Study and Evaluation Scheme

[Effective from the Session 2015 - 16]

B. Tech. (Chem. Engg.) **Year 3rd, Semester -V**

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
THEORY SUBJECTS											
1	NCH501	Mass Transfer II	3	1	0	30	20	50	100	150	4
2	NCH502	Transport Phenomena	3	1	0	30	20	50	100	150	4
3	NCH503	Chemical Reaction Engineering I	3	1	0	30	20	50	100	150	4
4	NCH504	Thermodynamics II	3	1	0	30	20	50	100	150	4
5	NCH505	Chemical Technology I	2	1	0	15	10	25	50	75	3
6	NHU-501	Engineering Economics	2	0	0	15	10	25	50	75	2
PRACTICAL/DESIGN/DRAWING											
7	NCH551	Mass Transfer Lab - II	0	0	3	10	10	20	30	50	1
8	NCH552	Chemical Reaction Engineering Lab - I	0	0	3	10	10	20	30	50	1
9	NCH553	Chemical Technology Lab	0	0	2	10	10	20	30	50	1
10	NCH554	Flow Sheeting Lab	0	0	2	10	10	20	30	50	1
11	NGP501	GP						50		50	
		TOTAL	16	5	10					1000	25

B. Tech. (Chem. Engg.) **Year 3rd, Semester - VI**

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
THEORY SUBJECTS											
1	NCH601	Chemical Reaction Engineering II	3	1	0	30	20	50	100	150	4
2	NCH602	Chemical Technology II	3	1	0	30	20	50	100	150	4
3	NCH603	Process Dynamics and Control	3	1	0	30	20	50	100	150	4
4	NCH011/ NCH015	Departmental Elective - I	3	1	0	30	20	50	100	150	4
5	NCH604	Process Instrumentation	2	1	0	15	10	25	50	75	3
6	NHU-601	Industrial Management	2	0	0	15	10	25	50	75	2
PRACTICAL/DESIGN/DRAWING											
7	NCH651	Chemical Reaction Engineering Lab - II	0	0	3	10	10	20	30	50	1
8	NCH652	CAD and Simulation Lab	0	0	2	10	10	20	30	50	1
9	NCH653	Process Dynamics and Control Lab	0	0	2	10	10	20	30	50	1
10	NCH654	SEMINAR	0	0	3		50	50		50	1
11	NGP601	GP						50		50	
		TOTAL	16	5	10					1000	25

Elective-I

1. **NCH011** Computational Fluid Dynamics
2. **NCH012** Statistical Design of Experiments
3. **NCH013** Process Flow Sheet Simulation
4. **NCH014** Process Integration
5. **NCH015** Piping Design

NCH501: MASS TRANSFER – II (3:1:0)

UNIT 1

Distillation: Basic fundamentals of distillation, Pressure-composition, Temperature-concentration, Enthalpy-concentration diagrams for ideal and non-ideal solutions, Raoult's law and its application, Maximum and minimum boiling mixtures, concept of relative volatility, Single Stage Distillation Differential distillation, Flash vaporization, Vacuum, molecular and steam distillation.

UNIT 2

Continuous Distillation of Binary Mixtures : Multistage contact operations, Characteristics of multistage tower, McCabe Thiele method, Ponchon Savarit method, Reflux, maximum, minimum and optimum reflux, Use of open steam, Tray efficiency, Determination of height and column diameter, Multistage batch distillation; Principles of azeotropic and extractive distillation, Introduction & Design of multicomponent distillation system.

UNIT 3

Liquid-Liquid Extraction: Ternary liquid equilibria, Triangular graphical representation concept of theoretical or ideal stage, Equipment used for single stage and multistage continuous operation; Analytical and graphical solution of single and multistage operation Super critical fluid extraction.

UNIT 4

Solid /Liquid Extraction: Leaching, Solid liquid equilibrium, Equipment used in solid – liquid extraction, Single and multistage cross current contact and counter current operations. Concept of an ideal stage, Overall stage efficiency, Determination of number of stages.

UNIT 5

Adsorption: Description of adsorption processes and their application, Types of adsorption, Nature of adsorbents adsorption equilibria and adsorption hysteresis, Stage wise and continuous
contact adsorption operations, Determination of number of stages, Ion exchange Equipments, Equilibrium relationship, Principle, techniques and applications of Ion-exchange, , Principles and application of Dialysis, Osmosis, Reverse osmosis, Thermal diffusion, Sweep diffusion.

Text Books:

1. Treybal, R "Mass Transfer Operations", 3rd Editon, New York: McGraw-Hill, (1980).
2. Sherwood T. K., Pigford R. L. and Wilke P. "Mass Transfer" McGraw Hill (1975)

Reference Books:

1. Foust A. S. et.al., "Principles of Unit Operations" John Wiley (1980).
2. Geankoplis, C.J.. "Transport Processes and Unit Operations", 3rd Editon, Prentice Hall. (1993)
3. Coulson, J. M. and Richardson J. F., "Chemical Engineering" Vol. I, II, IV & V: Pergamon Press.
4. Phillip C. Wankat, "Separation Process Engineering Includes Mass Transfer Analysis, 3rd Editon, Pearson

NCH502: TRANSPORT PHENOMENA (3:1:0)

UNIT 1

Vectors/Tensors, Newton's law of viscosity, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick's law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.

UNIT 2

Shell Momentum balances, velocity profiles, average velocity, momentum flux at the surfaces, Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal).

UNIT 3

Shell energy balances, temperature profiles, average temperature, energy fluxes at surfaces, Equations of change (non-isothermal), equation of continuity, equation of motion for forced and free convection, equation of energy (non-isothermal).

UNIT 4

Shell mass balances, concentration profiles, average concentration, mass flux at surfaces, Equations of change (multi-component), equations of continuity for each species, equation of energy (multi-component).

UNIT 5

Introduction to the concept of heat and mass transfer coefficients. Interphase mass transfer, various coefficient of mass transfer and their determination, resistance concept, controlling phase concept, Mass transfer in turbulent flow, Analogies of mass transfer, Empirical equations. Theories of mass transfer, two film theory, Higbies penetration theory, Derivation of flux equation, surface renewal theory.

Text Book:

1. Byron, R. B., Stewart, W. E., Lightfoot, E. N., "Transport Phenomena", John Wiley & Sons, 1960.

NCH503: CHEMICAL REACTION ENGINEERING – I (3:1:0)

UNIT 1
Rate of Reaction, Elementary and non-elementary homogeneous reactions, Molecularity and order of reaction, Mechanism of reaction, temperature dependency from thermodynamics, collision and activated complex theories. Integral and differential methods for analyzing kinetic data, interpretation of constant volume reactor, zero, first, second and third order reactions, half life period, irreversible reaction in parallel and series, catalytic reaction, auto catalytic reaction, reversible reactions.

UNIT 2
Interpretation of variable volume batch reactions for zero, first and second order reactions, design equation for batch, continuous stirred tank, plug flow reactors for isothermal reaction.

UNIT 3
Optimum reactor size, plug flow/mixed flow reactors in series and parallel, recycle reactor.

UNIT 4
Design of reactors for multiple reactions, parallel and series reactions. Temperature and pressure effects for single reaction.

UNIT 5
Residence time distribution of fluids in vessels, E, F and C curves, Dispersion model, Tank in series model. Non Isothermal PFR and CSTR, Safety issues in Non Isothermal Reactors.

Text Books:

1. Smith, J, M, "Chemical Engineering Kinetics", 3rd Edition, McGraw-Hill (1990).
2. Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition, John Wiley (1998).

Reference Book:

1. Keith J. Laidler, "Chemical Kinetics" 3rd Edition, Pearson (2013)

NCH504: THERMODYNAMICS – II (3:1:0)

UNIT 1.
An Introduction to vapour-Liquid Equilibria, qualitative behaviour of the vapour-liquid equilibria (VLE), Simple models for vapourliquid, equilibria: Raoult's and henry's laws, dew point and bubble point calculations, VLE by modified raoult's law and K-value correlations. Flash calculations.

UNIT 2
Solution Thermodynamics, theory fundamental property relation. The chemical potential and phase equilibria. Partial properties, equations relating molar and partial molar properties, partial properties in binary solutions, relations among partial properties, ideal gas mixtures, fugacity and
fugacity coefficient for pure species, VLE for pure species, fugacity of a pure liquid, fugacity and fugacity coefficient for species in solution, the fundamental residual property relation, fugacity coefficients from the virial equation of state and generalized correlations, the ideal solution, the Lewis/Randall rule, excess properties. The excess Gibbs energy and the activity coefficient, the nature of excess properties.

UNIT 3.
Solution Thermodynamics, Applications Liquid phase properties from VLE data. Fugacity. Activity coefficient. Excess Gibbs energy. Data reduction. Thermodynamic consistency. Models for the excess Gibbs energy. Local composition models. Property changes of mixing. Heat effects of mixing processes. Heats of solution. Enthalpy-Concentration diagrams.

UNIT 4.
Chemical Reaction Equilibria, The reaction coordinate. Multi reaction stoichiometry. Application of equilibrium criteria to chemical reactions. The standard Gibbs energy change and equilibrium constant. Effect of temperature on the equilibrium constant. Evaluation of equilibrium constants. Relation of equilibrium constants to composition. Gas-phase and liquid-phase reactions. Equilibrium conversions for single reactions. Single phase reactions. Reactions in heterogeneous systems. Multi reaction equilibria. Fuel cells.

UNIT 5
Topics in Phase Equilibria The gamma/phi formulation of VLE. VLE from cubic equations of state. Equilibrium and stability. Liquid-liquid equilibrium. Vapour-liquid-liquid equilibrium. Solid-liquid equilibrium. Osmotic equilibrium and osmotic pressure.

Text Book:

1. Smith, J. M., H. C. Van Ness & M. M. Abbot; Introduction to chemical engineering thermodynamics.

Reference Books:

1. Bevan Ott. and Juliana Boerio-Goates; Chemical Thermodynamics Principles and Applications, Elsevier (India Print 2006)
2. Gopinath Halder; Introduction to Chemical Engineering Thermodynamics, PHI Learning Pvt. Ltd. 2009
3. J. Richard Elliott & Carl T. Lira; Introductory Chemical Engineering Thermodynamics, II Ed. Pearson
4. Thomas Engel & Philip Reid, Thermodynamics, Statistical Thermodynamics and Kinetics, Pearson
5. J. Rajaram & J. C. Kuriacose, Chemical Thermodynamics Classical, Statistical and Irreversible, Pearson

NCH505: CHEMICAL TECHNOLOGY- I (3:1:0)

Introduction of CPT with reference to Indian resources, industries, trade and export potential, small scale industries and rural development. Preparation of process flow diagrams, Instrumentation diagrams and Process symbols. ; Introduction to the following industries lying emphasis on process flow sheet, material requirements, process conditions, material of construction and design aspects.

UNIT 1

Introduction - Mono and Disaccharides - Important reactions - Polysaccharides - Starch and Cellulose - Derivatives of Cellulose - Carboxy Methyl Cellulose and gun cotton - Structural aspects of cellulose.

UNIT 2

Sugar, Glucose, Starch, Fermentation products such as Alcohol, Acetic acid, Citric acid and antibiotics

UNIT 3

Soap and Surfactants, Glycerin, Fatty acids, Hydrogenation of edible oils, paper and pulp

UNIT 4

Synthetic and natural fibers: Nylon, Dacron, Terylyne, Polyester and other new products, Viscose rayon, acetate rayon , synthetic rubber with special reference to manufacture, vulcanization and reclaiming of rubber, SBR, Plastics, Thermosetting and Thermo Plastics (PVC, Polyethylene, Polyurethane, Teflon)

UNIT 5

Crude oil distillation, Thermal conversion processes (visbreaking, coking), Catalytic conversion processes (fluid catalytic cracking, catalytic reforming, hydro cracking, alkylation, isomerisation, polymerization) Finishing processes, sulphur removal process, lub oil manufacture; Petrochemicals (ethylene, propylene, formaldehyde, methanol, ethylene oxide, ethanolamine, cumene, ethylene glycol, ethyl benzene)

Text Books:

1. Dryden, C. E. "Outlines of Chemical Technology" (Edited and Revised by M. Gopala Rao and M. Sittig) East West Press. Pvt. Ltd, New Delhi, 3rd Edition (1997).
2. Austin G. T. Shreve's Chemical Process Industries", 5th Edition, McGraw Hill (1984).

NCH551: MASS TRANSFER LAB – II (0:0:3)

1. Determination of ternary curve for the system acetic acid-water-carbon tetrachloride.
2. Determination of distribution coefficient of a solute in two immiscible liquids.
3. Solid-Liquid extraction – Soxhlet's experiment.
4. Liquid - liquid extraction in packed bed.
5. Determination of adsorption kinetics and isotherm at solid-liquid interface.
6. Determination of the rate of drying in a tray dryer.
7. Estimation of efficiency of the fluidized bed dryer

NCH552: CHEMICAL REACTION ENGINEERING LAB – I (0:0:3)

1. Find out kinetic constant and study conversion of a given reaction in a batch reactor
2. Find out kinetic constant and study conversion of a given reaction in a plug flow reactor
3. Find out kinetic constant and study conversion of a given reaction in a CSTR
4. Study and operation of an adiabatic batch reactor
5. Study of a reversible reaction in a batch reactor
6. To determine energy of activation of reaction of ethyl acetate with sodium hydroxide
7. Find out specific rate contant and activation energy of a reaction in a plug flow reactor
8. To determine reaction equilibrium constant of reaction of acetic acid with ethanol.
9. To determine changes in free energy, enthalpy and entropy for the reaction of potassium iodide with iodine.
10. Study and operation of a cascade CSTR

The reaction of disappearance of phenolphthalein in NaOH solutions may be used for experiments 1, 2 and 3

NCH553: CHEMICAL TECHNOLOGY LAB (0:0:2)

Preparation and Quality evaluation of following items:-

1. Cement Paint
2. Dry Distemper
3. Oil bound Distemper
4. Plastic Emulsion Paint
5. Polystyrene by Bulk Polymerization Technique
6. PMMA by Bulk Polymerization Technique
7. Transparent Soaps
8. Powdered Detergent
9. Liquid Detergent

NCH554: FLOW SHEETING LAB (0:0:2)

1. Flowsheet preparation and drawing
2. Equipment selection, Equipment numbering, stream designation
3. Preparation of plant layouts
4. Piping layouts
5. Steady state flowsheeting using propositional logic in process synthesis
6. Steady state flowsheeting using resolution based synthesis procedure
7. Steady state flowsheeting of processes with recycle (recycle calculation sequence)
8. Network of heat exchangers
9. Sequencing of distillation columns
10. Development of process flowsheet for a specific chemical plant

Recommended to be done using a simulation package/ programming environment

NCH601: CHEMICAL REACTION ENGINEERING II (3:1:0)

UNIT 1
Introduction to heterogeneous reactions, rate equation for surface kinetics, pore diffusion resistance combined with surface kinetics, Fluid-fluid reactions: kinetics and design.

UNIT 2
Fluid-solid reactions, experimental methods for finding rates, selection of a model, shrinking-core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, determination of rate controlling step, kinetic and design, Design of packed bed and fluidized bed reactors.

UNIT 3
Nature of catalysis, Determination of surface area, void volume and solid density, pore-volume distribution, physical and chemical adsorption, adsorption isotherms, Physical properties of catalysts, preparation, testing and characterization of solid catalysts, catalyst selection, catalyst preparation, promoters and inhibitors, catalyst poisoning and mechanisms of catalytic reactions, catalyst deactivation.

UNIT 4
Reaction and diffusion within porous catalysts, effectiveness factor, various resistances to transfer of reactants to the catalyst site, intrinsic and global rate of reaction, kinetic regimes, heat effects during reaction, Performance equations for reactors containing porus catalyst particles, design of solid catalytic reactors.

UNIT 5
Biochemical reactors, polymerization reactors.

Books:

1. Smith, J, M, "Chemical Engineering Kinetics", 3rd Edition, McGraw-Hill (1990).
2. Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition, John Wiley, (1998).

Reference Books:

1. Daizo Kunii & Octave Levenspiel, "Fluidization Engineering" 2nd Edition, Elsevier (India Print 2005)
2. Coulson and Richardson's Chemical Engineering Volume 3 - Chemical and Biochemical Reactors and Process Control (3rd Edition)

NCH602: CHEMICAL TECHNOLOGY II (3:1:0)

Study of following chemical industries with reference to process technology, availability of raw materials, preparation of flow sheet, production trends and future prospects, pollution and major engineering problems:

UNIT 1
Pulp and paper industry: Different pulping process; Recovery of chemicals from cooking liquors; Paper making; Role of additives.
Oil, fats and waxes industry: Physical and chemical properties of oils and fats; Interesterification, transesterification and randomisation; Winning of oils and fats from vegetables and animal source; Refining; Vanaspati, margarine etc.; Waxes; Soaps.

UNIT 2
Food and food by-product industry: Sugar, glucose, fructose, starch; Food processing and preservation; Food by- products.
Wood and wood chemicals industry: Composite wood, plywood etc.; Manufacture of oleoresin, turpentine, menthol, rosin, and tall oil; Ethanol production; Essential oils, perfumes, flavours and cosmetics.

UNIT 3
Leather industry: Skin and hides; Tanning processes; Leather making; Embossing; Leather chemicals.
Petrochemical and synthetic chemical industries: Petrochemicals derived from C_1 to C_4 chemicals; BTX; Separation of xylenes.

UNIT 4
Surface coating industries: Types of surface coating; Paints, varnishes, distempers and enamels.
Dyes and dye intermediates industry: Classification of dyes; Dye and dye intermediates; Production of some important dyes, lacquers and toners.

UNIT 5
Pharmaceutical industries: Classification of drugs; Drug production based on some selected unit processes.
Agrochemical industries: Manufacturing process of some important pesticides, insecticides, fungicides, fumigants, plant growth regulators, yield stimulators and herbicides.

Text Books:

1. Austin, G. T., “Shreve’s Chemical Process Industries”, McGraw-Hill Book Co.
2. Dryden, C. E., “Outlines of Chemical Technology”, Affiliated East-West Press.

Reference Book:

1. “Chemtech” Volume I - IV, Chemical Engineering Education Development Centre, I.I.T., Madras.

NCH603: PROCESS DYNAMICS AND CONTROL (3:1:0)

UNIT 1

Dynamic modeling of first and second-order process; Interacting and non-interacting processes; Nonlinear and integrating processes; introduction to non-minimum phase processes; Distributed parameter processes and MIMO processes; Response of first and second order processes with respect to different types of forcing functions.

UNIT 2

Experimental estimation of dynamic process parameters and identification.

Modes of control action: Classification of controllers and control strategy.

UNIT 3

Closed loop feedback control: Servo and regulator problems; Offset; Selection of mode of control action; Closed loop response;

UNIT 4

Routh stability criterion; Controller tuning and design:, Online tuning- closed loop and open loop methods.

Frequency response technique: Phase margin and gain margin; Bode stability criterion; Nyquist stability criterion; Controller design.

Root locus plot and stability analysis.

UNIT 5

Cascade and feed forward control: Design of controller and analysis of control system.

Ratio, Adaptive, Model-based, Multivariable, Selective and Split range control.

Computer process control

Text Book:

1. Coughnaowr, D. R., "Process Systems Analysis and Control", McGraw-Hill, Inc.
2. Stephanopolous, G., "Chemical Process Control", Prentice-Hall.

Reference Books:

1. Seborg, D. E., Edgar, T., and Mellichamp, D. A., "Process Dynamics and Control", John Wiley and Sons.
2. Bequette, B. W., "Process Control: Modeling, Design, and Simulation", Prentice-Hall, Inc.
3. Chidambaram, M., "Computer Control of Processes" Narosa Publishing House Pvt. Ltd., India

NCH604: PROCESS INSTRUMENTATION (2:1:0)

UNIT 1

Introduction to process variables; Static and dynamic characteristics of instruments and their general classification.

Elements of measuring system and their functions; Signal transmission; Transmitters - Electronic, pneumatic, transducers.

UNIT 2

Principles, construction and operations of instruments for the measurement, transmission, control/ indication/ recording of various process variables such as temperature, pressure, flow, liquid level, humidity and composition.

UNIT 3

Principles and construction of electro-pneumatic transducer, pneumatic to electrical converter, multiplexers.

Construction and characteristics of final control elements such as pneumatic control valve, stepper motor, motorized valve.

UNIT 4

Principles and construction of pneumatic and electronic controller.

Introduction to data acquisition system and intelligent instruments.

UNIT 5

Process instrumentation diagrams and symbols: Instrumentation of process equipments such as distillation columns, heat exchangers, condenser, absorber, stripper, humidifier, evaporator and drier.

Text Books:

1. Patranabis, D, "Principles of Industrial Instrumentation", Tata McGraw-Hill Publishing Co. Ltd.
2. Johnson, C. D., "Process Control Instrumentation Technology", Pearson Education, Inc.

Reference Books:

1. Beckwith, T. G., Marangoni, R. D. and Lienhard, J. H., "Mechanical Measurements", Addison Wesley.
2. Jain, R. K., "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi

NCH651: CHEMICAL REACTION ENGINEERING LAB – II (0:0:3)

1. Study and operation Trickle bed reactor
2. Study and operation Condensation polymerization reactor
3. Study and operation Emulsion polymerization reactor
4. RTD study in a CSTR
5. RTD study in a plug flow reactor
6. Study and operation of a coiled tubular reactor
7. Study of heterogeneous catalytic reactor
8. Determination of porosity and pore volume of a substance. (kieselguhr, alkaline earth or alumina may be used as substance)
10. To study toluene hydrogenation over Raney nickel catalyst
11. To study acetaldehyde decomposition over copper gauze catalyst

NCH652: CAD AND SIMULATION LAB (0:0:2)

1. Study of dynamic behavior of simple systems like tank in series, double effect evaporators, etc.
2. Design of simple flow network consisting of fittings and piping
3. Design of complex flow network consisting of fittings, pumps and (horizontal, vertical & inclined) piping
4. Design of CSTR reactor without heat transfer
5. Design of CSTR reactor with heat transfer
6. Working out VLE data for a multicomponent mixture
7. Design of multicomponent distillation column (Fenske- Underwood- Gilliland approach)
8. Design of TEMA type shell and tube heat exchanger (no phase change)
9. Design of TEMA type shell and tube heat exchanger (with phase change)
10. Steady state flowsheeting of a specific process
11. Dynamic simulation of simple process systems with controllers

Recommended to be done using a process design and simulation softwares like
Aspen plus/ Hysis/ Pro II/ design II, etc.

NCH653: PROCESS DYNAMICS AND CONTROL LAB (0:0:2)

1. Transient response to single tank system with storage & Flow to (a) step change (b) impulse change in put.
2. Transient response of non-interacting system in series.
3. Transient response of interacting system in series.
4. Study the operation of ON-OFF electronic temperature controller & determination of its performance to control the temperature of a system having capacity to store thermal energy.
5. Study the principle of operation & working of pneumatic servo system with various input functions.
6. Transient response of a CSTR System to step change.
7. Controlling a batch reactor using digital PID controller.
8. Study the dynamics of parallel & counter flow shell & tube heat exchanger.
9. Controlling of Parallel Flow & counter flow STHE using digital PI controller to have desired output.
10. Dynamics characteristics of mercury & water manometers.
11. Study of control value characteristics.
12. Study the performance of cascade control system & to maintain desired level in a tank, with flow.
13. Study the dynamics of bubble cap distillation column.
14. Control of a bubble cap distillation column using digital PID controller.
15. Study of effect of PID controller on pressure process trainer.
16 Calibration of thermocouple/Bimetallic thermocouple/Resistance thermocouple.
17. Calibration of Pressure gauge/ Pnuematic pressure recorder/ Differential pressure recorder.
18. Calibration of Orificemeter/Venturimeter /Rotameter/ Gas flow meter.
19. Estimation of viscosity by Redwood/Saybolt/Ostwald viscometer.
20. Calibration of pH meter.
21. Calibration of conductivity meter.

NCH654: SEMINAR (0:0:3)

The students are required to submit and present a dissertation report on the innovative topics of technical or industrial importance.

ELECTIVE – I

1. NCH011: COMPUTATIONAL FLUID DYNAMICS (3:1:0)

UNIT 1

Basic Concepts of Fluid Flow: Philosophy of computational fluid dynamics, conservation principles of mass, energy, and momentum, simplified flow models such as incompressible, inviscid, potential and creeping flows, classification of flows.

UNIT 2

Turbulence and its Modelling: Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model, The k-e model, Reynolds stress equation models, Algebraic stress equation models.

UNIT 3

Grid Generation: Structured and unstructured grids, choice of grid, general transformation of equations, some modern developments in grid generation in solving the engineering problems.

Finite Difference Method: Discretization of ordinary and partial differential equations, approximation of first, second and mixed derivatives, implementation of boundary conditions, discretization errors, applications to the engineering problems.

UNIT 4

Finite Volume Method: Discretisation methods, approximations of surface integrals and volume integrals, interpolation and differentiation practices, implementation of boundary conditions, applications to the engineering problems. Introduction, one-dimensional steady state diffusion, two-dimensional diffusion problems, three-dimensional diffusion problems. The Finite Volume Method for Unsteady Flows and Implementation of Boundary Conditions: On e-dimensional unsteady heat conduction .

UNIT 5

Special Topics: Flow in a sudden pipe contraction / expansion, flow and heat transfer in a complex tubes and channels, reactive flow, multiphase flow, and turbulent flow processes.

Books:

1. Sengupta T. K., "Fundamentals of Computational Fluid Dynamics", University Press. 2013
2. Anderson Jr J. D., "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill. 1995
3. Muralidhar K. and Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House. 2003
4. H. K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics: the finite volume method, Longman scientific & technical publishers, 2007
5. Ferziger J. H. and Peric M., "Computational Methods for Fluid Dynamics", 3rd Ed., Springer. 2002
6. Ranade V. V, "Computation Flow Modeling for Chemical Reactor Engineering", Academic Press. 2002

2. NCH012: STATISTICAL DESIGN OF EXPERIMENTS (3:1:0)

UNIT 1

Introduction: Strategy of experimentation, basic principles, guidelines for designing experiments;

Simple Comparative Experiments: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means, randomized and paired comparison design.

Experiments with Single Factor: Analysis of variance, Covariance and analysis of covariance, analysis of fixed effects model, model adequacy analysis, non-parametric methods.

UNIT 2

Design of Experiments: Fundamental and types of Design of Experiment, Randomized blocks, latin squares, and related design, factorial design, two-factor factorial design, blocking in a factorial design, the 2^2 & 2^3 factorial design, the general 2^k factorial design, blocking and compounding in the 2^k factorial design, two-level, three level and mixed level factorial and fractional factorial designs.

UNIT 3

Parameter Estimation: Linear regression models, estimation of the parameters in linear regression models, hypothesis testing in multiple regression, non-linear regression, logistic and weighted regression, Chi-squared tests, confidence intervals in multiple regression, prediction of new response observations, regression model diagnostics, testing for lack of fit.

UNIT 4

Response Surface Methods: Central composite and Box-Behnken designs, method of steepest ascent, analysis of a second-order response surface, experimental designs for fitting response surfaces, mixture experiments, Simultaneous optimization of several responses, Simplex method, evolutionary operation, robust design.

UNIT 5

Experiments with Random Factors: Random effect model, two factor factorial with random factors, two-factor mixed model, sample size determination with random effects, approximate F tests.

Design and Analysis: Nested and split-plot design, non-normal responses and transformations, unbalanced data in a factorial design.

Books:

1. Lazic Z. R., "Design of Experiments in Chemical Engineering: A Practical Guide", Wiley, 2005.
2. Antony J.," Design of Experiments for Engineers and Scientists," Butterworth Heinemann, 2004,
3. Montgomery D. C., "Design and Analysis of Experiments", 5th Ed., Wiley, 2004.

3. NCH013: PROCESS FLOW SHEET SIMULATION (3:1:0)

UNIT 1

Introduction to Process Simulation: Background and history of process simulation; Steady State and Dynamic Simulation; Different approaches to process simulation; modules and components in a process simulation package, integration of simulation tools, structure and functionality of commercial simulation tools, selection of flowsheet and simulation software.

Process Flow sheeting: Approaches to flowsheeting, collection and estimation of thermo-physical properties for the chemical species of the system, thermo-physical properties banks, Flow sheet presentation, manual flow sheet calculations, computer aided flow-sheeting, manual calculations with recycle streams, partitioning and tearing a flowsheet.

UNIT 2

Fundamentals of systems engineering: system definition, system properties, aggregation/decomposition, hierarchies of systems; introduction of canonical modeling concepts: devices, connections, equations, variables; formalizing the modeling process: methods of structuring complex chemical processes, procedures for process modeling; degrees of freedom in a flow sheet. numerical properties of the model equations, numerical methods for steady-state and dynamic systems, Differential Algebraic Equations; Synthesis of reaction systems and synthesis of azeotropic separation systems.

UNIT 3

Processing Simulation with software's such as : ASPEN PLUS/Hysis/PRO II/Design II/UniSim/OLI Pro/Aspen Custom Modeler/TK-Solve r: Introduction to the Simulation Package; Features of simulation packages; Introduction to the simulation package Graphical User Interface; Example-1: Flashing of Light Hydrocarbons; Survey of unit operation models; Example-2: Vinyl chloride monomer (VCM) flowsheet.

UNIT 4

Flowsheet Calculations and Model Analysis Tools: Sensitivity and case-study runs; Design specifications and calculator blocks; Example-3: VCM flowsheet sensitivity run / design-spec run. Inorganic chemicals and electrolyte modeling; Example-4: sour water systems (CO_2 and H_2S removal for example)

UNIT 5

Physical Properties: Overview of physical property system; Property model specifications; Property data requirements and input; Physical property analysis; Example-1: Introducing a non-databank component. Multistage Separation: RADFRAC: Rigorous rating and design fractionation model; Example-2: Using RADFRAC in the VCM flowsheet. Introduction to ICARUS (an economic evaluation package inside ASPEN PLUS), Flowsheet Convergence: Example-3: VCM flowsheet convergence, Introduction to overall Plant automation through simulation, molecular modeling and how it will compliment standard simulators and dynamic simulation.

Case Study: Design and simulation of some of the inorganic and organic process plants such as sulphuric acid, ammonia.

Books and Resources:

1. Dimian A. C., "Integrated Design and Simulation of Chemical Processes", Elsevier, 2003
2. Westerberg, A. W., Hutchison, H. P., Motard, R. L. & Winter, P., "Process Flowsheeting", Cambridge University Press,1979.
3. Kumar, A., "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill, 1981.
4. K. M. Hangos and I. T. Cameron, "Process Modelling and Model Analysis", Academic Press, 2001
5. W. F. Ramirez, "Computational Methods for Process Simulation", 2nd ed., Butterworths, 1997
6. A.W. Westerberg, et al, "Process Flow Sheeting", Cambridge University Press, 1990

Resources:

- SCILAB, available at http://www.scilab.org, is an open-source simulation package, quite similar to MATLAB.
- Netlib online repository for numerical and scientific computing: http://www.netlib.org/
- Numerical Recipes: The art of scientific computing website: http://www.nr.com/

- CANTERA, Object-Oriented Software for Reacting Flows: http://www.cantera.org/
- Practice problems: http://www.che.eng.kmutt.ac.th/cheps/ChE656.htm

4. NCH014: PROCESS INTEGRATION (3:1:0)

UNIT 1
Process Integration and its Building Blocks: Definition of Process Integration (PI), Areas of application and Techniques available for Process Integration, Role of thermodynamic laws.

UNIT 2
Basic Elements of Pinch Technology: Data extraction, Targeting, Designing,Grid diagram, Composite curve, Problem table algorithm, Grand composite curve.

UNIT 3
Targeting of Heat Exchanger Network (HEN): Energy targeting, Area targeting, Number of units targeting, Shell targeting, cost targeting.

UNIT 4
Designing of HEN: Pinch design methods, Heuristic rules, Stream splitting, Design of maximum energy recovery (MER), Design of multiple utilities and pinches.

UNIT 5
Heat Integration of Equipments: Heat engine, Heat pump, Distillation column, Reactor, Evaporator, Drier, Refrigeration systems.

Books:

1. Linnhoff, B. Townsend D.W., Boland D., Hewitt G.F., Thomas, B.E.A., Guy, A. R. and Marsland, R. H., "A User's guide on process integration for the efficient use of energy", Inst. of Chemical Engineers, London (1982).
2. V. Uday Sheno, Heat Exchanger network synthesis, Gulf Publishing Co, USA, 1995
3. James M. Douglas Conceptual Design of Chemical Process, McGraw Hill, New York, 1988.
4. Smith, R., "Chemical Process Design", McGraw Hill (1995).

5. NCH015: PIPING DESIGN (3:1:0)

UNIT 1

Analysis of pipe flow: Energy losses in pipe lines, concept of equivalent length and equivalent pipes, problems in pipe flow, hydraulic power transmission through a pipe line.

UNIT 2

Negative pressure in pipe lines, Siphon, Multiple pipe systems, working pressure, design pressure, choice of pipe materials, hydraulic analysis of complex pipe networks.

UNIT 3

Aids in selecting pipe valves and fittings, standards for piping design, Dimensional and mechanical standards for pipe valves and fittings.

UNIT 4

Process piping arrangement

plant layout and equipment arrangement, criteria for equipment layout, piping layout and arrangement.

UNIT 5

Pipe fabrication, vibration, its prevention and control in piping systems.

Books:

1. King, R. C. and Croker, S., "Piping Handbook", McGraw Hill.
2. Kellogg, M. W Company., "Design of Piping Systems", Pullman Power Products, New York (1976).