SHIV NADAR UNIVERSITY

School of Engineering

Department of Chemical Engineering

Post Graduate Degree Course in Chemical Engineering is offered to the Graduates in Engineering, for awarding Master's Degree in Chemical Engineering from Shiv Nadar University(SNU), Gr. Noida. The course shall extent over a period of 24 months consisting of 4 semesters. M.Tech. Program at SNU is mainly designed to provide specialized knowledge so that students can meet the demand of the industry. It also enable students to fit the need of academia as well. The students go through an enriching curriculum that offers them a well-balanced mix of coursework and research based project. The main emphasis in the first two semesters is course work and remaining two semesters is dedicated to research project. The courses are classified as core and electives. The Department elective courses are decided by the student in consultation with his/her project supervisor. These are intended to equip the student with necessary background for carrying out the research project in the second half of the program. Research project spread over two semester trains the student in doing research in any area of chemical engineering.

M.Tech. Syllabus (2018-2020)

A) Core Courses

1. Advance Reaction Engineering
2. Advance Transport Phenomena
3. Advance Thermodynamics
4. Advanced separation Processes
5. Advanced Process Control

B) Elective Courses

6. Colloids and Interfacial Engineering
7. Rheology of Complex Fluids
8. Polymer Dynamics
9. Computational Fluid Dynamics
10. Finite element method for engineers
11. Environmental engg. and waste management
12. Chemical engineering process design and integration

Credit Requirement

Core Courses = 16

Electives = 15

Projects = 49

Total = 49

First Semester

S.No.	Year	Course Code	Course Name	Credits
1	1st (1st sem)	CHD 611	Advanced Thermodynamics	3
2	1st (1st sem)	CHD 612	Advanced Reaction Engineering	3
3	1st (1st sem)		Elective 1	3
4	1st (1st sem)	CHD614	Elective 2	3
	Total			12

Second semester

S.no	Year	Course Code	Course Name	Credits
1	1st (2nd sem)	CHD 621	Advanced Process Control	4
2	1st (2nd sem)	CHD 622	Advanced Transport Phenomenon	3(2+1)
3	1st (2nd sem)	CHD 623	Advanced separation process	3
4	1st (2nd sem)	CHD	Elective-3 (Microfluidics)	3
	Total			13

Third semester

S.no	Year	Course Code	Course Name	Credits
1	2nd (3rd sem)	CHD	Elective - 5	3
2	2nd (3rd sem)	CHD	Elective - 6	3
3	2nd (3rd sem)	CHD 701	Project – Phase 1	6
	Total			12

Fourth semester

S.no	Year	Course Code	Course Name	Credits
5	2nd (4th sem)	CHD 702	Project – Phase 2	12

Course content

Advanced Chemical Engineering Thermodynamics

Introduction:The central problems of thermodynamics; system of units; pressure, temperature and equilibrium state; heat, work and the conservation of energy; intensive and extensive variables; equation of state.

Conservation of mass: General balance equation and conserved quantities; conservation of mass; the mass balance equations for a multicomponent system with chemical reaction.

Conservation of energy: Conservation of energy; examples of using the energy balance; the thermodynamic properties of matter; applications of the mass and energy balances; conservation of momentum;

Entropy: An additional balance equation, entropy; the entropy balance, reversibility and irreversibility; heat, work, engines and entropy; entropy changes of matter; applications of the entropy balance

The thermodynamic properties of real substances: Mathematical preliminaries, the evaluation of thermodynamic partial derivatives, the ideal gas and absolute temperature scales, the evaluation of changes in the thermodynamic properties of real substances accompanying a change of state; the principle of corresponding states, generalized equations of state, the third law of thermodynamics, estimation methods for critical and other properties

Equilibrium and stability in one-component systems: The criteria for equilibrium; stability of thermodynamic systems; phase equilibria; application of the equilibrium and stability criteria to the equation of state; the molar Gibb's energy and fugacity of a pure component; the calculation of pure fluid-phase equilibrium; the computation of vapor-pressure from an equation of slate; specification of the equilibrium thermodynamic state of a system of several phases; the Gibb's phase rule for a one-component system; thermodynamic properties of phase transitions.

Equilibrium and stability in multicomponent mixtures: The thermodynamic description of mixtures, the partial molar Gibb's energy and the generalized Gibb's-Duhem equation, notations for chemical reactions, the equations of change for a multicomponent system, the heat of reaction and a convention for the thermodynamic properties of reacting mixtures, criteria phase equilibrium in multicomponent systems; criteria of phase equilibrium in multicomponent systems; criteria for chemical equilibrium, and combined chemical and phase equilibria; specification of equilibrium thermodynamic state of a multicomponent, multiphase system; the Gibb's phase rule.

The estimation of the Gibb's free energy and fugacity of a component in a mixture: The ideal gas mixture; the partial molar Gibb's energy and fugacity; ideal mixture and excess mixture properties; fugacity of species in gaseous, liquid. And solid mixtures; several correlative liquid mixture activity coefficient models; two predictive activity coefficient models; combined equation of state and excess Gibb's free energy model.

Advanced reaction engineering

Kinetics Of Heterogeneous Reactions: Catalytic Reactions, Rate controlling steps, Langmuir - Hinshelwood model, Rideal - Eiley Mechanism, Steady State approximation, Noncatalytic fluid - solid reactions, Shrinking and unreacted core model.

Population Balance Models: Mixing concepts, Residence Time Distribution, Response measurements, Segregated flow model, Dispersion model, Series of stirred tanks model, Recycle reactor model, Analysis of non-ideal reactors.

External Diffusion Effects In Heterogeneous Reactions: Mass and heat Transfer coefficients in packed beds, Quantitative treatment of external transport effects, Modeling diffusion with and without reaction.

Internal Transport Processes In Porous Catalysts: Intra pellet mass and heat transfer, Evaluation of effectiveness factor, mass and heat transfer with reaction.

Design Of Heterogeneous Catalytic Reactors: Isothermal and adiabatic fixed bed reactors, Non-isothermal and non-adiabatic fixed bed reactors. Introduction to multiphase reactor design, Two phase fluidized bed model, slurry reactor model, Trickle bed reactor model.

Introduction to multiphase reactor design: Two phase fluidized bed model, slurry reactor model, Trickle bed reactor model. Photocatalytic reactor, Sonochemical reactors.

References:

Smith J.M. - " Chemical Engineering Kinetics ", McGraw-Hill, 1981.

Fogler H.S - " Elements of Chemical Reaction Engineering ", Prentice - Hall 1986.

Advance transport phenomenon

Momentum Transport: Viscosity and the Mechanisms of Momentum Transport, Shell Momentum Balances and Velocity, The Equations of Change for Isothermal Systems, Velocity Distributions with More than One Independent Variable, Velocity Distributions in Turbulent Flow, Integral Averaging in Momentum Transfer, Integral Balances

Energy Transport: Thermal Conductivity and the Mechanisms of Energy Transport, Shell Energy Balances and Temperature Distributions in Solids and Laminar Flow, The Equations of Change for Nonisothermal Systems, Temperature Distributions with More than One Independent Variable, Temperature Distributions in Turbulent Flow, Integral Averaging in Energy Transfer

Mass Transport: Diffusivity and the Mechanisms of Mass Transport, Concentration Distributions in Solids and Laminar Flow, Shell Mass Balances; Boundary Conditions, Equations of Change for Multicomponent .Systems, Concentration Distributions with More than One Independent Variable, Time-Dependent Diffusion, Integral Averaging in Mass Transfer7. Problem-Solving Techniques, Aids, Philosophy.

References:

William M. Deen, Analysis of Transport Phenomena (Topics in Chemical Engineering) 2nd Edition, Oxford University Press
R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, Transport Phenomena, John Wiley & Sons

Advanced Process Control

Revision of fundamentals: Laplace transforms, SISO transfer functions, Frequency domain stability analysis, Design of PID controllers

Development of control relevant linear perturbation models: Linearization of mechanistic models , Introduction to z-transforms, Development of grey-box models

Development of linear black-box dynamic models: Stability analysis, output error models, Stochastic processes, ARX/ ARMAX models

Stability analysis, interaction analysis & multi-loop control, State estimation and Kalman filtering, Linear quadratic optimal control & model predictive control, Pole placement technique

References:

Astrom, K.J.; & B. Wittenmark – Computer Controlled Systems

Franklin, G.F.; Powell, J.D.; & Workman, M.L.– Digital Control Systems

Seborg, D.E.; Edgar, T.F.; & Mellichamp, D.A.– Process Dynamics and Control

Goodwin, G.C.; Graebe, S.F.; & Salgado, M.E. – Control System Design

Advanced separation process

Reveiw of conventional processes, Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and equipment used in cross flow filtration, cross flow electro filtration, dual functional filter, Surface based solid - liquid separations involving a second liquid, Sirofloc filter.

Membrane Separation: Types and choice of membranes, Plate and frame, tubular, spiral wound and hollow fiber membrane reactors and their relative merits, Commercial, pilot plant and laboratory membranes permeators involving dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis, Economics of membrane operations, Ceramic membranes.

Separation By Adsorption Techniques: Mechanism, Types and choice of adsorbents, Normal adsorption techniques, Affinity chromatography and immuno chromatography. Types of equipment and commercial processes, Recent advances and process economics.

Ionic Separations: Controlling factors, Applications, Types of equipment employed for electrophoresis, Di-electrophoresis, Ion exchange chromatography and electro dialysis, Commercial Processes.

Other Techniques: Separations involving Iyophilisation, Prevaporation and permeation techniques for solids, liquids and gases. Industrial viability and examples, Zone melting, Addluctive crystallization, Other separation process, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques.

References:

Lacey, R.E. and S.Loaeb - " Industrial Processing with Membranes ", Wiley -Inter Science, New York, 1972.

King, C.J. " Separation Processes ", Tata McGraw - Hill Publishing Co., Ltd., 1982.

Schoew, H.M. - " New Chemical Engineering Separation Techniques ", Interscience Publishers, 1972.

Ronald W.Roussel - " Handbook of Separation Process Technology ", John Wiley, New York, 1987.

5. Kestory, R.E. - " Synthetic polymeric membrances ", Wiley, New York, 1987.