JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

ANANTHAPURAMU

Course Structure and Syllabi for Pre Ph.D Programme

CHEMICAL ENGINEERING

PART - I

Choose any **one** subject from the following list

S.No.	Subject	Course code
1	Mathematical Methods in Chemical Engineering	17PH08101
2	Advanced Reaction Engineering	17PH08102
3	Process Modeling and Simulation	17PH08103
4	Advanced Transport Phenomena	17PH08104
5	Pollution Control in Process Industries	17PH08105

PART –II

Choose any **one** subject from the following list

S.No.	Subject	Course code
1	Advanced Biochemical Engineering	17PH08201
2	Enzyme and Microbial Technology	17PH08202
3	Advanced Heat Transfer	17PH08203
4	Advanced Mass Transfer	17PH08204
5	Rheology of Complex Fluids	17PH08205
6	Sustainable Energy Sources	17PH08206
7	Membrane Technology	17PH08207
8	Optimization Techniques	17PH08208
9	Instrumental Methods of Analysis	17PH08209
10	Fluidization Engineering	17PH08210
11	Nanotechnology	17PH08211
12	Colloidal and Interfacial Science	17PH08212
13	Advanced Process Control	17PH08213
14	Process Intensification	17PH08214
15	Safety and Risk Analysis in Process Industries	17PH08215

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08101) MATHEMATICAL METHODS IN CHEMICAL ENGINEERING

UNIT-I

Modeling and study of systems in Chemical Engineering leading to systems algebraic, of ordinary differential and partial equations (both linear and non-linear systems). Methods of solution of systems of linear & nonlinear algebraic equations: Gauss elimination, LU decomposition, single and multi-variable Newton-Raphson.

Linear homogeneous ordinary differential equations and linear non-homogeneous ordinary differential equations observed in systems of interest to chemical engineers by Runge-Kutta methods.

UNIT-II

Methods of solution of linear and non-linear finite difference equations, solution of differential – difference equations.

Numerical solution to partial differential equations by relaxation method, finite – difference method, introduction to finite element method and application to problems of interest in chemical engineering.

UNIT-III

Basic statistical concepts: Probability distributions, sampling and sampling distributions; Inferences about the differences in Means.

Randomized Designs: Hypothesis Testing – t-test, use of P-values; Confidence intervals, Inferences about the difference in means, paired comparison designs, inferences about the variances of normal distributions F-test

UNIT-IV

Analysis of variance: one-way and two way Analysis. Analysis of fixed effects model – Decomposition of the total sum of squares, statistical analysis. Factorial Experiments: Definitions, Interpretation of main effects and interactions, design with factors at two levels – Calculation of effects and Analysis of variance – Model adequacy testing, Estimating model parameters Analysis of 2^K factional design in detail.

UNIT-V

Regression Models: Linear Regression Models, Estimation of parameters, Multiple regression, Hypothesis Testing in multiple regression, confidence intervals in multiple regression. Response Surface Methodology: Introduction, Method of Steepest Ascent, Analysis of a second order response

References:

1. Mathematical Methods in Chemical Engineering by Jenson and Jeffereys, Academic press, 1963.
2. Design and Analysis of Experiments, 5th edition, by Douglas C. Montgomery, John Wiley and Sons, 2004.
3. Mathematical Methods in Chemical Engineering by S. Pushpavanam, Prentice Hall of India, New Delhi.
4. Probability and Statistics in Engineering and Management by W.L. Hines and D.C. Montgomery, John Wiley and Sons, 1980.
5. Design and Analysis of Industrial Experiments, 2nd Edition, Ed. Oven L. Davies Longman group, 1978.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08102) ADVANCED REACTION ENGINEERING

UNIT-I

Non-Ideal flow: Two- parameter models- Modeling real reactors with combination of ideal reactors, testing a model and determining its parameters.

Mixing of fluids: Zero parameter models, segregation model, and maximum mixedness.

UNIT-II

Fluid-Particle reactions: Application to design- Various types of contacting in gas- solid operations; Development of performance equation for frequently met contacting pattern assuming uniform gas composition, application to a fluidized bed with entrainment of solid fines.

UNIT-III

Fluid-Fluid Reactions: Applications to design- Towers for fast reaction; Towers for slow reaction, Mixer- settlers (Mixed flow of both phases), semi- batch contacting patterns, Reactive distillation and extractive reactions.

UNIT-IV

Catalysis and catalytic reactors: Design of reactors for gas- solid reactions. Heterogeneous data analysis for reactor design, catalytic deactivation moving bed reactors, fluidized bed reactors.

UNIT-V

External diffusion effects on heterogeneous reactions- External resistance to mass transfer. Diffusion and reaction in porous catalysts- Diffusion and reaction in spherical Catalyst pellets, internal effectiveness factor, Falsified kinetics, Overall effectiveness factor, Estimation of diffusion and reaction limited regions, Mass transfer and reaction in a packed bed.

References:

1. Elements of Chemical Reaction Engineering, 2nd Edition, Fogler, H.S, Prentice Hall, New Jersey, 1992.
2. Chemical Reaction Engineering, 3rd Edition, Octave Levenspiel, Wiley Eastern University, New Delhi, 1998.
3. Chemical Engineering Kinetics, Smith J.M, McGraw Hill, 3rd Edition, 1981.
4. The Engineering of Chemical Reactions, L. D. Schmidt, Oxford University Press, USA, 2nd edition, 2004.
5. Chemical Reaction Engineering and Reactor Technology, T.O. Salmi, J.P. Mikkola, J.P. Warna, CRC Press, 2010.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08103) PROCESS MODELING AND SIMULATION

UNIT-I

Mathematical models for chemical engineering systems: Principles of Modeling, fundamentals, introduction to fundamental laws: Total Continuity Equation, Equation of Energy, Equation of Motion, Transport laws.

UNIT-II

Classification of mathematical modeling, static and dynamic models, the complete mathematical model, Boundary conditions, the black box principle. Artificial Neural Networks: Network training, Models of training, Network architecture, Back-propagation algorithm, ANN applications.

UNIT-III

Models for chemical reaction with diffusion in a tubular reactor, chemical reaction with heat transfer in a packed bed reactor, gas absorption accompanied by chemical reaction.

UNIT-IV

Models in Heat Transfer Operations: Steady state heat conduction through a hollow cylindrical pipe, unsteady state steam heating of a liquid, heat transfer in a thermometer system, unsteady state heat transfer by conduction.

UNIT-V

Introduction to Process Plant Simulation, various Approaches to Plant Simulation, Steady State Sequential Modular Simulation Techniques. Equation Oriented Simulation Techniques, Simultaneous Modular Simulation Techniques.

References:

1. Process Modeling, Simulation and Control for Chemical Engineers, by William Luyben, McGraw Hill, New York, 1990.
2. Process Plant Simulation by B.V. Babu, Oxford University Press, 2004.
3. Numerical Methods for Engineers by S.K. Gupta, New Age International Publications, 2015.
4. Mathematical Methods in Chemical Engineering by S. Pushpavanam, PHI, 1998
5. Process Control Modeling, Design and Simulation by B. Wayne Bequette, Prentice Hall, 2003.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08104) ADVANCED TRANSPORT PHENOMENA

UNIT-I

Application of equation of change: Equation of change for isothermal systems – solution of steady state laminar flow problems – including the Newtonian and non- Newtonian Fluids.

UNIT-II

Equation of Change for non-isothermal system – Solution of steady state problems – Conduction, convection, problems with and without heat generation, limiting Nusselt Numbers for flow through pipes and slits.

Equation of change for multi-components – Summary of multi-component fluxes, use of equations of change for mixtures, Stefan-Maxwell equations, Solution of problem using stream functions.

UNIT-III

Unsteady State Problems: Unsteady state flow between two parallel plates, oscillating plates, unsteady state flow through a pipe heating of finite slab, cooling of a sphere in contact with well stirred fluid, unsteady state evaporation in a tube of infinite length, gas absorption with rapid chemical reaction.

UNIT-IV

Boundary layer studies**:** Flow near a wall suddenly set in motion, Flow near the leading edge of a plate, heat transfer in laminar forced convection along a heated plate, diffusion and chemical reaction in isothermal laminar flow along a soluble plate, steady state boundary layer theory for flow around objects.

UNIT-V

Turbulent flow: Time smoothed equations of change for incompressible fluids. Application of empirical expressions to solve turbulent flow problems with reference to momentum, energy and mass transport.

Note: Equations of change should be provided during the examinations or paper setter may give the appropriate equations.

References:

1. Transport Phenomena by R. B. Bird, W. E. Stewart and E. N. Lightfoot, Wiley International Edition, New York, 2002.
2. An Introduction to Fluid Dynamics by G.K. Batchelor, Cambridge University Press, Cambridge 1967.
3. Momentum, Energy and Mass Transfer in Continua, 2nd ed., by J.C. Slaterry, Krieger Publishing Company, New York, 1981.
4. Transport Processes and Unit Operations by Christie J. Geankoplis, PHI, 1993.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08105) POLLUTION CONTROL IN PROCESS INDUSTRIES

UNIT-I

Environment pollution and social issues of environment: Pollution & its types (Air, water, land, noise, thermal) causes, effects and control of these pollutions (case studies), role of man in prevention of pollution.

UNIT-II

Design of wastewater and industrial effluent treatment: Aerobic and anaerobic biological treatment processes. Design of activated sludge process.

Advanced wastewater treatment: R.O., Activated carbon, ultra filtration, ion exchange, UV-radiation for disinfection.

UNIT-III

Air Pollution and Management: Air pollution control methodologies, particulate emission control techniques like bag filter, electro static precipitator etc., air pollution control equipment, characteristics of air pollutants.

UNIT-IV

Pollution prevention: Pollution prevention and waste minimization; sustainable development; life cycle assessment, Noise pollution control measures.

Environmental Management: Environmental management system particularly ISO 14000 series. Successful case studies.

UNIT-V

Hazardous waste management: Solid waste disposal, Treatment, storage and disposal of hazardous waste, medical and pharmaceutical solid waste management.

References:

1. Pollution Control in Process Industries by S.P. Mahajan, McGraw-Hill Education, 2017.
2. Wastewater Engineering: Treatment & Reuse, 4th Edition, by Metcalf & Eddy, McGraw-Hill Education, 2005.
3. Waste Water Treatment, 3rd edition, by M. Narayana Rao and A. K. Datta, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi, 2008.
4. Air Pollution Control by P.Prathap Mouli and N.Venkata Subbayya, Divya Jyothi Prakashan, Jodhpur.
5. Environmental Pollution Control Engineering, 2nd edition, by Rao C. S., New Age International Publishers, 2006
6. Air Pollution Control Technology Handbook by Karl B. Schnelle Jr. & Charles A. Brown, CRC Press, 2001.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08201) ADVANCED BIOCHEMICAL ENGINEERING

UNIT-I

Microbial kinetics: unstructured batch growth models, growth of filamentous organisms; structured kinetic models, compartmental models, modeling cell growth as an optimum process, Thermal death kinetics of cells and spores.
Enzyme Kinetics: Enzyme immobilization, industrial processes, enzyme deactivation, mechanisms and manifestations of protein denaturation, strategies for enzyme stabilization.

UNIT-II

Reactor dynamics, dynamic models, stability; Reactors with non ideal mixing, mixing times in agitation tanks, residence time distributions, models for non-ideal reactors; immobilized biocatalysts, formulation and characterization of immobilized cell biocatalysts, applications of immobilized cell biocatalysts; packed bed reactors, bubble column bio reactors, fluidized bed bio reactors.

UNIT-III

Aeration and agitation in bioprocesses - mass transfer in cellular systems, bubble aeration, swarm of bubbles, aeration by mechanical means, power requirement in aeration, oxygen transfer coefficient and operating variables, bubble aeration and mechanical agitation.

UNIT-IV

Scale Up Operation: physical concept, biological concept, power to unit volume, volumetric oxygen transfer coefficient, and dynamic method.

UNIT-V

Molecular genetics - The process of gene expression, DNA replication and mutation, overview of information flow in the cell, Recombinant DNA technology, Enzymes for manipulating DNA.

References:

1. Biochemical Engineering Fundamentals, 2nd ed, by Bailey, J.E. and Ollis, D.F., McGraw Hill Education, 2017
2. Biochemical Engineering by Aiba, S., Humphrey, A.E, Academic Press, 1973.
3. Industrial Microbiology by Prescott, S.C.and Dunn, C.G., 4th edition CBS Publishers & Distributors, 2004
4. Bioprocess Engineering Principles, 2nd edition, Pauline M. Doran, Academic Press, 2012.
5. Biochemical Engineering, James M. Lee, PHI, 1st Ed, 1991.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08202) ENZYME AND MICROBIAL TECHNOLOGY

UNIT-I

Isolation, development and preservation of industrial microorganisms; substrates for industrial microbial processes.

Regulatory mechanisms of metabolic pathways in industrial strains.

UNIT-II

Analysis of various microbial processes used in production of biomass, primary and secondary metabolites.

UNIT-III

Microbial leaching of minerals, microorganisms in degradation of xenobiotics and removal of heavy metals, biotransformation.

UNIT-IV

Production, isolation, purification and application of industrial enzymes; immobilized enzymes.

UNIT-V

Stabilization of enzymes, Enzyme catalyzed organic synthesis, multi enzyme systems.

References:

1. A Practical Introduction to Structure, Mechanism and Data Analysis by Enzymes, Robert A. Copeland, Wiley-VCH, 2nd edition, 2000.
2. Enzyme Kinetics and Mechanism by Paul F. Cook, W.W. Cleland, Garland Science, 2007.
3. Molecular Biology and Biotechnology by J.M. Walker, R.Rapley, Royal Society of Chemistry; 4th edition, 2001.
4. Biochemical Engineering Fundamentals, 2nd ed, by Bailey, J.E. and Ollis, D.F., McGraw Hill Education, 2017
5. Bioprocess Engineering Basic Concepts by M. L. Shuler and F. Kargi, Prentice Hall of India, 2002.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08203) ADVANCED HEAT TRANSFER

UNIT-I

Heat exchanger design: Function and configuration of heat exchangers, evaluation of the mean temperature difference in a heat exchanger, heat exchanger effectiveness, and heat exchanger design

UNIT-II

Analysis of heat conduction and some steady state one-dimensional problems: The well-posed problem, the general solution, dimensional analysis, an illustration of dimensional analysis in a complex steady state conduction problem, Steady state multidimensional heat conduction, Fin design.

UNIT-III

Transient heat conduction: Introduction, lumped- capacity solutions, Transient conduction in a one dimensional slab, temperature response charts, one term solutions, transient heat conduction to a semi-infinite region, Transient multidimensional heat conduction.

UNIT-IV

Heat transfer with phase transformation, film-type condensation of vapor over vertical surfaces and inclined tubes. Analysis of heat transfer equipment efficiency – Pinch analysis (Qualitative treatment only). Selection and design of equipment with phase transformation (Qualitative treatment only). Heat exchanger networks (Qualitative treatment only).

UNIT-V

Numerical method for convective heat transfer. Simultaneous solution of velocity and temperature fields. Solution on Complex geometries. Transport analogies.

References:

1. Fundamentals of Momentum, Heat And Mass Transfer, 5th edition, by, James Welty, Charles E. Wicks, Gregory L. Rorrer Robert E. Wilson, John Wiley & Sons, 2008.
2. Heat Transfer by J. Holman, McGraw-Hill Science, 9th edition, 2001.
3. Process Heat Transfer: Principles and Applications by R.W. Serth, Academic Press, 2007.
4. Systematic Methods of Chemical Process Design, by by Lorenz T. Biegler, Ignacio E. Grossman, Arthur W. Westerberg, 1st ed. PHI, 1997.
5. Process Heat Transfer by Donald Q. Kern, International Student Ed., McGraw Hill Inc. 1950.
6. Heat Exchanger Network Synthesis, by Udai V. Shenoy, Gulf Publishing.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08204) ADVANCED MASS TRANSFER

UNIT-I

Characteristics of separation processes, inherent separation factors for equilibrium processes and rate- Governed processes. Selection of separation processes- Factors influencing the choice of a separation process, case studies

UNIT-II

Capacity and efficiency of contacting devices. Energy requirements of separation processes. Patterns of change and computational approaches- Binary multistage separations, Multi component multistage separations

UNIT-III

Multi component distillation – Mass Transfer models, Binary distillation in tray columns, Multi component distillation tray column, Distillation in Packed column Multi component distillation – Non equilibrium models, solving the model equations, Design studies on depropanizer and extractive distillation

UNIT-IV

Adsorption, Ion Exchange and Chromatography: Adsorbents, Equilibrium considerations, pure gas adsorption, liquid adsorption, ion exchange equilibria, equilibria in chromatography, kinetic and transport considerations, external & internal transport, mass transfer in ion exchange and chromatography.

UNIT-V

Introduction to membrane separation processes, cryogenic distillation, super critical extraction, reactive separation.

References:

1. Separation Processes by C. Judson King, McGraw Hill, 1982.
2. Multicomponent Mass Transfer by R.Krishna and Ross Taylor, John Wiley & Sons, 1993.
3. Equilibrium Staged Separations by P.H. Wankat, Elsevier, 1988.
4. Transport Processes and Unit operations by C.J. Geankoplis, Prentice Hall, 3rd Ed, 1993
5. Separation Process Principles by J. Sieder and Henly, Wiley Publishers, 1998.
6. Mass Transfer Operations by Treybal, McGraw Hill publishers.
7. Unit Operations in Chemical Engineering, 7th ed., by Julian C. Smith, Warren L. McCabe and Peter Harriott, McGraw-Hill Education, 2014
8. Membrane Technology in the Chemical Industry, 2nd revised and enlarged edition, Edited by S.P.Nunes and K.V. Peinemann, Wiley-VCH, 2006.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08205) RHEOLOGY OF COMPLEX FLUIDS

UNIT-I

Introduction to rheology, viscosity: rheometry, constitutive equations, variation with shear rate, temperature, pressure. The shear-dependent viscosity of non Newtonian liquids: definition on Newtonian behaviour, the shear thinning non Newtonian liquid, the shear-thickening non Newtonian liquid.

UNIT-II

Linear viscoelasticity: introduction, the meaning and consequences of linearity, the Kelvin and Maxwell models, the relaxation spectrum, oscillatory shear, relationships between functions of linear viscoelasticity, methods of measurement: static methods, dynamic methods-oscillatory strain, steady flow.

UNIT-III

Extensional viscosity: introduction, importance of extensional of flow, theoretical considerations, experimental methods: general considerations, homogeneous stretching method, constant stress devices, some demonstrations of high extensional viscosity behavior.

UNIT-IV

Rheology of polymeric liquids: introduction, general behaviour, effect of temperature on polymer rheology, effect of molecular weight on polymer rheology, effect of concentration on the rheology of polymer solutions, empirical relations between rheological functions. Practical applications: polymer processing, polymers in engine lubricants, enhanced oil recovery, polymers as thickners of water-based products.

UNIT-V

Rheology of suspensions: introduction-the the general form of the viscosity curve for suspensions, summary of the forces acting on particles suspended in liquid, rest structures, flow induced structures. The viscosity of suspensions of solid particles in Newtonian liquids: dilute dispersed suspensions, maximum packing fraction, concentrated Newtonian suspensions, concentrated shear thinning suspensions, practical consequences of the effect of phase volume, shear thickening of concentrated suspensions.

References:

1. Engineering Rheology by R.I. Tanner, Oxford University Press, USA, 2nd edition, 2000.

2. An Introduction to Rheology by H.A.Barnes, J.F. Hutton, K.Walters, Elseveir, 1989.

3. Understanding Rheology by F.A. Morrison, Oxford University Press, USA, 2001.

2. The Rheology Handbook by Thomas G. Mezger, Vincentz Network, 4th Ed, 2014.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08206) SUSTAINABLE ENERGY SOURCES

UNIT I

Solar and Wind Energy: Solar radiation its measurements and prediction - solar thermal flat plate collectors concentrating collectors – applications - heating, cooling, desalination, power generation, drying, cooking etc - principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping, power generation schemes

Wind Energy: Atmospheric circulations – classification - factors influencing wind - wind shear – turbulence - wind speed monitoring - wind energy conversion devices - classification, characteristics, applications.

UNIT II

Bio-energy: Biomass resources and their classification - chemical constituents and physicochemical characteristics of biomass - Biomass conversion processes - Thermo chemical conversion: direct combustion, gasification, pyrolysis and liquefaction - biochemical conversion: anaerobic digestion, alcohol production from biomass - chemical conversion process: hydrolysis and hydrogenation. Biogas - generation - types of biogas Plants- applications

UNIT III

Hydrogen and Fuel cells: Thermodynamics and electrochemical principles - basic design, types, and applications - production methods - Biophotolysis: Hydrogen generation from algae biological pathways - Storage gaseous, cryogenic and metal hydride and transportation.

Fuel cell – principle of working- various types - construction and applications.

UNIT IV

Nuclear Energy: Nuclear radiation, nuclear reactions, nuclear fission and fusion. Nuclear chain reactions, criticality, nuclear reactor core design fundamentals, neutron moderation, nuclear reactor control. Nuclear fuel cycle, resource and resource distribution, mining, milling, enrichment, fuel element fabrication, fuel utilization, burn up. Types and features of different nuclear reactors, including current models, next-generation designs and advanced reactor concepts

UNIT V

Other Energy Sources: Ocean energy resources - principles of ocean thermal energy conversion systems - ocean thermal power plants - principles of ocean wave energy conversion and tidal energy conversion. Hydropower – site selection, construction, environmental issues. Geothermal energy - types of geothermal energy sites, site selection, and geothermal power plants.

References:

1. Renewable Energy Sources by Twidell, J.W. and Weir, A., 3rd Edn. T&F Ltd., 2015
2. Solar Energy by Sukhatme, S.P., Tata McGraw Hill, 1984.
3. Principles of Solar Engineering by Kreith, F and Kreider, J. F., McGraw-Hill, 1978.
4. Renewable Energy, Power for a Sustainable Future by Godfrey Boyle, Oxford University Press, U.K, 1996.
5. Alternative Energy Sources by Veziroglu, T.N., McGraw-Hill, Vol 5 and 6, 1990
6. Biochemical and Photosynthetic aspects of Energy Production by Anthony San Pietro, Academic Press, 1980.
7. Thermochemical processing of Biomass by Bridgurater, A.V., Academic Press, 1981.
8. Fuel Cells: Theory & Applications by Hart, A.B., and Womack, G. J., Prentice Hall, 1997.
9. Nuclear Energy, Charles D. Ferguson - Oxford University Press, 2011.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08207) MEMBRANE TECHNOLOGY

UNIT-I

Introduction: Separation processes, introduction to membrane processes, history, definition of a membrane, membrane processes.

Membrane Processes: Introduction, osmosis, Pressure driven membrane processes, concentration driven membrane processes, electrically driven processes, membrane reactors.

UNIT-II

Preparation of Synthetic Membranes: Introduction, preparation of synthetic membranes, phase inversion membranes, preparation technique for immersion precipitation, and preparation technique for composite membranes.

Characterization of Membranes: Introduction, membrane characterization, characterization of porous membranes, characterization of ionic membranes, characterization of non-porous membranes.

UNIT-III

Transport in Membranes: Introduction, driving forces, non-equilibrium thermodynamics, transport through porous, non-porous, and ion exchange membranes.

UNIT-IV

Polarization phenomenon and fouling: introduction, concentration polarization, turbulence promoters, pressure drop, gel layer model, osmotic pressure model, boundary layer resistance model, concentration polarization in diffusive membrane separations and electro dialysis, membrane fouling, methods to reduce fouling, compaction.

UNIT-V

Module and process design: Introduction, plate and frame model, spiral wound module, tubular module, capillary module, hollow fiber model, comparison of module configurations, Design problems.

References:

1. Membrane Technology in the Chemical Industry by S. P. Nunes, and K. V. Peinemann, Wiley-VCH.
2. Membrane Process by R. Rautanbach and R. Albrecht, John Wiley & Sons.
3. Perevoparation Membrane Separation Processes by R.Y.M. Huang, Elsevier.
4. Membrane Processes in Separation and Purification by Crespo, J.G., Böddeker, Karl W. (Eds.), Springer, 1994.
5. Membrane Separations by M.H.V. Mulder, Kluwer Publictions.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08208) OPTIMIZATION TECHNIQUES

UNIT I

Introduction to process optimization; formulation of various process optimization problems and their classification, Basic concepts of optimization-convex and concave functions, necessary and sufficient conditions for stationary points.

UNIT II

Single variable optimization methods: Bracketing methods, Exhaustive search method, Bounding phase method, Region elimination methods, Fibonacci search method, Golden section search method. Point-Estimation method: Successive quadratic estimation method.

UNIT III

Gradient-based methods: Newton- Raphson method, Bisection method, Secant method, quadratic search method, Cubic search method.

Multivariable Optimization Algorithms: Optimality criteria, Unidirectional search, direct search methods: Gradient-based methods: Cauchy's (steepest descent) method, Newton's method, conjugate gradient method

UNIT IV

Constrained Optimization Algorithms: Kuhn-Tucker conditions, Transformation methods: Penalty function method, method of multipliers, Sensitivity analysis,

Direct search for constraint minimization: Variable elimination method, complex search method, quadratic programming, Successive quadratic programming, optimization of staged and discrete processes.

UNIT V

Specialized & Non-traditional Algorithms: Integer Programming: Penalty function method. Non-traditional Optimization Algorithms: Genetic Algorithms: Working principles. differences between GAs and traditional methods, similarities between GAS and traditional methods, GAs for constrained optimization.

References:

1. Optimization of Chemical Processes by T.F.Edgar and D.M.Himmelblau, McGraw Hill,1989.
2. Optimization Theory and Practice by G.S. Beveridge and R.S. Schechter, Mc Graw Hill,1970
3. Engineering Optimization-Methods and Applications by Reklljtis, G.V., Ravindran, A., and Ragdell, K.M., John Wiley, New York, 1983.
4. Optimization for Engineering Design by Kalyanmoy Deb, Prentice Hail of India.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08209) INSTRUMENTAL METHODS OF ANALYSIS

UNIT-I

Chromatographic techniques-Afinity,adsorption,paper,thin layer chromatography- Column-Ion exchange-gel chromatography. Gas liquid chromatography-instrumentation,applications and High performance liquid chromatography-instrumentaton,applications.

UNIT-II

General principles – Radiation, energy and atomic structure- types of spectra and their biochemical usefulness – basic laws of light absorption. Electromagnetic radiation & Spectrum, Beer – Lambert's Law and apparent deviations; UV - VIS Spectrophotometer, Spectro fluorimetry, Atomic absorption & Atomic emission spectroscopy, Circular Dichroism (CD)-principles, instrumentation and applications.

UNIT-III

Infra-Red Spectroscopy. Mass spectroscopy-Introduction, analysis, applications in biology ESR principles - instrumentation-applications.

High resolution NMR –Chemical shift-Spin-spin coupling Frequency lock- double resonance-applications of proton NMR-quantitative analysis-qualitative analysis, application of NMR in biology and study of macromolecules

UNIT-IV

Principles, Instrumentation and applications of AFM, SEM and TEM

UNIT-V

Centrifugal dialysis, ultra filtration, electrophoresis and lyophilisation-principle, instrumentation and their applications. P^H Titrations, buffer preparations-action physiological buffers-determination of p^{ka} values - potentiometric titrations.

References:

1. Chemical Analysis: Modern Instrumentation Methods and Techniques by F.Rouessac, A.Rouessac, Wiley, 2nd edition, 2007.
2. Principles of Instrumental Analysis by D.A. Skoog, F. J. Holler, S.R. Crouch, Brooks Cole Publishers, 6th edition, 2006.
3. Instrumental Methods for Determining Elements: Selection and Applications by L.R. Taylor, R.B. Papp, B.D. Pollard, Wiley-VCH, 1994.
4. Instrumental Methods of Chemical Analysis by G. Chatwal, S. Anand, Himalaya Publishing House, Bombay.
5. Instrumental Methods of Chemical Analysis by B.K. Sharma, Goel Publishing House, Meerut.
6. Instrumental Methods Analysis by H. Willard, L. Merritt, J. Dean, F. Settle, CBS Publishers & Distributors, Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08210) FLUIDIZATION ENGINEERING

UNIT-I

Introduction: The phenomenon of fluidization; liquid like behavior of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds.

Industrial applications of fluidized beds: Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization.

UNIT-II

Fluidization and mapping of regimes: Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems; Voidage diagram; Mapping of regimes of fluidization.

UNIT-III

Bubbles in dense bed: Single rising bubbles; Davidson model for gas flow at bubbles; Evaluation of models for gas flow at bubbles. Bubbling Fluidized beds: Experimental findings; Estimation of bed porosities; Physical models: simple two phase model; K-L model.

UNIT-IV

Fluidized bed heat transfer: Modes of heat transfer, heat transfer in beds of particles, estimation of bed to surface heat transfer coefficients, heat transfer between bed, distributor, containing walls, immersed tubes.

UNIT-V

Design of simple fluidized beds, estimation of bed dimensions and fluidizing velocity, TDH.

Fluidized bed combustion: introduction, combustion systems for solid fuels, fluidized bed combustion of solid fuels, size of fluidized bed combustion systems, efficiency of fluidized bed combustion systems, combustion of particles in fluidized bed.

References:

1. Fluidization Engineering, D. Kuni**i** and O. Levenspiel, 2nd edition, Elsevier, 1991.
2. Fluidized Bed Technology: Principles & Applications by J.R. Howard, Bristol:Hilger, Cop. 1989.
3. Handbook of Fluidization and Fluid-Particle Systems by W.C.Yang, CRC Press, 2003.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08211) NANOTECHNOLOGY

UNIT-I

Introduction to Nanotechnology: Effects of Confinement & Finite size in 1D &2D nanostructures (Concepts of surface & interfacial energy). Inter-molecular forces in organic polymerics, Aqueous, Biological, van der Waals, Electro static, Double Layer Forces in Acid Phase and Acid base systems.

UNIT-II

Depletion interactions, Hydrophobic forces layering, Mesoscale thermodynamics of nano scale particles. Gibbs treatment of interfaces, Mesoscale fluid dynamics, Thin films.

UNIT-III

Nano fabrication, nucleation, patterning of soft materials by self-organizing. Chemical Self-Assembly.

UNIT-IV

Synthesis of nano particles using solgel, hydro thermal methods, freeze drying attrition, ion implantation, gas phase condensation and Chemical Vapor Deposition.

UNIT-V

Failure analysis, QA/QC in nanofab: Analysis and metrology techniques in nanotechnology, Imaging using SEM, SPM-AFM, TEM, X-Ray Photo electron and augur spectroscopy, Power X-ray diffractometry, Traditional surface and materials analysis techniques

References:

1. Nanotechnology - A Gentle Introduction to the Next Big Idea by Ratner and Ratner, Prentice Hall PTR, 1st edition, 2002.
2. Engines of Creation by K E Drexler, Oxford Paperbacks, New York, 1996.
3. Nano Structures & Nano Materials, Synthesis, Properties and Applications by Guozhong Cao, Imperial College press, 2006.
4. Nano Material & Introduction to Synthesis, Properties & Application by Dieter Vollath, Wiley VCH, 2006.
5. Principles of Colloid and Surface Chemistry, Paul C. Hiemenz and Raj Rajagopalan. CRC Press; 3 edition, 1997.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08212) COLLOID AND INTERFACIAL SCIENCE

UNIT-I

Basic concepts of Colloids and Interfaces: Introduction, Examples of Interfacial Phenomena, Solid-Fluid Interfaces, Colloids. Properties of Colloid Dispersions: Introduction, Sedimentation under Gravity, Sedimentation in a Centrifugal Field, Brownian Motion, Osmotic pressure, Optical properties, Electrical Properties, Rheological Properties of Colloid Dispersions.

UNIT-II

Surfactants and their properties: Introduction, Surfactants and their Properties, Emulsions and Micro emulsions, Foams.

UNIT-III

Surface and Interfacial Tension: Introduction, Surface tension, Interfacial Tension, Contact Angle and Wetting, Shape of the Surfaces and interfaces. Measurement of Surface and Interfacial Tension, Measurement of Contact Angle; Intermolecular and Surface Forces: Introduction, van der Walls Forces.

UNIT-IV

Intermolecular and Surface Forces: Electrostatic double layer force, The DLVO theory, Non-DLVO forces.

UNIT-V

Adsorption at interfaces: Introduction, The Gibbs Dividing surface, Gibbs Adsorption Equation, Langmuir and Frumkin Adsorption Isotherms, Surface Equation of state(EOS), Effect of Salt on Adsorption of Surfactants. Adsorption Isotherms incorporating the Electrostatic Effects, Calculation of Free energy of Adsorption.

References:

1. Foundations of Colloid Science by R. J. Hunter, 2nd edition, Oxford University Press, USA, 2001.
2. Principles of Colloid and Surface Chemistry, Paul C. Hiemenz and Raj Rajagopalan. CRC Press; 3 edition, 1997.
3. Physical Chemistry of Surfaces by Arthur W. Adamson, Alice P. Gast, Wiley, 6th Ed, 1997.
4. Interfacial Science: An Introduction by G.Barnes, I.Gentle, Oxford University Press, USA, 2006.
5. Colloid and Interface Science by Pallab Ghosh, PHI, New Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08213) ADVANCED PROCESS CONTROL

UNIT-I

Review of single input single out put (SISO) systems: Review of first and second order systems transfer functions. Introduction to advanced control systems: Cascade control, feed forward control, Adaptive Control, Inferential control, Ratio control, Selective and split range control.

UNIT-II

Internal model Control, Model predictive control, Dynamic matrix control, Plant wide control.

UNIT-III

State space methods: State Space representation of Physical systems: State variables, State space description, Selection of state variables, Transfer function matrix, Transition matrix, Solution of state space models.

UNIT-IV

Multivariable control: control of interacting systems, Primary and Cross controllers, Relative Gain Analysis (RGA), Response of multi loop control system, Non interacting control: Decouplers. Stability of multivariable control systems.

UNIT-V

Sampling and Z-transforms, Open loop and closed loop response, Modified Z-transforms, Examples of Non-Linear systems.

References:

1. Process Control: Modeling, Design and Simulation by B.Wayne Bequette, PHI, 2003.
2. Process Systems Analysis And Control by Donald R. Coughanowr, Mc Graw-Hill Education , 3rd Ed., 2009
3. Principles & Practice of Automatic Process Control by CA Smith, A. Corripio, Wiley, 3rd Ed, 2006.
4. Chemical Process Control by George Stephanopoulos, Pearson, 1st Ed, 2015.
5. Chemical and Bio-Process Control by Riggs, J. B. and Karim, M. N., Pearson Education Inc, Third edition, 2007.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08214) PROCESS INTENSIFICATION

UNIT I

Introduction to Process Intensification (PI): Sustainability-related issues in process industry, definitions of Process Intensification, fundamental principles and techniques of PI, the original ICI PI strategy, benefits of PI and obstacles to PI

Issues in designing of a sustainable, inherently safer processing plant

UNIT-II

PI Approaches: Structure - PI approach in spatial domain, Energy - PI approach in thermodynamic domain, Synergy - PI approach in functional domain and Time - PI approach in temporal domain

Mechanisms involved in PI: Mechanisms of intensified heat transfer, mass transfer, electrically enhanced processes, micro fluidics

UNIT –III

Application of PI techniques to heat transfer: Compact & micro heat exchangers

Application of PI techniques to reactors: Spinning disc reactors, oscillatory baffled reactors (OBR), Rotating reactors, Micro reactors, membrane reactors, micro reactors, Reactive separation/ super critical operation and other intensified reactor types.

UNIT-IV

Intensification of Separation Processes: Distillation, Centrifuges, membranes, drying, precipitation and crystallization

Intensified Mixing: Inline mixers, mixing on spinning disk, induction heated mixer

UNIT –V

Application areas of PI: Petrochemicals and Fine Chemicals: Refineries, Bulk Chemicals, Fine Chemicals, Fine Chemicals and Pharmaceuticals, bio processing

Offshore Processing, Nuclear Industries, Food and drink water sector, Textiles, Aerospace, biotechnology

References

1. Process Intensification- Engineering for efficiency, sustainability and flexibility by David Reay, Colin Ramshaw, Adam Harvey, Butterworth Heinemann, (Elsevier) 2013.
2. Reengineering the Chemical Process Plants: Process Intensification, Stankiewicz, A. and J. A. Moulijn, (Eds.), CRC Press, 2003.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

(17PH08215) SAFETY & RISK ANALYSIS IN PROCESS INDUSTRIES

UNIT-I

Introduction : Importance of process safety with examples of major accidents; which might cover chemical, petroleum & petroleum chemical Industrial, safety legislation, safety programmes, public perceptions, engineering ethics, Govt. policies on safety.

UNIT-II

Material Hazards: Flammability, toxicity, Reaction Hazards, Burning Characteristics, Material Properties and Hazards. Hazard Analysis: Hazard identification, preliminary hazard analysis, HAZOP, event tree, fault tree analysis.

Process Hazards: Temperature & Pressure effects and deviations, flow, level and other process deviations. Toxic releases to phase phenomena, emission and dispersion models, estimation and prevention.

UNIT-III

Ignition Sources: Flames, Hot surfaces, static electricity, and the like Explosions: Confined & Unconfined explosions, BLEVES, Dust Explosions. Fire and explosions, chemistry of fire, fire triangle, fire and explosion index (FEI) estimation, heat effect, vapor cloud explosion, boiling liquid expanding, vapor explosion and prevention.

UNIT-IV

Safety Devices & Safety audit: Relief valves and Rupture disks Explosive relief, flare systems. Industrial hygiene, health hazards, evaluation of workers exposure to toxicants, control method.

UNIT-V

Safety in plant Design & lay-out: Electrical area classification, control of entry to confined spaces. Hazard management-Safety system. Safety Drills: Risk management routines, emergency plans, and disaster control ergonomics. Emergency preparedness & handling analysis of major accidents & preventive measures.

References:

1. Chemical Process Safety: Fundamentals with Applications, D. A. Crowl, J. F. Louvar, Printice Hall, 3rd ed., 2011
2. Safety in Process Plant Design by G. L. Wells, Halsted Pr, 1980.
3. Loss Prevention in Process Industries, Frank P. Lees, Butterworths, London.
4. Safety and Accident Prevention in Chemical Operations, 2nd edition H.H. Fawcett and W.S.Wood, John Wiley and sons, New York, 1982.
5. Coulson and Richardson's – Chemical engineering, Vol.6, R.K.Sinnot, Butterworth-Heinmann Limited, 1996.