School of Engineering

Department of Biotechnology and Chemical Engineering

Program: B. Tech. Chemical Engineering (2023-Onwards) **Total Credit: 160**

Third Semester

CHE2101 Process Calculations [3-1-0-4]

Guidelines for Problem-Solving; Review of Basic Concepts – Process variables & properties, Degree of Freedom, Material Balances: Steady State Material Balances – in non-reacting systems and reacting system, Recycle & purge, elemental vs. species balance, combustion of fossil fuels. Multiphase equilibrium: Single component and multicomponent phase equilibrium, Steady State Material balances in Multiphase systems. Energy Balances: Steady State Energy Balances – in non-reacting & reacting systems, De-Coupled & coupled mass & energy balances, Calculations for network of units with recycle & bypass, Process Flow sheeting with sequential modular calculations, Unsteady State Balances. Humidification: Terminology of humidity, Humidity charts, heating and cooling problems of moist air.

References

1. Himmelblau, D. M., Riggs, J.B., *Basic Principles and Calculations in Chemical Engineering* (8^{th} ed.), Pearson, 2012.
2. Felder, R. M. and Rousseau, R.W., *Elementary Principles of Chemical Processes* (3^{rd} ed.), John Wiley & Sons, 2004.
3. Hougen, O.A., Watson, K.M., Ragatz, R.A., *Chemical Process Principles Part-I: Material and Energy Balances* (2^{nd} ed.), CBS Publishers New Delhi, 2004.

Credit transfer: 50% of CWS via MOOC Course "Everyday Excel", offered by Microsoft on the Coursera platform.
Syllabus: Navigating Excel, Expression Entry and Common Excel Functions, More Excel functions, Managing Data, Plotting, Importing Data, and Converting to Other File Types.
Link: https://www.coursera.org/learn/everyday-excel-part-1

CHE2102 Fluid Mechanics [3-1-0-4]

Newton's law of viscosity, Newtonian and non-Newtonian fluids, viscometers, fluid statics, surface tension, shell-balances including differential form of Bernoulli equation and energy balance, equation of continuity, equation of motion, equation of mechanical energy, Review of Navier-Stokes' (NS) equations, non-dimensionalization of NS equations, introduction to turbulence, analogies, correlations for fluid flow, elementary boundary layer theory, Engineering Bernoulli Equation; f vs. NRe charts, K factors and equivalent lengths for various fittings, hydraulic diameter, Head vs. Q plots of centrifugal pumps, Net positive suction head (NPSH), cavitation and priming, flow measurements, compressors and blowers. Compressible flows in conduits. Mixing and Agitation: Power consumption, mixing times, scale-up, fundamentals of two-phase flow, free and hindered settling, flow through packed beds and in fluidized beds (pressure drops, loading and flooding).

References

1. de Nevers, N., "Fluid Mechanics for Chemical Engineers", McGraw Hill International, 2017.

2. McCabe, W.L., Smith, J.C., Harriott, P., "Unit operations of Chemical Engineering", McGraw Hill International, 2022.
3. Foust, A.S., Wenzel, L.A., Clump, C.W., Maus, L., Andersen, L.B., "Principles of Unit Operations", John Wiley & Sons, 2015.
4. Coulson, J.M., Richardson J.F, Backhurst, J.R., Harker, J.H., "Coulson and Richardson's Chemical Engineering Volume 1: Fluid Flow, Heat Transfer and Mass Transfer" Butterworth-Heinemann/Elsevier, 2018.
5. Streeter, V.L., Wiley, B., "Fluid Mechanics", McGraw Hill International, 2017.
6. Douglas, J.F., Gasiorek, J.M., Swaffield, J.A., "Fluid Mechanics", Pearson/Prentice Hall, 2008.
7. Bennett, C.O., Myers, J.E., "Momentum, Heat, and Mass Transfer", McGraw Hill International, 2015.
8. Bird, R.B., Stewart, W.E., Lightfoot, E.N., "Transport Phenomena", John Wiley & Sons, 2006.
9. Geankoplis, C.J., "Transport Processes and Separation Process Principles", Prentice Hall of India, 2015.

CHE2103 Chemical Engineering Thermodynamics [3-1-0-4]

Laws of Thermodynamics, P–V–T Relations of Pure Fluids - Graphical, Tabular and Mathematical representation; Generalized compressibility chart; Generalized EOS; Thermodynamic Potentials; Maxwell Relations, Thermodynamic Property Relations, Thermodynamic properties of real gases, Multicomponent mixtures, Properties of solutions, Phase Equilibrium (VLE, LLE, VLLE), Review of Thermochemistry; Chemical reaction equilibria.

References

1. J. M. Smith, H. C., Van Ness, M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, (6e), McGraw-Hill, 2019.

2. Y.V.C. Rao, Chemical Engineering Thermodynamics, University Press, 1997.

3. B.G. Kyle, Chemical and Process Thermodynamics, (3e), Pearson, 2015.

CHE2120 Solid-Fluid Operations [3-1-0-4]

Introduction: Solid particle characterization: Size distribution, determinations of mean particle size, methods of particle size measurement; **Fluid-particle mechanics:** Flow around immersed bodies, concept of drag, boundary layer separation; **Fluid-particle mechanics:** Motion of particles in a fluid, effect of particle shape, influence of boundaries on terminal velocity; **Fluid flow through granular and packed beds of particles:** Ergun equation, Kozeny- Carman equation, Darcy's law, permeability; **Fluidization:** Minimum fluidization velocity, relevant particle properties, types of fluidization, liquid-solid and gas-solid systems; **Introduction to separation of solids from fluids:** Sedimentation - Free and hindered settling, fine and coarse particles, Richardson-Zaki equation; **Filtration:** Principles of flow through filter cakes and medium, filtration practice, selection of filtration equipment; **Centrifugal separations:** Gas cyclone and hydrocyclone, efficiency of separation, sedimentation in a centrifugal field; **Particle size reduction:** Particle fracture mechanisms, energy requirement for size machine types and characteristics of comminution equipment, selection of appropriate machine; **Particle size enlargement:** Interparticle forces, comparison and interaction between forces, nucleation and growth of particles, granulation equipment; **Transport of fluid-solid systems:** Hydraulic and pneumatic transport, flow regimes, rheological models, dilute and dense phase; **Colloids and nanoparticles:** Introduction, surface forces, suspension rheology, and application.

References

1. McCabe, W.L., Smith, J.C., Harriott, P., "Unit operations of Chemical Engineering", McGraw Hill International, 2022.
2. Foust, A.S., Wenzel, L.A., Clump, C.W., Maus, L., Andersen, L.B., "Principles of Unit Operations", John Wiley & Sons, 2015.

B.Tech. (Chemical Engg) III Semester Lab Experiments

CHE2130 Fluid Mechanics Lab [0-0-3-1]

1. Study of Rotameter apparatus.
2. Study of Pitot Tube Apparatus.
3. Study of power consumption in an Agitated Vessel.
4. Study of particle size distribution using Sieve Analysis.
5. Study of major losses in pipes.
6. Study of minor losses in pipes/fittings.
7. Study of performance characteristics of a centrifugal pump.
8. Study of Orifice Meter Apparatus.
9. Study of Venturi Meter Apparatus.

10. Study of Reynolds Experiment.
11. Study of Bernoulli's Theorem experimentally.

CHE2131 Simulation Lab 1 [0-0-3-1]

1. An introduction to Excel
2. Working with functions in Excel
3. Organizing and Visualizing data in Excel
4. Process Calculations in Excel
5. Basics of ASPEN simulation software
6. Selection and estimation of Thermodynamic Properties
7. Simulation of simple units without reactions
8. Simulation of simple units with reactions
9. Simulation of multiunit systems with and without reactions
10. Case studies

Fourth Semester

CHE2201 Reaction Engineering [3-1-0-4]

Kinetics of homogeneous chemical reactions, Rate expressions, the Temperature dependence of rate differential, integral, Elementary, and Nonelementary reaction kinetics - pseudo, steady state hypothesis mechanism. Isothermal reactor design. Design of batch, semi-batch, CSTR's and PFR's. Multiple reactor systems, reactors in series or/and parallel, CSTRs series performance analysis, batch, semi-batch, continuous, and recycle reactors. Multiple reaction systems, series and parallel reactions in flow reactors, product distribution, yield, and selectivity. Non-isothermal homogeneous reactions, Concepts of RTD and RTD models.

References

1. O. Levenspiel, Chemical Reaction Engineering, (3e), Wiley India Pvt Ltd., 2010.

2. H. S. Fogler, Elements of Chemical Reaction Engineering, (4e), Prentice-Hall of India, 2003.

3. J.M. Smith, Chemical Engineering Kinetics, (3e), McGraw-Hill, 1981.

4. J. J. Carberry, Catalytic Reaction Engineering, McGraw-Hill, 1976.

5. O. Levenspiel, The Chemical Reactor Omnibook, OSU Bookstores, Corvallis Oregon, 1993.

6. G. F. Froment, K. B. Bischoff, *Chemical Reactor Analysis and Design*, (3e), John Wiley and Sons, 2010.

CHE2202 Heat and Mass Transfer [3-1-0-4]

Review of conduction, resistance concept, extended surfaces, lumped capacitance; Introduction to Convection, boundary layer theory, natural and forced convection, correlations; Radiation; Heat exchangers: LMTD, epsilon-NTU method; Interphase mass transfer, mass transfer coefficient, theories for interphase mass transfer, overall mass transfer coefficient, correlations, mass transfer with chemical reaction, simultaneous heat and mass transfer, analogy between momentum, heat and mass transfer; introduction to mass transfer operations.

References

1. F.P. Incropera and D.P. Dewitt, Introduction to Heat Transfer, 5th ed., Wiley, 2006.
2. E.L. Cussler, Diffusion: Mass Transfer in Fluid Systems, 2nd ed., CUP, 1997.
3. R.B. Bird, W.E. Stewart and E.N. Lightfoot, Transport Phenomena, 2nd ed., Wiley, 2006.
4. R.E. Treybal, Mass Transfer Operations, 3rd ed., McGraw Hill, 2017.
5. Y.A. Cengel, A.J.Ghajar, Heat and Mass Transfer: Fundamentals and Applications, 6th ed., McGraw Hill, 2020.

CHE2220 Process Modeling and Simulation [3-0-2-4]

Fundamentals and industrial applications of process modeling and simulation, macroscopic mass, energy, and momentum balances, integration of fluid thermodynamics, chemical equilibrium, reaction kinetics, and feed/ product property estimation in mathematical models. Steady-state lumped systems, modeling of chemical process equipment. Modeling and simulation of complex industrial processes; Simulation of process flow sheets using a modeling tool: case studies.

References

1. K. Hangos, I.T. Cameron, Process Modeling and Model Analysis, Academic Press, 2001.
2. J. Ingham, I.J. Dunn, E. Heinzle, J.E. Prenosil, J.B. Snape, Chemical Engineering Dynamics: An Introduction to Modelling and Computer Simulation, (3e), Wiley-VCH Verlag GmbH & Co. KGaA, 2007.
3. B.V. Babu, Process Plant Simulation, Oxford University Press, 2004.
4. W.L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, 1989.
5. C.D. Holland, Fundamentals and Modeling of Separation Processes, Prentice Hall, 1975.
6. D.M. Himmelblau, K.B. Bischoff, Process analysis and simulation: Deterministic systems, John Wiley, 1968.

CHE2240 Environmental Systems Engineering [3-0-0-3]

Characterization of Industrial wastewater, primary, secondary, and tertiary treatment, segregation, screening, equalization, coagulation, flocculation, precipitation, flotation, sedimentation, aerobic treatment, anaerobic treatment, absorption, ion exchange, membrane filtration, electro dialysis, sludge dewatering, and disposal methods. Sources and classification of air pollutants, nature and characteristics of gaseous and particulate pollutants, pollutants from automobiles. Air pollution meteorology, plume and its behavior and atmospheric dispersion, control of particulate emissions by gravity settling chamber, cyclones, wet scrubbers, bag filters, and electrostatic precipitators. Control of gaseous emissions by absorption, adsorption, chemical transformation, and combustion. Hazardous and non-hazardous waste, treatment, and disposal methods, landfilling, leachate treatment, and incineration of solid wastes.

References

1. M.L. Davis, D.A. Cornwell, Introduction to Environmental Engineering, (5e), McGraw-Hill, 2014.
2. G. Tchobanoglous, F.L. Burton, H.D. Stensel Wastewater Engineering: Treatment and Reuse, (4e), McGraw-Hill, 2003.
3. G.M. Masters, W.P. Ela, Introduction to Environmental Engineering and Science, Pearson Education Inc., 2015.
4. H. S. Peavy, D.R. Rowe, G. Tchobanoglous, Environmental Engineering, McGraw Hill, 2013.

5. S.C. Bhatia, Environmental Pollution and Control in Chemical Process Industries, Khanna Publishers, Delhi, 2001.
6. H.C. Perkins, Air Pollution, McGraw Hill, 1974.

CHE2241 Bioprocess Engineering [3-0-0-3]

Basics of biology and bioprocess engineering. Microbial growth and kinetics. Enzymes and enzyme kinetics. Bioreactor Engineering, Fermentation mechanisms, and kinetics. Types of fermenters, modeling of batch and continuous fermenter. Bioreactor design and mixing phenomena. Sterilization of media and air, sterilization equipment, and design. Downstream Processing (Recovery and Purification of Products): membrane separation processes, chromatographic methods, and electrokinetic separations: electro-dialysis, electrophoresis.

References

1. M.L. Shuler, F. Kargi, Bioprocess Engineering Basic Concepts, (2e), Prentice Hall of India, 2017.
2. J.E. Bailey, D.F. Ollis, Biochemical Engineering Fundamentals, (2e), McGraw Hill, 2017.
3. P. Doran, Bioprocess Engineering Principles, (2e), Elsevier, 2012.
4. K. Schugerl, K.V. Bellgardt, Bioreaction Engineering: Modeling and Control, Springer Verlag, Heidelberg, 2000.
5. S. Aiba, A.E. Humphrey, N.F. Millis, Biochemical Engineering, (2e), Academic Press, 1973.
6. H.W. Blanch, D.S. Clark Biochemical Engineering, (2e), CRC Press, New York, 1997.
7. H.C. Perkins, Air Pollution, McGraw Hill, 1974.

CHE2270 Project Based Learning 2 [0-0-2-1]

Project Based Learning will be a practical / simulation-based study in the emerging areas.

School of Engineering
Department of Biotechnology and Chemical Engineering
Program: B. Tech. Chemical Engineering (2023-Onwards) **Total Credit: 160**

B.Tech. (Chemical Engg) IV Semester Lab Experiments

CHE2230 Reaction Engineering Lab [0-0-3-1]

1. Non-catalytic homogenous reaction in a Plug Flow reactor
2. Non-catalytic homogenous reaction in Series of CSTRs
3. Non-catalytic homogenous reaction in PFR and CSTR in Series.
4. Reaction kinetics of non-catalytic homogenous reaction in a batch reactor.
5. Hydrodynamic characteristics of a trickle bed reactor.
6. Study of the kinetics of photocatalytic degradation of dye.
7. Study of RTD in a CSTR by using pulse input of a tracer.
8. Study of RTD in a PFR by using pulse input of a tracer.
9. Non-catalytic gas-solid reaction analysis.
10. Characterization of a given sample of adsorbent/catalyst to determine its properties.
11. Study of the ultrasound-assisted adsorption of an organic pollutant in wastewater.

CHE2231 Thermal Processes Lab [0-0-3-1]

1. Thermal conductivity of liquids
2. Heat transfer in an agitated vessel under an unsteady state
3. Heat transfer in an agitated vessel under steady state
4. Shell and tube heat transfer coefficient
5. Plate type heat exchanger
6. Cross-flow heat exchanger
7. Heat transfer in a fluidized bed
8. Single effect evaporator
9. Two-phase heat transfer unit
10. Drop-wise and film-wise condensation
11. Unsteady state heat transfer unit
12. Vertical and horizontal condenser
13. Stefan Boltzmann set up

School of Engineering
Department of Biotechnology and Chemical Engineering
Program: B. Tech. Chemical Engineering (2023-Onwards) **Total Credit: 160**

Fifth Semester

CHE3101 Process Plant Design [3-1-0-4]

Process Design and Development: The hierarchy of chemical process design, general design considerations, nature of process synthesis and analysis. Development of a conceptual design and determining the best flow sheet: input information and batch versus continuous, Input/output structure of the flow sheet; Recycle structure of flow sheet; Separation systems; Heat Exchanger Networks. Plant Design: Process design development and general design considerations. Process Economics.

References

1. J. M. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill, 1988.
2. M.S. Peters, K.D. Timmerhaus, R.E. West, Plant Design and Economics for Chemical Engineers, (5e), McGraw-Hill, 2003.
3. W.D. Seider, J.D. Seader, D.L. Lewin, Product and Process Design Principles: Synthesis, Analysis, and Evaluation, (3e), John-Wiley and Sons, 2008.
4. R. Turton, R.C. Bailie, W.B. Whiting, J.A. Shaeiwitz, D. Bhattacharyya, Analysis, Synthesis and Design of Chemical Processes, (4e), Prentice Hall India Learning Private Limited, 2015.
5. G. Towler R.K. Sinnott., Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design, CBSPD, 2009.
6. D.F. Rudd, C.C. Watson, Strategy of Process Engineering, John Wiley and Sons, 1968. A.W. Westerberg, H.P. Hutchison, R.L. Motard, P. Winter, Process Flowsheeting, Cambridge University Press, 2011.

CHE3102 Design of Separation Processes [3-1-0-4]

Gas Absorption, graphical calculation of number of theoretical stages for absorption and stripping columns. Adsorption, adsorption isotherm, batch and continuous stage adsorption, design of adsorption column, and adsorption equipment. Vapor gas mixtures, terminology, Psychometric chart, water cooling operations, gas-liquid contact operations, adiabatic operations. Distillation, concept of vapour liquid equilibrium, Raoult's law, deviations from ideal law, azeotropic distillation and steam distillation. Enthalpy concentration diagrams, binary systems, dew and bubble point calculations, flash vaporization, simple distillation, binary component distillation, Ponchan Savarit method, McCabe Thiele method, Liquid-Liquid Extraction: liquid-liquid-equilibria, ternary systems triangular and rectangular coordinates-choice of solvent-single stage and multi stage cross current, equipment such as mixer settler, packed and tray towers. Leaching, Drying and design criteria, Design of rotary dryers.

References

1. R.B. Bird, W.E. Stewart and E.N. Lightfoot, Transport Phenomena, 2nd ed., Wiley, 2006.
2. R.E. Treybal, Mass Transfer Operations, 3rd ed., McGraw Hill, 2017.

3. Seader, J.D., Henley, E.J., Roper D.K., "Separation Process Principles," 3rd ed., (International Edition), John Wiley & Sons.
4. McCabe and Smith, Unit Operations in Chemical Engineering, 5th ed., McGraw-Hill.
5. Coulson, J.M., Richardson, J.F., Chemical Engineering Volume-2, 5th ed., Butterworth-Heinemann.
6. Geankoplis, C. J., Transport Processes and Unit Operations, 3rd ed., PHI, New Delhi.

CHE3120 Process Safety Analysis [3-1-0-4]

Introduction – Accident and loss statistics, inherent safety, safety culture, ethics; **Toxicology-** How toxicants enter and are eliminated from biological organisms, Toxicological studies, Dose vs response, Relative toxicity, threshold limit values; **Industrial Hygiene:** Government regulations, Identification, Evaluation of exposures to volatile toxicants, dusts, noise, toxic vapors, Control; **Source Models:** Flow of liquid through hole, hole in a tank, pipes; Flow of vapor through holes, gases through pipes; Flashing liquids, Liquid pool evaporation or boiling, Toxic Release and dispersion models; **Fires and explosion:** Fire triangle, fire vs explosion, Flammability characteristics of liquid and vapors, TNT equivalency, energy of chemical and mechanical explosions, vapor cloud explosions, BLEVE, Inerting, Static electricity, Explosion proof equipment and instruments, Sprinkler systems; **Relief systems:** Relief concepts, Location of reliefs, Relief scenarios, Relief systems for flares, scrubbers, condensers, knock out drum; **Relief sizing:** Spring operated for liquid/vapor/gas service, Rupture disk relief for liquid/vapor/gas, reliefs for thermal expansion of process fluids; **Hazard Identification:** Surveys, HAZOP, safety reviews **Risk assessment:** Probability theory, event trees, fault trees, QRA, LOPA, **Accident investigations.**

References

1. Crowl, D.A., Louvar, J.F., Chemical Process Safety, Pearson, 3rd edition, 2015.
2. Center for Chemical Process Safety (CCPS), Introduction to process safety for undergraduates and engineers, Wiley, 1st Edition, 2016.
3. Sanders, R. E., Chemical Process Safety, Elsevier, 3rd edition, 2006.
   Klein, J.A., Vaughen, B.K., Process Safety: Key concepts and practical approaches, CRC press, 1st edition, 2017.

CHE3140 Process Optimization [3-0-0-3]

Formulation of the objective function. Unconstrained single variable optimization: Newton, Quasi-Newton methods, polynomial approximation methods. Unconstrained multivariable optimization: Direct search method, conjugate search method, steepest descent method, conjugate gradient method, Newton's method. Linear Programming: Formulation of LP problem, graphical solution of LP problem, simplex method, duality in Linear Programming, two-phase method. Nonlinear programming with constraints: Necessary and sufficiency conditions for a local extremum, Quadratic programming, successive quadratic programming, Generalized reduced gradient (GRG) method. Applications of optimization in Chemical Engineering.

References

1. T.F. Edgar, D.M. Himmelblau, L.S. Ladson, Optimization of Chemical Process, (2e), McGraw-Hill, 2001.
2. C.O. Godfrey, B.V. Babu, New Optimization Techniques in Engineering, Springer-Verlag, Germany, 2004.
3. G.S. Beveridge, R.S. Schechter, Optimization Theory and Practice, McGraw- Hill, New York, 1975.
4. G.V. Reklaitis, A. Ravindran, K. Ragsdell, M., Engineering Optimization-Methods and Applications, (2e) Wiley India Pvt Ltd., 2006.

CHE3141 Process Economics and Management [3-0-0-3]

Cash Flow Concepts, Present Future and Annual Values, Net Present Value, Present Value Ratio, Rate of Return, Breakeven, Depreciation and taxes, Project Definition, Project network, scheduling resource and cost, Managing project risk, Project progress, performance measurement, and evaluation.

References

1. "Economic Evaluation and Investment Decision Methods (14th Edition)", Franklin J Stermole and Johm M Stermole, Investment Evaluation Corporation, Golden, CO (USA), 2014.
2. "Operations Research: An Introduction", Hamdy A Taha, Prentice Hall, 1997.
3. Peters M. S., Timmerhaus K. D., and West R. E., Plant Design and Economics for Chemical Engineers, McGraw Hill Higher Education, 5th Edition, 2003.

CHE3142 Process Intensification [3-0-0-3]

Introduction to process intensification (PI): sustainability-related issues in the process industry; definitions of process intensification; fundamental principles and approaches of PI; design of sustainable and inherent safer processing plants. Mechanisms involved in PI: intensified heat transfer, intensified mass transfer, electrically enhanced processes, microfluidics; compact and micro heat exchangers; Reactors: reactor engineering theory, spinning disc reactors, oscillatory baffled reactors, microreactors, reactive separations, membrane reactors, supercritical operations, field enhanced reactors, rotating fluidized beds. Intensification and Separation Processes: distillation (reactive, extractive), centrifuges, membranes, drying, precipitation, and crystallization; Intensified mixers, PI case study.

References

1. D. A. Reay, C. Ramshaw, A.P. Harvey, Process Intensification: engineering for efficiency, sustainability and flexibility, (2e), (IChemE) Butterworth Harriman, London, 2008.
2. A. Stankiewicz, J.A. Moulijn, (Eds), Re-Engineering the Chemical Processing Plant: Process Intensification, CRC Press, 2003.

3. J.G. Segovia-Hernandez, A. Bonilla-Petriciolet, (Eds), Process Intensification in Chemical Engineering Design Optimization and Control, Springer, 2016.

4. F.J. Keil, (Ed), Modelling of Process Intensification, Wiley International, 2007.

5. A.A. Kiss, Process Intensification Technologies for Biodiesel Production, Springer, 2014.

6. H. Mothes, Process Design Synthesis, Intensification and Integration of Chemical Processes, Manufective, 2015.

CHE3143 Advanced Separation Technologies [3-0-0-3]

Separation process in chemical and biochemical industries, categorization of separation processes, equilibrium, and rate governed processes. Introduction to various new separation techniques, e.g., Membrane separation, ion-exchange foam separation, supercritical extraction, liquid membrane permeation, Pressure Swing Absorption (PSA), & Freeze drying. Membrane-based separation technique (MBSTs). Historical background, physical and chemical properties of membranes, Techniques of membrane preparation, membrane characterization, various types of membranes and modules. Osmosis and osmotic pressure. Working principle, operation, and design of Reverse osmosis, Ultrafiltration, Microfiltration, Electrodialysis, and Pervaporation. Gaseous separation by membranes. Ion Exchange, basic principle and mechanism of separation, Ion exchange resins, regeneration, and exchange capacity. Exchange equilibrium, affinity, selectivity, and kinetics of ion exchange. Design of ion exchange systems and their uses in the removal of ionic impurities from effluents. Introduction to foam separation, micellar separation, supercritical fluid extraction, liquid membrane permeation, and chromatographic separations.

References

1. C.J. King, Separation Processes, (2e), Dover Publishers, 2013.

2. S. Sourirajan, T. Matsura, Reverse Osmosis and Ultra-filtration - Process Principles, NRC Publications, 1985.

3. M.C. Porter, Handbook of Industrial Membrane Technology, Noyes Publication, 1990.

4. J.D. Henry, N.N. Li, New Separation Techniques, AIChE Today Series, AIChE 1975.

5. T. A. Hatton, J.F. Scamehorn, J.H. Harvell, Surfactant Based Separation Processes, Vol. 23, Surfactant Science Series, Marcel Dekker Inc.,1989.

6. M.A. McHugh, V.J. Krukonis, Supercritical Fluid Extraction, Butterworths,1985.

CHE3170 Project Based Learning 3 [0-0-2-1]

Project Based Learning will be a practical / simulation-based study in the emerging areas.

B.Tech. (Chemical Engg) V Semester Lab Experiments

CHE3130 Separation Processes lab [0-0-3-1]

1. Study on Humidification in wetted wall column.
2. Study on Sieve Plate Distillation column.
3. Study on Packed Bed Distillation column.
4. Study on Vapour-Liquid Equilibrium.
5. Study on Batch Crystallizer.
6. Study on Forced draft tray dryer.
7. Study on Mass transfer without chemical reaction.
8. Study on Mass transfer with chemical reaction.
9. Study on Liquid-liquid extraction.
10. Study on Absorption in wetted wall column.

CHE3131 Simulation Lab 2 [0-0-2-1]

Case Study - Designing a process on ASPEN HYSYS to simulate the functioning of a process pertaining to chemical industries.