B.E. (Chemical Engineering)

Description of Courses (as per Bulletin 2020-21, page VI-23-26)

Core Courses	**L P U**

CHE F211 Chemical Process Calculations **3 0 3**

Historical overview of Chemical Engineering, Principles of balancing with examples to illustrate differential and integral balances, lumped and distributed balances, Material balances in simple systems involving physical changes and chemical reactions, Systems involving recycle, purge and bypass, Properties of substances: single component & multicomponent, single and multiphase systems. Ideal liquid and gaseous mixtures, Energy balance calculations in simple systems, Introduction to Computer aided calculations-steady state material and energy balances for chemical plants

CHE F212 Fluid Mechanics **3 0 3**

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non-Newtonian flow, Introduction to Fluid Statics, Dimensional Analysis (Buckingham PI theorem), Types of flows, Fluid Statics, Bernoulli equation, Differential and Integral analysis methods of analysis, Navier Stokes equation, Potential flows, Stream functions and velocity potential, Boundary Layer Theory, Flow measurement, Pipe flow analysis, Flow past immersed objects, Packed beds, Fluidized beds, Sedimentation, Pumps and compressors Agitation and Mixing, (Power consumption, mixing times, scale up), Introduction to Turbulent Flows (Reynolds equations), Compressible flows.

CHE F213 Chemical Engineering Thermodynamics **3 0 3**

Review of work, heat, reversible and irreversible processes, First Law applications to closed and open systems, Second law, Entropy, and applications related to power and refrigeration, Heat effects, Availability and Exergy analyses Equations of state and generalized correlations for PVT behaviour, Maxwell relations and fluid properties estimation; Residual and excess properties, Partial molar quantities; Gibbs-Duhem Equation, Fugacity and Activity Coefficient models, Vapour-liquid equilibria, Chemical Reaction Equilibrium.

CHE F214 Engineering Chemistry **3 0 3**

Organic chemistry – Important functional groups, their reactions and named reactions, Physical chemistry – thermo-physical and thermodynamic properties determination, phase rule, Adsorption equilibria, Electrochemistry, Chemical methods of analysis, Instrumental methods of analysis, Water and waste water chemistry and analysis, Corrosion, Engineering materials and inorganic chemicals, Metals and alloys, Polymers, Fuels and fuel analysis.

CHE F241 Heat Transfer **3 0 3**

Steady state and unsteady state conduction, Fourier's law, Concepts of resistance to heat transfer and the heat transfer coefficient. Heat transfer in Cartesian, cylindrical and spherical coordinate systems, Insulation, critical radius, Convective heat transfer in laminar and turbulent boundary layers, Theories of heat transfer and analogy between momentum and heat transfer, Heat transfer by natural convection, Boiling and condensation, Radiation, Heat exchangers: LMTD, epsilon-NTU method, Co-current counter-current and cross flows, NTU – epsilon method for exchanger evaluation.

CHE F242 Numerical Methods for Chemical Engineers **3 0 3**

Introduction to mathematical modelling and engineering problem solving, Use of software packages and programming, Errors and approximations including error propagation and Numerical error, Roots of equations: Linear algebraic equations, 1-D and multi-dimensional unconstrained optimization including gradient methods, Linear programming, Non-linear constrained Optimization, Optimization with packages, Least Squares Regression including quantification of error, Polynomial regression, Lagrange, inverse and spline interpolation and Fourier approximation, Engineering applications, Numerical differentiation and integration, Ordinary differential equations, Partial differential equations, Engineering applications

CHE F243 Material Science and Engineering **3 0 3**

Introduction on materials for engineering, structures of metals, ceramics and polymers; crystalline structure imperfections; amorphous and semi-crystalline materials (includes glasses, introduction to polymers); Correlation of structure to properties and engineering functions (mechanical, chemical, electrical, magnetic and optical); phase diagrams; Improving properties by controlled solidification, diffusion or heat treatment; Failure analysis and non-destructive testing; Types of materials (includes synthesis, Fabrication and processing of materials): Polymers and composites, Environmental degradation of materials (corrosion); Evolution of materials (functional materials, Biomimetic materials, energy saving materials etc); Criteria for material selection.

CHE F244 Separation Processes I **3 0 3**

Molecular diffusion in fluids, Interphase mass transfer, mass transfer coefficient, Theories for interphase mass transfer, overall mass transfer coefficient and correlations, mass transfer with chemical reaction, analogy between momentum, heat and mass transfer, Absorption, Distillation including azeotropic and extractive distillation, Liquid-Liquid extraction, Leaching, Equipment for absorption, distillation, extraction and leaching.

CHE F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

CHE F311 Kinetics and Reactor Design 3 0 3

Kinetics Reaction rate, order, rate constant; Batch reactors Design + basics; Kinetic constants from batch reactor data; Ideal flow reactors Mass and Energy balances; Isothermal, adiabatic and non-isothermal operation; Catalysts, Catalytic rates, Reaction mechanisms; Internal/External transport in catalysts; Non-catalytic solid-gas reactions; Reactor design for ideal flow reactors; Kinetics of Solid Catalyzed Reactions; Yield and Selectivity; Concept of RTD; Segregation and Maximum Mixedness models.

CHE F312 Chemical Engineering Lab I 0 3 3

This course aims to help students gain practical experience using laboratory-scale experiments to supplement theory courses taught in classroom with major focus on chosen experiments from Fluid Mechanics, Engineering Chemistry, Heat transfer and Separation Processes–1. Students will collect and analyze experimental data using theoretical principles related to relevant courses already covered in previous Semesters.

CHE F313 Separation Processes II 3 0 3

Special equilibrium based separations like humidification and water cooling, Drying of wet solids, adsorption, crystallization etc., Mechanical separations like filtration, centrifugation, froth floatation etc., Solid separations based on size reduction including sieving operations and related equipment like crushers, mills, pulverizers etc., special separation processes like ion-exchange, membranes, chromatography etc.

CHE F314 Process Design Principles I 3 0 3

Process invention using heuristics and analysis (The Design process, Process creation and heuristics for process synthesis, Molecular structure design, Role of process simulators Like Aspen, Chemcad, Hysys etc. in process creation), Detailed process synthesis using algorithmic methods with emphasis on reactor networks, separation trains, batch processes, heat integration etc.

CHE F341 Chemical Engineering Laboratory II 0 3 3

This course aims to help students gain practical experience using laboratory-scale experiments to supplement theory courses taught in classroom with major focus on chosen experiments from Kinetics and Reactor Design, Process Dynamics and Control and Separation Processes – 2. Students will collect and analyze experimental data using theoretical principles related to relevant courses already covered in previous Semesters.

CHE F342 Process Dynamics and Control **3 0 3**

Introduction to process control, Theoretical models of chemical process, Laplace Transforms, Transfer functions and state space models, Dynamic response of first and second order processes, Effect of dead time, Dynamics response of more complicated systems, Development of empirical models from empirical data, Feedback control, Control system instrumentation, Overview of Control system design, Dynamic behavior and stability of closed loop system using root locus, frequency response using Bode and Nyquist plots, PID controller design and tuning, Control system design based on frequency response analysis, Feed forward, cascade and ratio control, Introduction to multivariable control system, identification of interaction, design of controllers in interactions, elimination of interactions, Control strategies for common industrial processes such distillation, heat exchangers, etc. Control strategies for Batch processes.

CHE F343 Process Design Principles II **3 0 3**

Review of process synthesis, Design and sizing of equipment of heat exchangers, separation towers, pumps etc. Cost accounting and capital cost estimation, Annual costs, earnings and profitability analysis, optimization of process flow sheets, Steps involved in designing configured industrial systems like solar desalinators, fuel cells, hand warmers etc.

CHE F366 Lab Project **3**

CHE F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CHE F376 Design Project **3**

CHE F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

Elective Courses

BIO G671 Bioconversion Technology **3 2 5**

Waste and by-product utilization; downstream processing; biogas production; principles of biodegradation process parameters; bioreactor design and operation; exploitation of waste streams enzyme-based bioconversions of high value products.

BIOT F245 Introduction to Environmental Biotechnology 3 0 3

Industrial processes, incorporating design and monitoring of waste treatment technologies; microbial removal and degradation of organics pollutants, phytoremediation of soil and water contaminated with toxic metals and radionuclides, wetlands as treatment processes, biofilms, biofilters for vapor-phase wastes, and composting; biosensors in environmental analysis, molecular biology applications in environmental engineering and genetic engineering of organisms for bioremediation.

BIOT F344 Downstream processing 2 1 3

Recovery and purification of biologically – produced products including biomass itself, extracellular and intracellular components; Strategies to recover and purify products, separation of insoluble products, cell disruption, separation of soluble products, finishing steps for purification, integration of reaction and separation.

BITS F415 Introduction to MEMS 3 1 4

Overview, history and industry perspective; working principles; mechanics and dynamics, thermofluid engineering; scaling law; microactuators, microsensors and microelectromechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micromanufacturing; microfludidics; microrobotics; case studies.

BITS F416 Introduction to Nanoscience 3 0 3

Introduction; nanoscience in nature; fundamental science behind nanomaterials; synthesis and properties of nanomaterials; tools to study the properties, size and shape determinations, application of nanomaterials in science, engineering and biomedical field; future trends

BITS F417 Microfluidics and its application 4

Introduction to microfluidics, scaling in microfluidics, theoretical microfluidics, Philosophy of Computational Fluid Dynamics, Concepts of discretization, fabrication techniques for microfluidic devices, microvalves, micropumps, microflow sensors, microfluidics for life sciences: micromixers, microneedles, microfilters, microseparators, microreactors, modeling and simulation on CAD tool.

BITS F418 Introduction to Biomedical Engineering 3 1 4

Introduction; Engineering principals applied for physiological phenomena; Bio implant materials:Metallic, ceramics; Polymeric materials for bio applications; Protein-biomaterial surface Interactions;Modification of surface of the biomaterials; Tissue engineering;Drug delivery systems, principals,and applications; Biomedical sensors; Modeling and simulation.

BITS F429 Nanotechnology for Renewable Energy and Environment 3 1 4

Basics of nano physics, macro vs. nano. Solar cells: Organic solar cell, quantum dot solar cell, dye sensitized solar cell. Self cleaning in solar panel. Fuel cell: Nano electrode and catalysts. Batteries: Nano electrode based batteries. Catalysts: H2 production and H2 storage. Carbon nano tube for energy. wind energy: Nanocomposites, nanocoating, and nanolubricants. Nanotechnology as tool for sustainability. Environmental fate & transport of nanomaterials. Nanomaterials for ground water remediation. Nanomaterials as adsorbents. Toxicity of nanomaterials, Ecotoxicological impacts of nanomaterials, Societal implications of nanotechnology.

CHE F411 Environmental Pollution Control 3 0 3

Air & water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies; associated laboratory.

CHE F412 Process Equipment Design 3 0 3

Application of principles of Chem. Engg. to the selection and design of equipment for Chemical industries; design, cost estimation and selection of process equipment; piping, pressure vessels, heat exchangers, distillation columns etc. Use of computer software packages in the design; plant safety practices; use of codes.

CHE F413 Process Plant Safety 3 0 3

Role of safety in society. Engineering aspects of process plant safety. Chemical hazards and worker safety. Hazardous properties of chemicals. Safety aspects in site selection and plant layout. Design and inspection of pressure vessels. Storage, handling and transportation of hazardous chemicals. Risk assessment methods. Toxic release, fire and explosions. Boiling liquid expanding vapor explosions. Safety audit. Emergency planning and disaster management. Case studies.

CHE F414 Transport Phenomena 3 0 3

Analogy for momentum, heat and mass transport; shell balance approach for analysis of individual and simultaneous momentum, heat and mass transport; hydrodynamic and thermal boundary layers; velocity, temperature and concentration distributions in turbulent flow; interphase transport for isothermal and non-isothermal systems.

CHE F415 Molecular and Statistical Thermodynamics 3 0 3

Fundamental of Statistical Mechanics, Quantum Mechanics, Postulates, Concept of Ensembles, Intermolecular Potential Energy functions; Distribution functions: Radial Distribution Function (RDF); Applications of Statistical Mechanics: Thermo-physical property calculations in ensembles; Cooperative Phenomenon: Phase Equilibria: Ising model, Gibbs Ensemble (VLE), Thermodynamic Integration, Gibbs-Duhem Integration, Free Energy calculation; Virial EOS: second virial coefficient; Special Applications: From Surface Adsorption: Adsorption Isotherm. Molecular Simulation Techniques: Molecular Dynamics and Monte Carlo Simulation, Monte Carlo Simulation in various En-semble.

CHE F416 Process Plant Design Project I 3

This course aims to train the student on various aspects involved in design of a process plant. It may be for a Battery limit (B/L) plant or for a Grass roots project. The design will have to be submitted in the form of a standard report. There would be two major submissions: (i) Process selection and PFD, (ii) Material and Energy Balance. This part of the project in conjunction with Process Plant Design Project 2 is a Basic Process Package Report for a complete process plant.

CHE F417 Process Plant Design Project II 3

This course is an extension of Process Plant Design Project 1 and aims to train the student on various aspects involved in design of a process plant. It may be for a Battery limit (B/L) plant or for a Grass roots project. The design will have to be submitted in the form of a standard report. There would be three major submissions in relation to the process selected in Process Plant Design Project 1: (i) Process Design, (ii) Mechanical design, (iii) Costing. This part of the project in conjunction with Process Plant Design Project 1 is part of detailed engineering and eco-omics for a complete process plant.

CHE F418 Modelling and Simulation in Chemical Engineering 3 0 3

Mathematical model and necessity, Introduction to modeling, Physical and Mathematical models, Modelling in Chemical Engineering, Formulation of dynamic models with case studies based on mass, component, momentum and energy balances, Modeling of selected fluid flow, heat transfer, mass transfer and reaction engineering phenomena, Role of Simulation and simulators, Sequential and modular approaches to Process Simulation, Equation solving approach, Decomposition of networks, Convergence promotion, Specific purpose simulation, Introduction to role of evolutionary computation in simulation.

CHE F419 Chemical Process Technology 3 0 3

Process synthesis concepts for flow sheet generation - Unit operations and unit processes, General principles applied in studying a chemical industry; Chemical processes based on agricultural and sylvi-cultural raw materials - Sugar, starch, alcohol, cellulose, etc; Selected technologies for chemicals from inorganic chemical industry covering contact process, fertilizer, chloral-alkali, cement and lime; Natural product industry covering manufacture of oils, soaps, detergents, paper and pulp, Coal and various coal-chemicals, Petroleum and petrochemical products, Raw materials and principles involved in the production of olefins and aromatics, Acetylene, Butadiene and typical intermediates from olefins and aromatics such as ethylene glycol, ethyl benzene, phenol, cumene and DMT/PTA, Dyes and pharmaceuticals.

CHE F421 Bio-chemical Engineering 3 0 3

Basics of Microbiology and Biochemistry; Introduction to Biochemical engineering, Mass and energy balance in microbial processes; Microbial growth, Substrate utilization and product formation kinetics; Medium and air sterilization; Enzyme kinetics and immobilized enzyme systems; Design of batch, continuous and fed-batch bioreactors; Transport Phenomena in biological reactors; Scale-up principles for biochemical processes; Instrumentation and control of bioprocesses, Bio-separations.

CHE F422 Petroleum Refining Technology 3 0 3

Current world oil and gas scenario; History and development of refining; Petroleum industry in India; Origin, formation, and composition of petroleum; Classification and evaluation of crude oils; Petroleum products and test methods; Crude oil distillation; Thermal, catalytic and finishing processes; Product blending; Lube oil and bitumen (asphalt) manufacturing processes.

CHE F423 Membrane Science and Engineering 3 0 3

Overview of membrane separation processes; Introduction to membranes; Polymeric membranes; Non-polymeric membranes; polymer synthesis; polymer characterization; Metallic membranes; Zeolites; Metal Organic Frameworks; Liquid membranes; Phase inversion; Thermodynamics of Phase inversion; Dip coating; Track etching; Chemical Vapor Deposition; Morphology of membranes; Hydrophilicity; Ultrafiltration; Microfiltration; Nanofiltration; Reverse Osmosis; Pervaporation; Membrane distillation; Gas separation; Biomedical engineering applications; Plate and Frame modules; Spiral wound modules; Hollow fiber membrane modules; Membrane contactors; Pore diffusion; Solu-tion diffusion mechanism; Mathematical modeling of membrane separation processes; Membrane fouling; Concentration polarization; Cake layer formation; Gel layer formation; Membrane cleaning; Industrial membrane installations; Economics of membrane plants; Opportunities for membrane technology in start-up ecosystem.

CHE F424 Rheology of complex fluids 3 0 3

Introduction to complex fluids, origins of non- Newtonian behaviour; fundamentals of rheology; rheological measurements and properties; linear and non-linear viscoelasticity; time-temperature superposition, Boltzmann superposition principle, types of flow fields; various characterization techniques; techniques in oscillatory shear rheology; theoretical models for visco-elastic fluids; Maxwell model, Kelvin–Voigt model, Generalized Maxwell model, Oldroyd model; rheology of dilute polymer solutions, ideal chain conformations, real chain conformations, unentangled polymer dynamics, entangled polymer dynamics; rheology of two phase systems, rheology of soft glassy materials, physical aging and rejuvenation.

CHE F433 Corrosion Engineering 3 0 3

Corrosion principles: electrochemical aspects, environmental effects, metallurgical & other aspects; various forms of corrosion. Materials: metals and alloys, non-metallics (polymers and ceramics). Corrosion prevention: materials selection, alternation of environment, design, cathodic and anodic protection, coatings.

CHE F471 Advanced Process Control 3 0 3

Process identification and adaptive control; Model predictive control structures; Model-based control structures; State estimation; Synthesis of control systems-some case studies; intelligent control.

CHE F491 Special Projects 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

CHE F497 Atomic and Molecular Simulations 3

Particle based simulations at atomic and molecular level. Molecular dynamics (MD), Lyapunov exponent, various algorithms for integrating the equation of motion, Verlet algorithm. Monte Carlo (MC) algorithm, Trial moves, MD and MC in various ensembles, thermostats, barostats etc. Hands-on simulations using GROMACS or LAMMPS or similar. Free energy calculations and phase equilibria. Various other applications of molecular mechanics calculations. State of the art development in the field, latest force fields, parameterization techniques etc. Introduction to density functional theory (DFT), Hands on simulations using any DFT packages such ADF or GAUSSIAN or GPAW or VASP or similar.

CHE F498 Colloids and Interface Engineering 3

Colloids – Intermolecular forces and Properties of the colloids. Interface and Surface active agents – Thermodynamics of interfaces, interfacial rheology and transport process, surface free energy, surface tension, thermodynamics of micelle and mixed micellar formation, electrical phenomena at interfaces. Emulsion, Micro emulsion and Foam – Preparation, mechanism and stabilization, characterization and application of foams. Measurement techniques – Interfacial tension, contact angle, zeta potential and particles size. Industrial applications – Applications of various interfacial phenomena in the industries. Nanomaterials – Application of surface active agent through the surface modifica-tion for the synthesis of nanostructured material.