Birla Institute of Technology & Science, Pilani
K K Birla Goa Campus

Department of Chemical Engineering (First Degree Compulsory Disciplinary Course Descriptions Sem. III onwards)

List of Compulsory Disciplinary Courses

S. No.	Course No.	Course Title	L	P	U
1.	CHE F211	Chemical Process Calculations	3	-	3
2.	CHE F212	Fluid Mechanics	3	-	3
3.	CHE F213	Chemical Engineering Thermodynamics	3	-	3
4.	CHE F214	Engineering Chemistry	3	-	3
5.	CHE F241	Heat Transfer	3	-	3
6.	CHE F242	Numerical Methods for Chemical Engineers	3	-	3
7.	CHE F243	Material Science and Engineering	3	-	3
8.	CHE F244	Separation Processes – 1	3	-	3
9.	CHE F311	Kinetics and Reactor Design	3	-	3
10.	CHE F312	Chemical Engineering Lab – 1	0	3	3
11.	CHE F313	Separation Processes – 2	3	-	3
12.	CHE F314	Process Design Principles – 1	3	-	3
13.	CHE F341	Chemical Engineering Lab – 2	0	3	3
14.	CHE F342	Process Dynamics and Control	3	-	3
15.	CHE F343	Process Design Principles - 2	3	-	3

SEMESTER III – YEAR 2

1. CHE C221 CHEMICAL PROCESS CALCULATIONS

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.

2. ENGINEERING CHEMISTRY

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

3. CHE C311 CHEMICAL ENGINEERING THERMODYNAMICS

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

4. FLUID MECHANICS

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

SEMESTER IV – YEAR 2

1. HEAT TRANSFER

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

2. NUMERICAL METHODS FOR CHEMICAL ENGINEERS

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

3. MATERIAL SCIENCE AND ENGINEERING

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

4. SEPARATION PROCESSES – 1

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

SEMESTER V – YEAR 3

1. CHEMICAL ENGINEERING LABORATORY– 1

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.

2. SEPARATION PROCESSES – 2

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.

3. CHE C312 KINETICS AND REACTOR DESIGN

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

4. PROCESS DESIGN PRINCIPLES – 1

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.

SEMESTER VI – YEAR 3

1. CHEMICAL ENGINEERING LABORATORY– 1

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.

2. PROCESS DYNAMICS AND CONTROL

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

3. PROCESS DESIGN PRINCIPLES – 2

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 flowsheets, Steps involved in designing configured industrial systems like solar desalinators, fuel cells, hand warmers etc.

List of Discipline Elective Courses

S. No.	Course No.	Course Title	L	P	U
1.	CHE F411	Environmental Pollution Control	3	-	3
2.	CHE F412	Process Equipment Design	3	-	3
3.	CHE C413	Process Plant Safety	3	-	3
4.	CHE C414	Transport Phenomena	3	-	3
5.	CHE F415	Molecular and Statistical Thermodynamics	3	-	3
6.	CHE F416	Process Plant Design Project 1	-	-	3
7.	CHE F417	Process Plant Design Project 2	-	-	3
8.	CHE F418	Modelling and Simulation in Chemical Engineering	3	-	3
9.	CHE F419	Chemical Process Technology	3	-	3
10.	CHE F421	Bio-chemical Engineering	3	-	3
11.	CHE F471	Advanced Process Control	3	-	3
12.	CHE F491	Special Projects	-	-	3

Some of the Higher Degree courses are also offered as electives to First Degree students provided all pre-requisites are met.