



School of Chemical Technology
Kalinga Institute of Industrial Technology (KIIT)
Deemed to be University U/S 3 of UGC Act, 1956

Curriculum and Syllabi

for

*Integrated Dual Degree Programme (BTech in Chemical Engineering and
MTech in Chemical Technology)
(2020-2025)*

and

*BTech in Chemical Engineering
(2020-2024)*

Integrated Dual Degree Programme Structure of BTech in Chemical Engineering and MTech in Chemical Technology

Detailed Curriculum							
First Year							
Semester-1				Semester-2			
Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
MA1003	Mathematics-I	3-1-0	4	MA1004	Mathematics-II	3-1-0	4
PH1007	Physics	3-1-0	4	CH1007	Chemistry	3-0-0	3
EE1003	Basic Electrical Engineering	3-0-0	3	HS1005	Professional Communication	2-0-0	2
ME1003	Engineering Mechanics	3-0-0	3	LS1001	Biology	2-0-0	2
PH1097	Physics Lab	0-0-3	1.5	CS1093	Computer Programming	0-2-6	4
EE1093	Basic Electrical Engineering Lab	0-0-4	2	CH1097	Chemistry Lab	0-0-3	1.5
ME1083	Basic Manufacturing Systems	0-1-2	2	HS1085	Language Lab	0-0-2	1
CH1081	Environmental Science	0-0-2	1	CE1083	Engineering Graphics	0-1-2	2
Total credit			20.5	Total Credit			19.5
Second Year							
Semester-3				Semester-4			
Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
MA2001	Mathematics-III	3-1-0	4	CL2002	Materials Science and Engineering	3-0-2	4
CL2003	Chemical Engineering Thermodynamics	3-0-2	4	CL2004	Numerical Methods in Chemical Engineering	3-1-0	4
CL2005	Chemical Process Calculation	3-1-0	4	CL2006	Process Heat Transfer	3-0-2	4
CL2007	Transport Phenomena	3-0-2	4	CL2008	Chemical Fluid Mechanics	3-0-2	4
CL2009	Basics of Solid Mechanics	3-1-0	4	CL2012	Principles of Management	3-0-0	3
	Humanities Elective-I	3-0-0	3		Humanities Elective-II	3-0-0	3
Total credit			23	Total credit			22
Summer Term (CL2081)		Industry Practice		Credit 2			
Third Year							
Semester-5				Semester-6			
Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
CL3001	Mass Transfer Operations-I	3-0-2	4	CL3002	Mass Transfer Operations-II	3-0-2	4
CL3003	Chemical Reaction Engineering	3-1-0	4	CL3004	Process Dynamics and Control	3-0-2	4
CL3005	Chemical Process Technology and Economics	3-1-0	4	CL3006	Chemical Reactor Design	3-1-0	4
CL3007	Process Equipment Design-I	2-0-2	3	CL3008	Chemical Process Modelling and Simulation	3-0-2	4
	Discipline Elective-I	3-0-0	3	CL3012	Process Equipment Design-II	2-0-2	3
	Humanities Elective-III	3-0-0	3		Discipline Elective-II	3-0-0	3
Total credit			21	Total credit			22
Fourth Year							
Semester-7				Semester-8			
Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
	Discipline Elective -III	3-0-0	3	CL4002	Computational Fluid Dynamics	3-0-2	4
	Discipline Elective -IV	3-0-0	3	CL4004	Biochemical Engineering	3-0-2	4
	Discipline Elective -V	3-0-0	3	CL4006	Fuel Engineering	3-0-2	4
	Open Elective -I	3-0-0	3	CL4008	Piping Engineering	3-0-2	4
	Open Elective -II	3-0-0	3	CL4012	Petroleum Refinery Engineering	3-0-2	4
	Open Elective -III	3-0-0	3				
Total credit			18	Total credit			20
Fifth Year							
Semester-9				Semester-10			
Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
CL5081	Industry Project-I / Internship-I Or Major Project-I		20	CL5082	Industry Project-II / Internship-II Or Major Project-II		20
Total credit				Total credit			

Credit Structure

S.No	Category of Courses	Credits
1	Science Foundation	13
2	Mathematics Foundation	12
3	Engineering Science	28
4	Humanities, Social Sciences and Management	15
5	Discipline Core	54
6	Discipline Electives	15
7	Dual Core	20
8	Open Electives	09
9	Capstone Project • Industry Project / Major Project	40

Total Credits

206

Science Foundation

Course Code	Course	L-T-P	Credits
PH 1003	Physics	3-1-0	4
PH 1097	Physics Lab	0-0-3	1.5
CH 1081	Environmental Science	0-0-2	1
CH 1007	Chemistry	3-0-0	3
CH 1097	Chemistry Lab	0-0-3	1.5
LS 1001	Biology	2-0-0	2
Total Credits			13

Mathematics Foundation

Course Code	Course	L-T-P	Credits
MA 1003	Mathematics-I	3-1-0	4
MA 1004	Mathematics-II	3-1-0	4
MA 2001	Mathematics-III	3-1-0	4
Total Credits			12

Engineering Science

Course Code	Course	L-T-P	Credits
EE 1003	Basic Electrical Engineering	3-0-0	3
EE 1093	Basic Electrical Engineering Lab	0-0-2	1
ME 1003	Engineering Mechanics	3-0-0	3
ME 1083	Basic Manufacturing Systems	0-1-2	2
CS 1093	Computer Programming	0-2-4	3
CE 1083	Engineering Graphics	0-1-2	2
CL2009	Mechanics of Solids	3-1-0	4
CL2002	Material Science and Engineering	3-0-2	4
CL2004	Numerical Methods in Chemical Engineering	3-1-0	4
CL2081	Industry Practice		2
Total Credits			28

Humanities, Social Sciences and Management

Course Code	Course	L-T-P	Credits
HS 1005	Professional Communication	2-0-0	2
HS 1085	Language Lab	0-0-2	1
CL2082	Principles of Management	3-0-0	3
	Humanities Elective I	3-0-0	3
	Humanities Elective II	3-0-0	3
	Humanities Elective II	3-0-0	3
Total Credits			15

Programme Structure of BTech in Chemical Engineering

Detailed Curriculum							
First Year							
Semester-1				Semester-2			
Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
MA1003	Mathematics-I	3-1-0	4	MA1004	Mathematics-II	3-1-0	4
PH1007	Physics	3-1-0	4	CH1007	Chemistry	3-0-0	3
EE1003	Basic Electrical Engineering	3-0-0	3	HS1005	Professional Communication	2-0-0	2
ME1003	Engineering Mechanics	3-0-0	3	LS1001	Biology	2-0-0	2
PH1097	Physics Lab	0-0-3	1.5	CS1093	Computer Programming	0-2-6	4
EE1093	Basic Electrical Engineering Lab	0-0-4	2	CH1097	Chemistry Lab	0-0-3	1.5
ME1083	Basic Manufacturing Systems	0-1-2	2	HS1085	Language Lab	0-0-2	1
CH1081	Environmental Science	0-0-2	1	CE1083	Engineering Graphics	0-1-2	2
Total credit			20.5	Total Credit			19.5
Second Year							
Semester-3				Semester-4			
Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
MA2001	Mathematics-III	3-1-0	4	CL2002	Materials Science and Engineering	3-0-2	4
CL2003	Chemical Engineering Thermodynamics	3-0-2	4	CL2004	Numerical Methods in Chemical Engineering	3-1-0	4
CL2005	Chemical Process Calculation	3-1-0	4	CL2006	Process Heat Transfer	3-0-2	4
CL2007	Transport Phenomena	3-0-2	4	CL2008	Chemical Fluid Mechanics	3-0-2	4
CL2009	Basics of Solid Mechanics	3-1-0	4	CL2012	Principles of Management	3-0-0	3
	Humanities Elective-I	3-0-0	3		Humanities Elective-II	3-0-0	3
Total credit			23	Total credit			22
Summer Term (CL2081)		Industry Practice		Credit 2			
Third Year							
Semester-5				Semester-6			
Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
CL3001	Mass Transfer Operations-I	3-0-2	4	CL3002	Mass Transfer Operations-II	3-0-2	4
CL3003	Chemical Reaction Engineering	3-1-0	4	CL3004	Process Dynamics and Control	3-0-2	4
CL3005	Chemical Process Technology and Economics	3-1-0	4	CL3006	Chemical Reactor Design	3-1-0	4
CL3007	Process Equipment Design-I	2-0-2	3	CL3008	Chemical Process Modelling and Simulation	3-0-2	4
	Discipline Elective-I	3-0-0	3	CL3012	Process Equipment Design-II	2-0-2	3
	Humanities Elective-III	3-0-0	3		Discipline Elective-II	3-0-0	3
Total credit			21	Total credit			22
Fourth Year							
Semester-7				Semester-8			
Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
	Discipline Elective -III	3-0-0	3		Discipline Elective -III	3-0-0	3
	Discipline Elective -IV	3-0-0	3		Discipline Elective -IV	3-0-0	3
	Discipline Elective -V	3-0-0	3		Discipline Elective -V	3-0-0	3
	Open Elective -I	3-0-0	3		Open Elective -I	3-0-0	3
	Open Elective -II	3-0-0	3		Open Elective -II	3-0-0	3
	Open Elective -III	3-0-0	3		Open Elective -III	3-0-0	3
CL4081	Or Industry Project / Internship OR Major Project		20	CL4082	Or Industry Project / Internship OR Major Project		20
Total credit			18 / 20	Total credit			18 / 20

Credit Structure

S.No	Category of Courses	Credits
1	Science Foundation	13
2	Mathematics Foundation	12
3	Engineering Science	28
4	Humanities, Social Sciences and Management	15
5	Discipline Core	54
6	Discipline Electives	15
8	Open Electives	09
9	Capstone Project • Industry Project / Major Project	20
Total Credits		166

Science Foundation

Course Code	Course	L-T-P	Credits
PH 1003	Physics	3-1-0	4
PH 1097	Physics Lab	0-0-3	1.5
CH 1081	Environmental Science	0-0-2	1
CH 1007	Chemistry	3-0-0	3
CH 1097	Chemistry Lab	0-0-3	1.5
LS 1001	Biology	2-0-0	2
Total Credits			13

Mathematics Foundation

Course Code	Course	L-T-P	Credits
MA 1003	Mathematics-I	3-1-0	4
MA 1004	Mathematics-II	3-1-0	4
MA 2001	Mathematics-III	3-1-0	4
Total Credits			12

Engineering Science

Course Code	Course	L-T-P	Credits
EE 1003	Basic Electrical Engineering	3-0-0	3
EE 1093	Basic Electrical Engineering Lab	0-0-2	1
ME 1003	Engineering Mechanics	3-0-0	3
ME 1083	Basic Manufacturing Systems	0-1-2	2
CS 1093	Computer Programming	0-2-4	3
CE 1083	Engineering Graphics	0-1-2	2
CL2009	Mechanics of Solids	3-1-0	4
CL2002	Material Science and Engineering	3-0-2	4
CL2004	Numerical Methods in Chemical Engineering	3-1-0	4
CL2081	Industry Practice		2
Total Credits			28

Humanities, Social Sciences and Management

Course Code	Course	L-T-P	Credits
HS 1005	Professional Communication	2-0-0	2
HS 1085	Language Lab	0-0-2	1
CL2082	Principles of Management	3-0-0	3
	Humanities Elective I	3-0-0	3
	Humanities Elective II	3-0-0	3
	Humanities Elective II	3-0-0	3
Total Credits			15

Discipline Core

Course Code	Course	L-T-P	Credits
CL2003	Chemical Engineering Thermodynamics	3-0-2	4
CL2005	Chemical Process Calculations	3-1-0	4
CL2007	Transport Phenomena	3-0-2	4
CL2006	Heat Transfer	3-0-2	4
CL2008	Fluid Mechanics	3-0-2	4
CL3001	Mass Transfer Operations-I	3-0-2	4
CL3003	Chemical Reaction Engineering	3-1-0	4
CL3005	Chemical Process Technology and Economics	3-1-0	4

CL3007	Process Equipment Design-I	2-0-2	3
CL3002	Mass Transfer Operations-II	3-0-2	4
CL3004	Process Dynamics and Control	3-0-2	4
CL3006	Chemical Reactor Design	3-1-0	4
CL3008	Chemical Process Modelling and Simulation	3-0-2	4
CL3012	Process Equipment Design-II	2-0-2	3
Total Credits		54	

Discipline Electives

Course Code	Course	L-T-P	Credits
CL3011	Basics of Polymer Science	3-0-0	3
CL3013	Interfacial Engineering	3-0-0	3
CL3015	Chemical Product Development	3-0-0	3
CL3017	Process Plant Safety	3-0-0	3
CL3022	Polymer Processing Technology	3-0-0	3
CL3024	Petroleum Reservoir Engineering	3-0-0	3
CL3026	Corrosion Engineering	3-0-0	3
CL3028	Materials Processing Technology	3-0-0	3
CL4011	Paint and Surface Coating Technology	3-0-0	3
CL4013	Instrumental Techniques of Chemical Analysis	3-0-0	3
CL4015	Petroleum Product Characterization	3-0-0	3
CL4017	Extractive Metallurgy	3-0-0	3
CL4018	Petrochemicals Technology	3-0-0	3
CL4019	Special Project		3
CL4020	Lab Project-I		3
CL4022	Design Project		3
CL4024	Computer Project		3
CL4026	Study Project		3
CL4028	Reading Course		3

Open Electives

Course Code	Course	L-T-P	Credits
CL4071	Pharmaceutical Technology	3-0-0	3
CL4073	Nanotechnology	3-0-0	3
CL4075	Ceramic Technology	3-0-0	3
CL4077	Catalysis	3-0-0	3
CL4079	Environmental Pollution Control	3-0-0	3
CL4081	Mineral Processing Technology	3-0-0	3
CL4083	IPR	3-0-0	3
CL4085	Lab Project-II		3

Humanities Electives

Course Code	Course	L-T-P	Credits
HM2001	Environmental Studies	3-0-0	3
HM2003	Srimad Bhagavad Gita	3-0-0	3
HM2005	Sankara's Thoughts	3-0-0	3
HM2007	Gandhian Thoughts	3-0-0	3
HM2009	Public Administration	3-0-0	3
HM3002	Dynamics of Social Change	3-0-0	3
HS2002	Engineering Economics	3-0-0	3
HM3004	Anthropology	3-0-0	3
HM3006	Principles of Economics	3-0-0	3
HM3008	Professional Ethics	3-0-0	3
HM4001	Reading Course		3

Dual Core

Course Code	Course	L-T-P	Credits
CL4002	Computational Fluid Dynamics	3-0-2	4
CL4004	Biochemical Engineering	3-0-2	4
CL4006	Fuel Engineering	3-0-2	4
CL4008	Piping Engineering	3-0-2	4
CL4012	Petroleum Refinery Engineering	3-0-2	4

Syllabus for BTech in Chemical Engineering / Integrated Dual Degree (BTech in Chemical Engineering and MTech in Chemical Technology)

Semester-3

MA2001 Mathematics-III

Partial Differential Equations: Basic concepts, Solution of PDE by Variable Separable method, Mathematical Modeling of one dimensional Wave equation and its solution, Classification of PDE and transformation into its Normal form, D'Alembert's solution of Wave equation, Solution of one dimensional Heat equation, Steady state flow of heat in a rectangular bar, Solution of one dimensional heat equation by Fourier Integral, Solution of two dimensional wave equation, Laplace Equation in Polar, Cylindrical and Spherical coordinates and applications. Solution of PDE by use of Laplace Transform

Complex Analysis: Complex Numbers and Functions: Basic concept, Complex functions, Derivatives, Analyticity, Cauchy Riemman equations, Exponential, Trigonometric, hyperbolic, Logarithmic functions, general powers, Complex integration: Line integral, Line Integral of independent path, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic function. Taylor's series, Maclaurin's series, Laurent's series, Expansion of functions, singularities, Residues, Residue Integration method, Evaluation of Real Integrals

Mapping: Conformal mapping and linear fractional transformation (LFT)

Text Book

1. Erwin Kryeszig, *Advanced Engineering Mathematics*, Wiley, INC, 9th Edition.
- B. V. Ramanna, *Higher Engineering Mathematics*, TMH

CL2003 Chemical Engineering Thermodynamics

Introduction and Basic Concepts, First Law of Thermodynamics, P-V-T Behaviour and Heat Effects, Second Law of Thermodynamics, Some Applications of the Laws Thermodynamics, Thermodynamic Properties of Pure Fluids, Properties of Solutions, Phase Equilibria, Chemical Reaction Equilibria

Text Book

2. K. V. Narayanan, *A Textbook of Chemical Engineering Thermodynamics*, PHI
3. J. M. Smith, *Introduction to Chemical Engineering Thermodynamics*, TMH

CL2005 Chemical Process Calculation

The chemical equation & stoichiometry, concept of limiting & excess reactants, conversion, degree of conversion, yield etc, Ideal gas laws, equation of state, Vapor pressure, Clausius-Clapeyron equation, humidity-relative saturation & percentage saturation, concept of wet & dry bulbs thermometer, use of humidity Chart, Material balances & unit operation-drying,

crystallization dissolution, combustion, Solving material balance with Chemical reaction, recycle, bypass & purge Calculations, Energy balance concepts & units, Heat capacity, Calculation of enthalpy changes without change of phase, Energy balance with Chemical reaction, Standard heat of reaction at constant, pressure & constant volume, effect of temperature, on heat of reaction, Adiabatic reaction of temperature, heat of solution & mixing

Text Book

1. B I Bhatt, M Vora, *Stoichiometry*, TMH
2. D. M. Himmelblau, *Basic Principles and Calculations in Chemical Engineering*, 6th Ed., PHI

CL2007 Transport Phenomena

Introduction to transport phenomena; molecular transport mechanisms and general properties; analogies amongst momentum, heat, and mass transport; boundary layer analysis for momentum, heat, & mass transfer; estimation of transport coefficient, non-Newtonian fluids, rheological characteristics of materials, agitation of non-Newtonian fluids. Heat & mass transfer with chemical reaction; Diffusion and chemical reaction inside a porous catalyst

Text Book

1. B. R. Bird, E. W. Stewart, N. E. Lightfoot, *Transport Phenomena*, 2nd Ed., John Wiley & Sons
2. W. L. McCabe, J. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, 6th Ed., TMH

CL2009 Basic Solid Mechanics

Simple Stresses and Strains, Principal Stresses and Strains, Bending Moments and Shearing Forces, Bending Stresses in Beams, Combined Direct and Bending Stresses, Shearing Stresses, Fixed and Continuous Beams, Thin Shells, Torsion of Circular and Non-circular Shafts, Springs, Strain Energy and Deflection Due to Shear and Bending, Theories of Failure, Stresses Due to Rotation, Centroid and Moment of Inertia, Unsymmetrical Bending and Shear Centre

Text Book

1. S. S. Rattan, *Strength of Material*, TMH
2. R. K. Rajput, *Strength of Material*, S. Chand and Co.

Semester-4

CL2002 Materials Science and Engineering

Atomic structure and interatomic bonding; structure of crystalline solids; imperfections; diffusion; Mechanical properties of metals; dislocation; strengthening; failure; phase diagram; structure, properties, applications, processing of ceramics and polymers; composites; corrosion

degradation of materials; corrosion protection; electrical, thermal, magnetic and optical properties; property requirements and material selection.

Text Book

1. V. Raghavan, *Materials Science and Engineering: A First Course*, PHI
2. William D. Callister Jr, *Materials Science and Engineering*, Wiley India (P) Ltd

CL2004 Numerical Methods in Chemical Engineering

Introduction to numerical methods: Understanding sources of errors; round-off errors, truncation errors, floating point arithmetic, Convergence, Solution of linear systems: Gauss elimination, Gauss Jordan elimination, Gauss-Seidel method, Diagonal dominance, Banded matrices, storage schemes for banded matrices, skyline solver, Solution of non-linear systems: Newton Raphson method, Local and global minimum, rates of convergence, convergence criteria, conjugate gradient method, Ordinary Differential Equations: Taylor series, Euler method, Runge-Kutta method, Finite Difference Method, Partial Differential Equations: Finite Difference Method – Laplace equation, Poisson equation, 1-D heat equation, 1-D wave equation.

Text Book

1. S. C. Chapra and R. P. Canale, *Numerical Methods for Engineers*, TMH
2. P. Ahuja, *Introduction to Numerical Methods in Chemical Engineering*, PHI

CL2006 Process Heat Transfer

Basic modes of heat transfer. Conduction: basic equations of one-dimensional, two-dimensional and three-dimensional conduction; steady conduction in slabs, cylinders and spheres; critical thickness of insulation; transient conduction: analytical solution for slabs; use of transient temperature charts for slabs, cylinders, and spheres; lumped system of analysis. Convection: equation of motion; equation of energy; hydrodynamic and thermal boundary layers; forced convection inside tubes, over cylinders and spheres; natural convection, Empirical equations for free and forced convection; boiling and condensation heat transfer; basic types of heat exchangers; overall heat transfer coefficient; LMTD method, effectiveness-NTU method. Radiation: black body and gray body radiation; shape factor; Kirchhoff's law; Radiation shields; radiation from gases. Evaporation: evaporator capacity, economy and types; single and multiple effect evaporators, forward and backward feed evaporation, evaporator calculations.

Text Book

1. D.Q. Kern, *Process Heat Transfer*, 2nd Ed., TMH
2. B. K. Dutta, *Heat Transfer*, PHI
3. W. L. McCabe, J. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, TMH

CL2008 Chemical Fluid Mechanics

Properties and classification of fluids; fluid statics; velocity field; stream function; irrotational flow; integral and differential analysis for fluid motion: Reynolds' transport theorem; Navier-Stoke's equation; Euler & Bernoulli's equation; dimensional analysis and similitude; internal and external fluid flow: friction factor; energy losses in fittings, valves etc.; flow measuring devices; fluid machinery: pump, blower; agitation; introduction to non-Newtonian fluid; introduction to compressible flow.

Text Book

1. R. W. Fox and A. T. McDonald, *Introduction to Fluid Mechanics*, John Wiley & Sons
2. W. L. McCabe, J. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, TMH
3. B. R. Bird, E. W. Stewart, and N. E. Lightfoot, *Transport Phenomena*, John Wiley & Sons

CL2012 Principles of Management

Management: Science, Theory, and Practice, Management and Society: The External Environment, Social Responsibility, and Ethics, Global, Comparative, and Quality Management Essentials of Planning and Managing by Objectives, Strategies, Policies, and Planning Premises, Decision Making, The Nature of Organizing, Entrepreneurship, and Reengineering

Text Book

1. Harold Koontz and Heinz Weihrich, *Essentials of Management*, TMH

Semester-5

CL3001 Mass Transfer Operations-I

Concepts of molecular diffusion and mass transfer coefficient; interphase mass transfer; the equilibrium stage approximation; conservation relations; reflux; constant molal overflow; batch distillation; Ponchon-Savarit and McCabe-Thiele analysis of binary distillation; introduction to multi-component distillation; equilibrium solubility of gases in liquids; counter-current multi-stage absorption; continuous contact equipment; multi-component systems; absorption with chemical reaction.

Text Book

1. R. E. Treybal, *Mass Transfer Operations*, 3rd Ed., TMH
2. B. K. Dutta, *Principles of Mass Transfer and Separation Processes*, PHI

CL3003 Chemical Reaction Engineering

Classification of chemical reactions; single, multiple, elementary and nonelementary homogeneous reactions; order and molecularity; temperature dependency; constant and variable volume batch reactor; reaction rate; rate constant; collection and interpretation of kinetic data; parallel and series reaction; batch, ideal plug flow and CSTR; temperature and pressure effects; Residence Time Distribution.

Text Book

1. O. Levenspiel, *Chemical Reaction Engineering*, 2nd Ed., Wiley Eastern
2. S. C. Roy, C. Guha, *A Text Book of Chemical Reaction Engineering*, Dhanpat Rai & Co.

Reference:

1. J. M. Smith, *Chemical Engineering Kinetics*, TMH
2. H. S. Fogler, *Elements of Chemical Reaction Engineering*, Prentice Hall

CL3005 Chemical Process Technology and Economics

Raw materials and principles of production of olefins and aromatics; typical intermediates from olefins and aromatics such as ethylene glycol, ethyl benzene, phenol, cumene and DMT, dyes, and pharmaceuticals; chemical processes based on raw materials sugar, starch, alcohol, cellulose, paper, glyceride, oils, soaps, detergents; industrial processes for the production of inorganic heavy chemicals such as acids, alkalis, salts, and fertilizers such as sulphuric, nitric, and phosphoric acids, soda ash, ammonia, etc.

Text Book

1. C. L. Dryden, *Outlines of Chemical Technology*, Affiliated East West, New Delhi
2. T. G. Austin and S. Shreve, *Chemical Process Industries*, TMH

CL3007 Process Equipment Design-I

Design of pressure vessel and vessel accessories like heads, nozzles, flanges, openings and supports; computer aided design (CAD) of heat exchanger; mechanical and fabrication aspects; Design of condenser, reboiler, and evaporator.

Text Book

1. B. C. Bhattacharyya, *Introduction to Chemical Equipment Design*, CBS Publishers & Distributors, New Delhi, 2003.
2. J. M. Coulson, J. F. Richardson and R. K. Sinnott, *Coulson and Richardson's Chemical Engineering: Chemical Engineering Design (Vol. 6)*, 3rd Ed. (Indian Print), Butterworth-Heinemann, 2004.

Semester-6

CL3002 Mass Transfer Operations-II

Simultaneous Heat and Mass Transfer; Drying: rate of drying for batch and continuous dryers; Humidification and Dehumidification: design of cooling towers; Adsorption: types and nature of adsorption, isotherm, stage wise and continuous adsorption; fixed, fluidized and moving beds; ion-exchange; Extraction: triangular diagram; Leaching: single and multistage operation, equipment for leaching; Crystallization: Millers theory, yield calculations, crystallizers; Membrane processes: liquid & gas separation processes, microfiltration, ultra-filtration, nanofiltration, reverse osmosis.

Text Book

1. R. E. Treybal, *Mass Transfer Operations*, 3rd Ed., TMH
2. B.K. Dutta, *Principles of Mass Transfer and Separation Processes*, PHI

CL3004 Process Dynamics and Control

First Principles model development; dynamics of first, second and higher order linear systems, open loop and closed loop systems; linearisation; feed back control; stability; root locus diagram; frequency response analysis; Bode stability criterion; Nyquist stability criterion; design of controller; dynamics of some complex processes; control valves and introduction to real time computer control of process equipment; cascade, feed forward, adaptive control; SISO; MIMO; A/D conversion, PLC architecture; Multi-variable control strategies.

Text Book

1. G. Stephanopoulos, *Chemical Process Control: An Introduction to Theory and Practice*, Prentice Hall of India.

References:

1. S. S. Bhagade, G. D. Nageshwar, *Process Dynamics and Control*, Prentice Hall of India.
2. D. R. Coughanowr, and L. B. Koppel, *Process systems Analysis and Control*, 2nd Ed., McGraw-Hill, 1991.

CL3006 Chemical Reactor Design

Heterogeneous reaction kinetics; selectivity; heterogeneous reactors: fluid-solid catalytic fixed bed reactor design principles; isothermal, adiabatic and non-isothermal operations; gas-solid non-catalytic reactor design; fluidized bed reactors; thermal stability in reactor operation

Text Book

1. O. Levenspiel, *Chemical Reaction Engineering*, 2nd Ed., Wiley Eastern
2. S.C. Roy, S.C. Guha, *A Text Book of Chemical Reaction Engineering*, Dhanpat Rai & Co.

Reference:

1. J. M. Smith, *Chemical Engineering Kinetics*, TMH
2. H. S. Fogler, *Elements of Chemical Reaction Engineering*, Prentice Hall

CL3008 Chemical Process Modeling and Simulations

Principle of formulations, Mathematical consistency of model, Continuity equations, Component continuity equations, Energy equations, Equations of motion, Transport equations, Equilibrium, Chemical Kinetics with examples, Modeling of chemical kinetics and reactor designs, Solve above developed modeling equations using polymath/matlab/c++

Text Book

1. Mickley H. S., Sherwood T. S., Reed C. E., *Application of Mathematical Modeling in Chemical Engineering*, Tata-McGraw-Hill

2. Lubyen W. L., Process Modeling, Simulation and Control for Chemical Engineers, McGraw-Hill, New York, 1989.
3. Kayode Coker, Modelling of Chemical Kinetics and Reactor Design, Gulf professional publication

CL3012 Process Equipment Design-II

Mechanical operations in chemical engineering, properties and storage of solids, size reduction of solids, solid-solid separation, solid-liquid separation, solid-gas separation, transportation of solids, mixing of solids, design of equipments and operational significance

Text Book

1. W. L. McCabe, J. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, 6th Ed., Mc-Graw Hill
2. A. K. Swain, H. Patra, G. K. Roy, *Mechanical Operations*, Mc-Graw Hill

References:

1. Richard G. Holdich, *Fundamentals of Particle Technology*, Midland Information Technology and Publishing, 2002.
2. Martin J. Rhodes, *Introduction to Particle Technology*, John Wiley & Sons 2008.

Semester-8

CL4002 Computational Fluid Dynamics

Introduction to floating point arithmetic. Introduction to numerical methods for Euler and Navier-Stokes equations with emphasis on error analysis, consistency, accuracy and stability, Modified equation analysis (dispersion vs. dissipation) and Von Neumann stability analysis, Finite difference methods, finite volume and spectral element methods, Explicit vs implicit time stepping methods, Solution of systems of linear algebraic systems, Higher-order vs higher resolution methods. Computation of turbulent flows, Compressible flows with highresolution shock-capturing methods (e.g. PPM, MUSCL, WENO), Theory of Riemann problems and weak solutions for hyperbolic equations

Text Book

1. Ferziger, J. H., Peric, M., *Computational Methods for Fluid Dynamics*, 3rd ed., Springer
2. Pletcher, R. H., Tannehill, J. C., Anderson, D., *Computational Fluid Mechanics and Heat Transfer*, CRC Press

CL4004 Biochemical Engineering

Introduction. Microbiology: Cell structure, characterization, classification of microorganisms; environmental and industrial microbiology; cell nutrients and growth media. Chemicals of Life: Repetitive and non repetitive biological polymers, lipids, fatty acids and other related lipids, carbohydrates, mono-, di- and polysaccharides, amino acids and proteins, structure of proteins,

protein denaturation and renaturation, antibodies, nucleic acids, nucleotides to RNA and DNA, DNA double helix model. Kinetics of Enzyme-Catalyzed Reactions: Chemical kinetics fundamentals, introduction to enzymes, classification of enzymes, enzymes of industrial importance, enzyme catalyzed reactions and kinetics, determination of kinetic parameters, inhibitors and inhibition kinetics, enzyme deactivation, immobilized enzyme technology. Metabolism and Bioenergetics: Thermodynamic principles, metabolic pathways for carbohydrates, lipids and proteins; ATP, TCA cycles etc. Cell Growth and Product Formation: Growth patterns and kinetics in batch culture, models with growth inhibitors, the ideal chemostat; Stoichiometry of microbial growth, theoretical prediction of yield coefficients. Bioprocess Systems: Transport phenomena in bioprocesses, mass transfer in bioreactors, solid-liquid mass transfer, power requirement, heat transfer; Various types of bioreactors, Scale-up and its difficulties; Downstream Processing: Strategies to recover and purify products Control of microorganism: Control fundamentals, antimicrobial action, control of microorganisms by physical and chemical method

Text Book

1. P. M. Duran, *Principles of Bioprocess Engineering*, Academic Press
2. M. L. Schuler and F. Kargi, *Bioprocess Engineering: Basic Concepts*, PHI

References

1. James Bailey & David Ollis, *Biochemical Engineering Fundamentals*, TMH

CL4006 Fuel Engineering

Conventional and non-conventional energy sources; solar energy; wind energy; energy from biomass; energy survey in India, Solid fuels: origin and composition of coal; analysis and properties of coal; coal classification; properties and storage of coal; coal carbonization, gasification and liquefaction. Liquid fuels: origin and composition of petroleum; petroleum processing; petroleum refining in India. Combustion process: combustion stoichiometry and combustion thermodynamics; gas burners; oil burners; coal burning equipment

Text Book

1. S. Sarkar, *Fuel & combustion*, 2nd Ed., Orient Longman
2. J. G. Speight, *Fuel Science & Technology Handbook*, Dekker

CL4008 Piping Engineering

Basics of fluid mechanics, dynamics of inviscid flows, flows with a free surface, flows through pipes, compressible flow, basics of pipe designing, applications

Text Book

1. S K Som, Gautam Biswas and S Chakraborty, *Introduction To Fluid Mechanics & Fluid Machines*, TMH

2. B. R. Bird, E. W. Stewart, and N. E. Lightfoot, *Transport Phenomena*, John Wiley & Sons

CL4012 Petroleum Refinery Engineering

Origin and occurrence, composition, classification and physico-chemical properties of petroleum; testing and uses of petroleum products; refining Processes such as distillation, cracking, reforming; conversion of petroleum gases into motor fuel, aviation fuel; lubricating oils and petroleum waxes; chemicals and clay treatment of petroleum products, desulfurization; refining operations -Dehydration, Desalting, Gas separation, Natural gas production and gas sweetening; tube still heater design; product profile of petrochemicals; petrochemical feed stocks; olefin and aromatic hydrocarbons production; Treatment and upgrading of olefinic C4 and C5 cuts; chemicals from C1 compounds, ethylene and its derivatives, propylene and its derivatives, butadiene and butene; BTX chemicals

Text Book

1. W.L. Nelson, *Petroleum Refinery Engineering*, McGraw Hill,
2. J. H. Gary and G. E. Handwork, *Petroleum Refining Technology and Economics*, Dekker

Discipline Electives

CL3011 Basics of Polymer Science

Polymerization, Step-Reaction (Condensation) Polymerization, Radical Chain (Addition) Polymerization, Ionic and Coordination Chain (Addition) Polymerization, Copolymerization, Polymerization Conditions and Polymer Reactions, Characterization, Polymer Solutions, Measurement of Molecular Weight and Size, Analysis and Testing of Polymers, Structure and Properties, Morphology and Order in Crystalline Polymers, Rheology and the Mechanical Properties of Polymers, Polymer Structure and Physical Properties

Text Book

1. Fred W. Billmeyer, *Textbook of Polymer Science*, Wiley
2. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, *Polymer Science*, New Age International

CL3013 Interfacial Engineering

Phenomenology of colloidal materials; Brownian diffusion; long range van der Waals forces; double layer forces and short range forces; DLVO theory of stability of lyophobic colloids; electrokinetic phenomena; association colloids; interfacial tension; wetting and contact angle; capillary hydrostatics; interfacial rheology and stability; some selected applications of principles of colloid and interface science in detergents, personal products, pharmaceuticals, food, textile, paint and petroleum industries

Text Book

1. P. C. Hiemenz and R. Rajgopalan, *Principles of Colloid and Surface Chemistry*, Dekker
2. P. Ghosh, *Colloid and Interface Science*, PHI
3. Shaw Duncan J., *Introduction to Colloid and Surface Chemistry*, Butterworth-Heinemann Ltd

CL3022 Polymer Processing Technology

Properties of Commercial Polymers, Hydrocarbon Plastics and Elastomers, Other Carbon-Chain Polymers, Heterochain Thermoplastics, Thermosetting Resins, Polymer Processing, Plastics Technology, Fiber Technology, Elastomer Technology

Text Book

1. Fred W. Billmeyer, *Textbook of Polymer Science*, Wiley
2. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, *Polymer Science*, New Age International

CL4011 Paint and Surface Coating Technology

Unit-1: Surface Chemistry and Surface Engineering

Application of surface chemistry, Interfacial tension, Free energy changes, wetting & emulsification; Chemistry & Technology of Surfactants, Introduction; Electroplating; Thermal Spray Coating; Cold Gas Dynamic Coating; Diffusion Coating; CVD & PVD; Plasma Immersion Ion implantation; DLC thin film; Sol Gel Coating; Laser Assisted Surface Engineering; Micro Arc Oxidation; Electro Spark Coating etc.

Unit-2: Chemistry & Technology of pigments

Concept of Dyes & Pigments: Lakes, Tonner, Resinated pigments, Flushed Colors, Dispersed Colors; Chemistry and Technology of Organic Pigments: Azo Pigments, Benzimidazolone dioxazines, Naphthol AS Pigments, perylenes, Phthalocyanines, Quinacridones etc. Technology & Applications of High Performance Pigments & Special Effect Pigments Types, preparation, and applications of Metallic Driers; Additives used in aqueous and non-aqueous paint systems for wetting and dispersion, Storage stability and application properties Solvents: Classification of Solvents, their characteristics, uses and application. Plasticizers: Classification, Characterization, Theory and application

Unit-3: Coating Properties & Analysis of Coating

Study of important characteristics of surface coating viz. Rheological properties, Optical Properties, Adhesion and Mechanical properties, Corrosion and Chemical resisting properties, Film thickness, Liquid Paint analysis according to ASTM, BIS and BS Standards, Characterization of Varnishes according to ASTM, BIS and BSS Standards.

Text Book

1. R. Lambourne & T.A. Stevens, *Paints and surface coatings -Theory & Practice*, 2nd ed., William Andrew Publishing, 1999.
2. WM Morgan, *Outlines of Paint Technology*, 3rd Ed, CBS Publishers & Distributors, 1996

Reference:

1. Swaraj Paul, Surface coating, 2nd ed., John Wiley & Sons Ltd, 1996
2. Surface Coatings – Raw Materials & Their Usage, OCCA-VOI I “Chapman and Hall”, NY, 1993

CL4013 Instrumental Techniques of Chemical Analysis

Unit-1: General Introduction to Spectroscopy

Define Spectroscopy, Types of spectroscopy, Absorption spectrum, Emission spectra, Wave length and Wave number, Electromagnetic radiation, visible spectrum, Stokes’s shift, Hypochromicity, transmittance

Unit-2: Introduction, basic principles and instrumentation of spectroscopy

UV/visible and Infrared Spectroscopy, Flame Photometry, Atomic Absorption Spectroscopy, Raman spectroscopy and Mass Spectrometry

Unit-3: Introduction to Chromatography

Classification – Theory – distribution coefficient, rate of travel, retention time, retention volume, adjusted retention volume, specific retention volume, column capacity, separation number, peak capacity, shapes of chromatic peak, column efficiency, resolution, optimization of column performance, Chromatogram, Void volume, TLC, GC, HPLC

Texts:

1. R.M. Silverstein and W.P. Webster, spectrometric Identification of organic compounds, 6th Edition, Wiley & Sons, 1999
2. K. Sharma, Instrumental Methods of Chemical Analysis, Goel Publishing House
3. Chatwal Anand, Instrumental Methods of Chemical Analysis, 3rd Edition, Himalaya Publishing House
4. G.W. Ewing, Instrumental methods of Chemical Analysis, 5th Edition, McGraw-Hill

References:

1. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt and J.A. Dean and F. A. Settle, CBS Publishers, 7th Edition, 1988

CL4017 Extractive Metallurgy

General principles of extraction of metals from oxides and sulphides; Mineral resources of non – ferrous metals in India; their production, consumption and demand; Future of non – ferrous metal industries in India; Kinetics of leaching of ores and the effects of operation variables, Aluminium: Bayer’s process and factors affecting its operation; Hall – Heroult process: principle & practices, use of electrodes, anode effect; Refining of Aluminium; Alternative methods of Alumina and Aluminium production, Copper: Roasting of sulphides; Matte smelting; Converting; Refining; By – products recovery; Recent developments; Continues copper production processes, hydrometallurgy of copper, Zinc: Pyrometallurgy of zinc; principles and practices of roasting, sintering and smelting; Hydrometallurgy of zinc.

Lead: Roasting and agglomeration of galena concentrate; Blast furnace smelting, Refining of lead bullion. Uranium: Processes for the digestion of Uranium ores; Purification of crude salts; Production of reactor grade UO₂, Titanium: Methods for upgrading ilmenite; Chlorination of

titanium; Kroll & Hunter processes; Consolidation and refining. Other Metals: Simplified flow sheets and relevant chemical principles of extraction of Ni, Mg, Au, Be, etc.

Text Book

1. Principles of Extractive Metallurgy, H S Ray & A Ghosh, New Age International
2. Chemical Metallurgy, Chiranjib Kumar Gupta, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim

Open Electives

CL4071 Pharmaceutical Technology

Unit-1: Principles of Pharmaceutical Processing

Mixing, milling, drying, compression and consolidation of powdered solids, emulsion and suspension dosage forms, pharmaceutical rheology, clarification and filtration

Unit-2: Pharmaceutical Dosage Forms

Preformulation, tablets and tablet coatings, capsules, sustained release dosage forms, pharmaceutical suspensions, emulsions, pharmaceutical aerosols

Unit-3: Product Processing, Packaging, Evaluation, and Regulations

Pilot plant scale-up techniques, packaging materials science, kinetic principles and stability testing, drug regulatory affairs

Text Book

1. The Theory and Practice of Industrial Pharmacy by Lachman, Lieberman and Kanig

References:

1. Modern Pharmaceutics, Marcel Dekker by Banker, G.S. and C.T. Rhodes

CL4073 Nanotechnology

Unit-1: The Science of Nanotechnology Nanotechnology: Definition of nano scale with reference to biosystems, Scope (Overview of current industry applications) and future prospects (Engineering principles for nanotechnology materials and applications). Physics of nano-structure - Quantum Size effect - optical properties, Semiconductor (magnetic, organic, and doped nanoparticles), Synthesis of bio-metric materials (Quantum dot, thin film etc) – Characterization techniques - Role of surfaces in nanotechnology devices – Nano fabrication nanotubes, nano-probes – biosensor, Brownian motions and Particle diffusion, Dispersion stability, Tuning interparticle interaction forces to generate different types of nano-structured materials, Principle of Bragg diffraction, Rheology, the science of flow (understanding mechanical properties of materials).

Unit-2: Techniques in Nanotechnology Nanomaterials: Polymers, Carbon Nanotubes, Nanowires, Nanocrystals, and Quantum Dots, Synthesis of nanomaterials, Top-down and bottom-up approach, Analytical Techniques used in nanotechnology for Particle Size

characterization of nanomaterials: SEM (scanning electron microscopy), Dynamic Light Scattering (DLS), Transmission Electron Microscopy (TEM), XRay Diffraction (XRD), Atomic Force Microscopy (AFM), Spectroscopic characterization (UVVisible).

Unit-3: Properties of nanomaterials Introduction, nanochemistry including self-assembly of materials; nanoparticles, carbon nanotubes, nanocomposites; synthesis and characterization of such materials Unit -4 Nanobiology: Introduction to nanobiology, bionanotechnology, nanobiochemistry, molecular nanotechnology, Nanosomes, Benefits of molecular nanotechnology)

Text Book

1. Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005

References:

1. C. N. R. Rao, A. Muller, A. K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag GmbH & Co, Weinheim, 2004
2. G. Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004.

CL4083 IPR

Unit-1: Definition of Property and various types of property: Historical development of property rights. Conceptual understanding of discovery enabled science and innovation. Basic Concepts of intellectual Property: Introduction to intellectual property rights, Intellectual property Law, Unit-2 Various forms of IPR: Patent, Copyright, trademark, Industrial Design, Geographical indication Trade Secret General Agreement on Tariffs and Trade (GATT), Trade Related Aspects of Intellectual Property rights (TRIPS), Importance of IPR in the field of Science and Technology.

Unit -3 IPR Laws: Rights of Patent; Patent Infringement, remedies for infringement for patent rights; Indian Patent Act 1970 and TRIPS; Major changes in Indian Patent system as post TRIPS effect; Draft of National Intellectual Property Policy; 2003 and 2005 amendments Content of Patent specification and procedure for patent; (a) Obtaining patent, (b) Geographical Indication, (c) WTO, Detailed Information on Patenting Biological Products, Cartagena Protocol.

Text Book

1. Intellectual property Rights and the law .Gogia Law agency

HM4001 Personality Development

The concept of Personality: significance of personality development, Dimensions of theories of Freud & Erickson- personality, The concept of success and failure, Attitude & Motivation: importance of Positive attitude & Self-motivation; self-esteem and character-building, Time Management, Decision making skills, Promoting Creative & Critical Thinking, Employability quotient: Participating in GD & Facing Mock interviews, Psychometric Test and Analysis,

Text Books

1. Alex, K. Soft Skills: Know yourself and Know the World. S.Chand.
2. Onkar, R. M. Personality Development and Career Management. S.Chand.
3. Rizvi, A. Effective Technical Communication. TMGH.