S Y L L A B U S

CHEMICAL ENGINEERING
(Semester Scheme)

B.Tech., Second Year Examination, 2016
B.Tech., Third Year Examination, 2017
B.Tech., Fourth Year Examination, 2018

JODHPUR NATIONAL UNIVERSITY
JODHPUR.

Jodhpur National University, Jodhpur
Teaching & Examination Scheme
B.Tech II Year (Chemical Engineering)

III Semester

A: THEORY PAPERS						
S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	BCH 301	Mathematics – I	3	-	100	03
2.	BCH 302	Computer Programming	3	1	100	03
3.	BCH 303	Fluid Flow Operations	3	1	100	03
4.	BCH 304	Chemical Engineering Thermodynamics	3	1	100	03
5.	BCH 305	Heat Transfer Operations – I	3	1	100	03
6.	BCH 306	Material Science	3	1	100	03
		TOTAL	18	05	600	

B: PRACTICAL AND SESSIONALS				
S. No.	Code No.	Subject	P	MM
1.	BCH 307	Computer Lab.	3	100
2.	BCH308	Fluid Flow operation Lab.	3	100
3.	BCH 309	Heat Transfer Operation –I	3	100
4.	BCH 310	Chemical Process Calculations Lab.	3	100
		TOTAL	12	400
		GRAND TOTAL		1000

Jodhpur National University, Jodhpur
Teaching & Examination Scheme
B.Tech II Year (Chemical Engineering)
IV Semester

A: THEORY PAPERS						
S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	BCH 401	Mathematics – II	3	1	100	03
2.	BCH 402	Elements of Equipment Design	3	1	100	03
3.	BCH 403	Computer Oriented Numerical Analysis	3	0	100	03
4.	BCH 404	Heat Transfer Operation –II	3	1	100	03
5.	BCH 405	Chemical Process Economics	3	0	100	03
6.	BCH 406	Process Instrumentation and Control	3	1	100	03
		TOTAL	18	04	600	

B: PRACTICAL AND SESSIONALS				
S. No.	Code No.	Subject	P	MM
1.	BCH 407	Chemical Analysis Lab.	3	100
2.	BCH 408	Computer Oriented Numerical Analysis Lab.	3	100
3.	BCH 409	Heat Transfer Operation – II Lab.	3	100
4.	BCH 410	Process Instrumentation Control Lab.	3	100
		TOTAL	12	400
		GRAND TOTAL		1000

Jodhpur National University, Jodhpur
Teaching & Examination Scheme
B.Tech III Year (Chemical Engineering)
V Semester

A: THEORY PAPERS						
S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	BCH 501	Chemical Technology – I	3	1	100	03
2.	BCH 502	Fluid Particle Dynamics	3	1	100	03
3.	BCH 503	Chemical Reaction Engineering	3	0	100	03
4.	BCH 504	Mass Transfer Operation – I	3	1	100	03
5.	BCH 505	Process Dynamics and Control	3	0	100	03
6.	BCH506	Elective -I	3	1	100	03
		TOTAL	18	04	600	

B: PRACTICAL AND SESSIONALS				
S. No.	Code No.	Subject	P	MM
1.	BCH 507	Fluid Particle Dynamics Lab.	3	100
2.	BCH 508	Chemical Reaction Engineering – I Lab.	3	100
3.	BCH 509	Mass Transfer Operation – I	3	100
4.	BCH 510	Process Dynamics and Control Lab.	3	100
		TOTAL	12	400
		GRAND TOTAL		1000

Jodhpur National University, Jodhpur
Teaching & Examination Scheme
B.Tech III Year (Chemical Engineering)

VI Semester

A: THEORY PAPERS						
S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	BCH601	Chemical Reaction Engineering – II	3	1	100	03
2.	BCH602	Mass Transfer Operation – II	3	1	100	03
3.	BCH603	Chemical Equipment Design	3	0	100	03
4.	BCH604	Chemical Technology –II	3	0	100	03
5.	BCH605	Industrial Management	3	1	100	03
6.	BCH606	Elective – II	3	1	100	03
		TOTAL	18	04	600	

B: PRACTICAL AND SESSIONALS				
S. No.	Code No.	Subject	P	MM
1.	BCH 607	Mass Transfer Operation – II	3	100
2.	BCH 608	Chemical Equipment Design Lab.	3	100

3.	BCH 609	Chemical Reaction Engineering – II Lab.	3	100
4.	BCH 610	Seminar	3	100
		TOTAL	**12**	**400**
		GRAND TOTAL		**1000**

Jodhpur National University, Jodhpur
Teaching & Examination Scheme
B.Tech IV Year (Chemical Engineering)
VII Semester

A: THEORY PAPERS						
S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	BCH 701	Safety in Chemical Process Plants	3	1	100	03
2.	BCH702	Molecular Biology	3	0	100	03
3.	BCH 703	Mathematical Methods In Chemical Engineering	3	1	100	03
4.	BCH 704	Petroleum Refining	3	0	100	03
5.	BCH 705	Elective - III	3	1	100	03
6.	BCH 706	Elective – IV	3	1	100	03
		TOTAL	**18**	**04**	**600**	

B: PRACTICALS AND SESSIONALS				
S. No.	Code No.	Subject	P	MM
7.	BCH 707	Chemical Technology Lab.	3	50
8.	BCH 708	Petroleum Analysis Lab.	3	100
9.	BCH 709	Practical Training	2	100
10.	BCH 710	Project	2	150
		TOTAL	**10**	**400**
		GRAND TOTAL		**1000**

Jodhpur National University, Jodhpur
Teaching & Examination Scheme
B.Tech IV Year (Chemical Engineering)
VIII Semester

A: THEORY PAPERS						
S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	BCH 801	Transport Phenomena	3	1	100	03
2.	BCH 802	Chemical Engineering Optimization	3	0	100	03
3.	BCH 803	Bio Chemical Engineering	3	1	100	03
4.	BCH 804	Elective – V	3	1	100	03
		TOTAL	**12**	**03**	**400**	

B: PRACTICAL AND SESSIONALS		

S. No.	Code No.	Subject	P	MM
5.	BCH 805	Industrial Tour	3	100
6.	BCH 806	Transport Phenomena Lab.	3	100
7.	BCH 807	Chemical Engineering Optimization	3	100
8.	BCH 808	Elective-VI	2	100
9.	BCH 809	Project-Part II	4	200
		TOTAL	**15**	**600**
		GRAND TOTAL		**1000**

BCH 301   MATHEMATICS-I

L-3,   **Exam. Hrs.:- 3**
                                                                          M.M. :- 100

Differential equations and their application: Linear Differential equations of second order including variation of parameters, Simultaneous Differential Equations.

Bessel's & Legendre's equation: Bessel's function of first kind (Definition of Jn (X), general solution, generating function, Recurrence formulae), Legendre's Polynomials, Legendre's function of first kind (Definition of Pn (X) & Qn (X), general solution, generating function, Orthogonality of Pn (X), Recurrence formulae.

Partial differential equations: First order by Lagrange's method, Partial Differential Equations of second order by Separation of variables.

One-dimensional heat & wave equations, Laplace equation in two dimensions.

BCH 302   COMPUTER PROGRAMMING

L-3,T-1   **Exam. Hrs.:- 3**
                                                                                                        M.M. :- 100

A Review of C. concept of object oriented programming using C++, data types: Elementary and drive data types, literals.

Operators and expression: operators, association and precedence rules of operators, expressions using unary, binary and ternary operators.

Conditional statement if. If – else and switch. Loop: for, while and do while, break, continue, go to statements.

Function: void functions, function with return value, call by value, call by reference parameter passing, default parameters, recursive functions, inline functions and return statements.

Classes: classes, objects, friends functions, classes within classes, constructor and destructors.

Derived classes: Single and multiple derivations of classes, types of inheritance, constructor, and destructors with inheritance classes.

Polymorphism: function and operator overloading, virtual functions.

Stream: input and output of build- in- data types, manipulators.

BCH 303   FLUID FLOW OPERATIONS

L-3,T-1   **Exam. Hrs.:- 3**
                                                                        M.M. :- 100

Basic principles: Units and dimensions, Properties of fluid, Classification of fluids –(Newtonian and Non-Newtonian fluid, Compressible and Incompressible fluids).

Fluid static: Fluid pressure & its measurement, Piezometers, Forces acting on immersed surfaces (Plane & Curved), Pressure diagrams.

Fluid dynamics: Laminar and turbulent flows, Conservation of mass, Continuity equation, Conservation of momentum and energy, Navier–stokes equation and its applications, Mechanical energy balance and Bernoulli's equation and its applications, Orifice meter and Venturi meter, impulse momentum equation and its application.

Dimensional analysis: Pi theorem, Dimensionless numbers and their physical significance, Similitude criterion. Introduction to boundary layer theory: Velocity distribution, Boundary layer calculations, and Boundary layer thickness.

Flow through orifices and mouthpieces: Classification of orifices and mouthpieces, Determination of the coefficient for an orifices, Energy and head losses of flowing liquid due to sudden changes in velocity.

Pipe Network: Specifications of standard pipes and tubes; Economic pipe diameter, Pipe fitting and valves, flow through pipes, Pressure drop, Friction factor, Darcy-Weishbach equation, Hydraulic Gradient Line (HGL) and Total Energy Line (TEL), Pressure drop in pipe network system, Hardy-Cross method.

Flow of compressible fluids: Isentropic expansion, Adiabatic, and Isothermal frictional flow.

Pumps, Blowers, and Compressors: Their types and basic working characteristics, their selection criteria, Cavitations, Net Positive Suction Head (NPSH).

BCH 304   CHEMICAL ENGINEERING THERMODYNAMICS

L-3,T-1   **Exam. Hrs.:- 3**
                                                                                                M.M. :- 100

Basic concepts: Review of laws of thermodynamics and their application to engineering process, Closed and Open system, Thermodynamics analysis chemical process.

Thermodynamic properties of fluids and their inter-relationships: PVT behavior of pure substance, Viral and Cubic equation, Equation of state, generalized correlations and acentric factor, PVT behavior of mixture, Entropy, Gibb's energy and its role as generating function, Helmoltz Energy, Residual properties, Properties of single and two-phase systems, Relationship among thermodynamic properties.

Refrigeration cycles: Vapour absorption and Compression cycles, selection of refrigerants.

Multicomponent systems: Partial molar properties, BCHmical potential, Gibb's-Duhem equation,

Ideal – non-ideal solutions. Raoults's & Henery's laws, Fugacity and fugacity coefficient. Excess properties of mixtures, Activity and activity coefficients, Gaseous mixtures and fundamental property relation.

Phase equilibrium and stability: General criteria for equilibrium, phase equilibrium, phase rule and its derivation, vapour – liquid equilibrium (VLE), Azeatropes, Liquid- Liquid equilibrium (LLE), and vapour- solid phase equilibrium and solid- liquid equilibrium (SLE)) (only general types, characteristics and qualitative behavior of these equilibrium systems).

chemical reaction equilibrium: Reaction coordinate, Evaluation of equilibrium constants and effect of temperature on them, Standard Gibb's free energy change, calculation of equilibrium conversion for single and multi-reaction systems, phase rule and Duhem equation for reacting systems.

BCH 305   HEAT- TRANSFER OPERATIONS- I

L-3 T-1   **Exam. Hrs.:- 3**
                                                                                             M.M. :- 100

Mechanism of heat transfer: Heat transfer rate, Flux, Coefficient and Resistance.
Thermal conductivity: Fourier's law, Conduction through flat and cylindrical walls, Spherical objects and finned surfaces, Composite walls, Heat losses and insulation. Application of energy equation one dimension and two dimensions (series solution) steady and unsteady state conduction, Solution of partial differential equation using numerical techniques.
Natural and forced convection: Film coefficient; Heat transfer between solid and fluids, Dimensionless analysis, laminar and turbulent flows through pipes.
Heat transfer with phase change: Film wise and Drop wise condensation- Film wise condensation on vertical and inclined plate, Equations for horizontal and vertical tubes, Calculations for condensers.
Radiant energy – Distribution, Emissive power, Planck's law, Wein's displacement law, Stephen-Boltzman law, Black body, Kirchoff's law, Gray body, Exchange of energy between two surfaces-Large plates, Infinites cylinders, Geometric factors, Gas radiation.
Heat transfer in reactive system- Endothermic reaction, Exothermic reaction, Heat transfer in catalytic bed reactor.

BCH 306   Material Science

L-3 T-1   **Exam. Hrs.:- 3**
                                                        M.M. :- 100

Mechanical, thermal, electrical, BCHmical, and optical properties of materials and their measurements (General Overview and introduction to common terms).
Atomic structure: Inter automatic attraction, Atomic co-ordination, Molecular structure, Crystalline and non-crystalline structure, Solid solutions, Crystal imperfections (point, line and interfacial and bulk defects), Atom movement.

Mechanical Properties: Elastic deformation, Plastic deformation, tensile properties, Stress-Strain relationship, compressive, shear and torsional deformation, Creep, hardness.
Dislocation and Strengthening: Dislocation, Slip system, Twinning, Grain-size reduction, Solid Solution strengthening, Strain Hardening, recovery, recrystallization, grain growth.
Phase Diagrams: Fe-C diagrams, Nomenclature for steels.
Polymorphic phase transformations: Metastable phases, Micro structural and property changes in Fe-C alloys, Isothermal transformation, Continuous cooling transformations, Tampered Martensite.
Thermal Processing: Annealing, Age hardening, Surface Hardening, Quenching and hardening.
Common engineering materials: Iron, Carbon and low alloy steels, S.S. and special steels, C.I, non-ferrous metal and alloys.
Stability in service conditions: corrosion, Oxidation, Thermal stability and radiation damage

B. TECH. SECOND YEAR (4TH SEMESTER)

BCH 401   MATHEMATICS – II

L-3, T-1   **Exam. Hrs.:- 3**
                                                                                                 M.M. :- 100

Complex Variables: Basic concepts (Polar form, Powers and Roots, limit, Derivatives, etc.), Singular points, Residue theorem, Calculus of residues, Evaluation of real-integrals, Bromwich contour integral (General Idea).
Probability and Statistics: Concept of probability, mean and variance, linear regression analysis.
Integral transforms and their applications: Laplace and Fourier transforms, Inverse transforms, Convolution, and Application to Ordinary and Partial differential equations, Initial and Boundary value problems by operational method.

BCH 402   ELEMENTS OF EQUIPMENT DESIGN

L-3, T-1   **Exam. Hrs.:- 3**
                                                                                M.M. :- 100

Mechanics of Materials: Stress and strain-Hook's law, tension, compression, and shear, complimentary shear stress, Poison's ratio, elastic constants and their relation for an isotropic material. Temperature stresses and composite bars, elastic and plastic behavior of structural steel i9n tensile and compression tests. Principal planes, stresses and strains. Bending moment and shearing force diagrams under static loads, concentrated uniformly distributed and uniformly varying loads on cantilever, simply supported and overhanging beams. Theory of simple bending, distribution of normal stress due to bending, section modulus. Torsion: shear stress in solid and hollow circular shafts, angle of twist, power transmitted by shaft under pure torsion. Combined bending and torsion.
Theories of columns, Thermal stress, Membrane stresses in shells of revolutions, Stress concentration, Theories of failures.
General Design Consideration: Design code, Design pressure, Design temperature of cylindrical and spherical shells under internal and external pressures, Selection and design of flat plate, Spherical, Ellipsoidal conical closures.
Tall vertical vessels: Pressure, Dead weight, Wind, Earthquake and Eccentric loads and induced stresses, Combined stresses.

Flanges: Types of flanges and their selection, Gaskets.

BCH 403   COMPUTER ORIENTED AND NUMERICAL ANALYSIS

L3   **Exam. Hrs.:- 3**
                                                                           M.M. :- 100

Numerical solution of Linear Equations: Roots of Equations, Newton-Raphson method, False Position method, Bisection method, and Secant method.

System of Linear Equations: Solutions of simultaneous equations by Gaussian-elimination, Gauss-Jordan and Gauss-Seidal method.

Interpolation: Lagrange's interpolation, Newton's Forward and Backward interpolation, Difference tables.

Curve Fitting: Least square method (Polynomial, Trigonometric & Exponential).

Numerical Integration: Simpson's 1/3 rule, Trapezoidal method, Gauss Quadrature method. Numerical Differentiation

Ordinary Differential Equation: Eulers, Runge Kutta second and fourth order, Predictor–corrector method, Finite-difference method.

Classification of Partial Differential Equations: Elliptical equation, 2D Laplace's equation for steady state problems (Only general Introduction).

Characteristic Equations: Estimation of Eigen values and Eigen Vectors of matrices (Only general Introduction). Programming approach (C++ programming)

BCH 404   HEAT TRANSFER OPERATIONS – II

L-3, T-1   **Exam. Hrs.:- 3**
                                                                                  M.M. :- 100

Heat exchangers: Types of Heat Exchangers, Double-pipe Heat Exchanger- Parallel and counter-current flows, Shell and Tube Heat exchangers, LMTD, Equivalent diameter; NTU and Effectiveness, Fouling factors, Cross flow heat exchangers and it's application.
Design of Shell - Tube Heat Exchangers: Calculation of heat transfer coefficient and pressure drop. Condensation of single vapors system and type of condenser.
Vaporizers, Evaporators and Reboilers: Forced and Natural circulation vaporizers (Kettle Reboiler), Reboilers arrangements, Heat flux and temperature difference, Single and multi-effect evaporators, BPR, Forward and Backward feeds, Calculations for BCHmical evaporators, Optimum numbers of effects. Batch and unsteady state heating arrangements in jacketed and agitated vessels.

BCH 405   CHEMICAL PROCESS ECONOMICS

L3   **Exam. Hrs.:- 3**
                                                                               M.M. :- 100

Economics of Chemical Industries in India- Demand: meaning and definition, elements, types.
Law of Demand: explanation and assumptions. Demand curve: cause of application and exceptions.
Difference between want and demand, expansion and contraction of demand, increase and decrease of
demand. Factors affecting demand. Elasticity of demand: concept, type and method of measurement,
determinants and its importance.

Cost estimation- elements of cost, components of cost, indirect expenses. Depreciation: its types and
various method of calculating it. Obsolence, Interest on capital, Idleness, Repairs and Maintenance.
Profitability.
Economic evaluation of plant- Break-even analysis: assumptions. Break-even point theory:
application. Non-linear break-even analysis.
Investment analysis- Time value of money, Interest rate, compound value, present value, annuities.
Payback method, ARR, NPV, IRR. Cash flow statement, Discounting.
Industrial financing- Sources of Business Finance: Nature and significance, types, classification.
Shares: types, merits, and demerits. Debentures: merits and demerits. Internal financing: loan
financing, types, merits, and demerits. Specialized financial institutions.

BCH 406   PROCESS INSTRUMENTATION & CONTROL

L 3, T-1   **Exam. Hrs.:- 3**
                                                                                              M.M. :- 100

Introduction to process variables: Direct and Inferential measurement, On and off line measurement, Static and Dynamic characteristics of instruments and their general classification, Error, Accuracy, Repeatability, Drift, Threshold, Zero-stability etc., Interpretation of performance specification of transducers.

Working principle of instruments: Classification of sensors and transducers based on their principles of measurement, Building block of an instrument- Transducer, Amplifier, Signal conditioner, Signal transmitter, Data acquisition, I/O devices (general working principle only).

Instrumentation Systems: Working principle of transducers/instruments employed for the measurement of Flow, Level, Pressure, Temperature, Density, Viscosity, pH, Radiation, Composition, Humidity, Advantages and Disadvantages, Preparation of instrumentation diagrams, Instrumentation of important equipments like Distillation column, Heat exchanger, etc.

Construction and characteristics of final control elements: Introduction to Pneumatic, Hydraulic and Electronic controllers, Pneumatic control valves, Characteristics and sizing, motorized valve etc.

Signal transmission and Telemetry: Sampling, Multiplexing, Modulation and Demodulation, Basic principle of DAC and ADC, Pneumatic and Electronic Transmitter and their Advantages and Disadvantages.

BCH 501   CHEMICAL TECHNOLOGY-I

L 3, T-1   **Exam. Hrs.:- 3**
                                                                                                              M.M. :- 100

Indian BCHmical Industry: An Overview
High temperature processes: Manufacture of Cement, Glass.
Chlor alkali industries.
Oil, fats, and Waxes: Vegetable oils, Animal fats and oils, Waxes.
Soaps and Detergent.
Sugar and Starch.
Paper and Pulp Industries: Different pulping processes.

BCH 502   FLUID PARTICLE DYNAMICS

L3, T-1   **Exam. Hrs.:- 3**
                                                                                               M.M. :- 100

Flow through bed: Free and hindered settling, Flows through immersed bodies, and Flow through porous media.

Fluidization: Importance of fluidization in process industry, bubbles behavior and bed properties, Entrainment and elutriation from fluidized bed, two phase-fluidized bed.

Filtration: Constant pressure and Constant rate filtration, Compressible cakes, Filtration rate calculation.

Particle size and shape: Measurement and analysis, Screening and screen analysis- Screen effectiveness, Working principle of industrial screening equipments, Shape factor, Selectivity index.

Size reduction: Principal of comminution, Crushing, Grinding, Pulverization, Ultra fine grinding, Grindability, Crushing laws.

Solid handling: Storage of solids, Transport of solid Screw and belt conveyors, Pneumatic transport, Hydraulic transport and different agitators.

Filtration: Type of Rotary vacuum filter, Filter press, working principles of cyclone separator, Gravity separators, Centrifugation, Bag filters, Electro static precipitators, Froth flotation processes.

Agitators: Types and basic principles, power calculations.

BCH 503   CHEMICAL REACTION ENGINEERING-I

L3   **Exam. Hrs.:- 3**
                                                                                                         M.M. :- 100

Introduction: Reaction rate, Type of reactions, Homogenous, and Heterogeneous reactions.
Kinetics of Homogenous Reaction: Simple reversible and irreversible reaction, Single and parallel reactions, Effects of concentration and temperature on reaction rate, Arrhenius equations, Transition-state and collision theory.

Interpretation of Reactor Data: Data procurement and analysis, Constant volume and Varying volume Batch Reactor, Integral, and differential methods of analysis for various types of reactions.
Designs fundamentals and behavior of Isothermal reactor: Performance equation for Ideal Batch Reactor, Space Time and Space Velocity, Performance equation for Mixed flow reactor and Plug flow reactor, Size comparison for single reaction, Multiple reactors, Mixed flow reactors in series, Recycle Reactors, Auto catalytic reactions, Design for parallel reactions, Multiple reactions in series and series-parallel combinations reactions, fractional yield.
Temperature and Pressure Effects: Single and multiple reactions.

BCH 504   MASS TRANSFER OPERATION-I

L3, T-1   **Exam. Hrs.:- 3**
                                                                                               M.M. :- 100

Physico-Chemical basis of separation processes, Thermodynamic consideration, Stage, and Continuous contacting operation, Concept of equilibrium states. Molecular diffusion in gases and liquids, Fick's first and second law, Mass transfer coefficient. Heat, Mass, and Momentum-transfer analogies. Film, Penetration, Surface- Renewal, Surface-Stretch Theories.
Diffusion in solids: Fick's law of solid diffusion, Types of solid diffusion.
Theory of interphase mass transfer: Individual and overall mass transfer coefficients, Steady-state co-current and counter-current process, Operating curve, Stages and stage efficiency, Murphee efficiency.

Gas Absorption: Equilibrium solubility of gases in liquids, One component transferred material balance, Calculation of operating lines, Counter current multistage operation, HETP dilute solution, HTU, NTU.
Distillation: Vapor-Liquid Equilibrium, Enthalpy-concentration diagrams, Differational and Extractive distillation, fractionating column, Plate and packed column, McCabe Thile and Ponchon Savarite distillation methods, Principle of Azeotropic and extractive distillation, Multi-component vapour liquid equilibrium, total, optimum reflux ratio and minimum reflux.
Drying: Equilibrium curve, Through Circulation and Cross circulation drying, Drying rate, Dryers and their selection.

BCH 505   PROCESS DYNAMICS AND CONTROL

L3   **Exam. Hrs.:- 3**
                                                               M.M. :- 100

Laplace Transformation: Introduction, Properties of transform (Initial and Final value theorem).

Response of system: Dynamics of first, second and higher order linear, open loop and close loop system, Characteristic equation, Stability, Bode diagram and Root locus diagram, Mode of control actions for negative feed back systems, Frequency response of system, Bode stability criterion, Nyquist stability criterion, Design of controller, Dynamics of some complex processes, Control valves.

BCH 506   ELECTIVE-1

L3, T-1   **Exam. Hrs.:- 3**
                                                              M.M. :- 100

B.TECH. THIRD YEAR (6th SEMESTER)

BCH 601   CHEMICAL REACTION ENGINEERING-II

L 3, T 1   **Exam. Hrs.:- 3**
                                                                                                          M.M. :- 100

Non ideal flow: Basic concepts of non-ideal flow, Exit age distribution of the fluid, conversion in the non-ideal reactors, Dispersion Model, Residence Time Distribution (RTD), BCHmical conversion, The conversion model and its RTD.
Introduction of Heterogeneous Reactions,
Heterogeneous Catalysis: Characteristics, Adsorption, Adsorption Isotherm, Properties, Classification, and Preparation.
Solid catalyzed reaction: Rate controlling steps, Rate equation for surface kinetic, Pore diffusion

control, Porous catalyst particles, Experimental methods for finding rates.

Transport Processes: External and Internal Transport process, Operating condition, Effectiveness factor, Effect on selectivity.
Catalyst Deactivation: Mechanism and Kinetics
Fluid particle reactions: Models, Determination for the rate-controlling step, Type of contacting.
Fluid-Fluid reactions: Kinetic and Rate expression.

BCH 602   MASS TRANSFER OPERATION-II

L 3,T-1   **Exam. Hrs.:- 3**
                                                                                    M.M. :- 100

Humidification: Vapor-Liquid Equilibrium, Vapor Gas Mixtures, Humidity charts and Calculations for humidification and dehumidification processes (adiabatic).
Equipment for gas-liquid operations: Sparged vessels, Mechanical agitated vessels, Tray Towers, Wetted-Wall Towers, Scrubbers, Spray Towers, Packed columns. Adsorption: Adsorption equilibrium, stage wise and Continuous adsorption, Industrial absorbers, Elution, Ion exchange.
Leaching: Principle of leaching, Batch and semi batch condition leaching, Retention of liquids after drainage, Calculation of stage in a sequence with or without reflux.

Liquid-Liquid Extraction: Ternary Liquid-Liquid Extraction, Batch and continuous liquid-liquid extraction, Design of extraction column, Stage calculations, Extraction with intermediate feed and Reflux, Selectivity, Rate of extraction system with complete immiscibility.

Crystallization: Equilibrium and yield, Factors governing nucleation and crystal growth rates, Controlled growth of crystal, Industrial Crystallizer.

Membrane separation: Thermodynamics basic of separation, Minimum work for separation, Types of barriers and estimation of separation factors.

BCH 603   CHEMICAL EQUIPMENT DESIGN

L 3   **Exam. Hrs.:- 3**
                                                                                                              M.M. :- 100

Vessel Supports: Design of skirt, lug and saddle supports. Design shell of supported vessel.
Liquid Storage Tanks: Classification, Storage tank codes, Design of shell, Bottom plates, Self-supported, and Column-supported roofs, Wind grinder, Nozzles.
High-pressure vessels: Stress analysis of thick walled cylindrical shell, Design of monoblock
Detailed process and mechanical design: Fixed and floating head shell and tube heat exchangers, Single and multiple effect evaporators, Plate and packed columns for distillation and absorption, Flash drum, Condenser cooling tower, Rotary drier, Fixed bed adsorption column, Cyclonic separator, Packed and fluidized bed reactors, Crystallizer, Setting tank, Piping network

BCH 604   CHEMICAL TECHNOLOGY – II

L 3
<div align="right">

Exam. Hrs.:- 3
M.M. :- 100
</div>

Indian Chemical Industry: An overview.

Sulfur and Sulfuric acid: Production of sulfur pyrites and their use in production of sulfuric acid, DOSA and DCDA processes.

Nitrogen fertilizer and other Chemical: Ammonia, Urea, and Calcium ammonium Nitrate etc. Nitric acid, Phosphatic mixed compound and other fertilizer- SSP, TSP, NPK, UAP, DAP and Nitro phosphates, Bio-fertilizers, Phosphoric acid.

Common Salts, KCl.

Unit Process- Alkylation, Carboxylation and Acetylation, Nitration, Dehydration, Halogenations, Sulphonation, Oxidation, Ammoxidation.

BCH 605   INDUSTRIAL MANAGEMENT

L 3, T-1   **Exam. Hrs.:- 3**
                                                                                                 M.M. :- 100

Management and Engineering and their relation with other fields- Taylor's scientific management, Fayols Principal of scientific management. Forms of industrial enterprise: sole propertership. Partnership firms: characteristic, kinds, essentials, advantages and disadvantages. Differences between sole propertership, Partnership, JHF and Co-ownership. Partners: types, rights, duties and liabilities. Companies: characteristics, kinds, difference with partnership, difference between private and public companies, advantages and disadvantages.

Organization structure- role and features, organization chart and manual, their uses and limitation. Departmentation: Need and importance. Span of management and factors affecting it. Delegation of authority and measures for effective delegation. Centralization and decentralization. Delegation and Decentralization. Factors determining degree of decentralization. Rationale centralization and decentralization.

Personnel Management- Manpower planning and Job analysis.

Production Management- Meaning and scope. Production planning: meaning, objectives, scope, and production planning as an integral part of cooperative planning process. Production control: meaning and importance. Quality control and SQC: meaning, importance, objective and techniques. Work study and Productivity. Motion study: aims and procedure, micro motion study and motion economy. Time study: use and procedure, performance rating and allowances.

Project Management: PERT and CPM techniques, Game theory.

BCH 606   Elective -II

BCH 701   SAFETY IN CHEMICAL PROCESS PLANTS

L 3, T-1   **Exam. Hrs.:- 3**
                                                                                                    M.M. :- 100

Introduction: Safety, hazard and Risk, accident- nature and loss statistic.
Hazards: Detection, Management, Recent trends in safety & hazard analysis, hazardous waste treatment, laws, codes and standards and case histories & judgments.
Industrial Hygiene: Identification and evaluation .
Source Models: Introduction, spills of toxic, flammable and explosive materials, various source models.
Fires and Explosions: Distinction, definitions, characteristics and explosion hazard rating of process plant, Preventions of fire and explosions.
Hazards Identification: Checklists, surveys, HAZOP and HAZAN.
Risk Assessment: Probability Theory and failure frequency analysis.
Case studies

BCH 702   MOLECULAR BIOLOGY

L 3   **Exam. Hrs.:- 3**
                                                                                     M.M. :- 100

Introduction: Living systems and their properties, Measure biological compounds, Physiological processes, Introduction to environment, Evolution, Ecology, Biogeography regions.

Biomolecules: Chemistry and function of the constituents of cells- water, Salts, Amino acids, Proteins and its synthesis, nucleic acids, Metabolism of carbohydrates, Lipids, Introduction to enzymes and their action, Hormones.

Cell biology: Prokaryotic and Eukaryotic cells, Organization of plant and animal cells, Organelles-structure, BCHmical composition, function.

Cellular processes and information transfer: Carbon and Nitrogen cycles in nature, Glycolysis, TCA cycle, Signal transduction, Receptor concept.

Genetics: Facts and theories of heredity, Elements of population genetics and species concept, Mendel's laws-segregation, independent assortment, Phenotype and Genotype, Mono- and di- hybrid crosses, Chromosomes, Gene concept, DNA–Protein interactions, Central Dogma-DNA Replication, RNA Transcription and its control, RNA Processing, Protein Translation, Translation mechanism of gene expression, Genetic code, Prokaryotic and Eukaryotic genomes, Introduction to the methods of introducing genes into the recipient cells- transformation, Transudation, Conjugation.

BCH 703 MATHEMATICAL METHODS IN CHEMICAL ENGINEERING

L 3, T-1   **Exam. Hrs.:- 3**
                                                                     M.M. :- 100

The mathematical statement of the problem: Introduction, Representation of the problem, Solvent extraction in two stages, and solvent extraction in N stages, simple water still with preheated feed, Unsteady state operation, salt accumulation in a stilled Tank, Radial heat transfer through a cylindrical

conductor, Heating a closed kettle, dependent and independent variables, parameters, Boundary conditions, Sign Conventions.

Ordinary differential equations Introduction, order and degree, first order differential equations, second order differential equations, linear differential equations, and simultaneous differential equations.

Solution of series introduction, Infinite series, power series, simple series solutions, methods of frobenius, Bessel's equation, properties of Bessel functions.

Complex algebra introduction, The complex number, the argon diagram, principle values, algebraic operations on the argand diagram, conjugate numbers, De Moiver's theorem, the nth roots of unity, complex number series, trigonometrical exponential identities, the derivatives of a complex variable, analytic functions, the complex variable and canohy's theorem, Laurent's expansion and the theory of residues.

Functions and definite integrals introduction, the error functions, the gamma function, the beta functions, and other tabulated functions which are defined by integrals, evolution of definite integral vector analysis.

BCH 704   PETROLEUM REFINING

L 3   **Exam. Hrs.:- 3**
                                                                                                 M.M. :- 100

Origin and Occurrence of Petroleum crude: status of petroleum refining industry in India, Composition, Classification and Physical properties of petroleum, Testing and uses of petroleum products.

Petroleum refining processes: Atmospheric and Vacuum distillation, Thermal and catalytic in vapor, liquid and mixed phases, Hydro cracking, Thermal reforming, Polyforming and plat forming, Catalytic reforming, Conversion of petroleum gases into motor fuel with reference to Alkylation, Polymerization, Isomerisation, Hydrogenation, Production of aviation gasoline, motor fuel, kerosene, diesel oil and jet fuel.

Vacuum distillation: solvent extraction, uses of lubricating oils & waxes, chemical & clay treatment of petroleum products, Desulphurization.

BCH 705   ELECTIVE-III

L 3, T-1

L 3, T-1

B.TECH. FINAL YEAR (8th SEMESTER)

BCH 801   TRANSPORT PHENOMENA

L 3, T-1   **Exam. Hrs.:- 3**
                                                                                          M.M. :- 100

Molecular Transport Phenomena: molecular transport of momentum, heat and mass, laws of molecular transport, Newton's law of viscosity, Fourier's law of conduction and Fick's law of diffusion, transport coefficients-viscosity, thermal conductivity, mass diffusivity, estimation of transport coefficients and temperature/pressure dependency.

Non-Newtonian fluids: time independent and dependent and viscoelastic fluids.

Laminar flow: Equation of continuity, motion, mechanical energy, energy and mass transport, shell balance method for momentum, heat and mass transport, velocity distribution.

Turbulence Phenomena: Basic theory of turbulence, time averaging, intensity and correlation coefficients, equation of continuity, motion and energy.

Diffusion Phenomena: diffusion of gases and liquids in porous solids, Knudsen diffusion.

Agitation and Mixing: introduction, agitation equipment, and power requirement.

Transport past emerged bodies: laminar and turbulent boundary layers, heat and mass transfer during boundary layer flow past a flat plate, cylinder and spheres.

Heat, mass and momentum transfer in duct flow

Mass transfer with Chemical reaction: enhancement due to reaction, determination of interfacial area.

Convective Transport: free and forced convective heat and mass transfer.

BCH 802   CHEMICAL ENGINEERING OPTIMIZATION

L 3   **Exam. Hrs.:- 3**
                                                                                             M.M. :- 100

Optimization –Definition of Optimization, Scope and Hierarchy of Optimization, Examples of Application, Essential Features and General Procedure for solving Optimization Problems, Obstacles to Optimization, Classification of Models, Degrees of Freedom, Examples of Inequality and Equality Constraints.

Objective function – Economic Objective Functions, Time Value of Money in Objective Functions and Measure of Profitability.

Basic concepts of optimization – Continuity of functions, NLP problem statement, Concave and Convex Functions, Necessary and Sufficient condition for stationary points.

Optimization of Unconstrained Functions – Newton and Quasi-Newton Methods of Uni-dimensional Search and Polynomial Approximation Methods.

Unconstrained multivariable optimization – Random search, Simplex Search Method, Methods using First Derivatives and Newton's Method. Linear programming and Applications.

Applications of Optimization – Optimizing Recovery of Waste Heat and Optimal Pipe Diameter.

BCH 803   BIO CHEMICAL ENGINEERING

L 3, T-1   **Exam. Hrs.:- 3**
                                                                                     M.M. :- 100

Cell Growth Kinetics: Product Formation Kinetics.

Transport phenomena in cellular systems: Oxygen transfer rates, Mass transfer coefficient and interfacial area; Mechanical area, Mechanical agitation and power requirement.

Ideal Bioreactors: Bioreactor dynamics, Multiphase bioreactors, Scale-up.

Instrumentation: Biosensors, Bioprocess control.

Thermal death kinetics: Media and air sterilization.

Enzymes and their classification: Enzymes kinetics, Inhibition, Immobilization of enzymes and whole cells, Industrial uses of enzymes, Immobilized enzyme kinetics. Down-stream processing with emphasis on cell separation: Cell disruption: Aqueous two phase separation.

Industrial production of: ethanol, baker's yeast, penicillin, vitamins and acids.

BCH 804   ELECTIVE - V

L 3, T-1   **Exam. Hrs.:- 3**
                                                             M.M. :- 100