Department of Chemical Engineering

BE II year (CHEMICAL), 2014 **Semester III Examination Scheme**

Branch Code	Subject Code		Subject	Lectures	Tutorials	Practical's	Contact H.	Credits	Units	Examination H.	Marks		
											Theory	Practical's and Sessionals	Total
		A	**Written Papers**										
Ma	201	A	Mathematics-I (ChE)	2	-	-	2	2	0.5	3	50	-	50
ChE	202	A	Computer Programming (ChE)	2	1	-	3	3	0.5	3	50	-	50
ChE	203	A	Fluid Flow Operation (ChE)	4	1	-	5	5	1.0	3	100	-	100
ChE	204	A	Chemical Engineering Thermodynamics (ChE)	4	1	-	5	5	1.0	3	100	-	100
ChE	205	A	Heat Transfer Operation-I (ChE)	4	1	-	5	5	1.0	3	100	-	100
			Total (A)	**16**	**4**	**-**	**20**	**20**	**4.0**	**-**	**400**	**-**	**400**
		B	**Practical's and Sessionals**										
ChE	221	B	Computer Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	222	B	Fluid Flow Operation Lab.(ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	223	B	Heat Transfer Operation-I Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	224	B	Chemical Process Calculations Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
			Total (B)	**-**	**-**	**12**	**12**	**6**	**2.0**	**-**	**-**	**200**	**200**
			Grand Total (A+B)	**16**	**4**	**12**	**32**	**26**	**6.0**	**-**	**400**	**200**	**600**

Joint award for III and IV Semester (Marks not counted for award of division)

FE	225	B	*Co-curricular Activities	-	1	1	2	1	0.5	**-**	**-**	**-**	**-**

For pass candidate must obtain:

a) 35 percent in each written paper.
b) 50 percent in each of the practical's and Sessionals, and
c) 45 percent grant total.

Department of Chemical Engineering

BE II year (CHEMICAL), 2014 **Semester IV Examination Scheme**

Branch C-ode	Subject Code		Subject	Lectures	Tutorials	Practical's	Contact H.	Credits	Units	Examination H.	Marks		
											Theory	Practical's and Sessionals	Total
		A	**Written Papers**										
Ma	251	A	Mathematics-II (ChE)	2	-	-	2	2.0	0.5	3	50	-	50
ChE	252	A	Elements of Equipment Design (ChE)	3	1	-	4	4.0	1.0	3	100	-	100
ChE	253	A	Computer Oriented Numerical Analysis (ChE)	2	1	-	3	3.0	0.5	3	50	-	50
ChE	254	A	Heat Transfer Operation-II (ChE)	3	2	-	5	5.0	1.0	3	100	-	100
ChE	255	A	Material Science (ChE)	3	-	-	3	3.0	0.5	3	50	-	50
ChE	256	A	Process Instrumentation and Control (ChE)	2	1		3	3.0	0.5	3	50	-	50
			Total (A)	**15**	**5**	**-**	**20**	**20.0**	**4.0**	**-**	**400**	**-**	**400**
		B	**Practical's and Sessionals**										
ChE	271	B	Chemical Analysis Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	272	B	Computer Oriented Numerical Analysis Lab (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	273	B	Heat Transfer Operation-II Lab (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	274	B	Process Instrumentation Control Lab (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
			Total (B)	**-**	**-**	**12**	**12**	**6.0**	**2.0**	**-**	**-**	**200**	**200**
			Grand Total (A+B)	**15**	**5**	**12**	**32**	**26.0**	**6.0**	**-**	**400**	**200**	**600**
Joint award for III and IV Semester (Marks not counted for award of division)													
FE	275	B	*Co-curricular Activities	-	1	1	2	1	0.5	**-**	**-**	100	100

For pass candidate must obtain:

a) 35 percent in each written paper
b) 50 percent in each of the Practical's and Sessionals, and
c) 45 percent grant total.

Department of Chemical Engineering

BE III year (CHEMICAL), 2015

Semester V Examination Scheme

Branch Code	Subject Code		Subject	Lectures	Tutorials	Practical's	Contact H.	Credits	Units	Examination H.	Marks		
											Theory	Practical's and Sessionals	Total
		A	**Written Papers**										
ChE	301	A	Chemical Technology-I (ChE)	2	-	-	2	2.0	0.5	3	50	-	50
ChE	302	A	Fluid Particle Dynamics (ChE)	3	1	-	4	4.0	0.5	3	50	-	50
ChE	303	A	Chemical Reaction Engineering-I (ChE)	3	2	-	5	5.0	1.0	3	100	-	100
ChE	304	A	Mass Transfer Operation-I (ChE)	3	2	-	5	5.0	1.0	3	100	-	100
ChE	305	A	Process Dynamics and Control (ChE)	2	1	-	3	3.0	0.5	3	50	-	50
ChE	306	A	Chemical Process Economics (ChE)	2	-	-	2	2.0	0.5	3	50	-	50
			Total (A)	**15**	**6**	**-**	**21**	**21.0**	**4.0**	**-**	**400**	**-**	**400**
		B	**Practical's and Sessionals**										
ChE	321	B	Fluid Particle Dynamics Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	322	B	Chemical Reaction Engineering-I Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	323	B	Mass Transfer Operation-I Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	324	B	Process Dynamics and Control Lab (ChE).	-	-	3	3	1.5	0.5	3	-	50	50
			Total (B)	**-**	**-**	**12**	**12**	**6.0**	**2.0**	**-**	**-**	**200**	**200**
			Grand Total (A+B)	**15**	**6**	**12**	**33**	**27**	**6.0**	**-**	**400**	**200**	**600**

Joint award for V and VI Semester (Marks not counted for award of division)

FE	325	B	*Co-curricular Activities	-	1	1	2	1	0.5	-	-	-	-

For pass candidate must obtain:

a) 35 percent in each written paper
b) 50percent in each of the practical's and Sessionals, and
c) 45 percent grant total.

Department of Chemical Engineering

BE III year (CHEMICAL), 2015 **Semester VI Examination Scheme**

Branch Code	Subject Code		Subject	Lectures	Tutorials	Practical's	Contact H.	Credits	Units	Examination H.	Marks		
											Theory	Practical's and Sessionals	Total
		A	**Written Papers**										
ChE	351	A	Chemical Reaction Engineering-II (ChE)	3	1	-	4	4.0	1.0	3	100	-	100
ChE	352	A	Mass Transfer Operation-II (ChE)	3	1	-	4	4.0	1.0	3	100	-	100
ChE	353	A	Chemical Equipment Design (ChE)	3	1	-	4	4.0	0.5	3	50	-	50
ChE	354	A	Chemical Technology-II (ChE)	3	1	-	4	4.0	0.5	3	50	-	50
ChE	355	A	Industrial Management (ChE)	2	1	-	3	3.0	0.5	3	50	-	50
			Total (A)	**14**	**5**	**-**	**19**	**19.0**	**3.5**	**-**	**350**	**-**	**350**
		B	**Practical's and Sessionals**										
ChE	371	B	Mass Transfer Operation-II Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	372	B	Chemical Equipment Design Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	373	B	Chemical Reaction Engineering- II Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
			Total (B)	**-**	**-**	**9**	**9**	**4.5**	**1.5**	**-**	**-**	**150**	**150**
ChE	374	C	**Seminar (ChE)**	-	-	4	4	2.0	1.0	-	-	100	100
			Total (C)	**-**	**-**	**4**	**4**	**2.0**	**1.0**	**-**	**-**	**100**	**100**
			Grand Total (A+B+C)	**14**	**5**	**13**	**32**	**25.5**	**6.0**	**-**	**350**	**250**	**600**

Joint award for V and VI Semester (Marks not counted for award of division)

F	FE	375	B	*Co-curricular Activities	**-**	**1**	**1**	**2**	**1**	**0.5**	**-**	**-**	**100**	**100**

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r pass candidate must obtain:

a) 35 percent in each written paper

b) 50 percent in each of the practical's and Sessionals, and

c) 45 percent grant total.

Department of Chemical Engineering

BE IV year (CHEMICAL), 2016 **Semester VII Examination Scheme**

Branch Code	Subject Code		Subject	Lectures	Tutorials	Practical's	Contact H.	Credits	Units	Examination H.	Marks		
											Theory	Practical's and Sessionals	Total
	A		**Written Papers**										
ChE	401	A	Safety in Chemical Process Plants (ChE)	3	1	-	4	4.0	0.5	3	50	-	50
ChE	402	A	Molecular Biology (ChE)	3	1	-	4	4.0	0.5	3	50	-	50
ChE	403	A	Mathematical Methods In Chemical Engineering (ChE)	4	1	-	5	5.0	1.0	3	100	-	100
ChE	404	A	Petroleum Refining (ChE)	3	1	-	4	4.0	0.5	3	50	-	50
ChE	405	A	Elective-I (ChE)	3	-	-	3	3.0	0.5	3	50	-	50
			Total (A)	**16**	**4**	**-**	**20**	**20.0**	**3.0**	**-**	**300**	**-**	**300**
		B	**Practical's and Sessionals**										
ChE	421	B	Chemical Technology Lab. (ChE)	-	-	4	4	2.0	1.0	3	-	100	100
ChE	422	B	Petroleum Analysis Lab. (ChE)	-	-	4	4	2.0	1.0	3	-	100	100
			Total (B)	-	-	**8**	**8**	**4.0**	**2.0**	**-**	**-**	**200**	**200**
		C	**Project**										
ChE	423	C	Project (ChE)	-	-	4	4	2.0	1.0	3	-	100	100
			Total (C)	**-**	**-**	**4**	**4**	**2.0**	**1.0**	**3**	**-**	**-**	**100**
			Grand Total (A+B+C)	**16**	**4**	**12**	**32**	**26.0**	**6.0**	**-**	**300**	**300**	**600**
Joint award for VII and VIII Semester (Marks not counted for award of division)													
FE	424	B	*Co-curricular Activities	-	1	1	2	1	0.5	-	-	-	-

For pass candidate must obtain:

a) 35 percent in each written paper
b) 50 percent in each of the practical's and Sessionals, and
c) 45 percent grant total

Department of Chemical Engineering

BE IV year (CHEMICAL), 2016 **Semester VIII Examination Scheme**

Branch Code	Subject Code		Subject	Lectures	Tutorials	Practical's	Contact H.	Credits	Units	Examination H.	Marks		
											Theory	Practical's and Sessionals	Total
		A	**Written Papers**										
ChE	451	A	Bio Chemical Engineering (ChE)	3	-	-	3	3.0	0.5	3	50	-	50
ChE	452	A	Transport Phenomena(ChE)	3	1	-	4	4.0	0.5	3	50	-	50
ChE	453	A	Chemical Engineering Optimization (ChE)	3	1	-	4	4.0	0.5	3	50	-	50
ChE	454	A	Elective-II (ChE)	3	1	-	4	4.0	0.5	3	50	-	50
ChE	455	A	Elective-III (ChE)	3	1	-	4	4.0	0.5	3	50	-	50
			Total (A)	**15**	**4**	**-**	**19**	**19.0**	**2.5**	**-**	**250**	**-**	**250**
		B	**Practical's and Sessionals**										
ChE	471	B	Polymer Science Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	472	B	Environmental Engineering Lab. (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
ChE	473	B	Simulation Lab (ChE)	-	-	3	3	1.5	0.5	3	-	50	50
			Total (B)	**-**	**-**	**9**	**9**	**4.5**	**1.5**	**-**	**-**	**150**	**150**
		C	**Practical Training and Tour**										
ChE	474	C	Industrial Tour (ChE)	-	-	-	-	1.5	0.25	-	-	25	25
ChE	475	C	Practical Training (ChE)	-	-	-	-	-	0.75	-	-	75	75
			Total (C)	**-**	**-**			**1.5**	**1.0**	**-**	**-**	**100**	**100**

		D	**Project (D)**										
ChE	476	D	Project (ChE)	-	-	4	4	2.0	1.0	-	-	100	100
			Total (D)	**-**	**-**	**4**	**4**	**2.0**	**1.0**	**-**	**-**	**100**	**100**
			Grand Total (A+B+C+D)	**14**	**4**	**13**	**32**	**27.0**	**6.0**	**-**	**250**	**350**	**600**

Joint award for VII and VIII Semester (Marks not counted for award of division)

FE	477	B	*Co-curricular Activities	-	1	1	2	1	0.5	-	-	100	100

For pass candidate must obtain:

a) 35 percent in each written paper
b) 50 percent in each of the practical's and Sessionals, and
c) 45 percent grant total

MA 201 A: MATHEMATICS-I

2 L, 0 T **Max. Marks 50**

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.

ChE 202 A: COMPUTER PROGRAMMING

2 L, 1 T **Max. Marks 50**

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.

ChE 203 A: FLUID FLOW OPERATIONS

4 L, 1 T **Max. Marks 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).

ChE 204 A: CHEMICAL ENGINEERING THERMODYNAMICS

4L, 1 T **Max. Marks 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, chemical 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.

ChE 205 A: HEAT- TRANSFER OPERATIONS- I

4 L, 1 T **Max. Marks 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.

Ma 251 A: MATHEMATICS – II

2 L, 0 T **Max. Marks 50**

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.

ChE 252 A: ELEMENTS OF EQUIPMENT DESIGN

3 L, 1 T **Max. Marks 100**

Solid friction, a law of friction, inclined plane screw jack, friction of plate collars and clutches.
Mechanical advantages, velocity ratio and efficiency, study of simple machines. Transmission of power by bells and ropes, length of belts, tension in belts, centrifugal tension, maximum power transmitted by belts.
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 in 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.

ChE 253 A: COMPUTER ORIENTED AND NUMERICAL ANALYSIS

2 L, 1 T **Max. Marks 50**

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)

ChE 254 A: HEAT TRANSFER OPERATIONS – II

3L, 2 T **Max. Marks 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 chemical evaporators, Optimum numbers of effects. Batch and unsteady state heating arrangements in jacketed and agitated vessels.

ChE 255 A: MATERIAL SCIENCE

3 L, 0 T **Max. Marks 50**

Mechanical, thermal, electrical, chemical, 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

ChE 256 A: PROCESS INSTRUMENTATION & CONTROL

2L,1T **Max. Marks 50**

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.

ChE- 301A CHEMICAL TECHNOLOGY-I

2 L, 0 T **Max. Marks 50**

Indian Chemical 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.

ChE- 302A FLUID PARTICLE DYNAMICS

3 L, 1 T **Max. Marks 50**

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.

ChE 303 A: CHEMICAL REACTION ENGINEERING-I

3 L, 2T **Max. Marks 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.

ChE 304 A: MASS TRANSFER OPERATION-I

3 L, 2 T **Max. Marks 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.

ChE305 A: PROCESS DYNAMICS AND CONTROL

2 L, 1 T **Max. Marks 50**

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.

ChE 306 A: CHEMICAL PROCESS ECONOMICS

2 L, 0 T **Max. Marks 50**

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.

ChE 351A: CHEMICAL REACTION ENGINEERING-II

3 L, 1 T **Max. Marks 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), Chemical 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.

ChE 352A: MASS TRANSFER OPERATION-II

3 L, 1 T **Max. Marks 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.

ChE 353A: CHEMICAL EQUIPMENT DESIGN

3 L, 1T **Max. Marks 50**

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.
Flanges: Types of flanges and their selection, Gaskets.
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

ChE 354A: CHEMICAL TECHNOLOGY – II

3 L, 1 T **Max. Marks 50**

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.

ChE 355A: INDUSTRIAL MANAGEMENT

2 L, 1T **Max. Marks 50**

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.

ChE 401A: SAFETY IN CHEMICAL PROCESS PLANTS

3L, 1 T **Max. Marks 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

ChE 402A: MOLECULAR BIOLOGY

3 L, 0 T **Max. Marks 50**

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, Chemical 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.

ChE 403A: MATHEMATICAL METHODS IN CHEMICAL ENGINEERING

3 L, 1T **Max. Marks 50**

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 n^{th} 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.

ChE 404A: PETROLEUM REFINING

3 L, 1 T **Max. Marks 50**

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.

ChE 405A: ELECTIVE-I (Any one of the following.)

2 L, 0T **Max. Marks 50**

1. Phase Equilibrium and Industrial applications

General Introduction: Phases, Components, Degrees of freedom, The phase rule and its derivation

One component system: Equilibrium between liquid and vapour, vaporization curve, Le chatelier principle, Clausis clapeyron equation, Equilibrium between solid and vapour, sublimation curve, equilibrium between solid and liquid, fusion curve, equilibrium among solid, liquid and vapour, Allotropy or polymorphism.

Two component Systems: System consisting of two liquid phases only; ideal solutions and Raoult's aw, partial and limited miscibility; Typical systems: Phenol and water, liquid phases, systems consisting of liquid and vapour phases only, Henry's law, water and propyl alcohol system; Systems consisting of solid and liquid phases only: KCL and AgCl systems

Three component systems: Liquid phases only, liquid and vapour phases: solid and liquid system

Systems NaCl, KCl, and H_2O, KCl- K_2SO_4-H_2O and similar systems.

2. Energy Resources

Conventional and non-conventional energy resources: position in India, Transport, storage and environmental problems.

Solar radiation: Available solar radiation and measurements, Radiation transmission through covers and absorption by collectors, Theory of flat plate collectors and their performance. Solar heating systems and design, Applications to solar cooling, Mechanical energy and solar industrial process heating, Heat pumps, Solar ponds, Chemical storage systems, Photochemical conversion, solar cells.

Solids fuels: Coal, biomass, solid wastes, briquettes; Progressive of solid fuels by pyrolysis, gasification & liquefaction to secondary fuels, Refuse derived fuels.

Coal: Origin: Classification Coal preparation; Carbonization; Coke ovens; Gasification of coal; Atmospheric and pressurized gasifiers; Fishcer – Tropsch synthesis, Methanol to gasoline conversion.

Petroleum: Origin and production of oil and gas, Petroleum refining and distillation; Cracking and reforming; Fluid catalytic cracking.

Proximate and ultimate analysis of solid, liquid and gaseous fuels: Calorific value; Antiknock rating and octane number; Cetane number; flash point; Char value; Smoke point; viscosity; Aniline point etc.

Combustion Kinetics of solid, liquid and gaseous fuels: Ignition temperature, Types of burners.

Nuclear energy: Fission and fusion reactions; Nuclear reactor for power generation.

Hydrogen energy: Hydrogen production by photochemical decomposition of water and its storage; Fuel cells.

Introduction to wind, tidal and geothermal energy: OTEC and MHD; Energy from biomass.

3. Biomass for Energy and Chemicals

Biomass as a source of energy, feed stock, food stuff., Biomass characterization. Solid, liquid and gaseous products from biomass, Sources of biomass-agricultural residue, forestry waste, industrial waste. Overview of conversion technologies – in particular, thermo chemical conversion of biomass.

Combustion, pyrolysis and gasification of biomass., Design of gasifier for biomass conversion., Electricity generation and charcoal production from biomass., Useful chemicals and energy from rice husk.

ChE 451A: BIO CHEMICAL ENGINEERING

3 L, 0 T **Max. Marks 50**

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.

ChE 452A: TRANSPORT PHENOMENA

2 L, 1 T **Max. Marks 50**

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.

ChE 453A: CHEMICAL ENGINEERING OPTIMIZATION

2 L, 1T **Max. Marks 50**

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.

ChE 454A: ELECTIVE-II (Any one of the following.)

3 L, 0 T **Max. Marks 50**

1. Pollution Engineering

Introduction: Classification of air pollutants, Primary and Secondary pollutants, Source of air pollulation.
Atmospheric Dispersion: Meteorology, Adiabatic lapse rate, Atmospheric stability, Inversion – types of inversion, maximum mixing height, Atmospheric classes, Plumes and types of plumes under different atmospheric condition, plume rise, Gaussian dispersion curve, Point dispersion model, Line and Area Model
Particulate Pollulation: Particulate pollulation and control equipment, centrifugal collector, Electronic precipators, Bag filter and Scrubber, Design and Efficiency.

Water pollulation: Water quantity modeling for streams, Oxygen Demand, BOD, NBOD, CBOD Primary Treatment by Sedimentation, Flocculation, Coagulation, Filtration, Disinfections, Waste water treatment, Biological (secondary) waste water treatment, Advance treatment methods Nitrogen and Phosphorous Removal.
Solid waste: Collection of Solid waste. Treatment by disposal, pyrolysis.
Waste recovery system and case study.
Odour pollulation: Determination of Odour, Threshold concentration, various control method.
Noise Pollution: Measurements and units of Noise, SPL, PWL, Effect of noise, Control by equipment, SPL indicator

2. CORROSION ENGINEERING

Corrosion direct & two stage attack, electrochemical attack, environment conditioning. Higher corrosion resistance through proper selection of material, isolation of corrosion prone materials form distructive environment, Technologies of anodisation, enamelling, rubber lining, glass lining, refractory lining, painting and other surface protective measures. Corrosion engineering in special applications such as material transport, pumping, filtration, condensation, boiling revetting, welding, high temperature environments etc. cost factor in cometitives corrosion prevention/inhibition techniques

ChE 455A: ELECTIVE-III (Any one of the following.)

1. POLYMER SCIENCE AND TECHNOLOGY. **2 L, 1 T** **Max. Marks 50**

Polymerization chemistry: Chain, Step, Addition, Condensation and miscellaneous polymerization reactions and polymerization technique.
Polymerization Kinetics: Free radical, Cationic and Anionic polymerization, Poly-condensation, Co-polymerization systems.
Microstructures of polymer molecules based on channel and geometrical structure: Transition associated properties, Factors influencing the glass transition temperature, Degree of crystallization, Factors affecting crystallizability, Effect of crystallinity on the properties of polymers.
Polymer reactions: Hydrolysis, Acidolysis, Hydrogenation, Addition and Substitution reactions, Reactions of various specific groups, Cyclyzation and Cross-Linking reactions, Reactions leading to graft and block copolymer.
Polymer Solutions: Process and thermodynamics of dissolution, Nature of polymer molecules in solutions, Size and shape of macromolecules in solution, Viscosity of dilute and concentrated polymer.
Manufacturing process of important polymers: Plastic – Polyethylene, Polypropylene, Polyvinyl chloride and copolymers, Polystyrene, Phenol-formaldehyde, Epoxides, Urethane, Teflon, Elastomers, Rubbers, Polymeric oils – Silicones, Fibers – Cellulosic (Rayon), Polyamides (6:6 Nylon), Polyesters (Dacron), Acrylic, Olefin, Composite materials – Ceramic and other fiber reinforced plastics, Polymer degradation – Thermal Mechanical, Ultrasonic, Photo, High-energy radiation, Oxidation and Hydrolytic degradation, Ecology and environmental aspects of polymer industries.
Principle of polymer processing: Behavior of viscoelastic fluids, Testing and evaluation of flow behavior, Mixing of powder and viscoelastic materials, various molding operations, Extrusion, calendaring and coating operations.

2. FLUIDIZATION ENGINEERING

Fundamentals, Industrial applsication; study, design and operation of fluidization units. Fluidization: particulate and aggregate beds. Application of fluidization. Regimes of fluidization. Bubbling fluidized beds. Two phase theory. Heat and mass transfer between fluids and particles. Performance of drier and reactors. Elutriation. Choking, Transport velocity. High velocity fluidized beds. Circulating fluidized beds. Design.

3. CATALYSIS

Physical adsorption: Type of adsorption isotherms, Surface area and BET and other methods of surface area measurement pore size distribution and its determination.
Chemisorption: theory of Chemisorption, heat of Chemisorption, Chemisorption with dissociation.
Catalyst preparation, Catalyst characterization, Carrier & Supports, Promoters, Accelerators, Poison & Inhibitors.

Design of a catalyst, Catalyst for different unit processes