BMS COLLEGE OF ENGINEERING,
BANGALORE-19
Autonomous College under VTU

Chemical Cluster

Scheme for III to VIII Semester

And

Syllabus for III to VIII Semester

in

CHEMICAL ENGINEERING

Batch: 2009-2013

Batch: 2010-2014

And

Batch: 2011-2015

BMS COLLEGE OF ENGINEERING, BANGALORE
Autonomous College under VTU
SCHEME OF INSTRUCTION
Department of Chemical Engineering Program BE Semester III

Subject Code										Subject Title	Credit Hours/Week				Contact hrs/wk	Marks		
											L	T	P	Total		CIE	SEE	Total
0	9	M	A	3	I	C	M	A	T	Engineering Mathematics 3	3	1	0	4	5	50	50	100
0	9	C	H	3	D	C	C	P	C	Process Principles & Calculation	4	0	0	4	4	50	50	100
0	9	C	H	3	D	C	F	M	E	Fluid Mechanics	4	0	1	5	6	50	50	100
0	9	C	Y	3	D	C	C	E	M	Technical Chemistry	3	0	1	4	5	50	50	100
0	9	C	H	3	D	C	M	O	P	Mechanical Operations	4	0	1	5	6	50	50	100
0	9	C	H	3	D	C	E	Q	D	Chemical Process Equipment Drawing	2	0	1	3	4	50	50	100
													Total	25	30	Total marks		600

L – Lecture Hours / week; T- Tutorial Lecture Hours / week; P-Practical Lecture Hours / week.
CIE- Continuous Internal Evaluation; SEE- Semester End Examination (of 3 Hours duration)
For lateral entry MA3IMDIP to be taken in addition to all the above

Dr. Samita Maitra
Chairperson-BOS/HOD

BMS COLLEGE OF ENGINEERING, BANGALORE
Autonomous College under VTU
SCHEME OF INSTRUCTION
Department of Chemical Engineering Program B E Semester IV

Subject Code										Subject Title	Credit Hours/Week				Contact hrs/wk	Marks		
											L	T	P	Total		CIE	SEE	Total
0	9	M	A	4	I	C	M	A	T	Engineering Mathematics -4	3	1	0	4	5	50	50	100
0	9	C	H	4	D	C	M	S	B	Material Sciences and Biomaterials	4	0	0	4	4	50	50	100
0	9	C	H	4	D	C	P	T	D	Process Engineering Thermodynamics	4	0	0	4	4	50	50	100
0	9	C	H	4	D	C	H	T	R	Process Heat Transfer	4	0	1	5	6	50	50	100
0	9	C	H	4	D	C	C	T	N	Chemical Technology	4	0	0	4	4	50	50	100
0	9	C	H	4	D	C	I	M	A	Instrumental Methods of Analysis	3	0	1	4	5	50	50	100
													Total	25	28	Total marks		600

L – Lecture Hours / week; T- Tutorial Lecture Hours / week; P-Practical Lecture Hours / week.
CIE- Continuous Internal Evaluation; SEE- Semester End Examination (of 3 Hours duration).
For lateral entry MA4IMDIP to be taken in addition to all the above

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Chairperson-BOS/HOD

BMS COLLEGE OF ENGINEERING, BANGALORE
Autonomous College under VTU
SCHEME OF INSTRUCTION
Department of Chemical Engineering Program BE Semester V

Subject Code										Subject Title	Credit Hours/Week				Contact Hrs/ Week	Marks		
											L	T	P	Total		CIE	SEE	Total
1	0	C	H	5	D	C	C	R	1	Chemical Reaction Engineering-I	4	0	1	5	7	50	50	100
1	0	C	H	5	D	C	M	T	1	Mass Transfer – I	4	0	1	5	7	50	50	100
1	0	C	H	5	D	C	P	C	L	Pollution Control	3	0	0	3	3	50	50	100
1	1	C	H	5	D	C	C	E	D	Chemical Equipment Design	4	0	0	4	4	50	50	100
1	0	C	H	5	D	E	L	A	1	Any One(Group A) 1. Food Technology	4	0	0	4	4	50	50	100
1	0	C	H	5	D	E	L	A	2	2. Petroleum Refining								
1	1	C	H	5	D	E	L	B	1	Any One(Group B) 1. Nano Technology	4	0	0	4	4	50	50	100
1	0	C	H	5	D	E	L	B	2	2. Polymer Processing								
										Total				25	29	300	300	600

L-Lecture Hours/week; T-Tutorial Lecture Hours/week; P-Practical hours/week. CIE-Continuous Internal Evaluation; SEE-Semester End Examination (of 3 Hours duration)

Dr. Samita Maitra
Chairperson-BOS/HOD

BMS COLLEGE OF ENGINEERING, BANGALORE
Autonomous College under VTU
SCHEME OF INSTRUCTION
Department of Chemical Engineering Program BE Semester VI

Subject Code										Subject Title	Credit Hours/Week				Contact Hrs/ Week	Marks		
											L	T	P	Total		CIE	SEE	Total
1	0	C	H	6	D	C	C	R	1	Chemical Reaction Engineering-II	4	0	0	4	4	50	50	100
1	0	C	H	6	D	C	I	P	C	Instrumentation and Process Control	4	0	1	5	7	50	50	100
1	0	C	H	6	D	C	M	T	2	Mass Transfer-II	4	0	1	5	7	50	50	100
1	1	C	H	6	D	C	N	E	T	Non-conventional Energy Technology	3	0	0	3	3	50	50	100
1	0	C	H	6	D	E	L	C	1	Any One(Group C) 1. Applied Mathematics in Chemical Engg. 2. Operation Research	3	0	0	3	3	50	50	100
1	0	C	H	6	D	E	L	C	2									
1	0	C	H	6	D	E	L	D	1	Any One(Group D) 1. C++ Programming 2. Interfacial Phenomenon and Separation Techniques	3	0	0	3	3	50	50	100
1	1	C	H	6	D	E	L	D	2									
1	0	C	H	6	D	H	S	S	1	Communicative English	2	0	0	2	2	50	50	100
										Total				25	29	350	350	700

L-Lecture Hours/week; T-Tutorial Lecture Hours/week; P-Practical hours/week. CIE-Continuous Internal Evaluation; SEE-Semester End Examination (of 3 Hours duration)

Dr. Samita Maitra
Chairperson-BOS/HOD

BMS COLLEGE OF ENGINEERING, BANGALORE
Autonomous College under VTU
SCHEME OF INSTRUCTION
Department of Chemical Engineering Program BE Semester VII

Subject Code										Subject Title	Credit Hours/Week				Contact Hrs/ Week	Marks		
											L	T	P	Total		CIE	SEE	Total
1	0	C	H	7	D	H	S	S	2	Plant Utilities & Safety	3	0	0	3	3	50	50	100
1	0	C	H	7	D	C	B	C	E	Biochemical Engg	4	0	0	4	4	50	50	100
1	0	C	H	7	D	C	P	E	D	Chemical Process Equipment Design and Drawing	3	0	1	4	5	50	50	100
1	0	C	H	7	D	C	P	P	W	Pre-Project Work				6	12	50	50	100
1	0	C	H	7	D	C	C	A	M	Computer Applications and Modeling	3	0	1	4	5	50	50	100
														21	29	300	300	600
										Institutional Electives courses				4	4	50	50	100
										10CH7IECP1 Composite Materials								
										10CH7IECP2 Advanced Bioprocess Engg								

L-Lecture Hours/week; T-Tutorial Lecture Hours/week; P-Practical hours/week.CIE-Continuous Internal Evaluation; SEE-Semester End Examination (of 3 Hours duration except CH7DCPED which is 4 Hours)

Dr. Samita Maitra

Chairperson-BOS/HOD

BMS COLLEGE OF ENGINEERING, BANGALORE
Autonomous College under VTU
SCHEME OF INSTRUCTION
Department of Chemical Engineering Program BE Semester VIII

		Subject Code								Subject Title	Credit Hours/Week				Contact Hrs/ Week	Marks		
											L	T	P	Total		CIE	SEE	Total
1	0	C	H	8	D	H	S	S	3	Process Engineering Economics	3	0	0	3	3	50	50	100
1	0	C	H	8	D	C	F	P	W	Final Project				12	24	50	50	100
1	0	C	H	8	D	C	I	T	S	Industrial Trip & Related seminar	2	0	0	2	2	100		100
1	0	C	H	8	D	C	T	R	P	Transport Phenomena	4	0	0	4	4	50	50	100
														21	33	300	200	500
										Institutional Electives courses				4	4	50	50	100
										10CH8IECK1 Waste Water Treatment and Engg								
										10CH8IECK2 Pilot Plant and Scale-Up								

L-Lecture Hours/week; T-Tutorial Lecture Hours/week; P-Practical hours/week.
CIE-Continuous Internal Evaluation; SEE-Semester End Examination (of 3 Hours duration)

Dr. Samita Maitra

Chairperson-BOS/HOD

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER III Cluster CHEMICAL

Subject Title	ENGINEERING MATHEMATICS - 3											Credits	4		
Sub. Code	0	9	M	A	3	I	C	M	A	T		L-T-P	3	1	0

UNIT 1

FOURIER SERIES

Infinite series, convergence and divergence of infinite series of positive terms, power series, periodic function, Dirichlet's conditions, statement of Fourier Theorem, Fourier series of periodic function of period 2π and arbitrary period, half range Fourier series, complex form of Fourier series, practical harmonic analysis. 9 Hrs 7L+2T

UNIT 2

FOURIER TRANSFORM

Infinite Fourier transform, Fourier Sine and Cosine transforms, properties, Inverse transforms, Convolution theorem (statement only), Parseval's identities for Fourier transform. Fourier transforms of the derivatives of a function. 9 Hrs 7L+2T

UNIT 3

PARTIAL DIFFERENTIAL EQUATIONS

Formation of Partial differential equations-elimination of arbitrary constants, elimination of arbitrary functions. Equations of first order- The linear equation $P\,p + Q\,q = R$ (Lagrange's partial differential equation). Method of separation of variables. 12 Hrs 5L+2T

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Derivation of one-dimensional heat equation, wave equation, various possible solutions of these by the method of separation of variables, D'Alembert's solution of wave equation. 4L+1T

UNIT 4

NUMERICAL METHODS

Finite Differences and interpolation: Forward differences, Backward differences.

Interpolation: Newton-Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Newton's general interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation. 11 Hrs

Numerical differentiation: Numerical differentiation using Newton-Gregory forward and backward interpolation formula 4L+2T

Numerical integration: Trapezoidal rule, Simpson's $1/3^{rd}$ rule, Simpson's $3/8^{th}$ rule, Weddle's rule.

Solution of algebraic and transcendental equations: Ramanujan's method, Newton-Raphson method, deductions.

Numerical solution of ordinary differential equations: Euler's modified method, Runge-Kutta method of fourth order. 4L+1T

UNIT 5

Z -TRANSFORMS

Definition, Properties, Transforms of standard functions, Inverse transforms.

APPLICATIONS OF Z -TRANSFORMS

Solution of difference equations using Z- transforms. 4L+2T

CALCULUS OF VARIATIONS

Variation of function and functional, Euler's equation, variational problem. 4L+1T

APPLICATIONS OF CALCULUS OF VARIATIONS

Geodesics, minimal surface of revolution, hanging chain, Brachistochrone problem. 11 Hrs

Text Books

1. Higher Engineering Mathematics, B.S. Grewal, 40th edition, 2007, Khanna Publishers.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 8th edition, 2007, Wiley-India
3. Introductory methods of Numerical Analysis, S. S. Sastry, 3rd edition, 1999, Prentice-Hall of India.

Reference Books:

1. Advanced Modern Engineering Mathematics, Glyn James, 3rd edition, 2004, Pearson Education.
2. Higher Engineering Mathematics, B.V. Ramana, 2007, Tata Mc. Graw Hill.
3. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.

MATHEMATICS DEPARTMENT
syllabus (2010 - 2011)
for students admitted to ii year through lateral entry
(common to all branches)

Subject Title	ENGINEERING MATHEMATICS - 1											Credits	4		
Sub. Code	0	9	M	A	3	I	M	D	I	P		L-T-P	3	1	0

UNIT 1

DIFFERENTIAL CALCULUS 1

Introduction to n^{th} derivatives of standard functions (self study), Leibnitz's theorem (without proof). Rolle's theorem-Geometrical interpretation, Lagrange's and Cauchy's mean value theorems (with proof). Taylor's and Maclaurin's series expansions for function of one variable (without proof). 5L+ 2T

Polar curves: angle between radius vector and tangent, angle between the polar curves, length of the perpendicular from pole to the tangent, pedal equations of polar curves. Derivatives of arc length (cartesian and polar form). Radius of curvature-cartesian, parametric, polar and pedal forms. 4L+1T 12Hrs

UNIT 2

DIFFERENTIAL CALCULUS 2

Indeterminate forms – L'Hospital's rule (without proof) 2L+1T

Partial differentiation: Partial derivatives, total differentiation, differentiation of composite and implicit functions, Jacobians and their properties (without proof). 4L+1T

Taylor's and Maclaurin's series expansions for functions of two variables. Maxima and Minima for functions of two variables. Leibnitz rule for differentiation under the integral sign (without proof) - simple problems with constant limits.

APPLICATIONS OF DIFFERENTIAL CALCULUS 3L+1T

Errors and approximations 12 Hrs

UNIT 3

INTEGRAL CALCULUS

Reduction formulae for the integration of $\sin^n x$, $\cos^n x$, $\sin^m x \cos^n x$ (m and n being positive integers) and evaluation of these integrals with standard limits. Tracing of standard curves: Cartesian form-Cissoid, Strophoid, Leminscate, Parametric form-Cycloid, Astroid, Polar form - Cardioid, Leminscate. 5L+1T

APPLICATIONS OF INTEGRAL CALCULUS

Area of a plane region, length of a plane curve, volume of revolution and surface area of revolution by a given curve (without proof and problems involving standard curves). 2L+1T = 9 Hrs

UNIT 4

ORDINARY DIFFERENTIAL EQUATIONS 1

Solution of first order and first degree differential equations-variables separable (self study), Homogeneous equations, equations reducible to homogeneous equations, Linear equations, Bernoulli's equation, exact equations, equations reducible to exact equations (first four cases only). 5L+1T

APPLICATIONS OF ORDINARY DIFFERENTIAL EQUATIONS OF FIRST ORDER Simple electric circuits (RL circuits), Newton's law of cooling, heat flux, rate of decay of radio activematerials. 2L+1T =9 Hrs

UNIT 5

ORDINARY DIFFERENTIAL EQUATIONS 2

Linear differential equations of second and higher order with constant coefficients, method of variation of parameters, solutions of Cauchy's homogenous linear equation and Legendre's equation. 5L+2T

APPLICATIONS OF LINEAR DIFFERENTIAL EQUATIONS

Simple harmonic motion, Simple Pendulum (small oscillations). 2L+1T=10 Hrs

Text Books

1. Higher Engineering Mathematics, B.S. Grewal, 40th edition, 2007, Khanna Publishers.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 8th edition, 2007, Wiley-India

Reference Books:

1. Advanced Modern Engineering Mathematics, Glyn James, 3rd edition, 2004, Pearson Education.
2. Higher Engineering Mathematics, B.V. Ramana, 7th reprint, 2009, Tata Mc. Graw Hill.
3. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.

SEMESTER III Cluster CHEMICAL

Subject Title	PROCESS PRINCIPLE & CALCULATIONS											Credits	4		
Sub. Code	0	9	C	H	3	D	C	C	P	C		L-T-P	4	0	0

UNIT – I

UNITS AND DIMENSIONS: Fundamental and derived units, Conversion. Dimensional consistency of equations. Dimensionless groups and constants. Conversion of equations. 4 Hrs

BASIC CHEMICAL CALCULATIONS: Concept of mole, Mole fraction. Compositions of mixtures of solids, liquids & gases. Concept of normality, Molarity, Molality, parts per million. Use of semi - log, triangular graphs. Ideal gas law, Amagat's law, Dalton's law calculations 6 Hrs

UNIT II

PSYCHROMETRY: Vapour-Pressure concept, Clausius- Clapyron equation. Cox chart and its use, Psychrometry, Absolute humidity, Molal humidity, Relative humidity, Dry bulb, Wet bulb thermometry, Humidity chart , Humidification and Dehumidification, Air-conditioning. 08 Hrs

UNIT – III

MATERIALS BALANCE WITHOUT REACTION: General material balance equation for steady state. Steady state material balances in distillation, extraction, crystallization and drying. 07 Hrs

Steady state material balance for mixing and evaporation. Elementary treatment of material balances involving recycling and bypass. 07 Hrs

UNIT –IV

STEADY STATE MATERIAL BALANCE WITH REACTION: Principles of stoichiometry, Concept of limiting and excess reactants and inerts, Fractional and percentage conversion, Fractional yield and percentage yield, Selectivity, Related problems. 07 Hrs

Ultimate and proximate analyses of fuels, Calculations involving burning of solid, liquid and gaseous fuels, excess air, Air-fuel ratio calculations. 07 Hrs

UNIT - V

ENERGY BALANCE: General steady state energy balance equation, Heat capacity, Enthalpy, Heat of formation, Heat of reaction, Heat of combustion, Heat of mixing, Determination of Heat of Formation at standard and elevated temperatures, Theoretical flame temperature and Adiabatic flame temperature. 06 Hrs

TEXT BOOKS:

1. K.V.Narayanan and B. Lakshmikutty 'Stoichiometry and Process Calculations', Second Edition, 2009, PHI Learning private Ltd. New Delhi-110001
2. Bhatt B.L. and Vora S.M. '*Stoichiometry* (SI Units)', Third Edition, 1996, Tata McGraw Hill Publishing Ltd., New Delhi – 1996.

REFERENCE BOOKS:

1. Hougen O.A., Waston K.M. and Ragatz R.A., 'Chemical Process Principles Part – I' Material and Energy Balances, Second edition, CBS publishers and distributors, New Delhi, 1995.
2. Himmelblau D.M., "Basic Principles and Calculations in Chemical Engineering", 6th Edn. Prentice Hall of India, New Delhi 1997.

Charts: Psychrometric chart, steam tables

SEMESTER III Cluster CHEMICAL

Subject Title	FLUID MECHANICS											Credits	5		
Sub. Code	0	9	C	H	3	D	C	F	M	E		L-T-P	4	0	1

UNIT – I -

FLUID STATICS AND ITS APPLICATIONS: Concept of unit operations, Concept of Momentum Transfer, Nature of fluids and pressure concept, Variation of pressure with height – hydrostatic equilibrium, Barometric equation, Measurement of fluid pressure – manometers (U-tube, Inverted U-Tub, Differential manometers). Continuous gravity decanter, Centrifugal decanter.

FLUID FLOW PHENOMENA: Types of fluids – shear stress and velocity gradient relation, Newtonian and non – Newtonian fluids, Viscosity of gases and liquids. Types of flow – laminar and turbulent flow, Reynolds stress, Eddy viscosity. Flow in boundary layers, Reynolds number, Boundary layer separation and wake formation. 12 Hrs

UNIT – II

BASIC EQUATIONS OF FLUID FLOW: Average velocity, Mass velocity, Continuity equation, Euler and Bernoulli equations, Modified equations for real fluids with correction factors. Pump work in Bernoulli equation.

FLOW OF COMPRESSIBLE FLUIDS: Basic equations of Compressible flow (Continuity, Bernoulli's or Energy equations, Momentum Equations and Equation of state), stagnation properties, Compressible fluid through Venturi, Pitot-Static tube, Concept of Mach number, Velocity of sound or Pressure wave in a fluid, Ideal gas equations. 12 Hrs

UNIT – III

FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYER: Laminar flow through circular and non-circular conduits. Hagen-Poiseuille equation, Turbulent flow in pipes and closed channels, Friction factor chart. Friction form change in velocity or direction. Form friction losses in Bernoulli equation.

UNIT – IV

METERING OF FLUIDS: Pipes, Fitting and valves, Measurement of liquid and gas flow rates by Orifice meter, Venturi meter, Rotameter and Pitot tube. Flow through open channels – weirs and notches. 12 Hrs

TRANSPORTATION OF FLUIDS: Performance and characteristics of pumps – Positive Displacement and centrifugal pumps. Fans, Compressor and Blowers. 10 Hrs

UNIT – V

DIMENSIONAL ANALYSIS: Dimensional homogeneity, Rayleigh's and Buckingham's II – methods. Significance of different dimensionless numbers. Elementary treatment of similitude between model and prototype 6 Hrs

LABORATORY COMPONENT

1. Determination of Friction factor in circular pipes
2. Determination of Friction factor in non circular pipes.
3. Friction in helical / spiral coils.

4. Flow rate measurement using Venturi / Orifice meters (incompressible fluid)
5. Measurement of pressure drop in Packed bed
6. Measurement of pressure drop in Fluidized bed
7. Study and development of characteristics for centrifugal pump
8. Study of various pipe fittings and their equivalent lengths
9. Compressible fluid flow measurement using Venturi / Orifice meters
10. Reynold's apparatus

TEXT BOOKS:

1. McCabe. W.L., et. al. "Unit Operations of Chemical Engineering", 5th edn., McGraw Hill, New York 1993.

REFERENCE BOOKS:

1. A Textbook of Fluid Mechanics (VTU),Dr.R.K.Bansal, Edition 2005,Laxmi Publications.
2. Coulson J. II and Richardson. J.F.., 'Chemical Engineering' Vol. L., 5th edn., Asian Books (p) Ltd., New Delhi, 1998.

SEMESTER III Cluster CHEMICAL

Subject Title	MECHANICAL OPERATIONS										Credits	5		
Sub Code	0	9	C	H	3	D	C	M	O	P	L-T-P	4	0	1

UNIT- I

PARTICLE TECHNOLOGY: Particle size analysis, Specific surface area, Screens: Ideal and actual screens, Differential and cumulative size analysis, Effectiveness, standard screens series, Motion of screens, Gyratory screen shaker , Vibrating screen shaker, Trommels. Sub sieve analysis. Problems. 09 Hrs

UNIT- II

SIZE REDUCTION: Forces used, Characteristics of products, Laws of size reduction, Work Index, Verification of laws, Problems. Open circuit grinding, Closed circuit grinding, Wet and dry grinding, Equipments: Jaw crusher, Gyratory crusher, Roll crusher, Attrition mill, Ball mill, Fluid energy mill, Hammer mill, Cutter . 9 Hrs

UNIT- III

FLOW OF FLUID PAST IMMERSED BODIES: Drag, Drag coefficient, Particle Reynolds number. Ergun equation and its modifications, Particle size determination by Kozeny Carmen equation. Fluidization, Types and Applications. Conveying of solids: Belt conveyors, Chain conveyors .

FILTRATION: Classification, Modification of Kozeny – Carman equation for filtration. Industrial filters: Filter press, leaf filter, Rotary drum filter, Bag filter, Suspended batch centrifuge, Filter aids. Principles of cake filtration. 14 Hrs

UNIT- IV -

MOTION OF PARTICLES THROUGH FLUIDS: Equation for one dimensional motion of particles through a fluid in gravitational and centrifugal field, Terminal settling velocity, motion of spherical particle in different regions, Criterion for settling .Hindered settling. Cyclones, hydro cyclones and air elutriator, Heavy media separation.

SEDIMENTATION: Batch settling test, theories, Application of batch settling test to design a continuous thickener, problems.

Storage of solids- Open and closed storage. 13 Hrs

UNIT- V

MISCELLANEOUS OPERATIONS

AGITATION AND MIXING: Equipment, Types of impellers. Flow patterns in agitated vessels, Prevention of swirling, Power correlation and calculation. Mixers: Muller mixer, Ribbon blender, internal screw mixer, tumbling mixer.

SEPARATIONS: Electrostatic separation, Jigging, Froth floatation.

SIZE ENLARGEMENT: Pelletization, agglomeration 7 Hrs

LABORATORY COMPONENT:

1. Air elutriation
2. Air permeability
3. Batch sedimentation
4. Beaker decantation
5. Drop weight crusher
6. ICI sedimentation
7. Jaw crusher

8. Leaf filter
9. Plate and frame filter press
10. Storage of solids- Open and closed storage. Screen effectiveness

TEXT BOOKS :

1. "Unit Operations of Chemical Engineering", McCabe W.L., et.al., V Edn., McGraw Hill International, Singapore , 2000.

REFERENCE BOOKS :

1. "Introduction to Chemical Engineering" III Edn., Badger, W.L. and Banchero J.T. McGraw Hill International Edition, Singapore 1999.

2. Coulson and Richardson's Chemical Engineering " Particle Technology and Separation Processes" IV Edn.,Coulson J.M. and Richardson J.F., Asian Books Pvt. Ltd. New Delhi, 1998

SEMESTER III Cluster CHEMICAL

Subject Title	PROCESS EQUIPMENT DRAWING											Credits	3		
Sub. Code	0	9	C	H	3	D	C	E	Q	D		L-T-P	2	0	1

All the units have drawing component

UNIT – I

SECTIONAL VIEWS:
Representation of the sectional planes, Sectional, lines and hatching, selection of section planes and types of sectional views. 04 Hrs

PROPORTIONATE DRAWING OF PROCESS EQUIPMENT:
Equipment and piping symbols, Vessel component; Vessel opening, Manholes, Vessel enclosures, Vessel support, Jackets, Shell and tube heat exchanger, Reaction vessel, Evaporator and fermenter. 07 Hrs

UNIT – II

ASSEMBLY DRAWING
Joints: Cotter joint with sleeve, Socket and cotter Spigot joint, Flanged pipe joint, Union joint, gland and stuffing box joint and gland and stuffing box expansion joint. 08 Hrs

Valves: Stop valve, Globe valve, Screw down Stop valve, Rams Bottom safety valve, Non-return valve. 14 Hrs
Pumps: Centrifugal pump, Gear pumps 06Hrs

Note:
1. First angle projection to be followed.
2. Examination consists of one question on proportionate drawing (30marks) and one question on Assembly drawing (70 Marks)
3. Unit – I: Proportional drawings and Unit II: Assembly drawings

TEXT BOOKS:
1. Gopal Krishna, K.R., "Machine Drawing", 9th Edn., Subhas Stores, Bangalore 1995.

REFERENCE BOOKS;
1. Bhatt, N.D., "Machine Drawing", 29th Edn., Charotar Publishing House, Anand, 1995.
2. Joshi, M.V., "Process Equipment Design", 3rd Edn. , Macmillan India.

SEMESTER III Cluster CHEMICAL

Subject Title	TECHNICAL CHEMISTRY											Credits	4		
Sub. Code	0	9	C	Y	3	D	C	C	E	M		L-T-P	3	0	1

UNIT-l

REACTION MECHANISMS-I

Bond cleavage- homolytic and heterolytic bond cleavage; concept of reactive intermediates- carbocations, carbanions and free radicals. Formation, Structure and Stability of Reactive Intermediates with suitable examples.Electron displacements in molecules -Inductive effect, resonance effect, conjugation effect, hyperconjugation effect and electromeric effect with examples Nucleophilic aliphatic substitution reactions-1Hr-SN1 reactions- Mechanism, kinetics, steareochemistry of the products with suitable examples. SN2 Reaction- Mechanism, kinetics, stereochemistry of the product- Walden Inversion. Factors affecting SN1 and SN2 reactions.

8 Hrs

UNIT-ll

REACTION MECHANISMS-II

Elimination reactions-Dehydrohalogenation. E1 and E2 mechanisms.,Discussion of mechanism, kinetics and geometry of the products, Factors favouring E reactions versus substitution reaction. Electrophillic addition reactions

Electrophollic aromatic substitution reactions. (Benzene): Mechanism of Nitration ; Sulphonation, Halogenation and Friedel crafts alkylation and acylation reactions. Orientation influence of the substituent in the benzene ring on further substitution. 8 Hrs

UNIT- lll

ACTIVE METHYLENE COMPOUNDS AND ORGANOMETALLICS

Definition of active methylene group and compounds with example

Malonic ester: Preparation and properties, synthetic application, Synthesis of mono carboxylic acids-butyric acids, dicarboxylic acids , unsaturated acids, cinnamic acid, ketonic acid-acetoaetic acid, ,heterocyclic compounds

Acetoacetic ester: Ketonic and acid hydrolysis , Praparation and properties, basis for synthetic application, synthesis of mono and dialkylderivatives, monocarboxylic acid –propionic acid, dicarboxylic acid succinic acid , unsaturated acids crotonic acid, heterocyclic compounds.

Organomettallic Compounds: Definition and examples. Grignard reagent, preparation, synthetic application,synthesis of alkane, aldehydes and ketones. 8 Hrs

UNIT-lV

INSECTICIDES: Intoduction, classification into contact, stomach, systematic and fumigant. Insecticides explanation with example Organochlorine insecticides – DDT and BHC, Cyclopentadienes- Aldrin and Dialdrin . Organophosphates-melathion .

DYES: Classification of dyes by structure and by method of application, colour and constitution-chromophore, auxochrome theory, Modern theory of colour. Synthesis of azo dyes, congo red. Synthesis of triaryl methane dyes- alizarin. Synthesis of vat dye, indigo 8 Hrs

UNIT-V

OILS AND FATS: Intoduction as triglycerides, properties and uses, vegetable oils examples, analysis of oil- Acid value, saponication value and iodine value- their determination.

SOAPS AND DETERGENTS: Soaps definition, types ,manufacture of soap, Detergents definition, various constituents of a detergent, Surfactants-anionic, cationic, zwitterionic and non ionic builders, Sud regulators, softeners and other additives, Cleansing action of detergent, Advantages of detergents over soaps. 7 Hrs

LABORATORY COMPONENT

1. Nitration of nitrobenzene to m- dinitrobenzene
2. Acetylation of aniline by acetic anhydride
3. Preparation of benzoic acid from benzaldehyde
4. Bromination of acetanilide to p-bromoacetanilide
5. Diazotization of aniline and coupling with phenol
6. Estimation of alcohol by acetylation
7. Estimation of amino group by acetylation
8. Estimation of phenol by bromination
9. Estimation of esters by hydrolysis
10. Estimation of carboxylic acid by iodometric titration
11. Reduction of O-nitro Aniline to O- phenylene diamine

Lab components must comprise of experiments that reinforce the theoretical understanding of the corresponding theory subject. Outlines of the laboratory components should be mentioned by the respective staff members well before the commencement of the course.

TEXT BOOKS:

1. Arun Bahl and B.S. Bahl. "A Text Book of Organic Chemistry", 15th Edition, S. Chand and Company, New Delhi, 1998.
2.Jerry March and Michael B. Smith "Advanced Organic Chemistry" Wiley Publication, 2001

REFERENCE BOOKS

1.Morrison B.R. and Boyd L.L., "Organic Chemistry", 6th Edition ELBS, New Delhi, 1999.
2.Finar, "Organic Chemistry Vol I and II" ULBS Publishers, New Delhi.
3.Tiwari Melhrotra and Vishnoi, "Organic Chemistry", 7th Edition, S. Chand and Company, New Delhi, 1996.
4.Sykes Peter, "Guide Book to Organic Reaction Mechanism". ULBS Publishers, New Delhi.
5.Sharma B.K., "Industrial Chemistry". 11th Edition, S. Chand and Company, New Delhi, 2001.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER IV Cluster CHEMICAL

Subject Title	ENGINEERING MATHAMATICS – IV											Credits	4		
Sub. Code	0	9	M	A	4	I	C	M	A	T		L-T-P	3	1	0

UNIT 1

STATISTICS 11 Hrs

Curve fitting – Fitting a straight line, fitting of a parabola, fitting of curves of the form $a\,b^x, a\,x^b,\ ae^{bx}$. Correlation, regression. 4L+1T

PROBABILITY 1

Probability of an event, axiomatic definition, addition theorem, conditional probability, multiplication theorem, Bayes' theorem. 4L+2T

UNIT 2

PROBABILITY 2 9 Hrs

Probability distributions: Random variables, Discrete probability distributions, continuous probability distributions, Some standard distributions: Binomial distribution, Poission distribution, exponential distribution, normal distribution. 7L+2T

UNIT 3

COMPLEX ANALYSIS 1 10 Hrs

Function of a complex variable, Analytic functions, Cauchy-Riemann equations, construction of analytic functions, Cauchy-Reimann equations in Polar form.

APPLICATION TO FLOW PROBLEMS

Complex potential, velocity potential, equipotential lines, stream functions, stream lines.

Transformations- $w = z^2$, $w = e^z$ and $w = z + \frac{a^2}{z}\ (z \neq 0)$, Bilinear transformations 8L+2T

UNIT 4

COMPLEX ANALYSIS 2 12 Hrs

Complex integration-Cauchy's theorem, Cauchy's integral formula, Taylor's and Laurent's series, Singular points, poles, residues, the residue theorem. 5L+2T

SERIES SOLUTION OF DIFFERENTIAL EQUATIONS

Series solution-Frobenius method, series solution of Bessel's differential equation leading to Bessel function of first kind, equations reducible to Bessel's differential equation, series solution of Legendre's differential equation leading to Legendre polynomials, Rodrigue's formula. 4L+1T

UNIT 5

OPTIMIZATION 10 Hrs

Linear programming, mathematical formulation of linear programming problem (LPP), graphical method, simplex method, artificial variable technique- M method, two phase method. 7L+3T

Text Books

1. Higher Engineering Mathematics, B.S. Grewal, 40th edition, 2007, Khanna Publishers.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 8th edition, 2007, Wiley-India

Reference Books:

1. Advanced Modern Engineering Mathematics, Glyn James, 3rd edition, 2004, Pearson Education.
2. Higher Engineering Mathematics, B.V. Ramana, 2007, Tata Mc. Graw Hill.
3. Advanced Engineering Mathematics, P. V. O' Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.

BMS COLLEGE OF ENGINEERING, BANGALORE – 560019
MATHEMATICS DEPARTMENT
SYLLABUS (2010 - 2011)
for students admitted to ii year through lateral entry
(common to all branches)

Subject Title	ENGINEERING MATHEMATICS - 2											Credits	4		
Sub. Code	0	9	M	A	4	I	M	D	I	P		L-T-P	3	1	0

UNIT -1

MATRICES

Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of system of linear equations and solution. Solution of a system of non-homogenous equations: Gauss elimination method, Gauss-Seidel method, LU decomposition method. Characteristic values and Characteristic vectors of matrices, Cayley-Hamilton theorem (without proof). Computation of largest eigen value and eigen vector using Rayleigh's power method.

APPLICATIONS OF MATRICIES 10 Hrs

To compute the inverse of for a 2x2 matrix using Cayley-Hamilton theorem. Diagonalisation of matrices. 8L+2T

UNIT 2

INTEGRAL CALCULUS

Multiple Integrals – Double integrals, evaluation of double integrals by change of order of integration, evaluation of double integrals by changing to polar form, Triple integrals.

APPLICATIONS OF DOUBLE AND TRIPLE INTEGRALS 09 Hrs

Area and volume 5L+2T

INTRODUCTION TO ORTHOGONAL CURVILINEAR COORDINATES

Definitions- Orthogonal curvilinear coordinates, scale factors, base vectors, orthogonality of cylindrical and spherical coordinate systems, expressing a given vector in cylindrical and spherical coordinates. Expressions for divergence, curl and Laplacian in orthogonal curvilinear coordinates (without proof). 2L+0T

UNIT 3

VECTOR CALCULUS

Scalar and vector point functions, vector differentiation, Gradient, Divergence, Curl, Laplacian, solenoidal, irrotational vectors. 12 Hrs

Vector identities: $\text{div}\left(\phi\vec{A}\right)$, $\text{curl}\left(\phi\vec{A}\right)$, $\text{curl}\left(\text{grad}\,\phi\right)$, $\text{div}\left(\text{curl}\vec{A}\right)$, $\text{div}\left(\vec{A}\times\vec{B}\right)$ and $\text{curl}\left(\text{curl}\vec{A}\right)$.

5L+2T

Vector integration – Line integrals, surface integrals, Green's theorem, Stokes' theorem and Gauss divergence theorem (without proof, statement and problems). 4L+1T

UNIT 4

LAPLACE TRANSFORMS

Definitions, properties, transforms of elementary functions, transforms of derivatives and integrals, properties, Periodic function, Unit step function and impulse function. 10 Hrs

7L+3T

UNIT 5

INVERSE LAPLACE TRANSFORMS

Inverse Laplace Transforms-properties, Convolution theorem.

APPLICATIONS OF LAPLACE TRANSFORMS

Solution of ordinary differential equations and simultaneous differential equations using Laplace transforms (intial-boundary value problems). 11 Hrs 5L+2T

BETA AND GAMMA FUNCTIONS

Beta and Gamma functions- Properties, relation between Beta and Gamma functions, Duplication formula. 3L+1T

Text Books

1. Higher Engineering Mathematics, B.S. Grewal, 40th edition, 2007, Khanna Publishers.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 8th edition, 2007, Wiley-India.
3. Higher Engineering Mathematics, B. V. Ramana, 7th reprint, 2009, Tata Mc. Graw Hill

Reference Books:

1. Advanced Modern Engineering Mathematics, Glyn James 3rd edition, 2004, Pearson Education.
2. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER IV Cluster CHEMICAL

Subject Title	CHEMICAL TECHNOLOGY											Credits	4		
Sub. Code	0	9	C	H	4	D	C	C	T	N		L-T-P	4	0	0

UNIT- I –

INTRODUCTION TO CT AND FUELS : Introduction-_Components of flowsheet.Fuels and Industrial gases- Hydrogenation of coal, LNG, LPG, Ammonia synthesis gas, Petroleum technology- Constituents, distillation of crude petroleum, Refining and processing (important chemical processes discussed briefly).Cryogenic industry- Nitrogen and Oxygen. 10 Hrs

UNIT- II -

INORGANIC CHEMICALS :_ Sulphur.-Mining process and Sulphuric acid - DCDA Process Alkali industry- Soda Ash, Caustic soda Nitrogen Industries- Ammonia and Nitric Acid. Phosphorous, phosphoric acid. (HCl leaching method) 12 Hrs

UNIT- III -

NATURAL INDUSTRIALS: Oil industry- vegetable oil extraction, Refining and hydrogenation.
Surfactant industry- Manufacture of soap and detergents.
Pulp and paper industry (sulfate process).
Effluent treatment for sulfate process. Sugar industry. 12 Hrs

UNIT IV

COMMERCIAL INDUSTRIES:
Fermentation industry- Manufacture of ethyl alcohol, penicillin
Lime stone beneficiation and Cement
LDPE, PVC, Rubber industry (Natural rubber and SBR) 9 Hrs

UNIT- V

MISCELLANEOUS INDUSTRIES: Paints-Zinc oxide, Titanium dioxide Glass, Bromine Fertilizers-Urea, NPK, biofertilizers, Coking of coal. 9 Hrs

TEXT BOOKS:

1. Dryden's outlines of Chemical Technology.
2. Shreve's chemical process industries, 4th edition.

REFERENCE BOOKS:

1. Textbook of chemical technology, Shukla and Pandey

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER IV Cluster CHEMICAL

Subject Title	PROCESS HEAT TRANSFER											Credits	5		
Sub. Code	0	9	C	H	4	D	C	H	T	R		L-T-P	4	0	1

UNIT – I :

INTRODUCTION: Various modes of heat transfer Viz. Conduction, Convection and Radiation

CONDUCTION: Fourier's law, Steady state unidirectional heat flow through single and multiple layer slabs, Cylinders and spheres for constant and variable thermal conductivity. 8 Hrs

UNIT – II :

INSULATION: Properties of insulation materials, Types of insulation, Critical and Optimum thickness of insulation.

EXTENDED SURFACES : Fins – Types of fins, Derivation of fin efficiency for longitudinal fins, Fin effectiveness.
Elementary treatment of unsteady state heat conduction. 13 Hrs

UNIT – III :

CONVECTION: Individual and overall heat transfer coefficient, LMTD, LMTD correction factor.

HEAT TRANSFER WITH PHASE CHANGE: Boiling phenomena, Nucleate and film boiling, Condensation – Film and Drop wise condensation, Nusselt's equations. 13 Hrs

UNIT – IV :

Dimensional numbers, - Dimensional analysis, Empirical correlation for forced and natural convection.
Analogy between momentum and heat transfer – Reynolds, Coulburn and Prandtl analogies.
9 Hrs

UNIT – V :

RADIATION: Properties and definitions, absorptivity, reflectivity, emissive power and intensity of radiation, black body radiation, grey body radiation, Stefan-boltzman law, wien's displacement law, kirchoff's law, view factors.
Radiation between surfaces – different shapes, radiation involving gases and vapours, radiation shields. 9 Hrs

LABORATORY COMPONENT

1. SHELL AND TUBE HEAT EXCHANGER
2. DOUBLE PIPE HEAT EXCHANGER
3. VERTICAL CONDENSER
4. EMISSIVITY
5. HELICAL COIL HEAT EXCHANGER
6. TRANSIENT HEAT CONDUCTION (CONSTANT TEMPERATURE)

7. BARE TUBE HEAT EXCHANGER
8. FIN TUBE HEAT EXCHANGER
9. PACKED BED HEAT EXCHANGER
10. TRANSIENT HEAT CONDUCTION (CONSTANT FLUX)

TEXT BOOKS:

1. Kern D.Q., "Process Heat Transfer", Mc Graw Hill., New York, 1965.

REFERENCE BOOK:

1. McCabe, W.L., et.al., "Unit Operations of Chemical Engineering", 5th Edn, McGraw Hill, New York 2000.
2. Coulsion J.M. and Richardson J.F., "Unit Operations of Chemical Engineering" Vol. 1, 5th Edn, Chemical Engineering Pergamon and ELBS, McGraw Hill, New York 2000.
3. Rao., Y.V.C., " Heat Transfer", 1st Edn., Universities Press (India) Ltd., New Delhi, 2000.
4. P.K.Nag, "Heat and Mass Transfer", Second Edition, Tata McGrawhill publications.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER IV Cluster CHEMICAL

Subject Title	PROCESS ENGINEERING THERMODYNAMICS											Credits	4		
Sub. Code	0	9	C	H	4	D	C	P	T	D		L-T-P	4	0	0

UNIT 1:

FIRST LAW OF THERMODYNAMICS AND BASIC CONCEPTS: Heat reservoir and Heat engines, Reversible and Irreversible processes. Zeroth law of thermodynamics. First law of thermodynamics for different systems, Derivation for steady state flow process, principles of flow calorimeter.

SECOND LAW OF THERMODYNAMICS: General statements of the Second law, concept of Entropy, The Carnot Principle, Calculation of entropy changes. Third law of thermodynamics. 8Hrs

UNIT 2:

P-V-T BEHAVIOUR: P-V-T behaviour of pure fluids, Equations of state and ideal gas law, Equations of state for real gases: Vander Waals equation, Redlich – Kwong equation, Virial equation. Compressibility charts, Thermodynamics diagrams.

Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. 8 Hrs

UNIT3:

THERMODYNAMIC PROPERTIES OF PURE FLUIDS, AND SOLUTIONS: Property relations for homogeneous systems, Clausius-Clapeyron equations, heat capacity, entropy, & energy relations, Gibbs-Helmholtz equation.

PROPERTIES OF SOLUTIONS: Partial molar properties, Chemical potential, Fugacity in solutions, Henry's law and dilute solutions, Activity in solutions, Activity coefficient, Property changes of mixing, excess properties. 13 Hrs

UNIT 4:

PHASE EQUILIBRIA: Criteria of phase equilibria, Criterion of stability, Duhem's theorem, Vapour – Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, VLE at low pressures, VLE at high pressures, Consistency test for VLE data, Calculation of Activity coefficients using Gibbs – Duhem equation, Liquid-Liquid equilibrium diagrams.

VLE correlations equations: Vander wall , Margules & Willson equations. 13 Hrs

UNIT 5:

Chemical Reaction Equilibria: Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Effect of temperature, pressure on equilibrium constants and other factors affecting equilibrium conversion, Liquid phase reactions, Heterogeneous reaction equilibria, phase rule for reacting system. 10 Hrs

TEXT BOOKS:

1. "Introduction to Chemical Engineering Thermodynamics", Fifth edition, Smith J.M. and Van Ness H.C., McGraw Hill, New York, 1996.
2. "Textbook of Chemical Engineering Thermodynamics", Narayanan, K.V. Prentice Hall of India Private Limited, New Delhi, 2001.

REFERENCE:

1. "Chemical Engineering Thermodynamics", Rao, Y.V.C., New Age International Publication, Nagpur, 2000.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER IV Cluster CHEMICAL

Subject Title	MATERIAL SCIENCE AND BIOMATERIALS									Credits	4		
Sub. Code	C	H	4	D	C	M	S	B		L-T-P	4	0	0

UNIT- I –

INTRODUCTION: Introduction to material science, classification of engineering materials. Crystal geometry and structure determination. Geometry of crystals -the Bravais lattices, Crystal directions and planes-the miller indices, Structure determination-X-Ray diffraction-Bragg law, the powder method. Crystal imperfections: Point imperfections, Line imperfections-edge and screw dislocations, Surface imperfections. 7 Hrs

UNIT- II–

PHASE DIAGRAM AND PHASE TRANSFORMATIONS: Phase rule, Single component systems, Binary phase diagrams, Lever rule, Typical phase diagrams for Copper-Zinc, Iron – Carbon systems, Nucleation & growth, solidification, Allotropic transformation, Cooling curve for pure iron, Iron-carbon equilibrium diagram, Isothermal transformations (TTT Curves). 14 Hrs

UNIT- III -

DEFORMATION OF MATERIALS AND FRACTURE:

Elastic .deformation, Plastic deformation, Visco-elastic deformation, and fracture. Heat treatment: Annealing Normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburizing, Cyaniding, Nitriding, Flame hardening.

Corrosion and its prevention: Direct corrosion, Electro- Chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, Factor influencing corrosion rate, Control and prevention of corrosion-Modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings. 14 Hrs

UNIT- IV -

TYPICAL ENGINEERING MATERIALS: Metals and nonmetals: -General properties of ferrous metals, Non ferrous metals and alloys –Copper and its alloys, Lead and its alloys, Nickel and its alloys, Alloys for high temperature service. Ceramic materials – Structure of ceramics, Polymorphism, Mechanical, electrical and thermal properties of ceramic phase. 10 Hrs

UNIT- V –

BIOMATERIALS

Introduction; Polymers as a biomaterial, microstructure, mechanical properties, biocompatibility of polymers.

Applications; In medicine and surgery, biodegradable polymers in drug delivery and drug carriers systems. Functional requirements of biomaterials, tissue and organ replacements. Orthopaedic biomaterials, dental biomaterials, cardiovascular biomaterials. 07 Hrs

TEXT BOOKS :

1. Hajra Choudhury S.K., "Material Science and Processes" Indian Book Distributing Co., 1982.
2. . Raghavan V., "Materials Science and Engineering – A First Course" 5thEdn., Prentice Hall of India Pvt. Ltd., New Delhi, 1996.

REFERENCE BOOKS:

1. Material Science by Smith, Mc graw Hill
2. Biomaterials science: An introduction to materials in medicine by Buddy dratner.Academic press {1996}
3. Polymeric biomaterials by Serverian Dumitrice
4. Corrosion engineering, Fontana and Green, 3rd edn. McGraw Hill.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER IV Cluster CHEMICAL

Subject Title	INSTRUMENTAL METHODS OF ANALYSIS											Credits	4		
Sub. Code	0	9	C	H	4	D	C	I	M	A		L-T-P	3	0	1

UNIT – I

INTRODUCTION

General introduction to classical qualitative and quantitative analysis , use of instrumentals for qualitative and quantitative analysis, classification of instrumental methods, errors, precision and accuracy of instruments. Properties of electromagnetic radiation, electromagnetic spectrum 6Hrs

Unit II

SPECTROSCOPY

Introduction – Regions of infrared spectrum, Requirement of IR absorption, instrumentation, qualitative and quantitative analysis using IR spectroscopy, theory. Introduction to UV and visible spectroscopy, theory, instrumentation and application. 9 Hrs

UNIT – III

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

Introduction to NMR, the nuclear spin, Larmor precession, NMR isotopes, energy levels , theory, chemical shift – definition, causes, measurement , factors affecting , instrumentation and application of NMR for qualitative and quantitative analysis

ELECTROPHORESIS:

Theory and principles, classifications, instrumentation, moving boundary electrophoresis, Zone Electrophoresis (ZE), Isoelectric focusing (IEF) and applications. 12 Hrs.

UNIT – IV

CONDUCTOMETRIC MEASUREMENTS

Introduction, conductance measurements,, applications of conductometric measurements, Measurement of pH-theory, instrumentation and application, Potentiometric titration - theory, instrumentation and application. 07 Hrs

UNIT – V

GAS CHROMATOGRAPHY: Introduction, Principle, carrier gas, stationery phase, instrumentation, sample injection, column detectors (TCD, FID, ECD, atomic emission detector), effect of temperature on retention, qualitative and quantitative analysis

HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

Principle, instrumentation, column, sample injection, detectors (absorbance, refractive index, electrochemical), mobile phase selection and application. 05 Hrs

LABORATORY COMPONENT

1. Analysis of effluents for pH, alkalinity and turbidity
2. Determination of COD and BOD
3. Measurement of particulate matter in Air
4. Analysis of exhaust gas be ORSAT apparatus

5. Determination of unknown concentration of potassium permanganate by UV visible spectrophotometer.
6. Determination of concentration of alkali metal by Flame photometer
7. Turbidometer
8. Dissolved Oxygen measurement
9. Potentiometer titration.
10. Establishment of neutralization curve by pH analysis.

TEXT BOOK:

1. Instrumental Methods of Chemical Analysis; Gurudeep R. Chatwal and Sham K. Anand, Himalaya Publishing House
2. Principles of Instrumental Analysis- D.Skoog and D. West

REFERENCE BOOKS:

1. Introduction to Chrmatography : Bobbit
2. Instrumental Methods of Analysis (CBS): H.H.Willard, L.L Merit J.A.Dean & F.A.Settle

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER V Cluster CHEMICAL

Subject Title	CHEMICAL REACTION ENGINEERING – I											Credits	5		
Sub Code	1	0	C	H	5	D	C	C	R	1		L-T-P	4	0	1

UNIT- 1

INTRODUCTION: Scope of Chemical Reaction Engineering, Classification of reactions, Rate equation and rate of reaction. Factors affecting rate of reaction. Chemical kinetics and Thermodynamics Equilibrium. Temperature- dependency of rate constant from Arrhenius, Collision and Transition state theories. Molecularity and order of reaction. 9Hrs

UNIT- II -

NON-ELEMENTARY REACTIONS: Difference between elementary and non- elementary reactions. Kinetic models and mechanisms for non-elementary reactions. Types of reactors. 9 Hrs

UNIT- III -

HOMOGENEOUS REACTIONS: Interpretation of batch reactor data. Constant & Variable Volume batch reactor. Analysis : Differential method, Integral method, half-life method. Method of excess and method of isolation (For Reversible and Irreversible reactions up to second order). Autocatalytic reactions.

DESIGN OF IDEAL REACTORS: Concept of ideality. Development of design equations for batch, tubular and stirred tank reactors for both constant and variable volume reactions. Evaluation of rate equations from data obtained in these reactors. 13 Hrs

UNIT- IV -

MULTIPLE REACTOR SYSTEMS: Plug flow and/or Mixed flow reactors in Series, parallel and series parallel. Reactors of different types and sizes in series. Comparison Of Ideal Reactors, General graphical comparison.

DESIGN OF REACTORS FOR MULTIPLE REACTIONS: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions (Only irreversible reactions must be considered). 13Hrs

UNIT- V

NON-ISOTHERMAL REACTORS: Introduction, Material, Energy balances and conversions.

ANALYSIS OF NON ISOTHERMAL REACTOR: Design procedure (For single/simple reactions only). Optimum temperature Progression. 8 Hrs

LABORATORY COMPONENT

1. Batch Reactor
2. Isothermal plug flow reactor
3. Mixed flow reactor
4. Semi batch reactor
5. Packed bed Reactor

6. RTD Studies in Tubular Reactor
7. Effect of temperature on Rate of reaction
8. Bio Chemical Reaction (Batch)
9. Enzyme catalyzed reactions in batch reactor
10. RTD Studies in mixed flow reactor
11. Adiabatic reactor

TEXT BOOKS

1. Chemical Reaction Engineering-Octave Levenspeil, 3rd edition, John Wiley & Sons, 2001.
2. Elements of Chemical Reaction Engineering-H. Scott Fogler, 3rd edition Prentice Hall 2001.

REFERENCE BOOKS:

1. Chemical Engineering Kinetics - J.M. Smith, 3rd Edition, McGraw Hill, 1984.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER V Cluster CHEMICAL

Subject Title	Mass Transfer-1										Credits	5		
Sub Code	1	0	C	H	5	D	C	M	T	1	L-T-P	4	0	1

UNIT- I

INTRODUCTION: Diffusion in fluids, Diffusion in solids, measurement and calculations of diffusivities. Eddy diffusion: MT coefficients and their correlations. Theories of MT. Interphase MT, J_D factor, Analogies in Mass Transfer, Heat Transfer and Momentum transfer processes. 14 Hrs

UNIT- II

HUMIDIFICATION: General theory, Psychrometric chart. Concepts in humidification, dehumidification. Equipment-cooling towers, spray chamber.

DRYING: Introduction, Equilibria, Drying rate curves, Mechanism of drying, types of dryers, Design of batch and continuous dryers. 14Hrs

UNIT- III

CRYSTALLIZATION: Factors governing nucleation and crystal growth rates, Controlled growth of crystals, Incorporation of principles into design of equipment , Crystallizer equipments: Swenson-Walker and Continuous crystallizers. 9 Hrs

UNIT- IV

ADSORPTION: Theories of adsorption , Isotherms, Industrial adsorbents. Material balance for co-current, cross current and counter current operations, concept of stages, cascades and equipments. 9 Hrs

UNIT- V

INTRODUCTION TO NOVEL SEPARATIONS: Ion exchange, membrane processes- Reverse osmosis, dialysis, ultra and micro filtrations, super-critical fluid extraction. 6 Hrs

LABORATORY COMPONENT:

1. Diffusion co-efficient of organic vapor into air.
2. Surface evaporation.
3. Drying characteristics.
4. Single stage adsorption.
5. Solid dissolution.
6. Multistage adsorption.
7. Wetted wall column.

TEXT BOOKS :

1. Mass transfer operations- Robert E. Treybal , McGraw Hill publications, 3rd edition.
2. Unit operations in chemical engineering- McCabe & Smith, McGraw Hill publications, 6th edition.

REFERENCE BOOKS :

1. Transport processes and unit operations-Geankoplis C. .J , prentice Hall(I) .
2. Chemical Engineering Vol I, II , IV & V- Coulson and Richardson, 4th edition, Pergamon press.
3. "Introduction to Chemical Engineering" III Edn., Badger, W.L. and Banchero J.T. McGraw Hill International Edition, Singapore 1999.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER V Cluster CHEMICAL

Subject Title	Pollution Control										Credits	3		
Sub Code	1	0	C	H	5	D	C	P	C	L	L-T-P	3	0	0

UNIT- I

INTRODUCTION: Importance of Environment for Mankind. Biosphere and Layers of Atmosphere. Hydrological Cycle and Nutrient Cycles. Types of Pollution. Damages from Environmental Pollution. Environmental Legislations and Environmental Acts in India. 6 Hrs

UNIT- II

WATER POLLUTION: Water Resources. Wastewater Classification. Types of Water Pollutants. Waste Water Sampling, Methods of Analysis: DO, BOD, COD, TOC, Nitrogen, Phosphorus, Trace Elements and Alkalinity. Wastewater Treatment: Preliminary, Primary, Secondary and Tertiary.

Advanced Wastewater Treatment: Micro straining, Adsorption on Activated Carbon, Ion Exchange, Reverse Osmosis, Electro dialysis cell. Applications to Industries: Petroleum refinery, distillery, Fertilizer and Textile processing. 12 Hrs

UNIT- III

AIR POLLUTION: Definition, Sources, Classification, Properties of air pollutants, Effects of air pollution on health vegetation and materials. Air pollution sampling: Ambient sampling and Stack sampling. Analysis of air pollutants. Control methods and Equipments for particulates and gaseous pollutants. Applications to Industries: Thermal power plants, Metallurgical and Cement industries. 11 Hrs

UNIT- IV

SOLID WASTE TREATEMENT: Sources and Classification, Effect on public health, Methods of Collection, Disposal Methods, Recovery and Recycling of Solid Waste. 5 Hrs

UNIT- V

NOISE POLLUTION: Definition, Sources, Effects of Noise, Equipments Used for Noise Measurement, Approaches for Noise Control. 5Hrs

TEXT BOOKS:

1. 'Environmental Pollution Control Engg', C.S Rao, New Age International Reprint, 2002.
2. 'Pollution Control In Industries', S.P. Mahajan,TMH, 1999.

REFERENCE BOOKS:

1. 'Environmental Chemistry and Pollution Control', S.S. Dara
2. 'Environmental Engineering', G.N.Pandey and G.C. Carney, Tata McGraw Hill 2002.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER V Cluster CHEMICAL

Subject Title	Chemical Equipment Design										Credits	4		
Sub Code	**C**	**H**	**5**	**D**	**C**	**C**	**E**	**D**			**L-T-P**	**4**	**0**	**0**

UNIT - 1

INTRODUCTION: Basic considerations in design. General design procedure. Equipment classification. Various components of process equipment. Design parameters. Pressure vessel codes. **7 Hours**

UNIT - 2

DESIGN CONSIDERATIONS: Material selection. Factors affecting design. Stresses due to static and dynamic loads (Internal & External). Temperature effects. Economic considerations.

DESIGN OF PRESSURE VESSELS: Design parameters, conditions & stresses. Design of shell and other vessel components. Vessel at low & high operating temperatures. Numerical design problems using given process parameters. **13 Hours**

UNIT - 3

VESSEL COMPONENT DESIGN: Design of supports for vessels - Bracket, Lug, Leg, Saddle and Skirt supports. Design of flanges & nozzles – Classification of flanges. Flange thickness calculation, Gasket selection and design, Bolt selection and calculation. Nozzle design. Design of vessel closures – Flat plates, Formed heads, Elliptical & Hemispherical heads.

REACTION VESSELS: Design of reaction tanks with agitation and jacket. Types of agitators, baffles. Power requirement calculations. Design of tank dimensions and agitation system components. Numerical problems. **14 Hours**

UNIT - 4

STORAGE VESSELS: Process conditions and design parameters for storage of volatile, non-volatile fluids & gases. Design of cylindrical tanks with fixed roofs. Design of components, supports and selection of vessels accessories & mountings. Numerical problems. **9 Hours**

UNIT - 5

PIPE LINE DESIGN: Pipe line sizing, Condensate and steam pipe design, Optimum size of delivery line in pumping operations. Concepts of P & I Diagrams, P & I Diagram for simple processes. **8 Hours**

TEXT BOOKS:

1. **Process Equipment Design -** M. V. Joshi, Macmillan & Co. India, Delhi, 3rd Edn. reprint 1998.
2. **Process Equipment Design – Vessel Design -** Brownell & Young, John Willey, 1951
3. **Process Design of Equipment – Vol 1** - S. D. Dawande, Central Techno Publications. 3rd. Edn, 2003.

REFERENCE BOOKS:

1. **Chemical Engineers Handbook -** Perry & Green, 7th Edn, McGraw Hill, 1997.
2. **Pressure Vessel Code – IS 2825 -** IS Code, B.I.S., New Delhi, 1969.
3. Flow of Fluids through Valves, Fittings & Pipes Crane Amazon-2006.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER V Cluster CHEMICAL

Subject Title	FOOD TECHNOLOGY											Credits	4		
Sub Code	1	0	C	H	5	D	E	L	A	1		L-T-P	4	0	0

UNIT- I

INTRODUCTION AND QUALITY ATTRIBUTES OF FOOD: Aim of food science and technology, function of foods, food in relation to health. Quality attributes – Appearance factors, Textural factors, Flavor factors. Visual and objectively measurable attributes. Additional quality; quality standards, quality control. Introduction to sensory evaluation of foods. Formation and Chemistry Of Food: Carbohydrates, Proteins, Lipids, Vitamins, Minerals, Water and Phytochemicals. 8 Hrs

UNIT- II

FOOD PROCESSING AND PRESERVATION: Causes for food deterioration. Aims and objectives of preservation and processing. Unit operations in processing.
Different methods of food preservation – low temperature, high temperature, preservatives, osmotic pressure, dehydrations, food irradiation.

PROCESSING AND PRESERVATIONS: Milk and dairy products, vegetables and fruits, cereals, meat and meat products, fats and oils, beverages, sweeteners. 13 Hrs

UNIT- III

ENZYMATIC AND NON-ENZYMATIC REACTIONS DURING STORAGE: Introduction to enzymes. Nature and function of enzymes. Classification of enzymes. Hydrolases – Esterase, amylases, pectic enzymes. Proteases. Oxidoreductases – phenolases, glucose oxidase, catalose, peroxidase, lipoxygenase, oxidase. Immobilized enzymes. Uses of enzyme in food processing. Non-enzymatic reactions. 9Hrs

UNIT- IV

FOOD ADDITIVES: Introduction and need for food additives. Types of additives –antioxidants, chelating agents, coloring agents, curing agents, emulsions, flavors and flavor enhancers, flavor improvers, humecants and anti caking agents, leavening agents, nutrient supplements, non-nutritive sweeteners, pH control agents. Preservatives – types and applications. Stabilizers and thickeners, other additives. Additives and food safety.
FOOD CONTAMINATION AND ADULTERATION: Types of adulterants and contaminants. Intentional adulterants. Incidental adulterants and its effects. Food laws and standards. 13Hrs

UNIT- V

ENVIRONMENTAL CONCERNS AND FOOD SAFETY: Water in food production. Properties and requirements of processing water. Environmental concerns – solid waste disposal, wastewater properties, wastewater treatment. Safety hazards and risks. Food related hazards. Processing and handling. Cleaning and sanitizing. Modern trends in food science: Biotechnology in food, Biofortification, Nutraceuticals,. Organic foods, Low cost nutrient supplements, Packaging of foods and nutrition labeling, Careers in food science and food industries. 09 Hrs

TEXT BOOKS:

1. 'Food Science',- Norman N. Potter and Joseph H. Hotchkin Avi Publishing Co. , 1968.
2. 'Foods, Facts and Principles', N. Shakuntala Manay and
M. Shadaksharamurthy, New Age Publishers, 2005.

REFERENCE BOOKS :

1. 'Food Science' B. Srilakshmi, 4th Edn., New Age International-2007.
2. 'Food Processing and Preservation', G. Subbulakshmi and Shobha A. Udupi, New Age International-2001.
3. 'Introduction to Food Science', Rick Parker & Thomsan Detmer, 2001.
4. 'Principles of Food Chemistry', John M DeMan, 3rd Edn., Springer publecations, 1999.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER V Cluster CHEMICAL

Subject Title	PETROLIUM REFINING										Credits	4		
Sub Code	1	0	C	H	5	D	E	L	A	2	L-T-P	4	0	0

UNIT I:

INDIAN PETROLEUM INDUSTRY: Prospects & Future. Major companies. World production, Markets, Offshore and onshore, Oil well technology.

COMPOSITION OF CRUDE: Classification. Evaluation of petroleum. UOP-k factor. TBP analysis. EFV analysis. Average boiling point. ASTM curves. Thermal properties of petroleum fractions. 6Hrs

UNIT II:

PRODUCT PROPERTIES AND TEST METHODS: Gas: Various types of gas and LPG. Reid vapor pressure analysis. Gasoline and naptha. Octane No. Oxidation stability. Additives for gasoline. Kerosene. Characterization for flash point or fire point, volatility, burning qualities etc, Diesel, octane testing, viscosity etc. Grades of diesels e.g. HSD, LDO. Diesel additives. Lube oils : Types, tests-carbon residue and viscosity index. 9 Hrs

UNIT III:

CRUDE PRETREATMENT: Pumping of crude oils. Dehydration of crude by chemical, gravity, centrifugal, electrical de-salter and comparision of each. Heating of crude- heater, different types of pipe still heaters. Crude distillation, arrangement of towers for various types of reflux.

TREATMENT TECHNIQUES: Types of impurities present and various desulfurisation processes. Production and treatment of LPG. LNG technology. Sweetening operations for gases. Catalytic desulphonisation. Treatment of kerosene. Treatment of diesel and Treatment of lubes: 15 Hrs

UNIT IV:

CATALYTIC CRACKING: Comparision of thermal and catalytic cracking and Cracking conditions. Various catalytic cracking processes: Fluid catalytic cracking-flexi cracking. Theory of coking: various types of coking processes. Naptha cracking,Hydro cracking. Theory of hydro cracking. Catalysts for hydro cracking.

CATALYTIC REFORMING: Theory. Factors influencing reforming, catalysts, feedstock requirements. 15 Hrs

UNIT V:

THERMAL PROCESSES: Reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. 7 Hrs

TEXT BOOKS:

1. Modern Petroleum Refining Processes - Bhaskara Rao, Oxford & IBH Publication, 3rd Edition, Reprint, 1999.
2. Petroleum Refinery Engineering - Nelson, McGraw Hill, 4th Edition, 14th Reprint, 1982.

REFERENCE BOOKS:

1. Petroleum Refining Technology- Ram Prasad, Khanna Publishers, I Edition, 2000.
2. Challenges in Crude Oil Evaluation- Nagnal J.M., Gate, McGraw Hill.
3. Petroleum Processing - Sland W.F. and Davidson R.L. McGraw Hill, 1967.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER V Cluster CHEMICAL

Subject Title	NANOTECHNOLOGY											Credits	4		
Sub Code	1	1	C	H	5	D	E	L	B	1		L-T-P	4	0	0

UNIT I:

Introduction to Physics of the Solid State: Structure, Energy Bands, Localized Particles. Methods of Measuring Properties: Atomic size, crystallography, Particle size determination, Surface structure, Microscopy- Transmission Electron Microscopy, Field Ion Microscopy, Scanning Microscopy; Spectroscopy- Infrared and Raman Spectroscopy, Photoemission and X-ray Spectroscopy, Magnetic resonance. 7 Hrs

UNIT II:

Properties of Individual Nanoparticles: Metal nanoclusters, Semiconducting nanoparticles, rare gas and molecular clusters, methods of synthesis- RF Plasma, Chemical Methods, Thermolysis, Pulsed Laser methods. 6 Hrs

Carbon nanostructures: Carbon molecule, Clusters, Carbon nanotubes, Applications Bulk nanostructured materials: Solid disordered nanostructures, nanostructure crystals. 6 Hrs

UNIT III:

Nanostructured Ferromagnetism: Basics of ferromagnetism, Effect of bulk nanostructuring of magnetic properties, dynamics of nanomagnets.

Optical and vibrational spectroscopy: Infrared frequency range, luminescence, nanostructures in zeolite cage. 7 Hrs

UNIT IV:

Quantum wells, wires and dots: Preparation of quantum nanostructures, Size & dimensionality effects, Excitons, Single electron tunneling, Applications, superconductivity. 6 Hrs

Catalysis: Nature of catalysis, Surface area of nanoparticles, porous materials, pillered clays, Colloids. 7 Hrs

UNIT V:

Biological materials: Biological building blocks, biological nanostructures. Nanomachines and nanodevices: Microelectromechanical systems (MEMSs), Nanoelectromechanical Systems (NEMSs) - Fabrication, Devices. Molecular and Supramolecular Switches. 7 Hrs

TEXT BOOK:

1. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens, John Wiley and Sons, 2009.

REFERENCE BOOK:

1. Handbook of Nanostructured Materials and Nanotechnology, Vol. 1-5, Academic Press, Boston, 2000.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER V Cluster CHEMICAL

Subject Title	POLYMER PROCESSING											Credits	4		
Sub Code	1	0	C	H	5	D	E	L	B	2		L-T-P	4	0	0

UNIT- I

PRINCIPLES OF PROCESSING OF POLYMERS: Melt processing of thermoplastics. Classification of processes, crystallization, orientation & shrinkage, Co polymers blendings, Compounding for engineering application, Stress – strain behavior, WLF equation, Practical assessment for long term behavior. 7 Hrs

UNIT- II -

POLYMER EXTRUSION: Single screw and double screw plasticating, Extruder zones, Extruder screws, Power calculation. Die and calibration equipment, Co extrusion, Extrusion coating, Extrusion film blowing, Reactive extrusion, Extrusion blow moulding for PET bottles, Wire drawing-PVC, Spinning . Application of various extruded products. Rheological aspects of extrusion and extrusion defects. Operational and maintenance of extrusion equipments. 10 Hrs

UNIT- III -

INJECTION MOULDING : Reciprocating screw injection moulding. Single impression mould. Multi impression moulds. Cooling requirements in moulds. Hot runner moulds, gates, mould clamping force calculations. Control of pressure, temperature and time of injection .Thermoset and Fiber reinforced polymer injection moulding, Sandwich moulding and Injection blow moulding. Rheological aspects and defects of injection. Comparision of injection moulding and extrusion of injection. Operational and maintenance of injection moulding equipments. Reaction injection moulding. Applications. 9 Hrs

UNIT- IV -

COMPRESSION MOULDING , TRANSFER MOULDING, CALENDERING : Compression moulding: Applications. Principles. Derivation of compression mould thickness or compaction force. Transfer moulding. Principles and operation of calendaring. Derivation of film thickness and pressure required for rollers. Guage control during calendaring. Application of PVC calendered products. 7 Hrs

UNIT- V –

THERMOFORMING AND ROTATIONAL MOULDING : Thermoforming: Basic principles. Vacuum forming. Pressure forming. Description of operations. Product design. Application. Derivation of thermoformed product thickness. Rotational moulding: Principles. Operation & applications. Thickeness. Cooling calculations. 6 Hrs

TEXT BOOKS :

1. 'Principles of Polymer Processing', Morton Jones,.
2. 'Plastic Engineering', R.J. Crawford.

REFERENCE BOOKS :

1. 'Principles of Polymer Engineering', N.G. McCrum, C.P. Buckley,

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VI Cluster CHEMICAL

Subject Title	CHEMICAL REACTION ENGINEERING – II											Credits	4		
Sub Code	1	0	C	H	6	D	C	C	R	1		L-T-P	4	0	0

UNIT- I

BASICS OF NON IDEAL FLOW: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation. Dispersion model. Tanks in series model. Conversion in non- ideal flow reactors for simple systems. 8 Hrs

UNIT- II

NON CATALYTIC SYSTEMS: Fluid-Fluid reactions and Kinetics.
FLUID PARTICLE REACTIONS: Mechanism and Kinetics. 14 Hrs

UNIT- III

CATALYSIS: Introduction to catalysis. Properties of catalysts. Estimation methods for catalytic properties. Promoters, inhibitors etc, Mechanism of catalysis. Rate equations for different rate controlling steps 8 Hrs

UNIT- IV

DEACTIVATION: Deactivating catalyst. Mechanism, rate & performance equation. SOLID CATALYZED REACTIONS: Heterogeneous reactions-Introduction., Kinetic regimes. Rate equation for surface kinetics. Pore diffusion resistance combined with surface kinetics. Thiele modulus and enhancement factor, Porous catalyst particles. Heat effects during reaction. 14 Hrs

UNIT- V

SOLID CATALYZED REACTIONS: Performance equations for reactors containing porous catalyst particles. Experimental methods for finding rates. Packed bed catalytic reactor & reactors with suspended solid catalyst. Fluidized reactors of various type.
GAS-LIQUID REACTORS: Trickle bed, slurry reactors. Three phase fluidized bed. 08 Hrs

TEXT BOOKS :

1. Chemical Reaction Engineering - Octave Levenspiel, 3rd Edition, John Wiley & Sons - 2001.
2. Chemical Engineering Kinetics - J.M. Smith, 3rd Edition, McGraw Hill

REFERENCE BOOKS :

1. Chemical & Catalytic Reaction Engineering - James J. Carberry, McGraw Hill - 1976.
2. Elements of Chemical Reaction Engineering - H. Scott Foggler, 3rd Edition, Prentice Hall - 2001.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VI Cluster CHEMICAL

Subject Title	**Instrumentation and Process Control**											Credits	5		
Sub Code	1	0	C	H	6	D	C	I	P	C		L-T-P	4	0	1

UNIT- I

INSTRUMENTATION: Fundamentals Static and dynamic characteristics. Indicators and recorders. Pressure measurement- Bourdon, diaphragm and bellow type gages. Vacuum measurements. Temperature measurement- Bimetal and resistance thermometers, thermocouples and pyrometers. 10 Hrs

UNIT- II

FIRST ORDER SYSTEMS: Thermometer, level, mixing tank, STR:Linearisation: I order systems in series. Response for various input forcing functions. 10 Hrs

UNIT- III

SECOND ORDER SYSTEMS: Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions,
response for step input for under damped case – Terms associated with it. Transportation lag.
10 Hrs

UNIT- IV

CLOSED LOOP SYSTEM: Basic components. Servo and regulator control. Controllers – P, I, D and On –Off modes. Controller combinations – Final control elements - Valves, actuators and valve positioners.
CLOSED LOOP RESPONSE: Block diagram, Closed loop transfer function, Transient response of servo and regulator control systems with various controller modes and their characteristics.
10 Hrs

UNIT- V

STABILITY: Stability of linear control systems. Routh Test. Frequency Response – Bode diagrams.
CONTROL SYSTEM DESIGN BY FREQUENCY RESPONSE: Bode criterion. Gain and Phase margins. Ziegler – Nichols controller tuning, Cohen-Coon controller tuning.
ROOT LOCUS: Rules for plotting and problems. 12 Hrs

LABORATORY COMPONENT:

1. Thermometer
2. Single tank - Step Response
3. Non Interacting Tanks - Step Response
4. Interacting Tanks - Step Response
5. Pressure Tank
6. U – Tube Manometer
7. Single tank - Impulse Response
8. Non Interacting Tanks - Impulse Response
9. Interacting Tanks - Impulse Response
10. Level control – P controller, PI controller, PD controller, PID controller
11. Valve characteristics.

TEXT BOOKS :

1. Process System Analysis and Control - Coughner & Koppel, McGraw Hill, New Delhi, II Edition, 1991.

REFERENCE BOOKS :

1. Chemical Engineering Vol. III, III Edition - Coulson & Richardson, Pergamon Press, 1998.

2. Chemical Process Control - George Stephanopoules, And Introduction to Theory & Practical, Prentice Hall, New Delhi, 1998.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VI Cluster CHEMICAL

Subject Title	Mass Transfer-II											Credits	5		
Sub Code	1	0	C	H	6	D	C	M	T	2		L-T-P	4	0	1

UNIT- I

GAS LIQUID CONTACTING SYSTEMS: Liquid and gas dispersion: Types, construction and working of tray and packed columns, types and properties of packings, tray efficiencies, HETP and HTU concepts, Concept of flooding , weeping, and entrainment. Comparision of tray and packed columns.

ABSORPTION: Equilibrium solubility of gases in liquids. One component transferred: Material balances. Counter current multistage operations: Isothermal only. Continuos contact equipment: Absorption of one component, Overall coefficients and transfer units, dilute solutions, Overall heights of transfer units. Design of packed towers from the data of NTU. Absorption with chemical reaction. 12 Hrs

UNIT- II

DISTILLATION : Introduction, Vapour liquid equilibria. Estimation of VLE data, VLE for multi-component systems. Flash vapourisation, Simple or differential distillation, Steam distillation, Continuous rectification, Design using McCabe Thiele method for binary mixtures. 14 Hrs

UNIT- III

DESIGN OF DISTILLATION COLUMN : Ponchon Savarit method. Efficiencies –overall, local, and Murphree plate efficiencies: Reboilers, Use of open steam, Vacuum, molecular, extractive and azeotropic distillations. 08 Hrs

UNIT- IV

LIQUID LIQUID EXTRACTION : Introduction, Ternary equilibrium. Solvent selection. Equipment and flow sheets: Single stage. Multi-stage cross-current. Insoluble systems, Continuous counter current multistage extraction, Equipments: Stage efficiency, stage type extractors(no design aspects): Mixer –settler cascades, Continuous contact equipments: packed towers, Rotating disc contactor, Pulsed column, Sheibel extractor, centrifugal extractor. 10 Hrs

UNIT- V

LEACHING OPERATION : Introduction, Preparation of solid, Equipment for unsteady state operation and steady state operation.

Methods of calculation: Euilibrium diagrams, Single stage and multi-stage cross and counter current operations, Counter current constant underflow case, leaching operation

8 Hrs

LABORATORY COMPONENT :

1. Simple distillation
2. Steam distillation
3. Single stage leaching
4. Packed column distillation
5. Single stage extraction
6. Multistage extraction
7. Multistage Leaching

TEXT BOOKS :

1. Mass Transfer Operations - Robert E Treybal, 3rd Edition, McGraw Hill, 1981.
2. Unit Operations in Chemical Engineering - McCabe & Smith, 6th Edition, McGraw Hall, 2001.

REFERENCE BOOKS :

1. Chemical Engineering, Vol II and V - Coulson and Richardson, 4th Edition, Pergamon Press, 1998.
2. Introduction to Chemical Engineering - Badger & Banchero, TMH, 1998.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VI Cluster CHEMICAL

Subject Title	Non-conventional Energy Technology											Credits	3		
Sub Code	1	1	C	H	6	D	C	N	E	T		L-T-P	3	0	0

UNIT 1

INTRODUCTION:
Man and Energy, Worlds and India's production and reserves of energy, present and future power position, need for alternate energy, energy alternatives. 5**Hrs.**

UNIT 2

SOLAR ENERGY: Introduction: Extraterrestrial solar radiation, radiation at ground level, collectors. Solar cells, applications of solar energy. **6 Hrs.**

UNIT 3

BIOMASS & GEOTHERMAL : Biomass Energy: Introduction, Biomass Conversion, Biogas Production, Ethanol Production, Pyrolysis and Gasification, Direct Combustion, Applications of biomass energy.

Recovery of thermal conversion products –Combustion of waste materials & related calculations, Waste incineration with heat recovery and use of Refused Derived Fuels (RDF).
Geothermal Energy: Introduction, resource types, resource base. Applications for heating and electricity generation. **12 Hrs.**

UNIT 4

WIND AND HYDRO ENERGY SOURCES: Introduction: Basic theory, types of turbines, applications. Hydropower: Introduction, basic concepts, site selection, types of turbines, small scale hydropower. **10Hrs.**

UNIT 5

FUEL CELLS: Introduction, Principle and operation of fuel cells, classification and types of fuel cells and application of fuel cells. **6 Hrs.**

TEXT BOOKS:
1. **'Non-conventional energy resources',** G.D.Rai
2. **'Non-conventional energy resources', B. H Khan,** Tata McGraw Hill, New Delhi
3. '**Fuel Cell Handbook**' , EG&G Technical Services, 7th edn., Inc**.** U.S. **,** Department of Energy Office of Fossil Energy, National Energy Technology Laboratory.

REFERENCES:
1. **'Fuel and energy' ,** Harker and Backhurst Academic press, London 1981.
2. **'Fuel science',** Harker and Allen Oliver and Boyd, 1972.
3. Environmental Engineering by Howard S. Peavy, Donald R Rowe & George Tchobanoglous, Mc GEngg Thermodynamics raw – Hill International Editions

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VI Cluster CHEMICAL

Subject Title	APPLIED MATHEMATICS IN CHEMICAL ENGINEERING											Credits	3		
Sub Code	1	0	C	H	6	D	E	L	C	1		L-T-P	3	0	0

UNIT – I

MATHEMATICAL FORMULATION OF THE PHYSICAL PROBLEMS: Applications of laws of conservation of mass, energy. Statement of the problem. Examples and problems. 7 Hrs

UNIT - II

ORDINARY DIFFERENTIAL EQUATIONS: Formulations of ordinary differential equations involving chemical engineering problems. Solutions- Equations of first order and first degree, Solutions - Equations of first order and second degree. Simultaneous linear differential equations. 10 Hrs

UNIT –III

PARTIAL DIFFERENTIAL EQUATIONS: Formulations of partial differential equations involving chemical engineering problems. Solutions.

FINITE DIFFERENCES: Analysis of stage-wise Processes. 10 Hrs

UNIT -IV

NUMERICAL METHODS: Solutions of ordinary differential equations. Solutions of partial differential equations. 7 Hrs

UNIT - V

Laplace transforms, inverse Laplace transforms, initial and final value theorem and their applications to chemical engineering. 5 Hrs

TEXT BOOKS:

1. Applied Mathematics in Chemical Engineering - H.S. Mickley, T.K. Sherwood and C.E. Reed, 3rd Edition, Tata McGraw Hill, 1999.

REFERENCE BOOK:

1. Applications of Mathematical Modeling to Process Development and Design, - L.M. Rose Applied Science Publishers Ltd., London, 1998.

2. Mathematical Methods in Chemical Engineering.- V.G. Jenson & G.V. Jeggreys, 1977.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VI Cluster CHEMICAL

Subject Title	OPERATIONS RESEARCH											Credits	3		
Sub Code	1	0	C	H	6	D	E	L	C	2		L-T-P	3	0	0

UNIT- I –

INTRODUCTION: Definition. Scope of Operations Research. Approach and limitations of O.R. Models. Characteristics and phases of O.R. Linear Programming Problems: Mathematical formulation of L.P. Problems. Graphical solution method.

THE SIMPLEX METHOD: Slack, surplus and artificial variables. Simplex, Dual simplex method. Big-M method. 11 Hrs

UNIT- II -

ASSIGNMENT PROBLEMS: Balanced and Unbalanced assignment problems. Maximization assignment problems. Travelling salesman problems. 6 Hrs

UNIT- III -

TRANSPORTATION PROBLEM: Basic feasible solutions by different methods. Finding optimal solution. MODI method. Degeneracy. Unbalanced transportation problems. Maximization Problems. 6 Hrs

UNIT- IV -

SEQUENCING: Johnson's algorithm. n jobs - 2 machines, n jobs -3, machines, and n jobs-n machines without passing sequence. 2 jobs-n, machines. Graphical solutions. 6 Hrs

UNIT- V -

PERT-CPM TECHNIQUES: Network construction. Determining time estimates and critical path. In network analysis. Variance and probability of completing the project. Calculation of different floats. Project duration. Crashing of simple networks. 10 Hrs

TEXT BOOKS :

1. Operation Research - S. D. Sharma, 8th Edition, Kedarnath & Co, 2003.
2. Operation Research – Kanti swaroop, P. K. Gupta and Manmohan,, 9th Edition, S Chand & Co. 1999.

REFERENCE BOOKS :

1. Introduction to Pert and CPM - L. S. Srinath,, 3 Edition, East West, 1998
2. Scientific Inventory Management - Hospach Buchan and Earnest Koenigberg 1989.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VI Cluster CHEMICAL

UNIT - I

Subject Title	C^{++} PROGRAMMING											Credits	3		
Sub Code	1	0	C	H	6	D	E	L	D	1		L-T-P	3	0	0

TOKENS, EXPRESSIONS AND CONTROL STRUCTURES: Scope resolution operator. Member dereferencing operators. Memory management operators. Manipulators. Type cast operator, expressions and implicit conversions. Operator precedence. Control structures. An Overview of C++: Old-style vs. Modern C++. Introducing C++ Classes. 7 Hrs

UNIT - II

AN OVERVIEW OF C++, CONSTRUCTORS AND DESTRUCTORS,
CLASSES AND OBJECTS: Overview of C++: Function overloading. Operator Overloading. Inheritance. Classes and Objects: Classes. Structures and Classes are related. Unions and Classes. Constructors and destructors: Parameterized constructors. Copy constructor. Dynamic constructors. 6 Hrs

UNIT - III

CLASSES AND OBJECTS: Friend Functions. Friend Classes. Inline Functions. Defining Inline Functions within a Class, Static Class Members, Nested Classes, Local Classes. Passing Objects to functions. Returning Objects. Object Assignment.
INHERITANCE: Base class access control. Inheritance and Protected members. Inheriting multiple base classes. Constructors, destructors and inheritance Granting access. Virtual base classes. 10 Hrs

UNIT - IV

POINTERS, VIRTUAL FUNCTIONS AND POLYMORPHISM: Introduction. Pointers to Objects. this Pointer. Pointers to Derived Classes. Virtual Functions. Pure Virtual Functions.
WORKING WITH FILES: Introduction. Classes for File Stream Operations. Opening and Closing a file. Detecting end-of-file. More about open () file modes. File pointers and their manipulations. Working with files: Sequential input and output operations. Updating a file: random access. Error handling during file operations. Command line arguments. 10 Hrs

UNIT – 5

EXCEPTION HANDLING: Exception handling fundamentals. Handling derived class exceptions. Exception handling options. Understanding terminate () and unexpected (). The uncaught_exception () functions. The exceptions and bad_exception classes. Applying exception handling. 06 Hrs

TEXT BOOKS:

1. C++ The Complete Reference- 4th Edition, Herbert Schildt, TMH, 2005
2. Object Oriented Programming with C++- 3rd Edition, Balagurusamy, TMH, 2006.

REFERENCE BOOKS:

1. C++ Primer - Stanley B, Lippman, Josse Lajoie, Barbara E Moo, 4th Edition, Addison Wesley, 2005.
2. Object Oriented Programming in TURBO C++- Robert Lafore, Galgotia Publications Pvt Ltd, 2005.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VI Cluster CHEMICAL

Subject Title	Interfacial phenomena and related separation techniques											Credits	3		
Sub Code	1	1	C	H	6	D	E	L	D	2		L-T-P	3	0	0

Unit – 1

Introduction: Concept of Interface. Surface Tension, Equivalence in the concepts of surface energy and surface tension. Application on interfacial science in industries.

Excess Pressure: Generalized equation for excess pressure across a curved surface- the equation of Young and Laplace and its application. Kelvin's equation and its application, Capillary condensation, Super Saturation, Nucleation. 8Hrs

Unit – 2

Measurement of Interfacial tension: Capillary rise method. Drop weight method, Wilhelmy plate method, Du Nuoy method. Methods based on shape of static drops or bubbles. 6 Hrs

Unit - 3

Wetting fundamentals and contact angles: Work of adhesion, cohesion. Criteria for spreading of liquids. Kinetics of spreading. Lens formation- three phase systems. Young's equation. Contact angle hysteresis. 5 Hrs

Unit – 4

EMULSIONS AND MICROEMULSIONS: The conditions required to form emulsions and microemulsions, charged colloids, emulsions in food science, photographic emulsions. 5 Hrs

Unit - 5

Electrical aspects of surfaces: The electrical double layer. Stern treatment of electrical double layer. Free energy of a diffused double layer. Repulsion between two plane double layers. Colloidal dispersions. Combined attractive and electrical interaction-DLVO theory. 7 Hrs

UNIT- V

Surfactants: Introduction to surfactants, common properties of surfactant solution, Thermodynamics of surfactant self assembly, self assembled surfactant structures, surfactants and detergency

SURFACTANT BASED SEPARATIONS: Fundamentals. Surfactants at inter phases and in bulk. Liquid membrane permeation. Foam separations. Micellar separations. 8 Hrs

TEXT BOOKS:

1. Colloids and Interface Science, Pallab Ghosh, Prantice Hall Publications

REFERENCE:

1. Physical chemistry of surfaces, A. W. Adamson, John Wiley, 5th edition, 1997.
2. Introduction to colloid and surface chemistry, Duncan J. Shaw, Butterworth Heinemann, 4th edition.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VI Cluster CHEMICAL

Subject Title	Communicative English											Credits	2		
Sub Code	1	0	C	H	6	D	H	S	S	1		L-T-P	2	0	0

I. Introduction to Communications: 2 hrs

- **a.** Basic model of communication
- **b.** Understanding the audience
- **c.** Current norms of courtesy: formal/ informal and written/ oral
- **d.** Choosing the appropriate mode of communication
    - i. Appropriate medium of communication
    - ii. Appropriate tone & language

II. Writing skills 4 hrs

- a. Formal Letters
- b. Invites
- c. E-mail
- d. Notices, Circulars & Memos

III. Business Documents 2 hrs

- **a.** Proposals
- **b.** Reports
- **c.** Abstracts

IV. Curriculum Vitae 2 hrs

V. Speaking Skills

- **a.** Corporate Presentation Skills: Organising slides, Argument, Tone of voice, Body language, Timing and Duration of speech, Audio visual aids in speech 8 hrs
- **b.** Group Discussion Techniques 8 hrs

TEXT BOOKS:

1. The Functional Aspects of Communication Skills, P Prasadm S K Kataria & Sons Publication , Fourth revised edition 2008

2. Developing Language Skills, Board of Editors: S C Sood et. al. Manohar Publication, Seventh Edition 2006.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VII Cluster CHEMICAL

Subject Title	Chemical Plant Utilities And Safety								Credits	03		
Sub Code	C	H	7	D	H	S	S	2	L-T-P	03	0	0

UNIT- I –

INTRODUCTION

Different utilities. Role of utilities in process plant operations and criteria for selection of suitable utilities.

Water: Water resources. Different impurities in water, Effect of impurities, Treatment processes for drinking water, Boiler feed water treatment. Storage and handling of water. Types and selection of pumps, piping and accessories. 07 Hrs

UNIT- II -

AIR, STEAM AND POWER

Air: Compressed air, Types of compressor. Power requirements, performance and related calculations. Air-water vapour system: humidification/ dehumidification-related calculations.

Steam and Power: Steam generation in chemical plants. Fire tube boiler and water tube boiler. Calculation: Boiler performance. Cogeneration power plants. Fuels: Types of fuel, Biofuel. Calculation: Calorific value. Proximate and ultimate analysis. Steam storage and handling, piping and accessories. 10Hrs

UNIT- III -

REFRIGERATION

Different refrigeration systems and their characteristics. Coefficient of performance. Power requirements and refrigeration effect- related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants. Air-conditioning systems.

Insulation: Types of insulation, Different types of insulating materials and their characteristics. Selection criteria for insulating material 08 Hrs

UNIT- IV -

PROCESS SAFETY AND ANALYSIS

Introduction to Process Safety: Intrinsic & Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire, Explosions. Ignition sources, Pressure.

Process Safety Analysis: HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis. 10 Hrs

UNIT- V –

SAFETY DEVICES

Pressure relief valves. Ruptures discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices.
05 Hrs

TEXT BOOKS :

1. Thermal Engineering - B.K. Sarkar, Tata Mc Grew Hill –1998.
2. Heat Engines - K.P. Roy, Media Promoters and Publishers-1995.
3. Chemical Engineers Handbook. – Perry 8th Edition –2007.
4. Chemical Engineering- Vol 6 - R.K. Sinnot, Coulson and Richardson's, 3rd Edition, BH, Reprint, 2000.

REFERENCE BOOKS :

1. Power Plant Engineering - P.K. Nag, Tata Mc Grew Hill –1998.
2.Loss prevention in chemical process industries', Vol 1,2,3 - Frank P Lees, Butterworth-Heiremann,1980.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VII Cluster CHEMICAL

Subject Title	Biochemical Engineering								Credits		4		
Sub Code	C	H	7	D	C	B	C	E	L-T-P		4	0	0

UNIT- I –

INTRODUCTION: Bioprocess engineering and technology. Role of a Chemical engineer in bioprocess industry.

An introduction to basic biological sciences. Microbiology: Structure of cells: Prokaryotes and Eukaryotes. Classification of micro-organisms. Taxonomy, Environmental and Industrial microbiology.

9Hours

UNIT- II -

BIOCHEMISTRY: Chemicals of Life: Lipids, Sugars, Polysaccharides, Amino acids and proteins, Vitamins, Biopolymers, Nucleic Acids: RNA, DNA and their derivatives (Structure, Biological function and Importance for life only to be studied).

ENZYMES AND PROTEINS: Detailed structure of proteins and enzymes. Functions. Methods of Production and purification of Enzymes. Nomenclature and Classification of enzymes. Kinetics of Enzyme action: Michaelis–Menten rate equation. Derivation.

12 Hours

UNIT- III -

KINETICS OF ENZYME ACTION: Reversible Enzyme. Two-substrate. Multi-complexes enzyme kinetics (Derivation of rate equations). Experimental determination of rate parameters: Batch and continuous flow experiments. Lineweaver–Burk, Eadie-Hofstee and Hanes-Woolf Plots. Batch Kinetics (Integral and Differential methods).

ENZYME INHIBITION: Effect of Inhibitors (Competitive, noncompetitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalyzed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization: Uses. Methods of enzyme immobilization.

13 Hours

UNIT- IV -

FERMENTATION TECHNOLOGY: Ideal reactors: A review of Batch and Continuous flow reactors for bio kinetic measurements. Microbiological reactors: Operation and maintenance of typical aseptic aerobic fermentation processes. Formulation of medium: Sources of nutrients. Alternate Bioreactor configurations. Introduction to sterilization of bioprocess equipment.

GROWTH KINETICS OF MICROORGANISMS: Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Continuous culture: Optimum Dilution rate in Ideal Chemostat. Introduction to Fed-batch reactors.

9 Hours

UNIT- V –

DOWNSTREAM PROCESSING: Strategies and Steps involved in product purification. Methods of Cell disruption, Filtration, Centrifugation,

Sedimentation, Chromatography, Freeze drying / lyophilization. Membrane separation Technology: Reverse Osmosis, Ultra filtration, Micro filtration, Dialysis.

9 Hours

TEXT BOOKS :

1. Biochemical Engineering Fundamentals - Bailey and Ollis, 2nd Edition, McGraw Hill, 1976.
2. Bioprocess Engineering- Shuler M. L. and Kargi F., 2nd Edition, Prentice Hall, 2002.

REFERENCE BOOKS :

1. Biochemical Engineering – James Lee Prentice Hall - 1992.
2. Biochemical Reactors - Atkinson B Llawbook co. and Australasia-1974.
3. Microbiology Concept and Application - Pelczer, 5th Edition, McGraw Hill, 2001 Reprint.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VII Cluster CHEMICAL

Subject Title	PROCESS EQUIPMENT DESIGN & DRAWING								Credits	4		
Sub Code	C	H	7	D	C	P	E	D	L-T-P	3	0	1

Detailed chemical engineering process design of the following equipment. Necessary aspects studied in "Chemical Equipment Design" is to be applied for mechanical design. Use of standard code books to be taught. The detailed dimensional drawings shall include sectional front view, Full Top/side view depending on equipment and major component drawing with dimensioning and part Template.

1. Double pipe Heat exchanger
2. Shell and Tube Heat exchanger
3. Condensers – Horizontal and vertical
4. Evaporator – Single effect
5. Bubble Cap Distillation Column
6. Packed Bed Absorption Column
7. Rotary Dryer.

TEXT BOOKS :

1 Process Heat Transfer - Donald Q. Kern, McGraw Hill, 1997.
2 Mass Transfer Operations - Robert E, Treybal, McGraw Hill, 1981.

REFERENCE BOOKS:

1. Chemical Engineers Handbook - R.H. Perry & D.W. Green, 7th Edition, McGraw Hill, 1998.
2 Chemical Engineering- Vol 6 - J.M. Coulson & J.F. Richardson, Pergemen Press, 1993
3. Shell & Tube Heat Exchanger - IS Code, IS 4503, BIS, New Delhi, 1969.
4. Process Design of Equipment- S.D. Dawande, Vol II, Central Techno Publications, 3rd Edition, 2003.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VII Cluster CHEMICAL

Subject Title	Computer Applications and Modeling								Credits	04		
Sub Code	C	H	7	D	C	C	A	M	L-T-P	03	0	01

UNIT- I –

Numerical Techniques and Applications
Non-linear algebraic equation-Newton Raphson. Ordinary Differential Equation- R-K Method. Numerical Integration-Simpson's 1/3 Rule. Curve Fitting-Least Squares.
Applications: Vapor- Liquid equilibria for binary mixtures. Calculation of Bubble Pressure and Bubble Point. Dew Pressure and Dew point for Ideal Binary and multi-component system.

10 Hrs

UNIT- II -
Unit Operations

Flash Vaporization for multi-component system. Design of Adiabatic Batch Reactor. Absorption & Distillation Columns: Calculations for Plate and Packed Columns.

7 Hrs

UNIT- III –
Design

Design of Adiabatic PFR, Adiabatic CSTR and Combinations. **Design:** Double Pipe Heat Exchanger (Area, Length and Pressure drop). Shell & Tube Heat Exchanger (Area, Number of tubes, Pressure drop.

8 Hrs

UNIT- IV –
Fundamentals of Modeling
Models and model building, principles of model formulations, precautions in model building, Fundamental laws: Review of shell balance approach, continuity equation, energy equation, equation of motion, transport equation of state equilibrium and Kinetics, classification of mathematical models

07 Hrs

UNIT- V –

Mathematical Modeling
Basic tank model – Level V/s time. Batch Distillation – Vapor composition with CSTRs in series time.

07 Hrs

LABORATORY COMPONENT

NUMERICAL METHODS AND COMPUTER APPLICATIONS

20 Marks

1. Non-linear algebraic equation- Newton Raphson (Specific volume of binary mixture)
2. Ordinary Differential Equation- R-K Method ($dCa/dt=kCa^2$)
3. Numerical Integration- Simpson's 1/3 Rule (Batch Reactor to find time)
4. Curve Fitting-Least Square (Nre vs f)
5. Calculation of Bubble Point and Dew Point for Ideal multi-component system
6. Flash Vaporisation for multi-component system
7. Design of Adiabatic Batch Reactor, PFR
8. Adiabatic Flame Temperature
9. Double pipe heat exchanger (Area, Length and Pressure drop)
10. Distillation Column (Bubble cap)

PART – B
SIMULATION

30 Marks

1. Introduction to suggested software available (flow sheeting)
2. Simulations Studies of flash drum, Distillation Column, CSTR, PFR, Heat Exchanger.
3. Simulation Studies of pump, compressor, cyclone, heater.
4. Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following:
    a) Ethylene Glycol from Ethylene oxide
    b) Atmospheric distillation of crude oil
    c) Propylene Glycol from Propylene oxide
    d) Aromatic stripper with recycle stream (Benzene, Toluene, Xylene)
    e) Styrene from Ethyl Benzene

SOFTWARES SUGGESTED

1. HYSYS
2. CHEMCAD
3. DESIGN-II
4. PROSIM
5. ASPEN PLUS

TEXT BOOKS:

1. **Computer based Numerical Analysis -** M. Shanthakumar, KPS Publisher, First Edition, 1987.
2. **Introduction to Chemical Engineering and Computer Calculations.-** Myers, A.L and Seider W.D, Prentice Hall – 1976.
3. **Process Modeling Simulation and Control for Chemical Engineering -** William. L Luyben, 2nd Edition., McGraw Hill, 1990.

REFERENCE BOOKS:

1. **Elements of Chemical Reaction Engineering -** H. Scott Fogler, 2nd Edition, Prentice Hall, 2001.
2. **Introduction to Chemical Engineering Thermodynamics -** Smith J. M. and H. C. Vanness, 5th Edition, McGraw Hill, 1996.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VII Cluster CHEMICAL

Subject Title	PRE PROJECT WORK											Credits	3		
Sub. Code	1	1	C	H	7	D	C	P	P	W		L-T-P	3	0	0

A project is assigned at the beginning of the seventh semester. The project group should complete the preliminary literature survey & plan of project and submit the synopsis at the end of seventh semester with a literature survey and plan for the experimental work to be performed with all parameters.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VIII Cluster CHEMICAL

Subject Title	PROCESS ENGINEERING ECONOMICS							Credits	3		
Sub Code	C	H	7	D	H	S	S	2	L-T-P	3	0	0

UNIT- I –
Factors affecting plant location, layout and desin, Feasibility studies, Design reort and types of reports.

10 Hrs

UNIT- II -
Cost Analysis, Components of total product cost, Problems

9 Hrs

UNIT- III –
Depreciation – types and problems
Taxes and depreciation
Interest – Simple Compound Nominal and Effective rates with problems

11 Hrs

UNIT- IV –
Profitability Replacements and Alternative Investments
Evaluation and comparison methods with treatment of numerical problems.
Net present value.

15 Hrs

UNIT- V

Financial statements and Break even analysis

07 Hrs

TEXT BOOKS:

1. Plant design and economics for chemical engineers Max Peters Klauss Timmerhaus.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VIII Cluster CHEMICAL

Subject Title	TRANSPORT PHENOMENA								Credits	3		
Sub Code	C	H	8	D	C	T	R	P	L-T-P	3	1	0

UNIT- I –

Introduction: Momentum , Energy and Mass Transport operations, Newton's law of viscosity (NLV). Newtonian and Non-Newtonian fluids. Fourier's law of heat conduction (FLHC). Fick's law of diffusion (FLD).Effect of temperature and pressure on transport properties of fluids. Numerical problems .

08h

UNIT- II -

Velocity Distribution in Laminar Flow: Different Flow situations, Steady state Shell momentum balances, Boundary conditions applicable to momentum transport problems, Flow over a flat plate, Flow through a circular tube, Flow through Annulus.
Flow between parallel plates and a slit.
Numerical problems .

14h

UNIT- III -

Steady State Shell Energy Balances: General Boundary conditions applicable to energy transport problems of chemical engineering. Heat conduction through compound walls. Overall heat transfer coefficient based on inner and outer surface area.
Temperature Distribution in Solids and in Laminar Flow: Heat conduction with internal generation by electrical, nuclear, viscous energy sources. Numerical problems.
Heat conduction in a cooling fin.
Forced and free convection heat transfer.

14h

UNIT- IV -

Concentration Distributions in Laminar Flow: Steady state Shell mass balances. General Boundary conditions applicable to mass transport problems of chemical engineering. Diffusion through stagnant gas and liquid films. Equimolar counter diffusion. Numerical problems.
Concentration Distributions in Laminar Flow: Diffusion with homogeneous and heterogeneous reaction. Diffusion into falling film – Forced convection mass transfer. Numerical problems.

09 h

UNIT- V –

Analogies between Momentum, Heat and Mass Transport: Reynold's, Prandtl's and Chilton & Colburn analogies.
Equations of Change: Equation of continuity , Equation of motion; Navier – Stokes equation, Euler's equation .

7h

TEXT BOOKS :

1. **Transport Phenomena -** Bird, Stewart and Lightfoot, Academic Press, 1994.

REFERENCE BOOKS:

1. **Momentum Heat and Mass Transport** - Welty, Wikes and Watson, John Wiley – 4th Ed.,, 2000.
2. **Principles of Unit Operations in Chemical engineering-** Foust et al John Wiley, 1990.

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SEMESTER VIII Cluster CHEMICAL

Subject	FINAL PROJECT										Credits	12
Sub. Code	1	0	C	H	8	D	C	F	P	W		

The students in a group will be assigned an experimental, design, a case study or an analytical problem, to be carried out under the supervision of a guide. The project has to be assigned at the beginning of the seventh semester. The project group should complete the preliminary literature survey & plan of project and submit the synopsis at the end of seventh semester. The project work should be carried out and completed at the end of eighth semester, which is evaluated by a committee constituted by the HoD for assessment. One technical paper should be submitted at the end of the semester in reputed National/International journals for publications.

BMS COLLEGE OF ENGINEERING, BANGALORE-560 019
SEMESTER VIII Cluster CHEMICAL

Subject	Industrial Trip and Related Seminar										Credits	2
Sub. Code	1	0	C	H	8	D	C	I	T	S		

The students are expected to undergo in-plant training in any chemical industry or in a reputed research laboratory with pilot plant facility. This shall be for a minimum period of two weeks during the vacation of sixth & seventh semester. If it is not possible, the students may be permitted to go on industrial visit and they should visit minimum of five major chemical industries. The student should submit a report separately, at the beginning of the eighth semester which is evaluated by a committee constituted by the HoD for internal assessment.