B.Tech. Chemical Engineering

(Effective from the admitted Batch in 2006-07 on wards)

I/IV B.Tech. (Year - Wise)
COMMON FOR ALL BRANCHES

II/IV B.Tech. (First Semester)

Code and Title of the Course		Periods (L-lect.; T-tutor.; P-pract.)				Marks (S-sess.; EE-external exam)			No. of Credits
Code	**Title**	**L**	**T**	**P**	**Total**	**S**	**EE**	**Total**	
CHE-211	Mathematics-III	3	1	-	4	30	70	100	4
CHE-212	Inorganic Chemistry	3	1	-	4	30	70	100	3
CHE-213	Physical Chemistry	3	1	-	4	30	70	100	4
CHE-214	Strength of Materials	3	1	-	4	30	70	100	4
CHE-215	Mechanical Engineering	3	1	-	4	30	70	100	4
CHE-216	Basic Electrical Engineering	3	1	-	4	30	70	100	4
CHE-217	Physical and Analytical Chemistry Lab.	-	-	3	3	50	50	100	2
CHE-218	General Engineering lab.	-	-	3	3	50	50	100	2
Total		**18**	**6**	**6**	**30**	**280**	**520**	**800**	**27**

II/IV B.Tech. (Second Semester)

Code and Title of the Course		Periods (L-Lect.; T-Tuto.; P-Pract.)				Marks (S-Sess.; EE-External Exam)			No. of Credits
Code	**Title**	**L**	**T**	**P**	**Total**	**S**	**EE**	**Total**	
CHE-221	Mathematics-IV	3	1	-	4	30	70	100	4
CHE-222	Organic Chemistry	3	1	-	4	30	70	100	3
CHE-223	Chemical Process Calculations	3	1	-	4	30	70	100	4
CHE-224	Fluid Mechanics	3	2	-	5	30	70	100	4
CHE-225	Mechanical Operations	3	1	-	4	30	70	100	4
CHE-226	Environmental Studies	3	-	-	3	30	70	100	2
CHE-227	Organic Chemistry Lab.	-	-	3	3	50	50	100	2
CHE-228	Fluid mechanics Lab.	-	-	3	3	50	50	100	2
CHE-229	Mechanical Operations Lab.	-	-	3	3	50	50	100	2
Total		**18**	**6**	**9**	**33**	**330**	**570**	**900**	**27**

III/IV B.Tech. (First Semester)

Code and Title of the Course		Periods (L-lect.; T-tutor.; P-pract.)				Marks (S-sess.; EE-external exam)			No. of Credits
Code	**Title**	**L**	**T**	**P**	**Total**	**S**	**EE**	**Total**	
CHE-311	Chemical Engineering Thermodynamics-I	3	2	-	5	30	70	100	4
CHE-312	Mass Transfer-I	3	2	-	5	30	70	100	4
CHE-313	Heat Transfer	3	1	-	4	30	70	100	4
CHE-314	Inorganic Chemical Technology	3	1	-	4	30	70	100	4
CHE-315	Process Instrumentation	3	1	-	4	30	70	100	4
CHE-316	Elective-I	3	1	-	4	30	70	100	4
CHE-317	Mass Transfer Lab.-I	-	-	3	3	50	50	100	2
CHE-318	Heat Transfer Lab.	-	-	3	3	50	50	100	2
CHE-319	Soft Skills	-	-	3	3	100	-	100	1
Total		**18**	**8**	**9**	**35**	**380**	**520**	**900**	**29**

III/IV B.Tech. (Second Semester)

Code and Title of the Course		Periods (L-lect.; T-tutor.; P-pract.)				Marks (S-sess.; EE-external exam)			No. of Credits
Code	**Title**	**L**	**T**	**P**	**Total**	**S**	**EE**	**Total**	
CHE-321	Chemical Engineering Thermodynamics-II	3	2	-	5	30	70	100	4
CHE-322	Mass Transfer-II	3	2	-	5	30	70	100	4
CHE-323	Material Science and Engineering	3	2	-	5	30	70	100	4
CHE-324	Organic Chemical Technology	3	1	-	4	30	70	100	4
CHE-325	Biochemical Engineering principles	3	1	-	4	30	70	100	4
CHE-326	Elective-II	3	1	-	4	30	70	100	4
CHE-327	Mass Transfer Lab.-II	-	-	3	3	50	50	100	2
CHE-328	Chemical Technology Lab.	-	-	3	3	50	50	100	2
Total		**18**	**9**	**6**	**33**	**280**	**520**	**800**	**28**

Note: There is Industrial Training at the end of III year II Semester for a minimum of three weeks during summer vacation. Assessment for the Industrial Training is made during IV year I Semester.

IV/IV B.Tech. (First Semester)

Code and Title of the Course		Periods (L-lect.; T-tutor.; P-pract.)				Marks (S-sess.; EE-external exam)			No. of Credits
Code	**Title**	**L**	**T**	**P**	**Total**	**S**	**EE**	**Total**	
CHE-411	Transport Phenomena	3	2	-	5	30	70	100	4
CHE-412	Chemical Engineering mathematics	3	1	-	4	30	70	100	4
CHE-413	Chemical Reaction Engineering	3	2	-	4	30	70	100	4
CHE-414	Industrial Management	3	1	-	4	30	70	100	4
CHE-415	Process Dynamics and Control	3	2	-	5	30	70	100	4
CHE-416	Elective-III	3	1	-	4	30	70	100	4
CHE-417	Chemical Reaction Engineering Lab.-I	-	-	3	3	50	50	100	2
CHE-418	Process Dynamics and Control Lab.	-	-	3	3	50	50	100	2
CHE-419	Industrial Training	-	-	-	-	100	-	100	2
CHE-420	Project Seminar	-	-	3	3	100	-	100	3
Total		**18**	**9**	**9**	**36**	**480**	**520**	**1000**	**33**

IV/IV B.Tech. (Second Semester)

Code and Title of the Course		Periods (L-lect.; T-tutor.; P-pract.)				Marks (S-sess.; EE-external exam)			No. of Credits
Code	**Title**	**L**	**T**	**P**	**Total**	**S**	**EE**	**Total**	
CHE-421	Chemical Process Equipment Design	3	2	-	5	30	70	100	4
CHE-422	Process Optimization	3	2	-	5	30	70	100	4
CHE-423	Process Engineering Economics	3	1	-	4	30	70	100	4
CHE-424	Chemical Process Equipment Design Lab.			6	6	50	50	100	2
CHE-425	Project			6	6	50	50	100	8
Total		**9**	**5**	**12**	**26**	**240**	**360**	**600**	**22**

LIST OF ELECTIVEVS TO BE OFFERED BY THE DEPT. OF CHEMICAL ENGINEERING

Elective-1:	1.Oracle	2.Visual Basic.net
	3.Java	4.MATLAB
	5. C #	6.Fortran
Elective-2:	1.Polymer Technology	2.Computer Applications
	3.Paper Technology	4. Protein Engineering
	5.Computational Fluid *Dynamics*	6.Finite Volume Method
Elective-3:	1.Computer Aided Design	2.Fludization Engineering
	3. Industrial Pollution & Control Engineering	4.Multicomponent Separation Processes
	5. Numerical Heat Transfer	6.Computer Process Control.

CHE-211 **MATHEMATICS -III** **L: 4**

Vector and Tensor Calculus : Scalar, Vector fields, Gradient, Divergence, curl, directional derivative, identities, irrotational and solenoid vector fields, line integral, surface integral and volume integral, introduction of orthogonal curvilinear coordinates: Cylindrical, spherical and polar coordinates, introduction to tensors, quotient law.

Complex Analysis: Differentiability, Cauchy-Riemann equations, analytic functions Cauchy Theorem, Cauchy integral formula, Taylor and Laurent expansions, (without proofs), singularities, Residue Theorem, contour integration, geometric representation of f(z), conformal transformation, some standard transformations: (1) $w = z + c$, (2) $c z$, $W = 1/Z$ $u = (a z + b) / (c z + d)$, $W = Z^2$, and $W = e^z$.

Fourier Transforms: Fourier Integral, Sine and Cosine Integrals, Complex forms of Fourier Integral, Fourier Transforms, Fourier and Cosine Transforms, Finite Fourier Sine and Cosine Transforms. Properties of F-Transforms, Convolution Theorem for F-Transforms, Parseval's identity for F-Transforms, Fourier Transforms of the derivatives of a function, applications to boundary value problems, using inverse Fourier Transforms only.

Z-Transforms: Some standard Z-transforms, Linear property, Damping rule, Shifting Rules, initial and final value theorems, Formation of difference equations, Solution of difference equations, linear difference equations, rules for finding CF and PI. Difference equations reducible to linear form, Simultaneous difference equations with constant coefficients, application to deflection of a loaded string. Applications of Z-Transform to difference equations.

Textbook: Scope as given in:

1. Higher Engineering Mathematics, by Dr B.S Grewal, Khanna Pub New Delhi - 110 006, 34 edition, 1998.

Reference:

1. Higher Engineering Mathematics, by M.K. Venkataraman, National Pub Co Madras.
2. Advanced Engg Maths, by Erwin Kreyszig, Wiley Eastern Pvt Ltd, New Delhi-49
3. Engineering Mathematics by P.P. Gupta, Krishna Prakasam Media P Ltd, Meerut Vol-2.

CHE-212 INORGANIC CHEMISTRY L: 4

1. **Atomic Structure and Periodic Table:** early models of atom: Rutherford's model, Bohr's model, Bohr-Sommerfeld model- Quantum numbers and their significance, dual nature of matter. Failure of Classical Mechanics. Louis de Broglie wavelength, the Uncertainty principle-Schrodinger Wave equation (derivation not required), the meaning of wave Function. Quantum mechanical model of the Hydrogen atom-some general conclusions. Radial dependence, radial probability distribution curves and angular dependence curves-electronic configuration of elements – the Modern Periodic Table (a brief discussion on the arrangement of elements)-classification of elements-periodic properties: Ionization Energy, electron affinity, electronic structure and color, electronic structure and magnetism.

2. **Chemical Bonding and Molecular Structure:** The Covalent Bond: The simplest molecule H^+ ion its exact description, dative Bond and its influence on Covalence-the concept of resonance and Hybridization. Multiple bonding characters of second period and higher period elements and the difference between the two. Pauling's electro-neutrality principle, valence shell, electron pair repulsion method. Molecular Orbital theory for homonuclear diatomic molecules only-Electro-negativity (Milliken approach)-Fajan's rules for the prediction of non-polar character.

3. **Chemistry of Transition Elements and Co-ordination Compounds:** First Transition series and their general physical and chemical properties-Oxides, Halides, Sulphides. Chemistry in aqueous solution of first transition metals. Co-ordination compounds. Nomenclature, Werner's Theory, isomerism in coordination compounds: Valence Bond theory-Crystal field theory, Colors of Transition metal complexes-stability of complexes.

4. **Analytical Chemistry:** Titrimetric Analysis, Classification of reactions in titrimetric analysis-Standard solutions, Equivalents, normalities and Oxidation Numbers. Preparation of Standard solutions, Primary and Secondary standards-classification of errors-accuracy, precision-minimization of errors,significant figures and computation-mean and standard deviation-reliability results-confidence interval.

Text Books:

1. University General Chemistry, CNR Rao, Macmillan India Ltd-Hyderabad
2. Concepts and Models of Inorganic Chemistry B.E Douglas, D.H McDaniel and J. Alexander. 3rd edition; John Wiley & Sons Inc., New York
3. Concise Inorganic Chemistry. J.D.Lee, Fourth Edn.,Chapman & Hall

CHE-213 PHYSICAL CHEMISTRY L: 4

1. **Liquid State:** Liquefaction of Gases, Critical constants, Classius-Clayperon Equation; Vapor pressure of Liquids, Salt hydrates, Variation of vapor-Pressure with temperature. Elementary treatment of vapor pressure-composition diagrams of Binary liquid mixtures. Azeotropic and Zeotropic mixtures, Fractional distillation and Steam Distillation.
2. **Physical Properties of Liquids:** Surface tension, explanation, measurement, effect of temperature on surface tension, applications. Viscosity: definition, measurement, applications. Intermolecular forces in liquids-Hydrogen Bond.
3. **Thermodynamics and Thermochemistry: First law**-Internal Energy, Work and Heat changes, Enthalpy, reversible changes, maximum work. Heat capacities at constant pressure and volume, adiabatic changes. Heat of Reaction, heat of Formation, Heat of Combustion, Thermo-chemical Laws, effect of temperature on Heat of Reaction. Second law of Thermodynamics,
   spontaneous processes, Entropy and Entropy change for an ideal gas. Entropy change accompanying phase change, physical significance of entropy, Gibb's Free Energy and applications.
4. **Chemical Equilibrium:** Reversible reactions, Law of Mass action, Homogeneous equilibria in gaseous and liquid systems and simple example of Heterogeneous equilibria. Effect of temperature on equilibrium-VantHoff's equation.
5. **Electrochemistry:** Laws of Electrolysis and their applications. Difference between Galvanic and Electrolytic cells, electrode reactions, polarized electrode, Decomposition potential, Over voltage and its applications.
   E.M.F. Galvanic cells, Free Energy changes in cells, Reversible electrode potentials, Single electrode potential and its determination. Nernst Equation and its derivation, Reference (Hydrogen and Calomel) electrode. EMF series and its applications. Primary and Secondary galvanic cells (acid and alkaline)-Lead Acid battery, Fuel Cells and applications.
6. **Phase Rule:** Definition and explanation of terms involved in Phase Rule, Derivation of the Phase Rule. One component systems (Ag-Pb and KI-H_2O). Eutectic point and its significance.
7. **Chemical Kinetics and Catalysis:** Order and molecularity of a reaction. Specific reaction rate and its determination. First Order and Second Order reactions, Half-Life period. Pseudo first order and second reactions-Effect of temperature on reaction rate. Energy of Activation-elementary treatment of collision theory and activated complex theory.
   Catalysis: Types, characteristics of a catalyst, Enzyme catalysts, Industrial applications of Catalysts.

Suggested Reading:

1. Elements of Physical Chemistry by Samuel Glasstone and David Lewis Macmillan & Co.Ltd., London.
2. Physical Chemistry (3 rd. Edition) by P.W.Atkins, Oxford University Press.
3. Text Book of Physical Chemistry by Bahl & Tuli.

CHE-214 **STRENGTH OF MATERIALS** **L: 4**

Axial loads: Simple stress and strain, Hook's law, load extension diagram for Mild steel. Stress in compound assemblies, Thermal stresses

Transverse loads: Shear force and bending moment diagrams for a) cantilevers b) simply supported beams c) Over-hanging beams due to i) concentrated loads and U D L s only

Theory of simple bending: Relation between i) f and y ; ii) M and I ; iii) E and R. Distribution of shear stress in common shapes of cross-section.

Principal stresses and principal planes, Maximum shear stress and its plane- Mohar's Circle of stress.

Torsion of solid and hollow circular shafts- transmission of horse power, Design of flange coupling, closed coil helical spring i) under axial load, ii) under axial twist. Riveted joints- design of lap joints.

Stress in thin i) cylindrical shells ii) spherical shells - stress in thick cylinders, compound cylinders, pressure due to shrink-fitting.

Textbook:

1. Strength of Materials., Ramamrutaham

Reference Books:

1. Elements of Strength of Materials. S.P.Timoshenko and Young D.H., East West Press, New Delhi.

CHE-215 MECHANICAL ENGINEERING L: 4

1. **Thermodynamics:** Definitions-Systems-classification of Thermodynamic Systems, Cycle, and Zeroth Law of Thermodynamics-First Law of Thermodynamics-closed system-Flow processes.-open systems with steady flow process-applications of steady flow energy equation to engineering systems.

2. **Second Law of Thermodynamics**-Carnot cycle-inequality of Clasius-Reversible Carnot Cycle-Entropy: Relation between Heat and Entropy-general expression for Entropy Change-Entropy change of a perfect gas during various Thermodynamic processes-air standard cycles: Otto-Diesel-dual combustion cycles.

3. **Properties of Steam and use of Steam tables** –Boilers-classification steam boilers –simple vertical –Cocheran locomotive boiler-Babcock and Wlcox boiler –Steam generation –Rankine Cycle.

4. **Impulse and Reaction Turbine**-classification of Steam Turbines-Velocity diagram and power produced in Impulse Turbine-performance of Steam Turbines-reduction of Rotor speed.

5. **I C engines:** classification-main composition of IC engines-carburetter-Fuel Pump injector-cooling systems for IC engines-working of 2-stroke and v4-stroke petrol and Diesel Engines-Power and efficiency of IC engines.

6. **Reciprocating Air-compressors:** Single stage –work done during cycle-effect of clearance-two stage compressors-condition for minimum work-effect of Inter-cooling-Efficiency.

7. **Drives:** Belts-expression for the ratios of tension on the slack and tight side.-power transmitted –V-Belts, Chain drives-Gears: Spur –Helical, Bevel gear –trains simple and compound.

Text Books:

1. A Text Book of Thermal Engineering by R.S.Khurmi and J.K.Gupta
2. Theory of Machines by R.S.Khurmi

Reference Books:

1. Engineering Thermodynamics by P.K.Nag
2. Engineering Thermodynamics by J.B.Jones and R.E.Dugar
3. Engineering Thermodynamics by R.K.Rajput
4. Theory of Machines by Balani

CHE-216 BASIC ELECTRICAL ENGINEERING L: 4

Magnetic Circuits: Definitions of magnetic circuit, Reluctance, magneto motive force (mmf), magnetic flux, Simple problems on magnetic circuits, Hysterisis loss (chapter 8, page Nos. 155-175).

Electromagnetic Induction: Faraday's laws of Electromagnetic Induction, Induced E.M.F., Dynamically induced E.M.F, statistically induced EMF, self inductance, Mutual inductance. (Chapter 9, page Nos. 176-190).

D.C. Generators: D.C Generator principle, construction of D.C generator, E.M.F equation of D.C generator, types of D.C generators, Armature reaction, Losses in D.C generator, efficiency, characteristics of D.C generators, applications of D.C generators (chapter 10, 11, pages 208-238).

D.C. Motors: D.C motor principle, working of D.C motors, significance of back, E.M.F, Torque equation of D.C motors, types of D.C motors, characteristics of D.C Motors, speed control methods of D.C motors, applications of D.C motor, Testing of D.C machines : Losses and Efficiency, direct load test and Swinburne's test. (Chapter 12, 13, page Nos. 239-269).

A.C Circuits: Introduction to steady state analysis of A.C circuits, single and balanced 3 phase circuits (chapter 16, page Nos. 323-348).

Transformers: Transformer principle, EMF-equation of transformer, transformer on load, equivalent circuit of transformer, voltage regulation of transformer, losses in a transformer, calculation of efficiency and regulation by open circuit and short circuit tests. (Chapter 20, page Nos. 423-455).

Three Phase Inductance Motor: Induction motor working principle, construction of 3phase induction motor, principle of operation, types of 3 phase induction motor, Torque equation of induction motor, Slip-Torque characteristics, Starting Torque, Torque under running condition, maximum Torque Equation, power stages of induction motor, efficiency calculation of induction motor by direct loading. (Chapter 21, page Nos. 463-489).

Altemator: Altenator working principle, EMF equation of Altenator, voltage regulation by Sync. Impedance method. (Chapter 23, page Nos. 505-515).

Synchonous Motor: Synchronous Motor principle of operation, construction, methods of starting of synchronous motor. (Chapter 24, page Nos. 516-526).

Textbook:

1. Elements of Electrical Engineering and Electronics by V.K. Mehta S.Chand & Co.

Reference Book:

1. A first course in Electrical Engineering, by Kothari.

CHE-217 **PHYSICAL AND ANALYTICAL CHEMISTRY LABORATORY**

1. Determination of dissolved oxygen percent in a given water sample (Winkler's method)

2. Estimation of Nickel using Erico-T as an indicator.

3. Determination of the strength of HCl solution using a standard solution of Sodium Hydroxide p^H metrically.

4. Estimation of Mohrs Salt by titrating against a standard solution of Potassium Dichromate potentiometrically.

5. Determination of conductance of a given sample of water with a Conductivity Meter.

6. Determination of partition coefficient of Iodine between Carbon Tetrachloride and Water.

7. Determination of reaction rate constant of an acid catalyzed hydrolysis of an ester.

8. Determination of the coefficient of viscosity of the given liquid by Ostwald Viscometer.

Suggested Books:

1. Vogel's Text Book of Quantitative Chemical Analysis,5 th. Edition.,Longman
2. Laboratory Manual on Engineering Chemistry, Dr. Sudha Rani, Dhanpat Raj Publishing Company (P) Ltd., New Delhi.

CHE-218 GENERAL ENGINEERING LABORATORY

Mechanical Engineering lab:

1. Find the viscosity of the given sample of oil using redwood Viscometer-1
2. Find the viscosity of the given sample of oil using redwood Viscometer-II
3. Find the Flash point of the given sample of oil using Abel's Flash point tester
4. To calibrate pressure gauge using standard pressure and standard weights.
5. Draw the Valve timing diagram of a 4-stroke Diesel Engine and port timing diagram of a 2-stroke petrol engine.
6. Perform Load Test at Full Load, Half Load, ¼ th.Load on a 4-stroke Ruston Engine and draw the performance curves.
7. Find the Volumetric efficiency, Isothermal Efficiency of the given Compressor.
8. To determine the Moment of Inertia of a Fly-Wheel and Shaft experimentally and compare the values with the calculated values.
9. To determine experimentally the Calorific Value of a gaseous fuel by using Junkers gas Calorimeter.
10. To determine the Modulus of Rigidity of the material of the Wire by Torsional Oscillators.

Electrical Engineering Lab:

1. Study and calibration of Ammeter.
2. Study and calibration of Voltmeter.
3. Study and calibration of Wattmeter.
4. Study and calibration of Energy meter.
5. Measurement of low resistance (armature)
6. Measurement of medium resistance (field)
7. Measurement of insulation resistance.
8. Measurement of filament resistance.
9. Verification of KCL and KVC
10. Superposition theorem.
11. Parameters of a Choke coil
12. OC and SC tests on transformer
13. Load test D.C. Shunt Machine.
14. OC test on DC,. Separately excited machine.
15. Swinburne's test.
16. 3-phase induction motor (No load and rotor block tests)
17. Alternator regulation by Syn.Impedance method.

CHE-221 MATHEMATICS -IV L: 4

Numerical Analysis: Solution of non-linear equations of one variable using false position, secant and Newton-Raphson methods, Solution of linear algebraic equations using jacobi, Gauss-Seidel iterative methods, eigen values, eigen vectors using power method, Numerical integration using trapezoidal, Simpson's and other quadrature formulae.

Partial Differential Equations and Applications: Introduction, first and second order equations, method of separation of variables, vibrations of a stretched string-wave equation, one-dimensional and two-dimensional heat flow equations, solution of Laplace equation, Laplace equation in polar coordinates.

Numerical Solutions of ODE's and PDE's : Numerical solutions of ODE's by Picard's method, Euler's method, Runge-Kutta method and numerical methods for solution of PDE's (1) Elliptic (Liebmann iteration process) (2) Parabolic (Schmidt explicit formula) (3) Hyperbolic and (4) Poisson's equations (Gauss-Siedel method).

Statistics : Review of probability distributions (not to be examined). Sampling Theory: Sampling distribution, standard error, testing of hypothesis, level of significance, confidence limits, simple sampling of attributes, sampling of variables , large samples and small samples, student's t-distribution, f-distribution, Fisher's Z-distribution and Chi-square distribution

Textbook: Scope as given in:

1. Higher Engineering Mathematics (34 edition.. 1998) by B.S. Grewal

Reference:

1. Higher Engineering Mathematics by M.K. Venkata Raman
2. Numerical methods for Scientific and Engineering Computation by M.K. Jain, S.R.K. Iyengar, R.K. Jain, publishers New Age International (p) Ltd, New Delhi.
3. Numerical Methods for Engineers by Santosh K. Gupta, Pub. New Age International (p) Ltd, New Delhi.
4. Numerical Analysis by G. Shankar Rao, Publishers New Age International New Delhi.

CHE-222 ORGANIC CHEMISTRY L: 4

UNIT-1

Numerical problems: Determination of percentage composition of Carbon, Hydrogen and Nitrogen. Molecular weights determination by depression in freezing point and elevation of boiling point methods. Molecular weight of acids by Silver salt method; Molecular weight of bases by Chloroplatinate method; Determination of Molecular formula of a compound; Problems relating to reactions of Carboxylic acids, functional derivatives of acids, Carbonyl compounds, Alcohols, Amines, Phenols, Diazonium salts applications, Alkenes and their laboratory tests.

Nomenclature of Alkanes, Alkenes, Alkynes, Dienes, Cyclic Aliphatic hydrocarbons, structure of Benzene, nomenclature of Benzene derivatives, Arenes; Industrial preparation of Ethylene, Acetylene; sp, sp^2 and sp^3 hybridization; preparation and chemical reactions; conformational analysis of Ethane, Propane and Butane. Wurtz reaction, Diels-Alder reaction. Aromaticity Morkovinkov Rule; Clemmensen and Wulf-Kishner reduction.

UNIT-2

Electro-philic and Nucleo-philic Aromatic substitution; Orientation in desubstituted Benzenes, mechanism of Nitration, Halogenation, Sulphonation, Friedel-Craft's alkylation and acylation reactions. Nomenclature of Alkyl halides, preparation and chemical reactions, mechanisms of SN_1, SN_2, E_1, E_2 reactions. Nomenclature of Aryl halides, Preparation and chemical reactions: Low reactivity of Vinyl and Aryl halides; Sandmeyer reaction.

UNIT-3

Nomenclature of Alcohols; industrial preparation of Ethyl alcohol, preparation and chemical reactions, Lucas Test. Nomenclature of Mono, Dicarboxylic acids, Industrial preparation of Formic, Acetic, Benzoic, Pthalic, Salicylic acids, preparation and chemical reactions. Mechanism of Hvz reaction and Claisen condensation; Nomenclature of Functional derivatives of acids, preparation and chemical reactions, Mechanism of Hoffmann Bromamide reaction, acid and base catalyzed hydrolysis of Ester. Nomenclature of Ethers and Epoxides; Industrial preparation of Ether and Ethylene Oxide, preparation and chemical reactions; Williamson's synthesis.

UNIT-4

Nomenclature of Aldehydes and Ketenes; Industrial preparation of Formaldehyde, Acetaldehyde, Benzaldehyde, Salicyaldehyde, Acetone; preparation and chemical reactions; mechanisms of Cannizaro, Aldol, Reformatsky and Wittig reactions. Reactions without mechanisms, Perkin, Cope, Knoevenagel and Pinacol-Pinacolone reactions, Difference between Aldehyde and Ketone. Nomenclature of Phenols, Industrial preparation of Phenol, preparation and chemical reactions, mechanisms of Fries

rearrangement, Kobe reaction, Reimer-Tiemann reaction. Classification of Carbohydrates, Structure of Glucose and Fructose, reactions of Glucose and Fructose, Ruff degradation, Wohls degradation, Kiliani-Fisher synthesis, Glucose into Fructose, Fructose into Glucose, Glucose to Vitamin C, mechanism of Osazone formation.

UNIT-5

Nomenclature of Amines, Industrial preparation of Aniline , preparation and chemical reactions ; Exhaustive Methylation, mechanism of Hoffmann elimination, Benzedene rearrangement without mechanism, Hinsberg test, differentiation test using Nitrous acid, preparation of Diazonium salts and Synthetic applications, preparation of Sulphanilamide, Sulphaguanidine, Sulphamerazine, Sulphapyridene (Sulpha drugs), mode of action of Sulpha drugs.

UNIT-6

Preparation of Soaps and Detergents; mode of action of soaps, differences between soaps and detergents; preparation of Malonic, Acetoacetic ester and their synthetic applications; Preparation of Grignard reagents and their synthetic applications, preparation of Polyethylene, Polystyrene, Teflon, PVC, Polyvinyl Cyanide,Rubber-vulcanisation, Styrene-Butadiene rubber , Polychloroprene, Bakelite, Nylon 6 and Nylon 6-6, Plexiglas, Terylene, Ziegler-Natta polymerization, definition of Thermoplastics and Thermosetting plastics.

UNIT-7

Isomerism: Structural and optical isomerism, geometrical isomerism, E Z configuration, sequence rules, R & S configuration, Racemic mixture and their separation, Asymmetric synthesis: Fischer projection Formula, definitions of Axial and Equatorial bonds, 1-3-diaxial interaction, Enatiomers, Diastereomers, Mesomers. Isomerism in Cyclic compounds, Chair, Boat and Twisted Boat structures (1-Methylcyclohexane, 1, 2-Cyclohexane Diol). Synthetic applications of:
Zn/Hg, Na-NH_3 $LiAH_4$, $NaBH_4$, Diborane and Zinc dust, Soda lime, OsO_4, Hydroxylamine, Acetic anhydride, Benzoylchloride and PCl_5.

Recommended Books:

1. Text Book of Organic Chemistry by Morrison & Boyd
2. Text Book of Organic Chemistry by Bahl & Tuli
3. Text Book of Organic Chemistry by M.K.Jain
4. Text Book of Organic Chemistry by I.L.Finar (Vols.1&2 as **reference books**)

CHE-223 CHEMICAL PROCESS CALCULATIONS L: 5

Stoichiometry and composition relationships, the gram-mole and pound-mole. Limiting reactant, Excess reactant- Degree of completion. Basis of calculation. Weight percent, volume percent and mole percent. Density and specific gravity: Baume and API gravity scales.

Behavior of ideal gases, application of the ideal-gas law. Dalton and Amagat laws to gaseous mixtures. Composition of gases on dry basis and on wet basis.

Vapor pressures. Effect of temperature on vapor pressure. Antoine equation. Reference substance vapor pressure plots. Vapor pressure of immiscible liquids. Ideal solutions and Raoult's law. Non-volatile solutes.

Humidity: Percentage saturation. Relative saturation or relative humidity. Dew point, Vaporization, Condensation. Wet and dry bulb temperatures. Adiabatic vaporization and adiabatic saturation temperature.

Material balances. Tie substance, Yield, Conversion. Processes involving chemical reactions. Material balance- calculations involving drying, dissolution, and crystallization. Processes involving recycle, bypass and purge.

Heat capacities of gases and gaseous mixtures. Effect of temperature on heat capacity of gas. Mean heat capacity of gas. Kopp's rule, Latent heats, Heat of fusion. Heat of vaporization, Trouton's rule. Kistyakowsky equation for non-polar liquids. Estimation of latent heat of vaporization using Classius-Clayperon equation. Enthalpy of humid air, and humid heat capacity.

Standard heat of reaction. Standard heat of formation. Laws of thermochemistry. Standard heat of combustion. Calculation of heat of formation from heats of combustion. Calculation standard heat of reaction from heats of formation, and from heats of combustion. Standard integral heat of solution. Effect of temperature on heat of reaction. Kirchoff's equation. Adiabatic and non-adiabatic reactions. Theoretical and actual flame temperatures.

Textbook:

1. Chemical Process Principles Part-I Material and Energy balances, by Olaf A Hougen, Kwenneth M. Watson, and Roland A Ragatz, CBS Publishers and Distributors (1995)

Reference Books:

1. Basic principles and calculations in chemical engineering by David M Himmelblau, Prentice Hall of India Pvt Ltd (1995).
2. Stoichiometry, by B.I. Bhatt, and S.M. Vora (Third Ed), Tata McGraw Hill Publishing Company Limited, New Delhi (1996).

3. Stoichiometry for chemical engineers, by Williams and Johnson, McGraw Hill.

CHE-224 FLUID MECHANICS L: 4

Units and dimensions, dimensional analysis, similarity, types of fluids, hydrostatic pressure, pressure distribution in a static fluid, pressure measuring devices.

Introduction to fluids in motion, concept of stream lines, stream tubes, viscosity, types of fluids, flow in boundary layers, its formation and growth in tubes and on plates, basic equations of fluid flow: continuity, motion, momentum and Bernoulli's equation.

Flow of incompressible fluids in pipes, relation between skin friction - wall shear, laminar flow in pipes, Hagen-Poiseulle equation, turbulent flow in pipes, velocity distribution equation, friction factor, friction from changes in velocity or direction, flow of compressible fluids, basic equations, flow through variable area conduits, adiabatic and isothermal frictional flow.

Flow past immersed bodies, Drag, drag coefficient, friction in flow through beds of solids, motion of particles through fluids, its mechanics, terminal velocity, fluidization, mechanism of fluidization, pressure drop in fluidization, applications of fluidization.

Transportation and metering of fluids, pumps , fans, blowers and compressors, reciprocating, rotary and centrifugal types, characteristics and calculations regarding power and efficiency. Flow measuring devices, venturi, orifice, pitot tube, rotameter, notches and weirs.

Textbook:

1. Unit Operations of Chemical Engineering. Warren L.McCabe and Julian C.Smith 7 th Edition.

Reference Book:

1. Unit Operations, Brown et al., Asian Publishing House.
2. Fluid Dynamics and Heat Transfer, Knudsen and Katz.

CHE-225 MECHANICAL OPERATIONS L: 4

Characteristics of solid particles - shape – size, Differential and cumulative screen analysis - specific surface area - particle population - different mean diameters for a mixture of particles.

Principles of comminution - laws of crushing, description and working of size reduction equipment - jaw, gyratory and roll crushers - Hammer mill - revolving mills - attrition mills - fluid energy mill - cutting machines - open and closed circuit grinding - wet and dry grinding - Grindability Index.

Size separation - screening - industrial screens - grizzly - gyratory and vibratory screens - revolving screens - trommels - capacity and effectiveness of screens - Magnetic separation - Electrostatic separation - froth flotation.

Filtration - description and working of filtration equipment - plate and frame filter press, shell and leaf filters, Rotary drum filter - filter aid - centrifugal filtration - Top suspended batch centrifuge - Theory of filtration - washing of cakes.

Motion of particles through fluids - drag - free and hindered settling - settling velocities-classification - sink and float methods - differential setting methods - jigging and Tabling - cyclone separators.

Batch sedimentation - Thickeners - Flocculation - Centrifugal sedimentation - gravity and centrifugal decanters.

Agitation of liquids - power consumption in agitated vessels - scale up of agitation equipment - Mixing equipment for mixing of solids and pastes - mixers for dry powders - Mixing index.

Conveying - Types of conveyors - Mechanical - belt, chain, screw conveyors, elevators - pneumatic conveyors. Size enlargement - need and applications.

Textbooks:

1. Unit Operations of Chemical Engineering" McCabe, W.L., Smith J.C, and Harriot P., McGraw- Hill Book Co.

Reference Books:

1. Chemical Engineering {Vol.2}, J.H.Coulson and Richardson, J.F., Pergaman press and ELBS.
2. Chemical Engineer's Hand Book ., Perry R.H, {ed} McGraw-Hill Book Co;
3. Unit Operations, Brown., et al., Asian Publishing House.
4. Introduction to Chemical Engineering., Badger and Banchero, McGraw-Hill Book Co;

CHE-226 **ENVIRONMENTAL STUDIES** **L: 3**

(2006-2007)

(COMMON FOR ALL BRANCHES)

CHE-227 **ORGANIC CHEMISTRY LABORATORY**

List of Experiments:

1. Preparation of Aspirin
2. Preparation of Benzanilide
3. Preparation of m-dinitrobenzene
4. Preparation of Benzoic acid
5. Preparation of Phthalimide
6. Preparation of Methyl Orange
7. Preparation of Parabenzoquinone
8. Preparation of nerolin
9. Detection of Extra elements
10. Analysis of Compound -1
11. Analysis of Compound -2
12. Analysis of Compound -3
13. Analysis of Compound -4
14. Analysis of Compound -5
15. Analysis of Compound -6

CHE-228 FLUID MECHANICS LABORATORY

List of Experiments:

1. Identification of laminar and turbulent flows (Reynolds apparatus)
2. Measurement of point velocities (Pitot tube)
3. Verification of Bernoulli's equation
4. Calibration of Rotameter
5. Variation of Orifice Coefficient with Reynolds Number
6. Determination of Venturi Coefficient
7. Friction losses in fluid flow in pipes
8. Pressure drop in a packed bed for different fluid velocities.
9. Pressure drop and void fraction in a fluidized bed
10. To Study the coefficient of contraction for a given open orifice
11. To Study the coefficient of discharge in a V - notch
12. To Study of the characteristics of a centrifugal pump.

CHE-229 MECHANICAL OPERATIONS LABORATORY

List of Experiments:

1. To take a representative sample from a bulk by two methods, viz. Riffle and Cone & Quartering and to find out the average size {volume-surface mean diameter} of the samples.
2. To determine the Grindability Index {G.I} of coal by Hard Groove Machine.
3. To determine the time of grinding in a ball mill for producing a product with 80% passing a given screen.
4. To verify the laws of crushing using any size reduction equipment like crushing rolls, ball mill or vibrating mill and to find out the work Index {W.I} of the material.
5. To compare open circuit and closed circuit grinding by means of a ball mill.
6. To determine the optimum time of sieving for a given sample of material.
7. To find the effectiveness of hand screening of a given sample by a given screen.
8. To find the screen effectiveness of a trommel.
9. To separate a mixture of coal into two fractions using sink and float method.
10. To separate a mixture of coal into two fractions using froth flotation technique.
11. To find the size analysis of a given fine sample using beaker decantation method.
12. To separate a mixture of particles by jigging.
13. To concentrate a given material by means of tabling.
14. To obtain batch sedimentation data and to calculate the minimum thickener area under given conditions.
15. To determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.

B.Tech. Chemical Engineering
(Effective from the admitted batch of 2006-2007)
3/4 B.Tech. Chemical Engineering (First semester)

S.No	Course code	Title	Work load				Total marks		Credits
			Theory		Pract.	Total	Univ. exam.	Sessional marks	
			L	T					
1.	CHE-311	Chemical Engineering Thermodynamics-I	5	-	-	5	70	30	4
2.	CHE-312	Mass Transfer - I	5	-	-	5	70	30	4
3.	CHE-313	Heat Transfer	4	-	-	4	70	30	4
4.	CHE-314	Inorganic Chemical Technology	4	-	-	4	70	30	4
5.	CHE-315	Process Instrumentation	4	-	-	4	70	30	4
6.	CHE-316	Elective – I	4	-	-	4	70	30	4
7.	CHE-317	Mass Transfer Laboratory - I	-	-	3	3	50	50	2
8.	CHE-318	Heat Transfer Laboratory	-	-	3	3	50	50	2
9	CHE-319	Communication Skills	-	-	3	3	-	100	1
Total:			26	-	9	35	520	380	29

B.Tech. Chemical Engineering
(Effective from the admitted batch of 2006-2007)
3/4 B.Tech. Chemical Engineering (Second semester)

S.No	Course code	Title	Work load				Total marks		Credits
			Theory		Pract.	Total	Univ. exam.	Sessional marks	
			L	T					
1.	CHE-321	Chemical Engineering Thermodynamics - II	5	-	-	5	70	30	4
2.	CHE-322	Mass Transfer – II	5	-	-	5	70	30	4
3.	CHE-323	Material Science & Engineering	5	-	-	5	70	30	4
4.	CHE-324	Organic Chemical Technology	4	-	-	4	70	30	4
5.	CHE-325	Bio-Chemical Engineering Principles	4	-	-	4	70	30	4
6.	CHE-326	Elective – II	4	-	-	4	70	30	4
7.	CHE-327	Mass Transfer Laboratory - II	-	-	3	3	50	50	2
8.	CHE-328	Chemical Technology / Elective Laboratory	-	-	3	3	50	50	2
Total:			27	-	6	33	520	380	28

B.Tech. Chemical Engineering
(Effective from the admitted Batch of 2006-07)
III/IV B.Tech. (First Semester)

ChE-311 Chemical Engineering Thermodynamics-I

The first law and other basic concepts: Joule's experiments, internal energy, the first law of thermodynamics, thermodynamic state and state functions, enthalpy, the steady-state, steady-flow process, equilibrium, the phase rule, the reversible process, constant-V and constant-P processes, heat capacity.

Volumetric properties of pure fluids: PVT behavior of pure substances, virial equations, the ideal gas, application of the virial equations, cubic equations of state, generalized correlations for gases, generalized correlations for liquids, molecular theory of fluids, second virial coefficients from potential functions.

Heat effects: Sensible heat effects, internal energy of ideal gases, microscopic view, latent heats of pure substances, standard heat of reaction, standard of heat of formation, standard heat of combustion, temperature dependence of heat effects of industrial reactions.

The Second law of thermodynamics: Statement of the second law, heat engines, thermodynamic temperature scales, thermodynamic temperature and ideal-gas scale, entropy, entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point.

Thermodynamic properties of fluids: Property relations for homogeneous phases, residual properties, two-phase systems, thermodynamic diagrams, generalized property correlations for gases.

Thermodynamics of flow processes: Equations of balance, duct flow of compressible fluids, turbines (expanders), compression processes.

Refrigeration and liquefaction: - The Carnot refrigerator, the vapor compression cycle-comparison of refrigeration cycles, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes.

Textbook:

1. `Introduction to Chemical Engineering Thermodynamics' by J.M.Smith, H.C.Van Ness and M.M.Abbott, 6th Edition, McGraw-Hill International Editions, 2000.

Reference Books:

1. `Chemical Engineering Thermodynamics' by B.F.Dodge, McGraw-Hill Book Co.,
2. `Schaum Outline of Theory and Problems of Thermodynamics' by Michael M. Abbott and Hendrick C.VanNess, McGraw-Hill International Book Co., Singapore, 1981.

CHE-312 Mass Transfer-I

Introduction: Mass transfer Operations.

Molecular diffusion in fluids: Binary solutions, Fick's law, equation of continuity, Steady state equimolal counter current diffusion, Stefan's diffusion, estimation of diffusivity of gases and liquids, application of molecular diffusion.

Mass transfer coefficients: Mass transfer coefficients in turbulent flow, theories of mass transfer, analogy between momentum, heat and mass transfer in laminar and turbulent flow, correlations for mass transfer coefficients in simple situations, diffusion in solids.

Interphase mass transfer: Concept of equilibrium, diffusion between phases, two resistance theory, material balances in steady state co-current and counter-current stage processes, Murphy stage efficiency.

Equipment for gas-liquid operations: Sparged vessels, mechanically agitated vessels for single phase liquids and gas-liquid mixtures, tray towers, sieve tray for absorption and distillation, venturi scrubbers, spray towers and spray chambers, packed towers for absorption and distillation, tray towers versus packed towers.

Humidification operations: Definition of fundamental terms, Psychrometric charts, theory of adiabatic saturation and wet bulb temperature, Lewis relation, gas-liquid contact operations, water cooling with air, dehumidification of air-water-vapor mixture, cooling towers, evaporative cooling.

Absorption: Solubility's of gases in liquids, two component systems, multi-component systems, ideal and non-ideal solutions, choice of solvent for absorption, single component absorption material balances, counter current multistage operations, dilute gas mixtures, on-isothermal operation, tray efficiency, continuous contact equipment, HETP, HTU, NTU concepts for single operation absorption with chemical reaction.

Distillation: Principles of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation, steam distillation, continuous distillation, McCabe-Thiele method, Ponchon-Savarit method, tray efficiencies, introduction to multi-component distillation, azeotropic and extractive distillations.

Textbook:

1. Mass transfer Operations, Robert E. Treybal, 3rd edition, McGraw-Hill Book Co.,

Reference Book:

1."Unit Operations in Chemical Engineering" by McCabe,W.L.,Smith,J.C.and Harriot,P., 5th Edition, McGraw-Hill Book Co.,
2. "Chemical Engineering Hand Book" by J.H. Perry.

ChE-313 Heat Transfer

1. Basic Concepts: Modes of heat transfer, conduction, convection and radiation, analogy between heat flow and electrical flow.

2. Conduction: One dimensional steady state heat conduction, the Fourier heat conduction equation, conduction through plane wall, variable thermal conductivity, conduction through cylindrical wall, spherical wall, combined mechanism of heat transfer (conduction-convection systems), conduction through composite slab, cylinder and sphere, thermal contact resistance, critical radius of insulation, heat transfer from a rectangular fin, fin effectiveness and efficiency, unsteady state heat conduction, negligible internal heat resistance and lumped heat analysis, response time of a temperature measuring instrument, unsteady state heat conduction through a semi-infinite slab, three dimensional heat conduction equations in cartesian, cylindrical and spherical coordinates.

3. Convection: The convective heat transfer coefficient, thermal boundary layers for the cases of flow of fluid over a flat plate and flow through pipe, dimensionless numbers in heat transfer and their significance, dimensional analysis, Buckingham's phi theorem, application of dimensional analysis to forced convection and natural convection.

4. Forced Convection: Correlation equations for heat transfer in laminar and turbulent flows in a circular tube and duct, Reynolds and Colburn analogies between momentum and heat transfer, heat transfer to liquid metals and heat transfer to tubes in cross flow.

5. Natural Convection: Natural convection from vertical and horizontal surfaces, Grashoff and Rayleigh numbers.

6. Heat transfer by radiation: Concept of black body, intensity of radiation, Laws of black body radiation, non-black surfaces, emissivity, Kirchhoff's law, radiation between black surfaces and gray surfaces, radiation shape factor, radiation between large parallel plates, concentric cylinders and spheres, radiation between a small gray body and a large gray enclosure.

7. Boiling and Condensation: Pool boiling, pool boiling curve for water, maximum and minimum heat fluxes, correlations for nucleate and film pool boiling, dropwise and filmwise condensation, Nusselt analysis for laminar film wise condensation on a vertical plate, film wise condensation on a horizontal tube, effect of non-condensable gases on rate of condensation.

8. Heat Exchangers: Types of heat exchangers, log-mean temperature difference, overall heat transfer coefficient, fouling factors, LMTD method for heat exchanger analysis, heat transfer in kettles.

9. Evaporation: Types of evaporators, boiling point elevation and Duhring's rule, material and energy balances for single effect evaporator, multiple effect evaporators, forward and backward feeds, capacity and economy of evaporators.

Text Books:

1. `Fundamentals of engineering heat and mass transfer (SI Units)' by R. C. Sachdeva, New Age International (P) Limited, Publishers, New Delhi (2001) (For items 1 to 8, heat transfer portion)
2. `Unit Operations of Chemical Engineering', ***6***th Ed. by W. L. McCabe, J. C. Smith and P. Harriot (For item 9, evaporation)

Reference Books:

1. `Heat Transfer–A Conceptual Approach' by P. K. Sarma and K. Ramakrishna, New Age International (P) Limited, Publishers, New Delhi (2001)
2. `Process Heat Transfer' by D. Q. Kern.

ChE-314 Inorganic Chemical Technology

Water: Sources of water, hardness, treatment for different end uses, municipal water conditioning, industrial waste water treatment.

Sulphur and sulphuric acid: Sources of sulphur-sulphuric acid, different processes of manufacturing-contact process, DCDA process for sulphuric acid manufacture.

Nitrogen industries: Manufacture of ammonia, nitric acid, urea and ammonium nitrate.

Phosphorous and phosphoric acid industries: Methods for production of phosphorous and phosphoric acid, manufacture of super phosphate and triple super phosphate.

Chloro-alkali industries: - Manufacture of soda ash, caustic soda and chlorine.

Cement: Types of cement, manufacture of ordinary portland cement [opc], slag cement.

Fuel and industrial gases: Production of water gas, producer gas and coke oven gas, production of acetylene, oxygen and nitrogen.

Metallurgy: Manufacture of pig iron, cast iron, methods of making steel, open hearth process, production of aluminium by electrolytic process.

Textbooks:

1. "Dryden's Outlines of Chemical Technology" by Gopala Rao, M & Marshall Sitting {Eds}.Affiliated East West Press Pvt. Ltd.
2. "Shreve's Chemical Process Industries" by Austin, G.T., McGraw Hill Book.

Reference Books:

1. " Encyclopedia of Chemical Technology" by Kirk, R.E. & Othmer, D.F.{eds} Interscience.

ChE-315 Process Instrumentation

Qualities of measurement: The elements of instruments, static and dynamic characteristics, dynamic response of first order and second order instruments.

Expansion thermometers: Temperature scales, constant-volume gas thermometer, pressure spring thermometer, theory of volumetric and pressure thermometers, static accuracy of thermometer, comparison of pressure-spring thermometers.

Thermoelectric temperature measurement: Thermoelectricity, industrial thermocouples, thermocouple lead wires, thermal wells, response of thermocouples, the millivoltmeter.

Resistance thermometers: Thermal coefficient of resistance, industrial resistance thermometer bulbs, resistance thermometer circuits, null-bridge resistance thermometers, deflectional resistance thermometers.

Radiation temperature measurement: Introduction, blackbody devices and radiation receiving elements, radiation pyrometers, photoelectric pyrometers and optical pyrometers.

Methods of Composition analysis: Gas analysis by thermal conductivity, analysis of moisture in gases (humidity), psychrometer method, hygrometer method, dew-point method for moisture analysis in gases, measurement of moisture in paper, textile and lumber.

Measurement of pressure and vacuum: Pressure, vacuum and head, liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measurement of pressure in corrosive fluids, static accuracy of pressure gauges.

Measurement of Head and Level: Density and specific gravity, direct measurement of liquid level, pressure(level) measurement in open vessels, level measurement in pressure vessels, density measurement, level measurement by weighing.

Textbooks:

1. Industrial Instrumentation, Donald P.Eckman.,Wiley Eastern Ltd.,

Reference Books:

1. Hand Book of Instrumentation and control, Considine.

ChE-316 MATLAB (Elective-I)

Introduction, Tutorial lessons: MATLAB session, working with arrays of numbers, creating and printing simple data, saving and executing a script file, creating and executing function files, working with files and directories.

Interactive computation: Matrices and vectors, matrix and array operations, creating and using inline functions, using built in functions and online help, saving and loading data, plotting simple graphs.

Script files, function files, language specific features, advanced data objects.

Applications: linear algebra, curve fitting and interpolation, data analysis and statistics, numerical integration, ordinary differential equations, nonlinear algebraic equations.

Basic 2D plots, using subplot to layout multiple graphs. 3-D plots, symbolic Math tool box: two useful tools in symbolic Math tool box, using symbolic Math tool box.

Text Book:

`Getting started with MATLAB: A quick introduction for scientists and engineers' by Rudra Pratap, Oxford University press, 2003

CHE-316 Petrochemicals (Elective-I)

Petrochemical industry-Feedstocks: Petrochemical industry in India, feed stocks for petrochemicals.

Chemicals from ethylene: Vinyl chloride monomer, vinylacetate monomer, ethylene oxide, ethylene glycol, acetaldehyde.

Chemicals from C_3,C_4 and higher carbon atoms: Isopropylalcohol, acrylonitrile, acrylic acid, phenol, bisphenol-A, iso and n-butanol, methyltertbutylether, methacrylic acid, malic anhydride.

Polymers of olefins: Polymer structure, methods of polymerization, high pressure polyethylene (LDPE), low pressure polyethylene (HDPE), polypropylene, polyvinylchloride, polystyrene.

Petroleum aromatics: Benzoic acid, caprolactum, terephthalic acid, phthalic anhydride,

Synthetic fibres: Production techniques of synthetic fibres, production of polyester, nylon-6,6, nylon-6, acrylic fibers.

Synthetic rubber: Styrene butadiene rubber (SBR), butyl rubber, synthesis of polyurethane.

Plastics: Phenol formaldehyde resins, urea formaldehyde resins, polycarbonates.

Synthetic detergents: Classification of detergents, general manufacture of sulphonates, keryl benzene sulphonate (Surf).

Textbook:

1. `A Text on Petrochemicals' by B.K.Bhaskara Rao, 3rd Edition, Khanna Publishers, NewDelhi.

References:

1. `Petrochemical processes', Vol.2, 2nd edition, by A.Chanvel and G. Lefebvre, Gulf publishing company.
2. `Shreve's chemical process industries', 5th edition, by George T. Austin, Mc Graw Hill Publishers

ChE-316 Microbiology (Elective-I)

Introduction to microbiology: Microbiology and origin of life, groups of micro organisms; applied areas and applications of microbiology.

Structure of bacterial cell: Distinguishing features of prokaryotes and eukaryotes, structure and functioning of bacterial cell.

Classification of bacteria: Characterisation, classification, general methods of classification, concepts of classification, nomenclature and identification of bacteria.

Cultivation of bacteria: Nutritional requirements, types of bacteriological media, nutritional types of bacteria, physical conditions requirement of bacteria.

Isolation of bacteria: Selective methods of isolation, isolation of pure culture techniques, cultural characteristics, staining techniques, methods of maintenance and preservation of bacteria and culture collections.

Reproduction and growth of bacteria: Reproduction and genetic transformations in bacteria, growth, growth curve, and measurements of bacterial growth.

Microbiology of water and waste water: Municipal water purification, determination of sanitary water quality, water pollution, waste water, chemical and biological characteristics of waste water, waste water treatment processes.

Textbooks:

1. `Microbiology' by Michael J. Pelezar Jr., E.C.S. Chan and Noel Kreig
2. `Microbiology' by Ananthnarayan
3. `Microbiology: A text book for university students' by Sharma P.D.

Reference Books:

1. `Microbiology' by Carpenter Philip, L.
2. `Microbiology' by Buffaloe Neal, D. and Freguson Dale,V.
3. `Microbiology Fundamentals and Applications' by Purhit, S.S.

ChE-316 Java (Elective-I)

Fundamentals of object oriented programming, overview of java language, constants, variables and other data types, operators and expressions, decision making and branching, classes, objects and methods, arrays, strings and vectors, managing input/output files in java.

Interfaces: multiple inheritance.

Text Book: `Programming With Java', a Primer 3rd Edition by E.Bala Guruswamy, Tata McGraw-Hill Publishing Company Limited, New Delhi.

ChE-316 FORTRAN (Elective-I)

Fortran programming preliminaries, constants and variables, arithmetic expressions, input-output statements, control statements, the do statements, format specification, functions and subroutines, FORTRAN program examples.

Text Book: `Principles of Computer Programming' by V.RajaRaman

ChE-317 Mass Transfer Laboratory – I

List of Experiments:

1. Steam distillation
2. Differential distillation
3. Height equivalent to a theoretical plate
4. Vapor-liquid equilibria
5. Determination of liquid diffusion coefficient
6. Determination of vapor diffusion coefficient
7. Surface evaporation
8. Height of a transfer unit

ChE-318 Heat Transfer Laboratory

List of Experiments:

1. Determination of total thermal resistance and thermal conductivity of composite wall.
2. Determination of the thermal conductivity of a metal rod.
3. Determination of the natural convective heat transfer coefficient for a vertical tube.
4. Determination of critical heat flux point for pool boiling of water.
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe.
6. Determination of over-all heat transfer coefficient in double pipe heat exchanger.
7. Study of the temperature distribution along the length of a pin fin under natural and forced convection conditions.
8. Estimation of unsteady state film heat transfer coefficient between the medium in which the body is cooled.
9. Determination of Stefan-Boltzmann constant.
10. Determination of emissivity of a given plate at various temperatures.
11. Determination of radiation constant of a given surface.

ChE-319 Communication Skills

Communication:
Importance of communication
Non verbal communication
Personal appearance
Posture
Gestures
Facial expressions
Eye contact
Space distancing

Goal setting:
Immediate, short term, long term,
Smart goals, strategies to achieve goals

Time management:
Types of time
Identifying time wasters
Time management skills

Leadership and team management:
Qualities of a good leader
Leadership styles
Decision making
Problem solving
Negotiation skills

Group discussions:
Purpose (Intellectual ability, creativity, approach to a problem, solving, tolerance, qualities of a leader)
Group behaviour, Analysing performance

Job interviews:
Identifying job openings
Preparing resumes & CV
Covering letter
Interview (Opening, body-answer Q, close-ask Q),
Types of questions

Reference books:

1. 'Effective Technical Communications' by Rizvi M. Ashraf, McGraw–Hill Publication
2. 'Developing Communication Skills' by Mohan Krishna & Meera Banerji, Macmillan
3. 'Creative English for Communication' by N.Krishnaswami & T.Sriraman, Macmillan
4. 'Professional Communication Skills' by Jain Alok, Pravin S.R. Bhatia & A.M. Sheikh, S.Chand & Co.

B.Tech. Chemical Engineering
(Effective from the admitted batch of 2006-07)
III/IV B.Tech. (Second semester)

ChE–321 Chemical Engineering Thermodynamics-II

Solution thermodynamics: Theory: Fundamental property relation, chemical potential as a criterion for phase equilibria, partial properties, ideal gas mixtures, fugacity and fugacity coefficient for a pure species, fugacity and fugacity coefficient for species in solution, generalized correlations for the fugacity coefficients, the ideal solution, excess properties, behaviour of excess properties of liquid mixtures,

Solution thermodynamics: Applications: Liquid-phase properties from VLE data, models for the excess Gibbs Energy, property changes of mixing, heat effects of mixing processes,

VLE at low to moderate pressures: The nature of equilibrium, the phase rule, Duhem's theorem, VLE- qualitative behavior, the gamma/phi formulation of VLE, dew point and bubble point calculations, flash calculations, solute (1)/solvent (2) systems,

Thermodynamic properties and VLE from equations of state: Properties of fluids from the virial equations of state, properties of fluids from cubic equations of state, fluid properties from correlations of the Pitzer type, VLE from cubic equations of state,

Topics in phase equilibria: Equilibrium and stability, liquid/liquid equilibrium(LLE), vapor/liquid/liquid equilibrium(VLLE), solid/liquid equilibrium (SLE), solid/vapor equilibrium (SVE),

Chemical reaction equillibria: The reaction coordinate,–application of equilibrium criteria to chemical reactions, the standard Gibbs energy change and the equilibrium constant, effect of temperature on the equilibrium constant, evaluation of equilibrium constants, relation of equilibrium constants to composition, equilibrium conversions for single reactions, phase rule and Duhem's theorem for reacting systems, multi reaction equilibria,

Thermodynamic analysis of processes: Calculation of ideal work, lost work, thermodynamic analysis of steady-state flow processes.

Text book:

1. `Introduction to Chemical Engineering Thermodynamics' by J.M.Smith, H.C.Van Ness and M.M.Abbott., 6th Edition, Tata McGraw-Hill Edition 2003

Reference books:

1. `Chemical Engineering Thermodynamics' by Y.V.C.Rao, University Press (India) Ltd., Hyderabad 1997

ChE-322

Mass Transfer-II

Liquid-liquid operations: Extraction: Introduction, liquid-liquid equilibria, analytical and graphical solutions for single and multistage operations, continuous counter current operation without and with reflux, fractional extraction, equipment for liquid-liquid contacting operations, single stage, multistage and continuous contacting equipment,

Leaching: Preparation of solid, steady and unsteady state operation, equipment, analytical methods both theoretical and problematic approaches for single and multistage operations,

Adsorption: Theory of adsorption, Industrial adsorbents, adsorption equilibria, Freundlich equation, single and multistage operations, unsteady state adsorption, equipment for single stage and continuous contact, ion-exchange,

Drying: Equilibria, drying rate curve, batch and continuous drying, time of drying and calculations, mechanism of batch drying, equipment's for batch and continuous drying operations,

Crystallization: Equipment and analytical methods, factors governing nucleation and crystal growth rates, controlled rate of crystals, incorporation of principles into the design of the equipment,

Less conventional operations: Dialysis, thermal diffusion, mass diffusion,

Membrane separation processes: Separation of gases, separation of liquids, dialysis, membranes for liquid extraction, pervaporation, reverse osmosis.

Text book:

1. 'Mass Transfer Operations', by Robert E.Treybal, III Edition, McGraw-Hill Book Co.

Reference books:

1. 'Unit Operations in Chemical Engineering' by McCabe,W.L., Smith, J.C. and Harriot, P., 5th Edition, McGraw-Hill Book Co.

2. 'Chemical Engineering Hand Book' by J.H.Perry

ChE–323

Material Science and Engineering

A brief re review on bonding, bond Energy, $?H_{crystal, ?} H_{lattice,}$

Crystal structure: Symmetry, elements of symmetry in cubic crystals-space lattices two and three dimensiona, unit cell, crystal, Bravais lattices, crystal systems with examples, lattice coordinates, Miller and Miller –Bravais indices for directions and planes, linear density of atoms, planar density of atoms-close packed directions and planes, atomic and ionic packing fractions, densities of metals and ionic structures, covalent structures, close packed structures, crystal structure determination,

X-ray diffraction: Powder method, ionic covalent and metallic structures, structure determination of cubic crystals, Ligancy and limiting radii ratio,

Basic thermodynamic functions: Impure phases, solid solutions, alloys, single phase and multi phase alloys, crystal defects, point imperfections, classification, application of configurational entropy to estimate vacancy concentration and other defect concentrations, defect structures, line imperfections, edge and screw dislocations –their nature, Burgers circuit and Burgers vector, dislocation reaction, dislocation motion, multiplication of dislocations during deformation, role of dislocations in determining crystal properties, twining – surface defects, grains and grain boundary, dislocation energy, stress required to move a dislocation, dislocation density,

Elasticity, plasticity, stress, strain: True stress, true strain, Poissons ratio, elastic compliances, strain energy, stress-strain diagrams for ductile and brittle materials, proof stress, yield stress, plastic stress, modulus of elasticity, rigidity, bulk modulus– relationship between the three, plastic deformation, uniform elongation and necking strain hardening, work hardening as strengthening mechanism, plastic deformation by slip-slip systems and planes, critical resolved shear stress (CRSS), cold working, dynamic recovery, re-crystallization, grain growth, grain size and yield stress, Hall-petch equation, single crystal, polycrystalline material, comparison of stress – strain diagrams, anelasticity, elastic after effect, damping, internal friction, energy loss, viscoelasticity, viscoelastic models,

Composite materials: Fibrous, particulate, their properties and Young's modulus of composites when axially and transversely loaded, fraction of the load taken by fiber and matrix,

Fracture, ductile and brittle: Griffth's criterion for brittle failure, ductile brittle transition temperature, creep, mechanisms of creep, creep resistance materials, creep rate and related equations to find creep rates, fatigue-mechanism-factors to increase fatigue resistance,

Transition between states of matter: Energetics of transitioin, structure of solids, nucleation, mechanisms, nucleation rates, homogeneous and heterogeneous nucleation, phase rule, unary, binary phase diagrams, thermal equilibrium diagrams, eutectic, eutectic phase diagrams, Cd-Bi, Pb-Sn, Cu-Ni, Ag-Cu, Fe-C or Fe-Fe_3C-phase transformations,

time temperature, transformation curves for eutectoid steels, plain carbon steels, effect of addition of alloying elements on the properties of steels, types of steels used in Chemical industries.

Text books:

1. `Materials Science & Engineering' by V.Raghavan, Prentice Hall of India Ltd, New Delhi.

2. `Elements of Materials Science & Engineering', 5th Edition, Lawrence H.VanVlack, Addision-Weley Publishing Co.

Reference books:

1. `Science of Engineering Materials', Vols.1-3, by Manas Chanda, McMillan Company of India, Delhi

2. `Principles of Materials Science & Engineering', William F.Smith, McGraw-Hill Publishing Co.

3. `Essentials of Materials Science' by A.G. Guy.

ChE-324

Organic Chemical Technology

Coal and Coal chemicals: Types of coal, different uses, distillation of coal, treatment of products, low and high temperature carbonization of coal, coal tar distillation,

Petroleum: Origin, classification, composition of crude oil, production of crude oil, distillation of crude petroleum, refining-methods, uses of products,

Extraction of vegetable oils: Purification, acid value, hydrogenation of oils,

Iodine value: Manufacture of fatty acids and soaps, saponification value, detergents-classification and manufacture.

Paints and varnishes: Constituents of paints, functions of paint, manufacturing procedures, Pigments-manufacture of lithophone, varnishes,

Manufacture of pulp: Kraft process and sulphite process, production of paper,

Manufacture of cane sugar: Refining, manufacture of starch, dextrin and dextrose, production of ethanol by fermentation, manufacture of pencillin,

Polymerisation: Different methods, manufacture of polyethylene, phenol formaldehyde, SBR, synthetic fibres, rayon, 6-nylon, 6,6-nylon, polyesters.

Text books:

1.`Dryden's out lines of chemical Technology' by Gopala Rao, M. & Marshall Sitting, .Affilated East West Press Pvt.Ltd.

2.`Shreve's Chemical Process Industries' Austin,G.T,,. Mcgraw Hill Publishers

Reference book:

1.`Encyclopedia of Chemical Technology' by Kirk.R.E & othmer,D.F., Inter Science.

ChE-325

Bio-chemical Engineering –Principles

Introduction to biochemical engineering – Comparison of chemical and biochemical processes, industrially important microbial strains used for different bio products,

Chemicals of life –Carbohydrates, proteins, lipids, nucleic acids, their classification and functions,

Biology of microbes – Protist kingdom, classification and structure of different cells,

Introduction to enzymes – Classification, kinetics of enzyme catalyzed reactions, factors affecting E.S complex, derivation of Michaelis Menten equation for single substrate, determination of M.M parameters, enzyme inhibition – types, immobilization of enzymes, methods, immobilized enzyme kinetics, applications of immobilized enzymes,

Kinetics of cell growth – Growth phases, yield coefficient, Monod growth kinetics, ideal bioreactors – batch –mixed flow and plug flow reactors, their analyses,

Transport phenomenon across the cell – Active, passive and facilitated diffusion, gas liquid mass transfer in cellular systems, determination of k_La values,

Sterilization - Media and air, methods,

Down stream processing – Special reference to membrane separation and chromatographic techniques, important industrial bio products – ethanol – penicillin – citric acid – acetic acid, effluent treatment, production of biogas.

Text book:

1. 'Biochemical Engineering Fundamentals' by J.B.Bailey and D.F.Ollis, McGraw Hill Inc.

Reference books:

1. 'Biochemical Engineering' by A.Aiba, E.Humphrey and N.R.Milli
2. 'Bioprocess Engineering - Basic Concepts' by M.L.Shuler and F.Kargi
3. 'Biochemical Engineering' by J.M.Lee
4. 'Biochemical Engineering' by H.W.Blanch and D.S.Clark

ChE-326
Biochemistry (Elective-II)

Cell structure: Eukaryotic cell – structure of a typical plant and animal cell, differences between plant and animal cell,

Biomolecules: **Carbohydrates -c**lassification, chemical reactions properties of ribose, glucose, fructose, sucrose, maltose, lactose, structure and configuration of glucose, structure and properties of starch, cellulose and glycogen, **Amino acids- c**lassification, properties and chemical reactions, peptide bond, **Protiens - c**lassification, primary, secondary, tertiary and quaternary structure of proteins, biological functions of proteins, **Lipids - c**lassification, structure, physical and chemical properties of triglycerides, fatty acids, phospholipids, cerebrosides, gangliosides, glycolipids and cholesterol, **Nucleic acids -s**tructure and properties of purine and pyrimididine bases, nucleosides and nucleotides, structure and properties of DNA & RNA,

Enzymes: Classification, mechanism of enzyme action, factors affecting enzyme activity –pH, temperature, substrate concentration, specificity of enzymes, enzyme inhibition, competitive and non competitive inhibition, significance of enzyme inhibition, applications of enzymes,

Vitamins: Fats and water soluble vitamins, occurance, properties,

Food: Digestion and absorption of food in the human beings,

Chromatography techniques: Paper chromatography and thin layer chromatography techniques for the separation of sugars and amino acids,

Elementary principals of genetic engineering: Fundamental tools and techniques of genetic Engineering – restriction endonucleases, cloning vectors, DNA-ligases, gene libraries (gene banks), southern blotting technique, northern blotting technique and western blotting technique, strategies of recombinant DNA technology in prokaryotes, significance of genetic engineering.

Text books:

1.`Textbook on Biochemistry' by A.V.S.S.Rama RAo, UBS Publishers & Distributor
2.`Biochemistry' by A.L.Lehninger, Worth Publishers
3.`Introductory Biotechnology' by R.P.Singh., Centrol Book Depot, Allhabad

Reference books:

1. `Introductory Cytology' by Dr.Veer Bala Rastogi, Kedar Nath Ram Nath,Meerut
2. `Introduction to practical Biochemistry' by David T. Plummer, Tata McGraw Hill
3. `Industrial Microbiology' by L.E.Casida,J.R., Willey Eastren Ltd.
4. `Textbook of Biochemistry' by West, Todd, Mason and Brugen, Macmillan
5. `Principals of Biochemistry' by White, Handler and Smith, Tata Mc Graw Hill
6. `Elements of Biotechnology' by P.K.Gupta., Rastogi and Co., Meerut

CHE-327

Mass Transfer Laboratory-II

List of experiments:

1. Ternary liquid equillibria (Binodal curve)
2. Liquid-liquid equilibria.
3. Limiting flow rates in spray tower
4. Hydrodynamics of perforated plate tower
5. Volumetric mass transfer coefficients in perforated plate tower
6. Dynamics of liquid drops (Single drop extraction tower)
7. Studies of axial mixing characteristics in a packed bed
8. Gas-liquid mass transfer in packed tower
9. Drying characteristics of a given material

ChE-328

Biotechnology Laboratory

List of experiments:

1. Preparation of culture media
2. Isolation of bacteria in pure cultures
3. Bacterial staining techniques
4. Determination of bacterial motility by hanging drop method
5. Qualitative analysis of carbohydrates
6. Qualitative analysis of amino acids and proteins
7. Estimation of reducing sugars by Benedicts titrimetric method
8. Estimation of glysine using Sorensons formal titration method
9. Estimation of carbohydrates by anthrone method
10. Production of urease
11. Preparation of acetate and phosphate buffers
12. Immobilization of enzymes/whole cells by entrapment method

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