B.TECH. (CHEMICAL ENGINEERING)

(Effective from the admitted batch of 2009-10)

Scheme and Syllabi

DEPARTMENT OF CHEMICAL ENGINEERING
AU COLLEGE OF ENGINEERING (A)
ANDHRA UNIVERSITY
VISAKHAPATNAM

Andhra University
Department of Chemical Engineering

I/IV B.Tech. Chemical Engineering (Year-end)
(Effective from the admitted batch of 2009 -2010)

S.No	Course code	Title	Work load				Total marks		Credits
			Theory		Pract.	Total	Univ. Exam.	Sessional Marks	
			L	T					
1.	CHE-101	English	2	-	1	3	70	30	2
2.	CHE-102	Mathematics-I	3	-	-	3	70	30	4
3.	CHE-103	Mathematics-II	3		-	3	70	30	4
4.	CHE-104	Physics Theory	3		-	3	70	30	4
5.	CHE-105	Chemistry Theory	3	-	-	3	70	30	4
6.	CHE-106	History of Science & Technology	3	-	-	3	70	30	2
7.	CHE-107	CPNM*	3	-	-	3	70	30	4
8.	CHE-108	Engineering Graphics	2	-	4	6	70	30	5
9	CHE-109	Physics Laboratory	-	-	3	3	50	50	2
10.	CHE-110	Chemistry Laboratory	-	-	3	3	50	50	2
11.	CHE-111	Workshop Practical	-		3	3	50	50	2
12.	CHE-112	Programming Laboratory	-		3	3	50	50	2
Total:			22	-	17	39	760	440	37

***Computer Programming and Numerical Methods**

2/4 B.Tech. Chemical Engineering (First semester)
(Effective from the admitted batch of 2009-2010)

S.No	Course code	Title	Work load				Total marks		Credits
			Theory		Pract.	Total	Univ. exam.	Sessional marks	
			L	T					
1.	CHE-211	Mathematics-III	4	-	-	4	70	30	4
2.	CHE-212	Inorganic Chemistry	4	-	-	4	70	30	3
3.	CHE-213	Physical Chemistry	4	-	-	4	70	30	4
4.	CHE-214	Strength of Materials	4	-	-	4	70	30	4
5.	CHE-215	Mechanical Engineering	4	-	-	4	70	30	4
6.	CHE-216	Basic Electrical Engineering	4	-	-	4	70	30	4
7.	CHE-217	Physical and Analytical Chemistry Laboratory - I	-	-	3	3	50	50	2
8.	CHE-218	General Engineering Laboratory	-	-	3	3	50	50	2
Total:			24	-	6	30	520	280	27

2/4 B.Tech. Chemical Engineering (Second semester)
(Effective from the admitted batch of 2009-2010)

S.No	Course code	Title	Work load				Total marks		Credits
			Theory		Pract.	Total	Univ. exam.	Sessional marks	
			L	T					
1.	CHE-221	Mathematics – IV	4	-	-	4	70	30	4
2.	CHE-222	Organic Chemistry	4	-	-	4	70	30	3
3.	CHE-223	Chemical Process Calculations	5	-	-	5	70	30	4
4.	CHE-224	Fluid Mechanics	4	-	-	4	70	30	4
5.	CHE-225	Mechanical Operations	4	-	-	4	70	30	4
6.	CHE-226	Environmental Studies	3	-	-	3	70	30	2
7.	CHE-227	Organic Chemistry Laboratory	-	-	3	3	50	50	2
8.	CHE-228	Fluid Mechanics Laboratory	-	-	3	3	50	50	2
9.	CHE-229	Mechanical operations Laboratory	-	-	3	3	50	50	2
Total:			24	-	9	33	570	330	27

3/4 B.Tech. Chemical Engineering (First semester)
(Effective from the admitted batch of 2009-2010)

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.	FE-01	Free Elective	4			4	70	30	4
8.	CHE-317	Mass Transfer Laboratory – I	-	-	3	3	50	50	2
9.	CHE-318	Heat Transfer Laboratory	-	-	3	3	50	50	2
10	CHE-319	Communication Skills	-	-	3	3	-	100	1
Total:			30	-	9	39	590	410	33

3/4 B.Tech. Chemical Engineering (Second semester)
(Effective from the admitted batch of 2011-2012)

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

***Summer Industrial Training is compulsory at the end of III year II Semester and assessment will be carried out at the end of IV year I Semester.**.

4/4 B.Tech. Chemical Engineering (First semester)
(Effective from the admitted batch of 2009-2010)

S.No	Course code	Title	Work load				Total marks		Credits
			Theory		Pract.	Total	Univ. exam.	Sessional	
			L	T					
1.	CHE-411	Transport Phenomena	5	-	-	5	70	30	4
2.	CHE-412	Chem. Engg. Maths	4	-	-	4	70	30	4
3.	CHE-413	Chem. Reaction Engg.	5	-	-	5	70	30	4
4.	CHE-414	Industrial Management	5	-	-	5	70	30	4
5.	CHE-415	Process Dynamics & Control	5	-	-	5	70	30	4
6.	CHE-416	Elective – III	4	-	-	4	70	30	4
7.	CHE-417	Chemical Reaction Engg. Laboratory	-	-	3	3	50	50	2
8.	CHE-418	Process Dynamics & Control Laboratory	-	-	3	3	50	50	2
9	CHE-419	Seminar	-	-	3	3	-	100	3
10.	CHE-420	Industrial Training Report	-	-	-	-	100	-	2
Total:			28	-	9	37	620	380	33

4/4 B.Tech. Chemical Engineering (Second semester)
(Effective from the admitted batch of 2011-2012)

S.No	Course code	Title	Work load				Total marks		Credits
			Theory		Pract -icals	Total	Univ. exam.	Sessional	
			L	T					
1.	CHE-421	Chemical Process Equipment Design	5	-	-	5	70	30	4
2.	CHE-422	Elective – IV	5	-	-	5	70	30	4
3.	CHE-423	Process Engineering Economics	4	-	-	4	70	30	4
4.	FE-02	Free Elective	4			4	70	30	4
4.	CHE-424	CPED Laboratory	-	-	6	6	50	50	2
5.	CHE-425	Project	-	-	6	6	50	50	8
Total:			18	-	12	30	380	220	26

List of electives to be offered from the admitted batch of 2011-2012::

Elective-I: **1. Polymer Technology 2. Paper Technology 3. Fertilizer Technology**
4. Fuel Cell Technology 5. Nuclear Reactor Material Technology
6. Petrochemicals 7. Microbiology 8. Ceramic Raw Materials

Elective-II: **1. Computational Fluid Dynamics 2. Object Oriented Programming**
3.Biochemistry 4. Computer Application in Chemical Engineering
5.Multicomponent Separation Processes 6. Petroleum Refining
7. White ware and Heavy clayware

Elective-III: **1.Computer Aided Design 2.Fludization Engineering**
3. Industrial Pollution & Control Engineering 4. MATLAB
5.Numerical Heat Transfer 6. Reservoir Engineering
7. Biochemical Engineering 8. Fuels, Refractories and Furnaces

Elective-IV: **1.Process Optimization 2.Process Modeling and Simulation**
3. Artificial Intelligence in Process Engineering
4. Ceramic Science and Phase Equilibria in Ceramics
5. Natural Gas Engineering 6. Bioinformatics
7. Bio-Chemical Engineering Principles

***Elective –IV is effective from the admitted batch of 2011-2012**

***Chemical Engineering Department is offering 'Corrosion Engineering' (FE-01) and 'Industrial Safety' (FE-02) as free electives - effective from the admitted batch of 2007-2008.**

I/IV B.Tech. Chemical Engineering
(Effective from the admitted Batch of 2009-10)

BTM-101 English

The emphasis on English Language is enormously increasing as an effective medium of communication in all sectors the World over. As a consequence of this, the acquisition of effective communication skills in English has become most important to the students to flourish in their careers. In this connection, there is a need to train the students to equip themselves with the necessary skills required for effective communication in English thereby enabling them to get a good placement immediately after the completion of their undergraduate courses. To meet the objectives of developing proficiency in English communication skills and developing Listening, Speaking, Reading and Writing (LSRW) skills, the following curriculum is designed.

Theory and Practice (Language Laboratory)

1. A text with focus on Skills approacr:
Intended to develop the language skills of Listening, Speaking, Reading and Writing,

2. Vocabulary:
a) One – word substitutes
b) Words often confused – Pairs of Words
c) Synonyms and Antonyms
d) Foreign Phrases
e) Phrasal verbs derived from the following dynamic verbs: Go, Get, Run, Take, Look, Hold, Put, Stand Etc.
f) Idioms and phrases

3. Grammer:
a) Error analysis
• Correction of errors in a given sentence, errors in the use of words, errors of indianisms, use of slang, errors in punctuation
b) Concord
c) Articles, prepositions and words followed by prepositions
d) Tenses

4. Writing skills:
1. Précis writing
2. Note making
3. Letter writing
4. Technical Report Writing
5. Preparation of C.V and Resume writing
6. Reading comprehension
7. Memo
8. Notices/Circulars agenda and Minutes of a meeting
9. E-Mail etiquette
10. Essay writing

Text book:
In order to improve the proficiency of the student in the acquisition of the above mentioned skills, the following texts and course content is prescribed.

• **LEARNING ENGLISH :** A Communicative Approach, Hyderabad: Orient Long man. (selected lessons)
The following lessons are prescribed from the above text:
i) Astronomy (1)
ii) Travel and transport (3)
iii) Humour (4)
iv) Environment (6)
v) Inspiration (7)
vi) Human interest (8)

Reference books:

1. 'English for Engineering Students' by Sharma, G.V.L.N.,
2. 'Examine your English' by Margaret M Maison, Orient Longman
3. 'Current English for Colleges' by Krishnaswami, N. and Sriraman, T., Macmillan
4. 'Creative English for Communication' by Krishnaswami, N. and Sriraman, T., Macmillan
5. 'Effective Technical Communication' by Rizvi, M Ashraf, McGraw – Hill
6. 'English for Technical Communication' by K.R. Lakshminarayana, SCITECH

BTM -102 Mathematics-I

Partial differentiation and its applications: Functions of two or more variables, partial derivatives, homogeneous functions- Euler's theorem, total derivative, differentiation of implicit functions, geometrical interpretation - tangent plane and normal to a surface, change of variables, Jacobians, Taylor's theorem for functions of two variables, Jacobians, Taylor's theorem for functions of two variables, errors and approximations, total differential, maxima and minima of functions two variables, Lagrange's method of undetermined multiples, differentiation under the integral sign – Leibnitz Rule, involutes and evolutes,

Multiple integrals and their applications: Double integrals, change of order of integration, double integrals in polar co-ordinates, areas enclosed by plane curves, triple integrals, volume of solids, change of variables, area of a curve of a curved surface, calculation of mass, center of gravity, center of pressure, moment of inertia, product of inertia, principle axes, beta function, gamma function, relation between beta and gamma functions, error function or probability integral,

Solid geometry (Vector treatment): Equation of a plane, equations of straight line, condition for a line to lie in a plane, coplanar lines, shortest distance between two lines, interaction of three planes, equation of sphere, tangent plane to a sphere, cone, cylinder, quadric surfaces,

Infinite series: Definitions - convergence, divergence and oscillation of a series, general properties, series of positive terms, comparison tests, integral test, D'Alembert's ratio test, Raabe's test, Logarithmic test, Cauchy's Root test, alternating series- Leibnitz's rule, series of positive or negative terms, power series, convergence of exponential, logerithmic and bionomial series, uniform convergence, Weirstrass M-test, properties of uniformly onvergent series.

Fourier series: Euler's formulae, conditions for a Fourier expansion, functions having points of discontinuity, change of interval, odd and even functions – expansions of odd or even periodic function, half range series, Parsevel formula, practical harmonic analysis,

Text books:

1. 'Higher Engineering Mathematics' by B.S.Grewal
2. 'Mathematics for Engineering' by Chandrica Prasad

Reference books:

1. 'Higher Engineering Mathematics' by M.K.Venkatraman
2. 'Advanced Engineering Mathematics' by Erwin Kreyszig

BTM -103 Mathematics-II

Linear algebra: Rank of a matrix, Eigen values, Eigen vectors of a matrix, Cayley Hamilton theorem, consistency of equations, matrix invertion, Gaussian Elimination scheme, Cholesky factorization, Jacobi and Gauss-Seidal iterative methods for solving simultaneous equations, Eigen value solution using forward iteration, inverse itrration, Hermitian and skew Hermitian forms, unitary matrix, functions of a matrix, quadratic forms and conical forms,

Differential equations of first order and its applications: Formation of differential equations, solution of a differential equation, geometrical meaning, equations of the first order and first degree, variables separable, homogeneous equations, linear equations, Bernoulli's equation, exact equations, equation reducible to exact equations, equations of the first order and higher degree, Calirut's equation, geometric applications, orthogonal trajectories, physical applications, simple electric circuits, heat flow, chemical applications, Newton's law of cooling,

Linear differential equations: Higher order linear differential equations with constant coefficients, deflection of beams, simple harmonic motion, oscillatory electric circuits,

Series solutions of differential equations: Frobenis method, special function as solution from series, Bessel equation, Bessel functions of first and second kind, equation reducible to Bessel's equations, Legender's equations, Legender polynomial, Rodrigues formula, generating functions, recurrence relation, orthonogolity relation for Bessel functions and Legendre polynomial,

Laplace transforms: Transforms of elementary functions, properties of Laplace transforms, existence conditions, inverse transforms, transform of derivatives, transform of integrals, multiplication's by 't'- division by 't', convolution theorem, application to ordinary differential equations and simultaneous linear equations with constant coefficients, unit step function, impulse functions and periodic functions.

Text books:

1. 'Theory of Matrices' by Shanti narayanan.
2. 'Higher Engineering Mathematics' by B.S. Grewal
3. 'Advanced Mathematics for Engineering students, vol. 2' by Narayana, Manieavachgon Pillay, Ramanaiah

Reference books:

1. 'Higher Engineering Mathematics' by M.K.Venkataraman
2. 'Advanced Engineering Mathematics' by Erwin Kreyozig
3. 'Engineering Mathematics' by P.P. Gupta
4. 'A text book on Engineering Mathematics' by N.P.Bali

BTM -104 Physics

Thermodynamics: Heat and work, first law of thermodynamics and its applications, reversible and irreversible processes, Carnot cycle and efficiency, entropy, second law of thermodynamics, entropy and disorder, entropy and probability, third law of thermodynamics, thermography and its applications.

Electromagnetism: Concept of electric field – point charge in electric field, dipole in an electric field, Gauss law, some applications, electric potential and field strength, potential due to a point charge and dipole, magnetic field – magnetic force on current, torque on current loop, hall effect, Ampere's law, B near a long wire, B for a solenoid and toroid, the Biot-Savart's law, B for a circular current loop, Faraday's law of induction, Lenz's law, calculation of inductance, L-R circuit, energy stored in magnetic field, induced magnetic fields, displacement current, energy density in electric and magnetic fields, Poynting vectors, Maxwells equations and electromagnetic waves (both differential and integral forms), magnetic properties of materials, paramagnetism, diamagnetism, ferromagnetism, ferrites and its applications,

Optics: Interference, principles of superposition, Young's experiment, coherence, interference of thin films, wedge shaped film, Newtons rings, Michelson interferometer and its applications, diffraction – single slit (qualitative and quantitative treatment), polarization, polarisation by reflection, refraction and double refraction in uniaxial crystals, Nicol prism, quarter and half wave plate, circular and elliptical polarization and detection,

Lasers and fibre optics: Spontaneous and stimulated emissions, population inversions, Ruby laser, Gas laser, semiconductor laser, applications of lasers, fibre optics, optical fibre and total internal reflection, acceptance angle and cone of a fibre, fibre optics in communications, optical parts in fibre, fibre optic sensors,

Ultrasonics: Production of ultrasonics by magnetostriction and piezoelectric effects, ultrasonics and diffraction pattern, applications of ultrasonics,

Modern physics: The quantization of energy, photoelectric effect, De Broglie concept of matter waves, uncertainty principle, Schrodinger wave equation, application to a particle in a box, elementary concepts of Maxwell-Boltzman, Bose-Einstein's and Fermi Dirac Statistics, Fermi Dirac distribution function (no derivations), free electron theory of metals, Band theory of solids, Kronig Penny model, metals, insulators and semiconductors, ferroelectrics and their applications, super conductivity, Meisner effect, types of superconductors and applications of superconductors, nanophase materials, synthesis, characterization of nanostructured materials, properties and applications, renewable energies – solar, wind and tidal, their applications.

Text books:

1. 'Engineering Physics' by R.K. Gaur and S.D. Gupta
2. 'Physics' by David Halliday and Robert Resnick – Part I and Part II
3. 'Modern Engineering Physics' by A.S. Vadudeva
4. 'University Physics' by Young and Freedman
5. 'Materials Science' by V. Rajendra and A. Marikani
6. 'Nonconventional Energy' by Ashoke V. Desai

BTM -105 Chemistry

Water chemistry and pollution:
Water chemistry: Sources of water, impurities – hardness and its determination, W.H.O. Limits, boiler troubles and their removal, water softening methods – lime soda, Zeolite and ion exchange, municipal water treatment – break point chlorination, desalination of sea water - electrodialysis and reverse osmosis methods,
Water pollution: Source – BOD, COD, sewage treatment - preliminary, primary, secondary and tertiary,
Air pollution: Source – air pollutants – CO , SOx , NOx , hydrocarbons and particulates, acid rain, green house effect, control of air pollution (general),

Solid state chemistry:
Classification of solids – Types of crystals, properties, imperfections in crystals, Band theory of solids, chemistry of semiconductors - intrinsic, extrinsic, compound and defect, organic semiconductors and superconductivity, purification of solids by zone refining, single crystal growth, epitaxial growth, elementary ideas on liquid crystals,

Energy sources:
Thermal energy: Coal- Ranking of coal - analysis (proximate and ultimate), calorific value and determination (Bomb calorimeter method), COKE, manufacture, Otto Hoffmann's process, applications,
Chemical energy: Electrode potential – calomel electrode, galvanic cells, primary, secondary – acid and alkaline cells, fuel cells,
Nuclear Energy : Fission and fusion, power rectors, atomic pile applications .
Solar Energy : Methods of utilization, thermal conversion, liquid flat–plate collector, photovoltaic conversion, solar cell – applications,

Corrosion chemistry:
Origin and theories of corrosion, types of corrosion, factors affecting corrosion, corrosion control methods, protective coatings, metallic coatings, chemical conversion coatings - phosphate, chromate, anodized, organic coating, paints, special paints, varnishes and lacquers,

Fuels and Lubricants:
Petroleum refining, motor fuels, petrol and diesel oil, knocking, octane number, Cetane number, synthetic petrol – Fisher - Tropsch and Bergius methods, LPG and CNG – applications, rocket fuels, propellants, classification,
Lubricants: Classification, mechanism, properties of lubricating oils, selection of lubricants for engineering applications,

Polymers and plastics:
Definition, types of polymerization, mechanism of addition polymerization, effect of polymer sructure on properties, plastics – thermoplastic resins and thermosetting resins, compounding of plastics, fabrication of plastics, preparation and properties of cellulose derivatives - Vinyl resins-Nylon(6,6)- bakelites – polycarbonates - epoxy resins, reinforced plastics, conducting polymers, engineering applications of polymers,

Building Materials:
Portland cement: Manufacture, dry and wet processes, setting and hardening of cement, cement concrete - RCC - decay of concrete - special cements,

Refractories: Classifications, properties, engineering applications,
Ceramics: Classification, properties, uses.

Text books:

1. 'Engineering Chemistry' by P.C. Jain and M. Jain, Dhanapathi Rai & Sons, Delhi
2. 'A Text Book of Engineering Chemistry' by S.S. Dara - S. Chand & Co. New Delhi
3. 'Engineering Chemistry' by B.K. Sharma, Krishna Prakashan, Meerut
4. 'A Text Book of Engineering Chemistry, Allied Publishers Balasubramanian et.al.,
5. 'Material Science and Engineering V. Raghavan - Prentice-Hall India Ltd.,

BTM -106 History of Science and Technology

1. Historical perspective:
The Nature of Science and Technology, roots of science and technology in India, science and society, scientists and society, science and faith and the rise of applied sciences,
2. Polices and plans after independence:
Nehru's vision of science for independent India, science and technology developments in the new era, science and technology developments during the five year plan periods and science and technology policy resolutions,
3. Research and Development (R&D) in India:
Expenditure in R&D, science and technology education, research activities and promotion of technology development, technology mission, programs aimed at technological self reliance, activities of Council of Scientific and Industrial Research (CSIR),
4. Science and Technological Developments in major areas:
Space – Objectives of space programs, geostationary satellite services – INSAT system and INSAT services remote sensing applications, Launch Vehicle Technology,
Ocean development – Objectives of ocean development, biological and mineral resources, marine research and capacity building,
Defense research- Spin-off technologies for civilian use,
Biotechnology--Applications of biotechnology in - medicine, biocatalysts, agriculture, food, fuel and fodder, development of biosensors and animal husbandry,
Energy – Research and development in conservation of energy, India's nuclear energy program, technology spin –offs,
5. Nexus between technology transfer and development:
Transfer of technology - Types, methods, mechanisms, process, channels and techniques, appropriate technology, technology assessment, technological forecasting, technological innovations and barriers of technological change.

Test books:

1. 'Science and Technology in India' by Kalpana Rajaram, Spectrum Books (P) Ltd., New Delhi,
    1. 'Management of Science and Technology' (Problems & Prospects) by M.Srinivasan, East West Press (P) Ltd., New Delhi,

Reference books :

1. 'Science, Technology and Education for Development' K.A.Ramasamy and K.Seshagiri Rao, K., Nayudamma Memorial Science Foundation, Channai,
2. 'The Role and Impact of Science and Technology in The Development of India' by G.R.Kohili, Surjeet publications,
3. 'Five Year Plans'Government of India, Planning Commission, New Delhi,
4. 'Science, Technology and Development' by K.D. Sharma and M.A.Quresh, Sterling Publications Ltd., New Delhi.

BTM -107 Computer Programming and Numerical Methods

Objectives:
To make the student familiar with programming in C and enable the student to implement the numerical methods described in this course using C as Programming language

Section A
Computer programming in C:
Basics: Variables, constants, expressions, operators and their precedence and associativity, basic input and output statements, control structures, simple programs in C using all the operators and control structure,
Functions: Concept of a function, parameters and how they are passed, automatic variables, recursion, scope and extent of variables, writing programs using recursive and non-recursive functions,
Arrays and strings: Single and multidimensional arrays, character array as a string, functions on strings, writing C programs using arrays and for string manipulation,
Structures: Declaring and using structures, operations on structures, arrays of structures, user defined data types, pointers to using files,
Files: Introduction, file structure, file handing functions, file types, files, error handing, C programming examples for using files.

Section B
Computer oriented numerical methods:
Basic concepts: Preliminary concepts of algorithms, flow charts and their execution traces, a simplified model of a computer,
Representation for characters and numbers: Representation for integer and real numbers, effect of finite representation on arithmetic operations for ex. overflow, underflow, associativity and normalization, some elementary methods for overcoming these limitations,
Numerical methods: Notation of round-off and truncation errors, numerical methods of finding roots of an algebraic equation of one variable, successive bisection method, false position method, Newton Raphson method and Secant method,
Solutions of simultaneous algebraic equations; Gauss elimination method and Gauss Seidal methods,
Interpolation: Lagrange's interpolation and difference table methods,
Numerical integration: Simpson's rule, Gaussian quadrature formula,
Numerical solution of differential equation: Euler's method, Taylor's series method and Runge-Kutta method.

Text books:
1. Section A: 'Programming with C' by K.R.Venugopal and Sudeep R. Prasad
2. Section B: 'Introduction to Numerical Methods' by S.S Sastry
3. 'Elementary Numerical Methods' by S.D.Conte

Reference book:
1. C' Programming Language' by Kerningham and Ritchie

BTM -108 Engineering Graphics

Introduction:
Drawing instruments and uses, lettering scales in common use,
Curves:
Curves used in engineering practice, conic sections, construction of conics by different methods, rectangular-hyperbola, cycloidal curves, trochoids, epi and hypo-cycloids, involutes and Archemedian spiral,
Orthographic projections:
Projection of points, projection of straight lines, traces of a line, projection of planes and projection on auxiliary planes,
Solids and developments:
Projection of solids in simple positions, projection of solids with axis inclined to one of the reference planes and parallel to the other, projection of solids with axis inclined to both the reference planes, projection of spheres, development of surfaces of solids, development of transition piece connecting a square and circular pipe, helices and screw threads,
Sections and intersections:
Sections of different solids and true shape of sections, intersection of surfaces-simple problems with cylinders, prisms and cones,
Isometric and perspective projections:
Isometric projection and conversion of orthographic projection into isometric projection, perspective projection, theory of visual ray method and vanishing point method, simple problems involving regular geometrical solids,

Text book:
1. 'Elements of Engineering Drawing' by N.D. Bhatt

Reference book:
1. 'Engineering Graphics' by K.L. Narayana and P. Kannaiah

BTM -109 Physics Laboratory

12 of the following experiments must be completed:

1. Lee's method- determination of coefficient of thermal conductivity of a bad conductor
2. Melde's experiment-determination of the frequency of an electrically maintained tuning fork
3. Newton's rings- determination of radius of curvature of a convex lens
4. Diffraction grating-determination of wavelengths in mercury line spectrum-using spectrometer
5. Determination of Cauchy's constants using spectrometer and mercury light
6. Wedge method-det. of thickness of a paper by forming parallel interference fringes
7. Michelson's interferometer- a) det. of wavelength of light b) Resolution of spectral lines _ using calcite crystal 8. Det. of
9. Optical Bench – a) Young's double slit, b) Lloyd's mirror, c) biprism, d) diffraction at an edge, and e) thickness of wire
10. Ultrasonic diffraction – Velocity of ultrasonic waves in liquids
11. Variation of magnetic field along the axis of current carrying circular coil – Stewart and Gee's apparatus
12. Calibration of voltmeter using potentiometer
13. Carey Foster's bridge a) laws of resistance and b) temperature coefficient of resistance
14. B-H curves – determination of hysterisis loss
15. Calendar and Barnes method – determination of specific heat of water
16. Hall effect – a) Determination of hall coefficient and b) determination of charge density
17. Photoelectric effect – a) characteristics of photoelectric cell b) det. of Planck's constant
18. Determination of Rydberg constant using hydrogen discharge tube
19. Determination of e/m of an electron – Thomson's method
20. Determination of band gap of semi conductor

BTM -110 Chemistry Laboratory

List of Experiments:
01. Determination of sodium carbonate
02. Determination of sulfuric acid using a strong base
03. Estimation of iron (II) using potassium permanganate
04. Estimation of oxalic acid using potassium permanganate
05. Determination of volume strength of hydrogen peroxide
06. Estimation of calcium in a sample of Portland cement
07. Estimation of chromium (VI) using ferrous ammonium sulphate
08. Estimation of copper (II) using sodium thiosulphate
09. Analysis of bleaching powder for chlorine content
10. Estimation of zinc by EDTA method
11. Determination of hardness of a water sample (EDTA Method)
12. Determination of alkalinity of a water sample

Demonstration experiments:
13. Determination of viscosity of a lubricating oil
14. Preparation of copper pigment
15. Preparation of phenol-formaldehyde resin
16. Digital pH meter
17. Digital potentiometer
18. D.O. Analyzer

BTM -111 Workshop Practice

1. Carpentry:
Bench work, tools used in carpentry,
Jobs for class work – half lap joint, mortise and tenon joint, half –lap dovetail joint, corner dovetail joint, bridle joint,

2. Sheet Metal:
Tools used in sheet metal work, laying developments of sheet metal jobs, soldering,
Jobs for class work – square tray, taper side tray, funnel, elbow pipe,

3. Fitting:
Tools used in fitting work, different files, chisels, hammers and bench vice,
Jobs for class work – hexagon, rectangular, circular and triangular fits, external and internal threads with dies and taps,

Reference book;
1. 'Elements of Workshop technology', Vol.1 by S.K. and H.K. Hajra Choudary

BTM -112 Programming Laboratory

1. Write a program to read x-y coordinates of 3 points and then calculate the area of a triangle formed by them and print the coordinates of the three points and the area of the triangle. What will be the output from your program if the three given points are in a straight line?
2. Write a program, which generates 100 random integers in the range of 1 to 100. Store them in an array and then print the arrays. Write 3 versions of the program using different loop constructs. (e.g. for, while, and do while)
3. Write a set of string manipulation functions e.g. for getting a sub-string from a given position, Copying one string to another, Reversing a string, adding one string to another.
4. Write a program which determines the largest and the smallest number that can be stored in different data types like short, int., long, float and double. What happens when you add 1 to the largest possible integer number that can be stored?
5. Write a program, which generates 100 random real numbers in the range of 10.0 to 20.0, and sort them in descending order.
6. Write a function for transposing a square matrix in place (in place means that you are not allowed to have full temporary matrix).
7. First use an editor to create a file with some integer numbers. Now write a program, which reads these numbers and determines their mean and standard deviation.
8. Given two points on the surface of the sphere, Write a program to determine the smallest arc length between them.
9. Implement bisection method to find the square root of a given number to a given accuracy.
10. Implement Newton Raphson method to det. a root of polynomial equation.
11. Given a table of x and corresponding f(x) values, write a program which will determine f(x) value at an intermediate x value using Lagrange's interpolation.
12. Write a function which will invert a matrix.
13. Implement Simpson's rule for numerical integration.
14. Implement Gaussian quadrature for numerical integration.
15. Write a program to solve a set of linear algebraic equations

II/IV B.Tech. (Chemical Engineering) First Semester

CHE-211 Mathematics -III

(Effective from the admitted Batch of 2013-14)

I. VECTOR CALCULUS :

Differentiation of vectors, Curves in space, velocity and acceleration, Relative velocity and acceleration, scalar and vector point functions. Vector operator, ∇, applied to scalar point functions, gradient, ∇ applied to vector point functions, divergence and curl. Physical interpretation ∇f. $\nabla \overline{F}$, ∇ X $\overline{F}$, ∇ applied twice to point functions, ∇ applied to product of two functions; Irrotational and Solenoidal fields.

Integration of vectors, line integral, circulation, work done, surface integral-flux, Green's theorem in the plane, Stoke's theorem, volume integral, Gauss Divergence theorem.

Introduction of orthogonal curvilinear coordinates, cylindrical and spherical polar coordinates.

II. INTRODUCTON TO PARTIAL DIFFERENTIAL EQUATIONS:

Formation of partial differential equations, solutions of partial differential equations-equations solvable by direct integration, linear equations of first order, : Lagrange's Linear equation, non-linear equations of first order, Charpit's method.

Homogeneous linear equations with constant coefficients – rules for finding the complementary function, rules for finding the particular integral (working procedure), non-homogeneous linear equations.

III. APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS:

Method of separation of variables, one- dimensional wave equation - vibrations of a stretched string, one dimensional heat equation, two dimensional heat flow in steady state - solution of Laplace's equations in Cartesian and polar coordinates (two dimensional).

IV. INTEGRAL TRANSFORMS:

Introduction, definition, Fourier Integral, sine and cosine integrals, complex forms of Fourier integral, Fourier transform, Fourier sine and cosine transforms. Finite fourier sine and cosine Transforms, properties of Fourier Transforms, Convolution theorem for Fourier Transforms, Parseval's Identity for Fourier Transforms, Fourier Transforms of the derivatives of a function, applications to boundary value problems.

Text book: Scope and treatment as in **"**Higher Engineering Mathematics" by B.S. Grewal, 42nd edition, Khanna Publishers.

References :

1. A text book on Engineering Mathematics by M.P. Bali leyangar, Lakshmi Publications.
2. Advanced Engineering Mathematics by H.K. Dass, S.Chand Company.
3. Higher Engineering Mathematics by B.V. Ramana, Tata McGraw Hill Company.

CHE-212 Inorganic Chemistry

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,

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,

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,

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' by C.N.R. Rao, MacMillan India Ltd., Hyderabad
2. C'oncepts and Models of Inorganic Chemistry' by B.E Douglas, D.H McDaniel and J. Alexander. 3rd edition; John Wiley & Sons Inc., New York
3. 'Concise Inorganic Chemistry' by J.D.Lee, Fourth Edition, Chapman & Hall

CHE-213 Physical Chemistry

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.
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,

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,

Chemical equilibrium: Reversible reactions, law of mass action, homogeneous equilibria in gaseous and liquid systems, simple example of heterogeneous equilibria, effect of temperature on equilibrium, Van'tHoff equation,

Electrochemistry: Laws of electrolysis and their applications, difference between galvanic and electrolytic cells, electrode reactions, polarized electrode, decomposition potential, over voltage and its applications, EMF 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,

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,

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.

Text books:

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

CHE-214 Strength of Materials

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 and c) over-hanging beams due to 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 and ii) under axial twist, riveted joints, design of lap joints,

Stress in thin cylindrical shells and spherical shells, stress in thick cylinders, compound cylinders, pressure due to shrink-fitting,

Text book:

1. 'Strength of Materials' by Ramamrutaham

Reference book:

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

CHE-215 Mechanical Engineering

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,

Second law of thermodynamics: Carnot cycle, inequality of Classius-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,

Properties of steam and use of steam tables: Boilers, classification steam boilers, simple vertical, Cocheran locomotive boiler, Babcock and Wilcox boiler, steam generation, Rankine cycle,

Impulse and reaction turbine: Classification of steam turbines, velocity diagram and power produced in impulse turbine, performance of steam turbines, reduction of rotor speed,

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,

Reciprocating air-compressors: Single stage, work done during cycle, effect of clearance, two stage compressors, condition for minimum work, effect of inter-cooling, efficiency,

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

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 3-phase 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 Synchronised 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),

Text book:

1. 'Elements of Electrical Engineering & 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 water sample 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

Reference books:

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

CHE-218 General Engineering Laboratory

Mechanical Engineering Laboratory:

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 Laboratory:

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

II/IV B.Tech. (Chemical Engineering) Second Semester

CHE-221 Mathematics -IV

(Effective from the admitted Batch of 2011-12)

I. FUNCTIONS OF A COMPLEX VARIABLE:

Continuity concept of f(z), derivative of f(z), Cauchy – Riemann equations, analytic functions, Harmonic functions, Orthogonal systems, Applications to flow problems, integration of complex functions, Cauchy's theorem, Cauchy's integral formula, Taylor's and laurent's series (without proofs), singular points, residues and calculation of residues, Cauchy's Residue Theorem, Evaluation of real definite integrals (integration around Unit Circle, semi circle, rectangular and contours having poles on the real axes).

Geometric representation of f(z), Conformal transformation, some standard transformations :

(i) $w = s + c$, (ii) $w = 1/z$, (iii)$w = cz$ (iv) Bilinear transformation.

Special standard transformations (iv) $w = z^{2,}$ (iv) $w = e^{z}$

II. STATISTICAL METHODS:

Random variable, Discrete probability distribution, expectation, repeated trials, Binomial distribution, Poisson distribution, Continuous probability distributions – Normal distribution.

Sampling Theory:

Sampling distribution, standard error, testing of hypothesis, level of significance, confidence limits, simple sampling of attributes, sampling of variable-large samples and small samples, students t-distribution, X^2 distribution, F-distribution.

III. DIFFERENCE EQUATIONS AND Z – TRANSFORMS:

Finite difference equations-definition, order and solution of difference equations, formation of difference equations, linear difference equations, rules for finding particular integral, simultaneous difference equations with constant coefficients.

Z – transforms-definition, some standard Z-transforms, Linear property, damping rules, some standard results, shifting rules, initial and final value theorems, convolution theorem, evaluation of inverse transforms, applications of z – transforms to difference equations.

Text book: Scope and treatment as in **"**Higher Engineering Mathematics" by B.S. Grewal, 42nd edition, Khanna Publishers.

References :

1. A text book on Engineering Mathematics by M.P. Bali leyangar, Lakshmi Publications.
2. Advanced Engineering Mathematics by H.K. Dass, S.Chand Company.
3. Higher Engineering Mathematics by B.V. Ramana, Tata McGraw Hill Company.

CHE-222 Organic Chemistry

Numerical problems: Determination of percentage composition of carbon, hydrogen and nitrogen, molecular weight 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, arenas, 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,

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,

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,

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, filiani-Fisher synthesis, glucose into fructose, fructose into glucose, glucose to vitamin-C, mechanism of Osazone formation,

Nomenclature of amines, industrial preparation of aAniline, 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,

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,

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), sSynthetic 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.

Reference 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

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.

Text book:

1. 'Chemical Process Principles, Part-I - Material and Energy balances' by Olaf A Hougen, K.M. Watson and R.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, 3rd Edition, Tata McGraw Hill Publishing Company Limited, New Delhi (1996)
3. 'Stoichiometry for Chemical Engineers' by Williams and Johnson, McGraw Hill Publishers.

CHE-224 Fluid Mechanics
(Effective from the admitted Batch of 2013-14)

Dimensional Analysis: Units and Dimensions, Dimensional Homogeneity, Dimensional Analysis, Buckingham π theorem, Geometric similarity, kinematic similarity, and dynamic similarity.

Fluid Statics and Applications: Nature of fluids, Hydrostatic Equilibrium, Applications of fluid statics – Manometers, continuous gravity decanter and centrifugal decanter.

Fluid Flow Phenomena: Laminar flow, shear rate, shear stress. Rheological properties of fluids – Newtonian fluids, Non Newtonian fluids, time dependent flow, viscoelastic fluids. Viscosity, Reynolds number, Turbulence – nature of turbulence. Boundary layers – boundary layer formation over flat plate, flow in boundary layers, laminar and turbulent flow in boundary layers, boundary layer formation in straight tubes, boundary layer separation and wake formation.

Basic Equations of Fluid Flow: Continuity equation (Mass Balance in a flowing fluid), equation of motion (Differential Momentum Balance), Navier – stokes equations, Euler's equation, Couette flow, Macroscopic Momentum Balance, layer flow with free surface, Bernoulli equation (Energy equation), corrections for effect of solid boundaries and pump work.

Incompressible flow in pipes and channels: Shear Stress and skin friction in pipes, Relation with skin friction and wall shear, Friction factor, relations between skin friction parameters, equivalent diameter, laminar flow in pipes and channels, velocity distribution, average velocity, Kinetic energy correction factor and momentum correction factor for laminar flow, Hagen-Poiseuille equation, laminar flow of non-Newtonian liquids, laminar flow in annulus. Turbulent flow in pipes and channels, Velocity distribution for turbulent flow, effect of roughness, friction factor chart, drag reduction, friction from changes in velocity or direction – sudden expansion, sudden contraction, pipe fittings, friction losses in Bernoulli equation, velocity heads, separation of boundary layer in diverging channel, minimizing losses.

Flow in compressible fluids : Definitions and basic equations, processes of compressible flow, isentropic flow through nozzles, Adiabatic friction flow, Isothermal friction flow.

Flow past immersed objects : Drag and drag coefficients, flow through bed of solids, Motion of particles through fluids – mechanics of particle motion, equation for one-dimensional motion of particles through fluid, terminal velocity, criterion for settling, free and hindered settling, Fluidization – conditions, minimum fluidization velocity, types of fluidizations and its applications.

Transportation and Metering of Fluids : Pipes, fittings, valves, positive displacement pumps reciprocating, rotary and peristaltic pumps. centrifugal

pumps – theory, construction, performance, single and multistage pumps. Fans, Blowers and Compressors, Vacuum pumps – jet ejectors.

Metering of Fluids : Full bore meters – Venturi meter, Orifice meter, Rotameters, Vortex-Shedding meters, Magnetic meters and Coriolis meters. Insertion meters – Pitot Tube, thermal meters, notches and weirs.

Text books:

1. "Unit Operations of Chemical Engineering" Seventh Edition, by W.L. McCabe, J C Smith and P Harriot, McGraw Hill.

Reference books:

1. "Chemical Engineering" Volume I by Coulson J.M. and Richardson J.F., Elsevier.
2. "Fluid Mechanics" 2nd edition by Noel de Nevers, McGraw Hill.

CHE-225 Mechanical Operations

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 mills, 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, trammels, 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, tpes of conveyors – mechanical, belt, chain and screw conveyors, elevators, pneumatic conveyors, size enlargement - need and applications.

Text books:

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

Reference books:

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

CHE-226 Environmental Studies

(Common for all branches)

Introduction: Definition, scope and importance, measuring and defining environmental development – indicators,

Ecosystems: Introduction, types, characteristic features, structure and functions of ecosystems – forest, grassland, desert, aquatic (lakes, rivers and estuaries),

Environmental and natural resources management: Land resources- land as a resource, common property resources, land degradation, soil erosion and desertification, effects of modern agriculture, fertilizer-pesticide problems,
Forest resources- use and over-exploitation, mining and dams –their effects on forest and tribal people,
Water resources – use and over utilization of surface and ground water, floods, droughts, water logging and salinity, dams-benefits and costs, conflicts over water,
Energy resources- Energy needs, renewable and non-renewable energy sources, use of alternate energy sources, impact of energy use on environment,

Bio-diversity and its conservation: Value of bio-diversity- consumptive and productive use, social, ethical, aesthetic and option values, bio-geographical classification of India - India as a mega diversity nation, threats to biodiversity, hot spots, habitat loss, poaching of wild life, loss of species, seeds etc., conservation of biodiversity - in-situ and ex-situ conservation,

Environmental pollution- local and global issues: Causes, effects and control measures of air pollution, indoor air pollution, water pollution, soil pollution, marine pollution, noise pollution, solid waste management, composting, vermiculture, urban and industrial wastes, recycling and re-use, nature of thermal pollution and nuclear hazards, global warming, acid rain , ozone depletion,

Environmental problems in India: Drinking water, sanitation and public health, effects of activities on the quality of environment, urbanization, transportation, industrialization, green revolution, water scarcity and ground water depletion, controversies on major dams – resettlement and rehabilitation of people: problems and concerns, rain water harvesting, cloud seeding and watershed management,

Economy and environment: The economy and environment interaction, economics of development, preservation and conservation, sustainability: theory and practice, limits to growth, equitable use of resources for sustainable lifestyles, environmental impact assessment,

Social issues and the environment: Population growth and environment, environmental education, environment movements, environment versus development,

Institutions and governance: Regulation by Government, monitoring and enforcement of environmental regulation, environmental Acts, water (prevention and control of pollution) act, air (prevention and control of pollution) act, environment .protection act, wild life protection act, forest conservation act, coastal zone regulations, institutions and policies relating to India, environmental governance,

International conventions: Stockholm conference-1972, Earth summit-1992, World commission for environmental development (WCED),

Case studies: Chipko movement, Narmada bachao andolan, Silent valley project, Madhura refinery and Taj mahal, Industrialization of Pattancheru, Nuclear reactor at Nagarjuna sagar, Tehri dam, Ralegaon siddhi (Anna Hazare), Kolleru lake-aquaculture, Fluorosis in Andhra Pradesh,

Field work: Visit to a local area to document and mapping environmental assets – river/forest/grass land / hill/ mountain, study of local environment-common plants, insects, birds, study of simple ecosystems – pond, river hill, slopes etc, visits to industries- water treatment plants, effluent treatment plants.

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 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 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 {GI} 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 {WI} 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.

III/IV B.Tech. (Chemical Engineering) First Semester
(Effective from the admitted Batch of 2009-10)

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.

Text book:

1. Mass transfer Operations, Robert E. Treybal, 3rd 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-313 Heat Transfer
(Effective from the admitted Batch of 2011-12)

Nature of heat flow: Conduction, convection, natural and forced convection, radiation.

Heat transfer by conduction : Basic laws of conduction, thermal conductivity; Steady-state conduction – compound resistances in series, heat flow through a cylinder; Unsteady-state conduction – one dimensional heat flow with constant surface temperature, het flow with variable surface temperature, semi-infinite solid;

Heat transfer by convection: Principles of heat flow in fluids – Typical heat exchange equipment, countercurrent and parallel flows, energy balances, heat flux and heat transfer coefficients, overall heat transfer coefficients, integration over total surface, LMTD, individual heat transfer coefficients.

Heat transfer to fluids without phase change : boundary layers, laminar flow heat transfer, correction for heating and cooling, heat transfer in turbulent flow, estimation of wall temperature, cross-sections other than circular, analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids outside tubes, natural convection.

Heat transfer to fluids with phase change: heat transfer from condensing vapors, heat transfer to boiling liquids.

Radiation heat transfer: Fundamental facts concerning radiation, emission of radiation, absorption of radiation by opaque solids, radiation between surfaces, radiation to semitransparent materials, combined heat transfer by conduction-convection-radiation.

Heat-exchange equipment: General design of heat exchange equipment, shell and tube heat exchangers, plate-type exchangers, extended surface equipment, heat pipes, scraped-surface exchangers, condensers and vaporizers, heat transfer in agitated vessels, heat transfer in packed beds.

Evaporation: Evaporation, types of evaporators, performance of tubular evaporators, multiple-effect evaporators, methods of feeding, vapor compression.

Text Book: Unit Operations of Chemical Engineering, 7^{th} Ed. by W. L. McCabe, J. C. Smith and P. Harriot, McGraw Hill International Edition, Singapore (2005).

Reference book: Process Heat Transfer, by D. Q. Kern, Tata McGraw Hill, New Delhi.

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 M.Gopala Rao & Marshall Sitting (Editors). Affiliated East West Press Pvt. Ltd.
2. "Shreve's Chemical Process Industries" by G.T.Austin, McGraw Hill Books

Reference Books:

1. " Encyclopedia of Chemical Technology" by R.E.Kirk & D.F.Othmer (Editors) 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:

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

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-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).

Text book:

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

Reference books:

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: Characterization, 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.

Text books:

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 Ceramic Raw Materials (Elective-I)

General geology and minerology: Formation of rocks, their characteristics, classification into igneous, sedimentary and metamorphic groups, formation of mineral deposits, physical and mineral characteristics of minerals – composition, color, streak, luster, fracture, cleavage, hardness, density and tenacity, elements of optical mineralogy.

Clays: Clay minerals, clay structure – kaolinite and montmorillonite groups, geology of clay deposits, their classification - china clay, ball clay, fire clay, building clay etc., beneficiation of clays, mica chlorite, illite group, talc, pyrophyllite, wollastonite group, chemical properties, physical properties.

Fluxes: Soda and potash feldspar, other feldspars, nephline syenite, geology of formation, physical and chemical properties, beneficiation.

Silica and silicate materials: Silica, polymorphic modification, silica structure, physical and chemical properties of silica, silicate chemistry, minerals, sillimanite, kyanite, and alusite, availability in India and their uses in ceramic industry.

Other raw materials: Geology of bauxite, magnesite, dolomite, chrome, limestone, rutile, zircon, beryllia minerals, alumina, carbides, nitrides, properties and uses.

Textbooks:

1. 'Fine Ceramics Technology and Applications' by F.H.Norton, McGraw Hill Publishers, New York,
2. 'Ceramic Raw Materials' by W.E.Worrall, Pergamon press, New York.

Reference books:

1. 'Forming Minerals' by W.A.Deer, R.A. Howie & J.Rock, Longman Publishers, London
2. 'Properties of Ceramic Raw Materials' by W.Ryan, Pergamon press, 2nd Edition
3. 'Clay Mineralogy' by M.J.Wilson, Chapman & Hall.

FE-01 Corrosion Engineering (Free Elective)

Introduction and scope: Corrosion definition, wet and dry corrosion, mechanism, electro-chemical principles and aspects of corrosion, Faradays laws, resistance, specific resistance, conductance, specific conductance, transport numbers, ionic mobility, corrosion rate expressions, calculation of corrosion rates, thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions,

Polarisation and corrosion potentials: References electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarizations, Tafel constant, Evans diagrams, anodic control, cathodic control, mixed control, Pourbaix-diagram for Fe-H_2O system,

Various forms of corrosion: Uniform attack, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching (dezincification), cavitation damage, fretting corrosion, erosion corrosion, and stress corrosion and remedial measures,

Prevention techniques: Modification of the material by alloying, appropriate heat treatment, chemical and mechanical methods of surface treatment, metallic, non-metallic linings, inhibitors, passivity, cathodic protection and anodic protection.

Text books:

1.'Corrosion Engineering' by Mars G. Fortana, Tata McGraw Hill Publishing Company, New Delhi
2.'Corosion and Corrosion Control' by H.H.Uhllg, John Wiley & Sons Inc., America

Reference books:

1.'Electrochemistry' by Samuel Glasstone, Litton Educational Publishing Company
2.'Electrochemistry, Principles & Applications' by Edmond C.Potter, Cleaver Hume Press Limited

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.

III/IV B.Tech. (Chemical Engineering) Second semester
(Effective from the admitted batch of 2009-10)

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 book:

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 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 Company

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 M.Gopala Rao & Marshall Sitting, Affilated East West Press Pvt.Ltd.

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

Reference book:

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

CHE – 325 Chemical Reaction Engineering – I
(Effective from the admitted batch of 2011-12)

Introduction and overview of chemical reaction engineering – Variables affecting a chemical reaction – Kinetics of homogeneous reactions – Concentration dependent term of rate equation – Elementary and nonelementary reactions – Temperature dependent term – Arrhenius law, activation energy, collision theory, transition state theory Searching for a mechanism.

Interpretation of batch reactor data – Methods of analysis, integral, differential and half life methods – Analysis of different types of reactions, irreversible and reversible – Variable volume reactor.

Ideal reactors for a single reaction – Performance equations for batch, mixed flow and plug flow reactors – Space time, space velocity and mean residence time.

Design for single reactions – Size comparison of reactors – Multiple reactor systems – Recycle reactor.

Design for parallel reactions – Qualitative and quantitative discussion about product distribution.

Design for series reactions – Qualitative and quantitative discussion about product distribution.

Textbook:

1. "Chemical Reaction Engineering"., Levenspiel, O. 3rd Edition, John Wiley and Sons.

Reference Books:

1. "Chemical Engineering Kinetics"., Smith, J.M, 3rd Edition. McGraw Hill Inc.
2. "Elements of Chemical Reaction Engineering"., Fogler, H.S, 3rd Edition, Prentice Hall India Ltd.

ChE-326

Polymer Technology (Elective-II)

Introductory concepts and fundamentals: Definitions and concepts of plastics and polymers, comer, co-monomer, mesomer, co-polymer, functionality, visco-elasticity, Classification of polymers, methods of determining molecular weights of polymers-

(i) Methods based on colligative properties
(ii) Sedimentation velocity method
(iii) Sedimentation equilibrium method
(iv) Gel-chromatography method
(v) Light scattering analysis method
(vi) End-group analysis method

Natural polymers- brief study of rubber, shellac, rosin, cellulose, proteins, Lignin's,

Chemistry of polymerization: Elementary concepts of addition polymerization, condensation polymerization and co-polymerization, glass transition temperature of polymers, methods of determining Tg, degradation of polymers due to mechanical, hydrolytic, thermal and backbone effects,
Relation of the mechanical, thermal, electrical, physical and chemical properties with the structure of the polymer,

Methods of polymerization: Mass, solution, emulsion and suspension, role of the initiators, catalysts, inhibitors, solvents, fillers, reinforcing agents, stabilizers, plasticizers, lubricants, blowing agents, coupling agents, flame retardants, photo-degradants and bio-degradable on polymerization,

Methods of manufacture, properties and uses of the following addition products;
Polyethylene (LDPE and HDPE) , polypropylene, PVC and its copolymers, Polystyrene and its copolymers, acetals and PTFE (polytetraflouroethylene),

Methods of manufacture, properties and uses of the following condensation products: (i) Polyesters-PMMA, PET and ALKYO, (ii) PF-, UF- and MF-resins (iii) epoxy resins, polyurethanes and silicones,

Description of the following processing methods: (with the principles involved and equipments used) Mixing and compounding, extrusion, calendaring, laminating, moulding-compression, transfer, injection and blow moulding.

Text books:

1. `Plastic Materials' by J.A.Brydson, Newnes-Butterworths (London) 1989
2. `Textbook of Polymer Science', Billymeyer, F.W.Jr., 3rd edition, John Wiley & Sons,

Reference books:

1. 'Introduction to Plastics' by J.H.Briston and C.C. Gosselin, Newnes, London
2. 'Polymeric Materials' by C.C.Winding and G.D.Hiatt, McGraw-Hill Publishers

ChE-326
Computer Applications in Chemical Engineering (Elective-II)

Roots of algebraic and transcendental equations: Iteration methods, Regula-Falsi method, Newton Rapson method, roots of simultaneous sets of transcendental and algebraic equations,

System of linear equations and their solution by different techniques, numerical differential and integration, regression analysis, least squares and orthogonal polynomial approximation,

Numerical solution of ordinary differential equations,

Numerical solution of partial differential equations (simple case studies),

Application of the above techniques to problems of interest in Chemical Engineering.

Text book:

1. 'Digital computation for chemical engineers' by Leaon Lapidus, McGraw Hill Book Company

Reference books:

1. 'Applied Numerical Methods' by Camehanet, McGraw Hill Book Co.

2. 'Applied Numerical Methods with Personal Computers, by Constantinides, McGraw Hill Book Co, New York

ChE-326

Paper Technology (Elective-II)

History: Importance of paper industry, historical background of paper making, development of paper industry in India,

Different types and uses of paper: Different types and uses of papers and paper boards, composition, method of making different types of papers and boards,

Raw materials for paper making: Classification of fibres, characteristics and composition of some important vegetable fibers (hard woods, softwoods, bagasse, straws, rags and paper stock)

Preparation of raw materials: Wood preparation – pulp wood measurement, barking, chipping, screening and conveying of chips)

Pulping processes: Mechanical pulping, alkaline pulping (Soda and Kraft), sulfite pulping, semi-chemical pulping, recovery of cooking chemicals from spent cooking liquors,

Pulp bleaching: Bleaching agents, bleaching methods – single stage and multi stage bleaching,

Stock preparation: Beating and refining, sizing and loading (filling),

Manufacture of paper: Paper machines (Fourdrinier and Cylinder), making of paper – forming section, press section, dryer section, calendaring section,

Testing of different properties of pulp and paper: Testing and evaluation of pulp, various properties of pulp and paper and their testing.

Text books:

1. 'Handbook of Pulp and Paper Technology' by Kenneth W.Britt, Vols.I&II

2. 'Modern Pulp and Paper Making' edited by John B.Calkin

3. `Pulp and Paper: Science and Technology - Vols.I&II' by E.Libby, McGraw Hill Books Co.

4. 'Pulp and Paper Manufacture- Vols. I & II' by R.C.McDonald & Others, McGraw Hill Books Company.

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-326

Petroleum Refining (Elective-II)

Origin and formation of petroleum,
Reserves and deposits of the world,
Indian petroleum industry,
Composition of crudes,
Refinery products and test methods,
Evaluation of crudes,
Crude pretreatment,
Dehydration and desalting pipe still heater,
Atmospheric and vacuum distillation of crude oil,
Treatment of products, additives, blending of gasoline, treatment of gasoline, kerosene, lubes, lubricating oils and wax,
Thermal and catalytic cracking,
Hydrocracking and hydrotreating,
Coking,
Visbreaking,
Alkylation,
Isomerisation,
Polymerisation,
Asphalt and air blown asphalt.

Text books:

1.`Petroleum refining Engineering' by Nelson, McGraw Hill company
2.`Modern Petroleum Refining Processes' by B.K.B.Rao, Oxford, OBH Publishers

ChE-326

Computational Fluid Dynamics (Elective-II)

Numerical solution of ordinary differential equations: Initial value problems of first order, Runge-Kuta methods, linear multi-step and predictor-corrector methods, R-K method for two simultaneous first order equations,

Finite difference discretization of first and second derivatives: Implementation of finite difference equations, explicit and implicit methods, errors and stability analysis,

Selected examples for finite difference applications in heat conduction: Heat dissipation through a constant area fin, two-dimensional steady heat conduction in rectangular geometry, one dimensional transient heat conduction in a slab, Crank-Nicolson method, Thomas algorithm,

Fundamentals of fluid flow modeling: Upwind scheme, transportive property, second upwind differencing, hybrid scheme,

Solution of unsteady Navier-Stokes equations for incompressible flows: Staggered grid, introduction to MAC method, MAC formulation of momentum balance equation, pressure correction equation,

Introduction to SIMPLE method: One-dimensional convection, diffusion equation, formulation of flow problem, discretized continuity and momentum equations, pressure correction equation,

Concept of finite volume method: Regular finite volumes, discretization procedure for continuity equation.

Text Book:

1. 'Computational Fluid Flow and Heat Transfer' 2nd edition by K. Muralidharan and T. Sundararajan, Narosa Publishing House, New Delhi, 2003

Reference book:

1.'Computational Fluid Dynamics - The Basics and Applications' by John D. Anderson, Jr., McGraw-Hill Inc., New Delhi, 1995.

ChE-326 White ware and Heavy Clayware (Elective-II)

Claassification of whiteware products: Body formulation and properties, tableware, earthenware talc bodies, vitreous bodies, high alumina bodies, porcelain, bone china, sanitary ware, stoneware, majolica, terracotta, art ware, physical properties of mixtures, role of water.

Whiteware: Classification, body composition, white wares at home, construction, electrical appliances, industrial uses, manufacturing and properties.

Heavy clayware: Raw materials, methods of winning and handling, classification of building materials, manufacture of building bricks, hollow bricks and other bricks, roof tiles, paving tiles, sewer pipes.

Fine ceramics: Packing of two component system, porosity, effect of grain size, unfired porosity, experimental verifications, wet to dry contraction, unfired strength, permeability and casting rate, dry to fired contraction.

Tests and quality control: IS inspection, LOI, plasticity, strength, MOR, thermal shock resistance, abrasion resistance, porosity, acid and alkali resistance, chipping resistance, chemical analysis, electrical and thermal conductivity.

Text books:

1. 'Pottery Science: Materials, Processes and Products' by Allen Dinsdale, Ellis Horwood Ltd., New York,
2. 'Ceramic White Ware' by Sudhir Sen, Oxford & IBH Publishing Co., New Delhi

Reference book:

1. 'Industrial Ceramics' by F. Singer and S. Singer, Oxford & IBH Publishing Company,

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

Chemical Technology Laboratory

List of experiments:

A. Analysis of water:

1. Total solids, dissolved solids,pH
2. Chlorides and sulphates
3. Temporary, permanent and total hardness.

B. Analysis of oils:

4. Acid value
5. Iodine value
6. Saponification value

C. Miscellaneous analysis:

7. Analysis of coal: Proximate analysis
8. Analysis of lime: Estimation of acid insolubles, available lime and calcium carbonate
9. Analysis of bleaching powder: Estimation of chlorine content.
10. Analysis of starch/glucose: Estimation of total reducing sugars
11. Analysis of saw dust: Estimation of total cellulose and –cellulose

E. Miscellaneous preparations:

12. Preparation of soap
13. Preparation of copper pigment
14. Preparation of chrome yellow pigment
15. Preparation of phenol formaldehyde resin

ChE-328

Petroleum Engineering Laboratory (Elective-II)

List of experiments:

1. Evaluation and test methods for crude petroleum
2. Evaluation and test methods for products
3. ASTM distillation
4. TBP distillation
5. Flash and fire points
6. Viscosity index
7. Smoke point
8. Cloud and pour points
9. Carbon residue
10. Aniline point and diesel index
11. Drop point
12. Penetration number
13. Softening point
14. Water content and melting point
15. Demonstration experiments:
    Extraction in RDC column and catalytic reactors

ChE-328

Biotechnology Laboratory (Elective-II)

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

ChE-328 Ceramic Technology Laboratory (Elective-II)

List of experiments:

1. Preparation of ceramic slip in a pot mill
2. Determination of slip specific gravity
3. Determination of slip viscosity
4. Effect of water on viscosity of slip
5. Effect of deflocculant on viscosity of slip
6. Determination of residue in a slip
7. Plaster mould making
8. Making of solid slip cast article
9. Making of drain slip cast article
10. Biscuit firing

IV/IV B.Tech. (Chemical Engineering) First semester
(Effective from the admitted batch of 2009-10)

CHE–411 Transport Phenomena

PART-A

Momentum transport: Viscosity and the mechanism of momentum transport- i). Newton's law of viscosity, ii). Non-Newtonian fluids and iii). pressure and temperature dependence of viscosity,

Velocity distributions in laminar flow: i). Shell momentum balances boundary conditions, ii). flow of a falling film, iii). flow through a circular tube and iv). flow through an annulus,

The equations of change for isothermal systems: i). The equations of continuity, motion and mechanical energy in rectangular and curvilinear coordinates, ii). use of the equations of change to set up steady flow problems and iii). dimensional analysis of the equations of change,

Velocity distributions with more than one independent variable and unsteady viscous flow,

Velocity distributions in turbulent flow: i). Fluctuations and time-smoothed quantities, ii). time-smoothing of the equations of change for an incompressible fluid and iii). semiempirical expressions for the Reynolds stresses,

Interphase transport in isothermal systems: i) Definition of friction factors, ii). friction factors for flow in tubes and iii). friction factors for flow around spheres,

PART-B

Energy transport: Thermal conductivity and the mechanism of energy transport- i). Fourier's law of heat conduction and ii). temperature and pressure dependence of thermal conductivity in gases and liquids,

Temperature distributions in solids and in laminar flow: i) Shell energy balances-boundary conditions, ii). heat conduction with an electrical heat source, iii). heat conduction with a viscous heat source, iv). heat conduction through composite walls, v). forced convection and vi). free convection,

The equations of change for non-isothermal systems: i). The equation of energy in rectangular and curvilinear coordinates, ii). the equations of motion for forced and free convection in non-isothermal flow, iii). use of the equations of change to set up steady state heat transfer problems and iv). dimensional analysis of the equations of change,

Temperature distribution with more than one independent variable: Unsteady state heat conduction in solids,

Temperature distribution in turbulent flow: i). Temperature fluctuations and the time-smoothed temperature, ii). time smoothing the energy equation and iii). semi empirical expressions for the turbulent energy flux,

Interphase transport in non-isothermal systems: i). Definition of the heat transfer coefficient, ii). heat transfer coefficients for forced convection in tubes and around submerged objects and iii). heat transfer coefficients for free convection,

PART-C

Mass transport: Diffusivity and mechanism of mass transport- i). Definitions of concentrations, velocities and mass fluxes, ii). Fick's law of diffusion and iii). temperature and pressure dependence of mass diffusivity,

Concentration distribution in solids and in laminar flow: i). Shell mass balances – boundary conditions, ii). diffusion through a stagnant gas film, iii). diffusion with heterogeneous chemical reaction, iv). diffusion with homogeneous chemical reaction and v). diffusion into a falling liquid film,

The equations of change for multicomponent systems: i). The equations of continuity for a binary mixture, ii). the equations of continuity of A in curvilinear coordinates and iii). dimensional analysis of the equations of change for a binary isothermal fluid mixture,

Concentration distributions in turbulent flow: i).Concentration fluctuations and the time smoothed concentration and ii). time-smoothing of the equation of continuity of A,

Interphase transport in multicomponent systems: i). Definition of binary mass transfer coefficients in one phase, ii). correlations of binary masstransfer coefficients in one phase at low mass-transfer rates, iii). definition of binary mass-transfer coefficients in two phases at low mass-transfer rates and iv). definition of the transfer coefficients for high mass transfer rates.

Text book:

1. 'Transport Phenomena' by R. Byron Bird, W.E. Steward and Edwin N. Lightfoot, John Wiley & Sons Inc., New York

Reference books:

1. 'Transport phenomena' by Robert S. Brodkey & Haryr C. Hershey, McGraw Hills Company, New Yark
2. 'Transport Phenomena-for engineers' byLouis Theodore, International Book Compnay, London
3. 'Transport Phenomena' by W.J.Book and K.M.K.Multzall, JW&Sons Ltd.
4. 'Fundamentals of Momentum, Heat and Mass Transfer' by Mames R Welty, Charlese Wicks and Robert E Wilson, J W & Sons Inc., New York
5. 'Fluid Dynamics and Heat Transfer' by James G. Knudsen and Donald L.Katz., McGraw Hills Company Inc., New York.

CHE–412 Chemical Engineering Mathematics

Mathematical formulation of the physical problems: i). Application of the law of conservation of mass, salt accumulation in stirred tank, starting an equilibrium still, solvent extraction in N stages, diffusion with chemical reaction and ii). application of the law of conservation of energy, radial heat transfer through a cylindrical conductor, heating a closed kettle, flow of heat from fin,

Analytical (explicit) solution of ordinary differential equations encountered in Chemical engineering problems: i). First order differential equations, method of separation of variables, equations solved by integration factors, certain examples involving mass and energy balances and reaction kinetics and ii). second order differential equations, non-linear equations, linear equations, simultaneous diffusion and chemical reaction in a tubular reactor, continuous hydrolysis of tallow in a spray column,

Partial differential equations: i). Formulation of partial differential equations, unsteady-state heat conduction in one dimension, mass transfer with axial symmetry, continuity equation, ii). boundary conditions- function specified, derivative specified and mixed conditions and iii). particular solutions of partial differential equation-compounding the independent variable into one variable, superposition of solutions, the method of images and particular solution suggested by the boundary conditions,

Finite differences: i). The difference operator, properties of the difference operator, difference tables, other difference operators, ii). linear finite difference equation, complementary solution, particular solution, simultaneous linear difference equations and iii). non-linear finite difference equations, analytical solutions,

Solutions for the following type of problems by finite difference method: a). Calculation of the number of plates required for an absorption column, b). calculation of the number of theoretical plates required for distillation column and c). calculation of number of stages required for a counter current extraction and leaching operation,

Application of statistical methods: i). Propagation of errors of experimental data, ii). parameter estimation of algebraic equations encountered in heat and mass transfer, kinetics and thermodynamics by method of averages, linear least squares and weighted linear least squares methods and iii). design of experiments - factorial and fractional factorial methods.

Text book:

1. 'Mathematical Methods in Chemical Engineering' by V.G.Jenson and G.V.Jeffreys, Academic Press, London

Reference books:

1. 'Applied Mathematics in Chemical Engineering' by Harold S. Mickley, Thomas S. Sherwood and Charles E. Reed, Tata McGraw Hill Publications
2. 'Applied Statistics' 2nd edition by Volk, W., McGraw Hill Chemical Engg. series
3. 'Applied Numerical Methods with Personal Computers, by Alkis Constantinides,S., McGraw Hills, Chemical Engineering series, 1987

CHE–413 Chemical Reaction Engineering – II
(Effective from the admitted batch of 2011-12)

Temperature and pressure effects – Heats of reaction and temperature – Equilibrium constants from thermodynamics – Equilibrium conversion – General graphical design procedure – Optimum temperature progression – Adiabatic operations.

Non ideal flow – Basics – C,E and F curves – Conversion in non ideal flow reactors – Dispersion model – Tanks-in-series model.

Heterogeneous catalysis – Physical adsorption – Chemisorption – Catalytic properties – Estimation of surface area, pore volume and porosity – Catalyst preparation – Catalyst poisons – Catalytic deactivation.

Solid catalysed reactions – Rate equations – Pore diffusion combined with surface kinetics – Thiele modulus – Effectiveness factor – Performance equations for reactions containing porous catalyst particles – Experimental methods for finding rates – Determining controlling resistances.

Noncatalytic systems – Design of fluid-fluid reactors – Factors to consider in selecting a contractor – Various contractors and contacting patterns for G/L reactions.

Design of fluid particle reactions – Progressive Conversion Model (PCM), Shrinking Core Model (SCM) – Comparison – Controlling mechanisms – Determination of rate controlling step.

Text book:

1. 'Chemical Reaction Engineering' Levenspiel O, 3rd Edition, John Wiley & Sons.

Reference books:

1. "Chemical Engineering Kinetics' by Smith, J.M. 3rd Edition, McGraw Hill Inc.
2. "Elements of Chemical Reaction Engineering" by Fogler, H.S, 3rd Edition, Printice Hall India Ltd.

CHE–414 Industrial Management

Management: Functions of management - Planning, organizing, staffing, directing controlling and coordinating, levels of management, role of Manager, skills of manager, pioneers in management–F.W.Taylors scientific management and Henry Fayol's principles of management,

Organization: Meaning of organization, principles of organization, organization structure, types of organization structures - line organization structure, line and staff organization structure, functional organization structure, committee organization structure and matrix organization structure,

Forms of business organizations: Salient features of sole proprietorship, partnership, joint stock company, private limited company and public limited company, government enterprises and co-operative societies,

Production operations management: Production **p**lanning and control, **p**lant location and factors affecting plant location, plant layout and types of layout, line or product layout, process or functional layout, fixed position layout and combination layout, work study and method study,

Human resources management: Basic functions of human resource management: Man power planning, recruitment, selection, training, development, placement, compensation and performance appraisal.

Text books:

1. 'Industrial Organization & Engineering Economics' by S.C.Sharma & T.R.Banga, . Khanna Publishers, Delhi
2. **'**Management Science' by A.R.Aryasri**,** Tata McGraw Hill, Publishers, New Delhi

Reference book:

1. 'Industrial Engineering and Management' by O.P.Khanna, Dhanpat Raj and Sons.

CHE–415 Process Dynamics and Control

Linear Open loop systems: Simple first order and second order systems, physical examples of first and second order systems, response of first order systems in series, transportation lag,

Linear closed loop systems : The control systems, controllers , final control element, block diagram of chemical reactor control systems, closed loop transfer functions , transient response of simple control systems,

Stability: Stability, root locus, frequency response, control system design by frequency response, Bode diagram, Bode stability criteria,

Analysis and design of feed –back control systems : Concept of feed back control, types of feed- back controllers, measuring devices, final control elements, dynamic behavior of feed-back control process, block diagram and closed loop response, effect of P.I. & D control action on the response of a controlled process,

Analysis and design of control systems: Cascade control, feed forward control, ratio control,

Introduction to process applications: Controller tunings, controller mechanisms, control valves,

Text book:

1. 'Process Analysis and Control' 2nd edition by Donald R.Coughnowr, McGraw Hills

Reference books:

1. 'Chemical Process Control- An Introduction to Theory and Practice' by G.Stephanopoulas, Prentice Hall of India Pvt. Ltd., New Delhi

2. 'Computer Control of Industrial Processes' by E.S.Savas, McGraw Hill,London

3. 'Handbook of Instrumentation and Control' by Considine

4. 'Process Modeling Simulation and Control for Chemical Engineers' by Lubin

5. 'Industrial Instrumentation' by Donald P. Eckmen, Wiley Eastern Limited.

CHE–416 Fluidization Engineering (Elective-III)

Introduction: Phenomena of fluidization, liquid like behavior of fluidized beds, advantages and disadvantages of fluidized beds, different types of fluidized beds, applications of fluidization technique in process industries,

Fixed Bed: Derivation of fixed bed pressure drop equation from fundamental characteristics – Kozeny–Carman equation and Ergun equation, effects of - particle size, sphericity, vesicularity, wall effect, surface roughness and voidage on fixed bed pressure drop.

Minimum fluidization: Derivation for minimum fluidization mass velocity and pressure drop equation for minimum fluidization,

Fluidization: Types of fluidization– batch, continuous and semi fluidizations, classifications based on particle diameter and movement, pressure drop-flow diagrams for fluidized bed, slugging bed and channeling bed, effects of L/d, fluid distributors, mode of fluidization, power consumption and pumping requirements, hindered and free settlings, stratification, voidage function, fluidization efficiency, fluctuation ratio,

Liquid fluidized beds: Rechardson and Zaki correlation,

Bubbles in dense beds: Single rising bubble, two dimensional Davidson model, stream of bubbles from single source, bubble volume and frequency, bubbles in ordinary bubbling beds and bubbling bed model for the bubble phase,

Emulsion phase in dense bubbling beds: Movement of individual particles, turn over rate of solids, residence time distribution, diffusion model and bubbling bed model,

Terminal velocity: Derivation for terminal velocity,

Entertainment and Elutriation: Definitions, transport disengaging height (TDH), entrainment at or above TDH for single size and size distribution of solids, entrainment below TDH, effects of various parameters, entrainment for an infinite free board and a small free board, parameters effecting elutriation, elutriation rate equation, elutriation of fines,

Flow of high bulk density and low bulk density mixtures: Pressure drops in stick-slip flow and aerated flow and related equations, downward discharge from a vertical pipe, flow in a horizontal pipe, saltation velocity, choking velocity, pressure drop in pneumatic conveying, pressure drop in bends and cyclones in fluidization bed reactors,

Spouted bed: Definition, pressure drop-flow diagram, minimum spouting correlation and effect of various parameters on spouting,

Heat and mass transfer in fluidized beds: Variables affecting heat transfer rate, heat transfer at the wall of containing vessel, heat transfer to immersed tubes, models proposed by i) Wicke-Fetting, ii)Mickley and Fair Banks and iii) Levenspiel and Walton, heat transfer in fixed and fluidized beds, definition and evaluation of mass transfer coefficient.

Text books:

1. `Fluidization Engineering' by Diazo Kunii,and Ocatve Levenspiel (Chapters1,2,3,4,5,6,7,8,9,10 and 12).
2. `Fluidization' by Max Leva (Chapters 2,3,4,5and 7).

CHE–416 Computer Aided Design (Elective-III)

CAD of fluid flow system: Flow of Newtonian fluids in pipes, pressure drop in compressible flow, flow of non-Newtonian fluids in pipes, pipe network calculations, two phase flow system,

CAD of heat transfer equipment: Shell and tube exchangers without phase change, condensers, reboilers, furnaces,

CAD of mass transfer equipment: Distillation, gas absorption, liquid extraction,

CAD of chemical reactors: Chemical reaction equilibrium, analysis of rate data, ideal reactor models, non-ideality in chemical reaction, performance analysis using residence time distribution, temperature effects in homogeneous reactors, heterogeneous systems and fluidized bed reactors.

Text book:

1. 'Chemical Process Computation' by Raghu Raman, Elsevier Scientific Publications,

Reference books:

1. 'Fundamentals and Modelling of Seperation Process' by C.D.Holland, Prentice Hall Inc., New Jercey
2. 'Catalytic Reactor Design' by Orhan Tarhan, Mc Graw hills Ltd.
3. 'Chemical Engineering' Volume-6, by Sinnot, Pergamon Press, 1993.

CHE–416 Multi component Separation Processes (Elective-III)

Multi component vapor –liquid equilibria: Ideal mixtures at low pressures, non-ideal mixtures, activity coefficient models - Wilson, NRTL, UNIQUAC and UNIFAC equations, evaluation of model constants from binary experimental data, prediction of multicomponenet VLE from the model constants of the constituent binaries,

High pressure equilibria: Vaporization constants, K, Thermodynamic method for K, graphical charts, chao-Seader correlation,

Equilibrium and Simple Distillation: Multicomponent equilibrium, flash vaporization(EFV), multicomponent differential distillation,

Design considerations in fractionating process: Quantitative relationships, temary and multicomponent system fractionation, key fractionation concepts, selecton of key components, column pressure, material balance, rigorous and approximate minimum reflux calculations, recommended short-cut methods for minimum reflux minimum plates at total reflux, FUG methods, Smith Brinkley method,

Multicomponent fractionation rigorous design procedures: Sorel method, Lewi Metheson method, Thiele-Geddes method and its versions in distillation column design, techniques of separating azeotropic and close boiling mixtures by fractional distillation, azeotropic and extractive distillation, selection of solvents, design considerations, pseudo binary methods, solvent recovery,

Tray design and operation: The common tray types, tray capacity limits, tray hydraulics parameters, flow regies on trays, column sizing, tray efficiency, fundamentals, tray efficiency prediction,

Packing design and operation: Packing types, packing hydraulics, comparing packings and trays, packing efficiency and scale-up.

Text books:

1. 'Distillation' by M.Van Winkle, McGraw Hill Book Company
2. 'Phase Equilibria in Chemical Engineering' by S.M.Wales, Butterworth publishers, 1985
3. 'Distillation Design' by Henery Z Kister, McGraw Hill Book Company

CHE-416 Biochemical Engineering (Elective-III)

Introduction to Biochemical engineering and Biotechnology: Overall view of biotechnology since its practice–to date, enzyme kinetics, derivation of M.M. equation of single as well as multiple substrates, enzyme inhibition, determination of M.M. parameters, industrial applications of enzymes,

Cell cultivation & kinetics: Microbial, animal and plant cell cultivation, cell immobilization, batch growth of cells, yield coefficient, monod growth kinetics,

Analysis and design of fermenters: Batch fermenter, mixed flow fermenter (chemostat), plug flow fermenter, mixed flow fermenters in series, and cell recycling,

Genetic engineering: DNA and RNA, cloning of genes, stability of recombinant microorganisms, gene manipulation,

Sterilization: Sterilization of media and air, thermal death kinetics, design criterion, continuous sterilization methods,

Aeration and agitation in fermenters: Correlations of mass transfer coefficient, measurement of interfacial area and gas holdup, power consumption, scale up concepts,

Bioanalytical techniques: Gas chromatography, thin layer and paper chromatography, HPLC, affinity, gel, adsorption and ion exchange chromatography.

Text book:

1. 'Biochemical Engineering Fundamentals' 2nd edition by J.E.Bailey and D.F.Ollis, McGraw-Hill Publishers, Newyork, 1986

Reference books:

1. 'Chemical Engineering' volume-3, 3rd Edition by J.F Richardson and D.G. peacock, (Chapter-5: Biochemical Reaction Engineering), Pergomon Press, U.K, 1994
2. 'Bioprocess Engineering: Basic Concepts' 2nd edition by M.L.Shuler and F.Kargi, Prentice Hall India, New Delhi, 2003
3. 'Biochemical engineering' by D.G. Rao, Tata McGraw-Hill Publishers, New Delhi,
4. 'Biochemical Engineering' by J.M. Lee, Prentice Hall, Englewood Clifts, 1992.

CHE-416 Reservoir Engineering (Elective-III)

Fundamental concepts of Reservoir Engineering: Possibility, fluid saturation, permeability, flow through layered beds, flow through series beds, Klinkenberg effect, effective permeability data, phase behaviour,

Oil reservoirs: Reservoir driving mechanisms, basic equation and tools, volatile oil reservoirs, identification of volatile oil reservoirs, ultimate recovery, predicting reservoirs behavior, performance, mechanics of reservoir performance, prediction procedure, limitations of predictions, relating reservoir performance to time, factors affecting ultimate recovery, analysis gas oil ratio history,

Water drive reservoirs: Effect of free gas saturation on recovery, predicting reservoirs performance, calculating water influx, use of the unsteady state equation in predicting reservoir performance, validity of performance prediction, limitations in predicting reservoir performance, the material balance equation as a straight line,

Gravity drainage reservoirs: Permeability in the direction dip, dip of the reservoir, reservoir producing rates, oil viscosity, relative permeability characteristics, fundamental recovery process, predicting reservoir performance, apparent relative permeability, oil saturation method,

Combination of drive reservoirs: Index of drives, equations used, material balance equations, instantaneous gas oil ratio equation,

Pressure maintenance: Pressure maintenance by gas injection, condensing gas drive, predicting performance by gas injected gas drive index, pressure maintenance by water injection, predicting performance by water injection, index of injected water drive, control of the gas cap, typical water injection pressure maintenance operations,

Improving oil recovery: Improving oil recovery by fluid immiscible gas–water, miscible fluid injection thermal oil recovery, predicting recovery from fluid injection products, Stiles's method of water flood prediction, derivation of water out and recovery equations, frontal advance techniques for prediction result of either water or gas injection, well arrangements, peripheral water flooding, predicting behavior of peripheral water floods, special consideration involved in water flooding, water flood case history, predicting the results of water flooding.

Text book:

1. 'Reservoir Engineering Manual' – 2nd Edition by Frank W. Cole, Gulf Publishing Company, Houstan, Texas, 1969.

CHE–416 Industrial Pollution and Control Engineering (Elective-III)

Types of emission from chemical industries and their effects on environment, Environmental legislation, noise pollution, occupational health hazards, meteriological factors in pollution dispersion (ALP and ELP), plume behaviour and characteristics, chimney design considerations: Plume raise, effective stack height,

Methods of analysis of air pollutants, particulate matter, SO_x, NO_x, CO_x analysis, removal of particulate matters: principles and design of setting chambers, solid traps, cyclone separators, fabric and design of fibre filters, scrubbers and electrostatic precipitators,

General methods of control and removal of sulphur dioxide, oxides of nitrogen, organic vapors from gaseous effluents with design aspects, sources of waste waters, effluent guidelines and standards, characterization of effluent streams, oxygen demanding wastes, oxygen sag curve, BOD curve, analysis of water pollutants,

Methods of primary treatment: Screening, sedimentation, floatation and neutralization, biological treatment, bacteria and bacterial growth curve, aerobic processes suspended growth processes, activated sludge process, extended aeration, contact stabilization, aerated lagoons and stabilization ponds, attached growth process with design aspects, trickling filters, rotary drum filters, fluidized bed contactors, anaerobic processes,

Methods of tertiary treatment: Carbon adsorption, ion exchange, reverse osmosis, ultra filtration, chlorination, ozonation & sonozone process, sludge treatment and disposal,

Solid waste management: solid waste collection, transportation, solid waste processing and recovery, hazards in waste management, risk assessment and safety measures, types of hazardous wastes, health effects, safety measures, risk assessment response measures, case studies or pollutants removal and safety measures in fertilizer, petrochemical, paper, pharmaceutical industries and petroleum refinery,

Industrial safety: Why safety, accidents, causes and remedial measures, safety aspects of site selection, plant layout and unit plot planning, hazards of commercial chemical operations and reactions, safety aspects of process design, instrumentation for safe operations, safety aspects in design and inspection of pressure vessels, effect of toxic agents, toxicity vs hazards, respiratory hazards, safe experimentation and testing of reactions, materials for safety,

Flamable materials: Fire extinguishing agents and their applications, eye safety in chemical processing, personnel protective equipment, permit systems, hazard evaluation techniques, modern safety management systems, safety effectiveness.

Text books:

1. 'Environmental Pollution Control', by C.S. Rao, Wiley Eastern Limited
2. 'Safety and Accident Prevention in Chemical Operations' by Fawcett and Wood

Reference books:

1. 'Environmental Engineering' by Arcdio P.Sincero and Geogoria Sincero
2. 'Loss Prevention in Chemical Industries' by Frank P.Lees

ChE-416 Fuels, Refractories and Furnaces (Elective-III)

Part-A

Wood, charcoal and coal characteristics, formation of coal, grading of coal, handling of storage of coal, coal washing, hardness and grindability of coal, calorific value, manufacture of coal, coal analysis.

Origin and composition of natural oil, refining process of liquid petroleum products, synthetic liquid products, calorific values, storage and handling liquid fuels, natural gas – composition and calorific values, liquefied petroleum gas, oil gas, coal gas, air requirement, combustion process of solid, liquid and gaseous fuels, control of combustion process, testing of fuels.

Part-B

Silica refractories: Raw materials and composition, manufacturing process steps, quality of raw materials and process parameter on quartz inversion, glassy phase and other micro structural features, porosity, strength, RUL dependence on micro structure, specifications of silica refractories.

Alumina – silica refractories: Al_2O_3–SiO_2 phase diagram, clay, pyrophyllite, sillimanite, grog, bauxite and diaspore as raw materials, manufacturing processes, micro structure and properties.

Basic refractories: Magnesite, forsterite, dolomite and chrome based refractories, raw materials and composition, manufacturing processes, micro structure and properties.

Special refractories: Oxide based, carbide based and nitride based refractories, cordierite, zirconia, carbon, fusion cast refractories, slide gate, purging refractories and continuous casting refractories, ceramic fibres.

Part-C

Kiln accessories: Equipment for solid fuel combustion, types and classification of burners used for liquid and gaseous fuels, nature of flames – laminar, turbulent, premixed and diffusion flames, burning velocity.

Furnace design: Factors for consideration, draught establishment, natural/induced draught, measurement of draught, chimney calculation, heat transfer in kilns, safety aspects, types of refractories and insulating material used in furnaces.

Kilns and furnaces: Classification of kilns: open top kiln, up draught kilns, down draught kilns, bottle kilns, muffle kilns, chamber kilns, Hoffman's kiln, tunnel kilns, rotary kilns, glass tank furnace, blast furnace, open hearth furnaces.

Text books:

1. 'Raw Materials for the Refractory Industries and Industry Materials and Consumer Survey' by M.Coop and E. M. Piekson
2. 'Combustion Engineering and Fuel Technology' by A.K.Shah, Oxford& IBH Publishing Company, New Delhi
3. 'Elements of Fuels, Furnaces & Refractories' by Om Prakash Guptha, Khanna Publishers.

Reference books:

1. 'Fuels & Fuel Technology'. by Wilfrid Francis & Matin C. Peter, Pergamon Press
2. 'Fuels & Combustion', by Samir Sarkar, 2nd edition, Orient Longman, Bombay' 1990
3 'Fuels, Furnaces & Refractories', by J.D. Gillchrist, Pergamon Press, NY, 1977
4 'Kiln's Design, Construction and Operation', by Daneil Rhodes, Chilton Book Company, Pennsylvania, 1974.

CHE–417 Chemical Reaction Engineering Laboratory

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) differential method and (b) integral method
2. Determination of the activation energy of a reaction using a batch reactor
3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR
4. To determine the specific reaction rate constant of a reaction of a known order using a batch reaction.
5. To determine the order of the reaction and the rate constant using a tubular reactor
6. Determination of RTD and dispersion number in a tubular reactor using a tracer
7. Mass transfer with chemical reaction (solid-liquid system) – Determination of mass transfer coefficient
8. Axial mixing in a packed bed - Determination of RTD and the dispersion number for a packed bed using tracer
9. Langmuir adsorption isotherm - Determination of surface area of activated charcoal.
10. Performance of reactors in series: (i) A plug flow reactor followed by a CSTR and (ii) A CSTR followed by a plug flow reactor.

CHE-418 Process Dynamics and Control Laboratory

1. Response of mercury-in glass thermometer
2. Response of mercury-in glass thermometer with thermal well.
3. Calibration & response of resistance thermometer
4. Response of manometer
5. Calibration of thermocouples
6. Response of single-tank liquid level system
7. Response of two-tank non-interacting liquid level system
8. Response of two tank interacting liquid level system
9. Study of on-off control – Control let off position.
10. Valve characteristics of equal % control valve
11. Valve characteristics of linear control valve
12. On-off control – controller on position
13. Studies on hysteresis characteristics of Bourdon pressure gauze
14. Hysteresis characteristics of equal % control valve
15. Studies on hysteresis characteristics of linear control valve
16. Response studies for different types of controller (P, PI, PID) using PID control trainer.
17. Level control trainer
18. Pressure control trainer
19. Temperature control trainer

CHE-419 Seminar

CHE-420 Viva-voce on Industrial Training Report

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

CHE-421 Chemical Process Equipment Design

Introduction of plant design and costs,

Process design development: Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design, comparison of different processes, firm process design, equipment design and specialization, scale up in design, safety factors specifications, materials of construction,

General design considerations: Health and safety hazards, fire and explosion hazards, personnel safety, loss prevention, thermal pollution control, noise pollution and control, plant location, plant layout, plant operation and control, utilities, structural design, storage, materials handling, materials and fabrication selection.

Material transfer, handling and treatment equipment design and costs: Incompressible fluid flow systems design, flow through parallel, series and piping network systems, compressible fluid flow systems design, design and cost estimation of filters.

Mechanical design of process equipment: Design and selection of storage vessels and low pressure vessels, design of roofs, bottom plates, formed heads, flat plate and conical closures, tall vertical columns, supports to process vessels, distillation columns, heat exchanges, evaporators.

Heat transfer equipment design and costs: Heat exchangers for sensible heat exchange - double pipe, shell and tube, plate heat exchangers, heat exchangers with extended surface, optimum heat exchanger design, heat exchangers with phase change – single effect evaporators, multiple effect evaporators, vapor recompression evaporators, condensers – condensation of single vapors, condensation with boiling range, reboilers.

Mass transfer equipment design: Continuous distillation- design for binary systems and pseudo binary systems for multi component distillation, plate efficiencies, entrainment, approximate column sizing, selection of plate type, plate construction, plate hydraulic design, plate design procedure, plate areas, diameters, liquid flow arrangements, entrainment, weep point weir dimensions, perforated area, hole size, hole pitch, hydraulic gradient, liquid flow, plate pressure drop, down comer design, packed columns - choice of plate or packing, types of packing, packed bed height, prediction of height of transfer unit (HTU) liquid distribution, stimulation of pressure drop in packed towers, allowable velocities, column diameter, column internals, wetting rates, reactor design, equations for reactor design application - batch reactor, tubular flow reactor, back mix reactors expression of reaction rates mechanical features of reactor design.

Text books:

1. 'Plant design & Economics for Chemical Engineers', 4th edition, M.S.Peters & K.D.Timmerhaus, Mc Graw Hills Publishing Company
2. 'Process Equipment Design', 3rd Edition, M.V.Joshi, MacMillan India Ltd 1981

Reference books:

1. 'Process-Plant-Design' by J.R.Backhurst & J.H.Harker, Heieman Education London
2. 'Chemical Engineering' Volume-VI (An introduction to Chemical Engineering Design' by J.M.Coulson & J.F.Richardon

CHE-422 Process Optimization (Elective-IV)

Monotonic function, unimodal function, stochastic process, deterministic process, convex and concave sets, feasible and infeasible regions, state and control variables, Lagrange multipliers, saddle point, sensitivity analysis, iterative rule, slake variable principle of optimality, design constraints, constraint surface, objective function, classification of optimization problems, basic and non-basic variables, functions of one variables, methods based on interval of uncertainty, sequential search methods, quadratic interpolation, qubic interpolation, regular Falsi technique,

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Non–linear programming, unconstrained optimization techniques, univarient methods, functions of several variables, alternate variable search method, exploratory and pattern moves method, conjugate gradient method, quasi Newton methods, variable metric method, Powell's method, Newton-Raphson method,

Constrained optima, pivot operation, linear programming, simplex method, revised simplex method, dual relations, dual simplex method, decomposition principle, changes in the right hand side constraints, changes in the cost coefficients, addition of constraints, Kuhn Tucker conditions,

Polynomial: Solution of an unconstrained geometric programming problem, solution of a constrained geometric programming problem, dynamic programming, multi-stage optimization, stochastic dynamic programming, integer linear programming, integer non-linear programming, network problems, CPM and PERT methods, transportation problems.

Text books:

1.'Optimisation Theory and Applications' by S.S.Rao, 2nd edition, Wiley Eastern Limited
2. 'Optimisation Techniques for Chemical Engineers' by Asghar Hussain and Kota Gangiah
3. 'Formulation and Optimisation of Mathematical Models' by C.L.Smith, R.W.Pike and P.W.Mur
4. 'Optimization of Chemical Process' by Edgar and Himmelblau, 2nd Edition, McGraw Hill Publications.

CHE-422 Process Modeling and Simulation (Elective –IV)

Mathematical models for chemical engineering systems: Introduction, use of mathematical models, scope of coverage, principles of formation, fundamental laws, continuity equation, energy equation, equations of motions, transport equations, equations of state, equilibrium, chemical kinetics,

Examples of mathematical models of chemical engineering systems: Introduction, series of isothermal, constant hold up CSTRs, CSTRs with variable hold-ups, two heated tanks, gas phase pressurized CSTR, non-isothermal CSTR, single component vaporizer, multi-component flash drum, batch reactor, reactor with mass transfer, ideal binary distillation, batch distillation with holdup, pH systems,

General concepts of simulation for process design: Introduction, process simulation models, methods for solving non-linear equations, recycle partitioning and tearing, simulation examples,

Computer simulation: Simulation examples, gravity flow tank, three CSTRs in series, non-isothermal CSTR, binary distillation column, multi-component distillation column, batch reactor.

Text books:

1. 'Process Modeling Simulation and Control for Chemical Engineers', 2nd edition, by W.L.Luyben, McGraw Hill Publishers
2. 'Process Flow Sheeting' by A.W.Westerberg, H.P.Hutchison, R.L.Motard and P.Winter, Cambridge University Press, 1985

Reference books:

1. 'Process Dynamics: Modelling, Analysis and Simulation', by B.W.Bequette, Prentice Hall
2. 'Computational Methods for Process Simulation', by W.Fred Ramirez (Betterworthus Series in Chemical Engineering)

CHE-422 Ceramic Science and Phase Equilibria in Ceramics (Elective –IV)

Mechanical Properties of Finished ware: Stress, strain, Young's modulus, critical stain, strength, porosity, effects of grain size on strength , fillers, higher Young's modulus, glazing – principal reason, stress in glaze and body due to thermal expansion difference, variation of modulus of rupture with temperature, impact strength, edge chipping,

Thermal Properties: Specific heat capacity, thermal expansion, thermal conductivity, thermal diffusivity, thermal shock resistance, effect of temperature difference on firing the body, critical strain,

Optical Properties: Basic relationship, loss of intensity, scattering of light by a spherical bubble, boundary reflectance and surface gloss, opacity and translucency, absorption and colour, applications,

Electrical Properties and Magnetic Properties: Definitions – resistivity, composition of bodies, insulators, electronic conduction, variation of resistivity with temperature, Rasch-Hinrichsen equation, effect of porosity, moisture and frequency, dielectric strength, permittivity, dielectric loss, low thermal expansion bodies, conducting glazes, Susceptibility, permeability, flux density, types of magnetism and their origin, electronic structure and magnetic moment, spinal structure and ferro magnetism, exchange interaction and super exchange interaction, hysterisis loop and magnetic domain, domain structure,

Binary Phase Diagrams: Lever rule, complete solubility, eutectic and pritectic reactions, partial solid solubility, congruent and incongruent melting compounds, liquid immiscibility, binary diagrams – SiO_2 – Al_2O_3, SiO_2 - Na_2O, MgO - Al_2O_3, SiO_2 – ZrO_2, different types, lever rule and crystallization paths, ternary diagrams - Na_2O - SiO_2 - Al_2O_3, K_2O – SiO_2 –Al_2O_3, MgO – Al_2O_3, CaO – Al_2O_3 – SiO_2, diffusion controlled and diffusion less transformation, nucleation and growth, concept of critical nucleus size and critical free energy, effect of surface energy, free energies of homogeneous and heterogeneous nucleation, kinetics of nucleation, growth and overall transformation, devitrification of glass, single crystal growth, atomistic mechanism and kinetics of spinoidal decomposition.

Text books:

1. 'Fundamentals of Ceramics ' by M.W. Barsoum, McGraw Hill Publishers
2. 'Introduction to Ceramics' by W.D.Kingery, H.K.Bowen and D.R.Uhlmann, John Weily & Sons, 1991
3. 'Phase Eqilibiria in Ceramics Systems' by Floyd, A, Hanmel, Marcel Dekker, 1984.
4. 'Physical Ceramics Principles for Ceramic Sciences & Engineering' by W.D.Kingery, John Weily & Sons, 1997.

Reference books:

1. 'Pottery Science, Materials, Process & Products' by Allen Dinsadle, Ellis Harwood Ltd, NY, 1986
2. 'Fundamental of Ceramics' by M.W. Barsoum, McGraw Hill Publishers, 1997
3. 'Electro Ceramics' by A. J. Moulson and H. M. Herbert, Chapman Hall, London, 1990
4. 'Ceramic Materials for Electronics' by R.C. Buchanan, Marcel Dekker Inc, NY, 1991

CHE-422 Artificial Intelligence in Process Engineering (Elective –IV)

Intorduction-History and relation of artificial intelligence (AI) to process engineering;

Knowledge representation I- Predicate calculus and semantic networks, search-forward / backward. depth / breadth/ best - first search, production systems, History, components,

Knowledge representation II - Frames, objects, inexact reasoning - introduction, blackboard architecture, expert systems, applications to industry's programming languages, expert system shells,

Neural nets - introduction and application to process engineering.

Text books:

1. "Problem Solving Methods in Artificial Intelligence", by N.L.Nilsson, McGraw Hill Publishers, 1971
2. "Artificial Intelligence in Chemical Engineering", by T.E.Quantrille and Y.A.Liu, Academic Press, 1991
3. "Introduction to Artificial Neural Systems", by J.Zuarda,West Pub. Company, St.Paul, MN, 1992

Reference book:

1."Intelligent Systems in Process Engineering", by J.F.Davis, G.Stephanopoulos and V.Venkatasubramanian, ALChE Symposium Series, Volume 92, 1996.

CHE-422 Natural Gas Engineering (Elective-IV)

Properties of Natural gas and volatile hydrocarbon liquids: The equation of state, the gas law, compressibility factor, average molecular weight and gas gravity, thermal conductivity, Surface tension, heat capacity, latent heat, heating value, viscosity, gas and liquid diffusion coefficients,

Water – Hydrocarbon systems: Water vapor, hydrate formation, prevention of hydrate formation, solubility of natural gas in water, solubility of water in natural gas,

Flow and compression calculations: Flow equation, calculation of static bottom – hole pressure in gas wells, friction in pipe, pipe wise flow calculations, flow in natural gas wells, **Gas flow measurements:** Measurement by orifice meter, pitot tube, choke nipple, volumetric meters,

Field separation of natural gas: Field separation, separation of condensate fluids, expansion, refrigeration systems, absorption and stripping,

Low temperature processing: Phase behavior, low temperature processing of natural gas, natural gas liquefaction.
Dehydration and sweetening of natural gas: Dehydration of natural gas, gas dehydration by adsorption, dehydration of liquids, sweetening of natural gases, requirements of sweetening process,

Underground storage of natural gas: Load factor in gas distribution, preparation of storage schedule, storage field development, operation of storage facilities, storage of gas in depleted oil fields, economics of storage,

Transportation to market: Design of pipe lines, pipe line routes, contracts for pipe line construction, construction of pipe lines, operation of pipe lines, distribution systems.

Text book:

‘Hand Book of Natural Gas Engineering’ by Katz et al, Gulf Publishing Company, Texas.

ChE-422 Bio-informatics (Elective –IV)

Major bioinformatics resources: Knowledge of the following databases with respect to: organization of data, retrieval of data using text-based search tools, sources of data method for deposition of data to databases,

Introduction, primary and secondary database,

Nucleic acid sequence databases: GenBank, EMBL, DDBJ
Protein sequence databases: SWISS-PROT, TrEMBL, PIR_PSD
Genome Databases: at NCBI, EBI, ExPASy, TIGR, SANGER Prosite, PRODOM, Pfam, PRINTS, CATH, SCOP, DSSP, FSSP, DALI

Sequence and structure databases: PDB, MMDB, metabolic pathways databases such as KEGG, EMP,

Sequence Alignment and Database Searching: Introduction, collection, annotation and alignment of sequences, basic concepts of sequence similarity, identity and homology, scoring matrices – PAM and BLOSUM, gap penalties, database similarity searching, FASTA, BLAST,

Pairwise sequence alignments: Basic concepts of sequence alignment, dynamic programming- Needleman & Wuncsh, Smith & Waterman, algorithms for pairwise alignments,

Multiple sequence alignments (MSA): The need for MSA, basic concepts of MSA (e,g. progressive, hierarchical etc.), algorithm of CLUSTALW, use of HMM method, concept of dendograms and its interpretation,

Taxonomy and phylogenetic analysis: Basic concepts in taxonomy and phylogeny; molecular evolution; nature of data used, definition and description of phylogenetic trees and various types of trees, tree building and tree evaluation methods, phylogenetic analysis algorithms such as maximum Parsimony, UPGMA, neighbor-joining; maximum likelihood algorithm,

Secondary structure prediction methods- ChouFASMAN/GOR, nearest neighbor, neural network,

Genome Mapping and Applications: Human genome project, application of genome mapping, DNA microarrays.

Text books:

1.'Introduction to Bioinformatics' by T.K.Attwood and P.J.Parry–Smith Pearson Bioinformatics.

2. 'Bioinformatics: Sequence and Genome Analysis' by D.W. Mount, Cold Spring Harbor Laboratory Press.

Reference books:

1. 'Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins' by A.D. Baxevanis and B.F.F. Ouellette (Editors), John Wiley and Sons

2. 'Statistical Methods in Bioinformatics: An Introduction' by W.J.Evens and G.R.Grant

3. 'Bioinformatics Basics. Applications in Biological Science and Medicine' by Hooman H.Rashidi and Lukas K.Buehler, CAC Press

4. 'Algorithms on Strings Trees and Sequences' by Dan Gusfiled, Cambridge University Press

ChE-422 Biochemical Engineering –Principles (Elective – IV)

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-423 Process Engineering Economics

Value of money - equivalence: Value of money, equations for economic studies, equivalence, types of interest- discrete and continuous, annuities - relation between ordinary annuity and the periodic payments, continuous cash flow and interest compounding, present worth of an annuity, perpetuities and capitalized costs, bonds and debentures, value of a bond and yield rate,

Depreciation: Types and various methods of calculating depreciations, depreciation accounting,

Cost accounting: Basic relationship in accounting, balance sheet and income statement, various ratios to study the balance sheet and income statements,

Cost estimation: Cash flow for industrial operations, factors affecting investments and production costs, estimation of capital investment, cost indices, cost factors in capital investment, methods of estimating capital investment, estimation of total product cost-manufacturing costs and general expenses,

Profitability: Alternate investments and replacements. mathematical methods for profitability evaluation, economic production charts for plants operating below 100%, above 100% and under dumping conditions, general procedure for determining optimum conditions, break even chart for production schedule and its significance for optimum analysis,

Economic balance in fluid flow, heat transfer and mass transfer operations; optimum economic pipe diameter in fluid dynamics, optimum flow rate of cooling water in condenser in heat transfer and optimum reflux ratio in distillation operation,

Economic balance in cyclic operations and semi continuous cyclic operations, economic balance in yield and recovery, economic balance in chemical reactors, batch and flow reactors.

Text books:

1. `Plant Design and Economics for Engineers' by Max S. Peters and K.D.Timmerhans, McGraw Hill Book Company,

2.`Process Engineering Economics' by Herbest E. Schweyer, McGraw Hill Book Company.

FE-02 INDUSTRIAL SAFETY AND OCCUPATIONAL HEALTH
(Free Elective)
(Effective from the admitted batch of 2013-14)

Introduction : Industrial Safety, Incident, accident, near miss, hazard, risk, emergency, disasters, risk criteria, Safety at work.

Pediction and evaluation of unsafe conditions :
Identification of unsafe areas, unsafe acts, manifestation of unsafe conditions to emergency situation, lessons from accidents and disasters, safety audit and its elements, safety in plant layout, equipment design. Construction, erection, commissioning, material handling.

Hazards – chemical hazards, thermodynamic hazards, electrical & electromagnetic hazards, mechanical hazards.

Risk – Definition, causes, potential and adverse effects.

Hazard Analysis – incident scenarios, residual risk, Concept Hazard Analysis (CHA), Preliminary Process Hazard Analysis PPHA, HAZOP, Fault Tree Analysis (FTA), Event Tree Analysis (ETA).

Risk Assessment – Risk criteria, causes of death/damage, individual risk, societal risk, criteria for acceptable risk tolerable risk, application of risk assessment, computation of fatality rates, severity rates, vulnerability analysis, introduction to computerized risk assessment techniques.

Safety Management (General) – safety policy perceptions, safety organization, safety audit techniques, project and **Construction Safety** – welding & cutting operations, fabrication, material handling, equipment spacing, safe plant layout procedures, storage tanks, erection & commissioning works, housekeeping methods, maintenance of storage yards, erection & maintenance of electrical panels and MCC rooms, electrical & mechanical safe guarding.

Emergency Preparedness – onsite & offsite emergency preparedness, emergency preparedness plans, site specific action plans and contingency plans, emergency facilities, rehabilitation & rescue operations, post emergency actions.

Safety Management (Industry Specific)

Chemical Manufacturing Plants, Fertilisers, Steel Plants, Petrochemical Plants, Metallurgical Plants, Mineral Process Industries, Sugar plants, semiconductor industry, Polymer manufacturing plans, Paper industry, Pharmaceutical and bulk drug industries, Vessel manufacturing industry, LPG bottling plants, Power Plants, tanneries and textiles.

Statutory framework – key provisions of Factories Act, Environmental Protection Act, Manufacture, Storage and Import of Hazardous Chemical rules, Static and Mobile Pressure Vessels rules, NFPA specifications, OSHA regulations.

Occupational health management – occupational health perspectives, pre-employment & periodical medical examinations, diseases, causes, consequences, **Occupational health hazards in various industries** – aluminium industry, asbestos, battery manufacturing, sugar, cement, coke ovens, cotton ginning, dairy, electro plating, fish canning, poultries, irrigation, lead smelting, mining, pesticides, power plants, refineries, pulp & paper industry, PVC processing, steel plants, fertilizers, sulphuric acid plants, tanneries and textiles.

International standards – British council's five star rating systems, International Safety Rating Systems (ISRS), ISO 14001 EMS, ISO 18001 OHSAS, BIS 14489 Code of Conduct for conducting safety audits.

Prescribed books:

1. "Hazards in Chemical industries, 3rd edition" – Authored by Frank P.Lees
2. "Hazard identification and risk assessment" – Authored by Geoff Wells ; Published by Institution of Chemical Engineers, Davis Building, 165-189 Railway Terrace, Rugby, Warwickshire CV21 3HQ, UK.

References

1. "Safety Management 5th edition" – Authored by John V. Grimaldi and Rollin H. Simonds; Published by A.I.T.B.S. Publishers & Distributors, J-5/6, Krishna Nagar, Delhi – 110051.

"Environmental Health and Safety Management" – Authored by Nicholas P. Cheremisinoff and Madelyn L. Graffia; Published by Jaico Publishing House, Hyderabad.

CHE-424 Chemical Process Equipment Design Laboratory

(Open book practical examination)

The following equipment are to be designed in detail:

1. Sensible heat exchangers (1-2 or 2-4),
2. Condenser and reboiler,
3. Multiple effect evaporator,
4. Fractionating column-Plate and packed columns,
5. Packed bed absorber,
6. Continuous tubular reactor (homogeneous and heterogeneous)

CHE-425 Project Work

The project work should consist of a comprehensive design of a chemical plant in the form of a report with the following chapters.

1. Introduction
2. Physical and chemical properties and uses
3. Literature survey for different processes
4. Selection of the process
5. Material and energy balances
6. Specific equipment design (Process as well as mechanical design with drawings)
7. General equipment specifications
8. Plant location and layout
9. Materials of construction
10. Health and safety factors
11. Preliminary cost estimation
12. Bibliography