Bachelor of Technology (Chemical Engineering)
Program: CE
Program Code: 14

Duration – 4 Years (Full time)

Program Scheme and Syllabus
(1st to 8th semester)

University School of Chemical Technology
GGS INDRAPRASTHA UNIVERSITY
SECTOR 16C, DWARKA, NEW DELHI-110078

Table of Contents

FIRST SEMESTER EXAMINATION

L	T	P	Credits
17	5	11	28

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
99109	BA-109	Mathematics I	3	1	0	4
99111	BA-111	Physics I	2	1	0	3
99117	BA-117	Organic Chemistry	3	1	0	4
98101	HS-101	Communication Skills I	2	1	0	3
98119	HS-119*	Impact of Science & Technology on Society	1	0	0	1
15105	IT-105	Introduction to Computers	3	0	0	3
15107	IT-107	Electrical Science	3	1	0	4
Practical/Viva Voce						
99163	BA-163	Organic Chemistry Lab	0	0	3	2
99153	BA-153	Physics I Lab	0	0	2	1
15155	IT-155	Computer Programming Lab	0	0	2	1
15157	IT-157	Engineering Graphics I	0	0	2	1
15159	IT-159	Electrical Science Lab	0	0	2	1
		Total	**17**	**5**	**11**	**28**

Paper ID	Paper	L	T	P	Credit
99109	BA-109 Mathematics I	3	1	0	4

Unit I **14 Hrs**

Calculus of functions of one variable

i. Successive Differentiation, Leibnitz's theorem (without proof). Lagrange's Theorem, Cauchy Mean value theorems, Taylor's theorem (without proof), Remainder term, Asymptotes, Curvature, Curve Tracing.

ii. Infinite Series: Convergence, divergence, Comparison test, Ration Test, Cauchy n^{th} root test, Leibnitz's test (without proof), Absolute and Conditional Convergence, Taylor and Meclaurin series, Power Series, Radius of Convergence.

iii. Integral Calculus: Reduction Formulae of trigonometric functions, Properties of definite Integral, Applications to length, area, volume, surface of revolution, Definition of improper integrals, Beta-Gamma functions

Unit II **12 Hrs**

Calculus of Functions of several variables

Partial derivatives, Chain rule, Differentiation of Implicit functions, Exact differentials. Maxima, Minima and saddle points, Method of Lagrange multipliers. Differentiation under Integral sign, Jacobians and transformations of coordinates. Double and Triple integrals. Simple applications to areas, Volumes etc.

Unit III **12 Hrs**

Vector Calculus

Scalar and vector fields, Curves, Arc length, Tangent, normal, Directional Derivative, Gradient of scalar field, divergence and curl of a vector field. Line integral (independent of path), Green's theorem, Divergence theorem and Stoke's theorem (without proofs), Surface Integrals.

Text Books

1. Calculus and Analytic Geometry by G.B. Thomas and R.L. Finney, Addison Wesley/Narosa. publications
2. Higher Engineering Mathematics by Grewal B.S., Khanna Publications

Reference Books

1. Advanced Engineering Mathematics by E. Kreyszig, Wiley Eastern Ltd.
2. Theory and Problems of Vectors Analysis by Murray R. Spiegel, Schaum's Outline Series, Mc Graw Hill.
3. Mathematical Analysis by S.C. Malik, Wiley Eastern Ltd.
4. Advanced Calculus, Schaum's Outline Series, Mc Graw Hill
5. Advanced Calculus by Widder, Prentice Hall Publishers.
6. Shanti Narayan, "Differential Calculus", S. Chand & Co.
7. Shanti Narayan, "Integral Calculus", S. Chand & Co.

Paper ID	Paper	L	T	P	Credit
99111	BA-111 Physics I	2	1	0	3

UNIT I **19 Hrs**

Optics

i. **Polarization:**Types of polarization, elliptically and circularly polarized light Brewsters law, Malu's law, Nicol prism, double refraction, quarter-wave and half-wave plates, optical activity, specific rotation, Laurent half shade polarimeter.

ii. **Interference:** Coherence and coherent sources, interference by division of wave front (young's double slit experiment, Fresnel's biprism), interference by division of amplitude (thin films, Newton's rings, Michelson's interferrometer, Fabry Perot interferrometer)

iii. **Diffraction:** (Fresnel and Fraunhofer types of diffraction) Fraunhofer difraction: Single slit, double slit, circular aperture and N-slit, diffraction grating wavelength determination, resolving power and dispersive power, Fresnel Diffraction: Zone plate, circular aperture, opaque circular disc, narrow slit.

UNIT II **10 Hrs**

Laser and Fibre Optics

i. **Lasers :** Introduction, coherence, Einstein A and B coefficients, population inversion, basic principle and operation of a laser, type of lasers, He-Ne laser, Ruby laser, semiconductor laser, holography-theory and applications.

ii. **Fibre Optics:** Introduction to optical fibre, types of optical fibres and their characteristics, (Attenuation and dispersion step index and graded index fibres, principle of fibre optic communication-total internal reflection, numerical aperture, fibre optical communication network (qualitative)-its advantages.

UNIT III **5 Hrs**

Theory of relativity

Absolute and Inertial frames of reference, Galenlian transformations, Michelson-Morley experiment, the postulates of the special theory of relativity, Lorentz transformations, time dilation, length contraction, velocity addition, mass energy equivalence

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Text Books

1. Concept of Modern Physics: A. Beiser
2. Optics by Ghatak

Reference Books

1. Modern Physics: Kenneth Krane
2. Fundamentals of Optics: Jenkins and White
3. Fundamental of Physics by Resnick and Halliday

Paper ID	Paper	L	T	P	Credit
99117	BA-117 Organic Chemistry	3	1	0	4

UNIT I

Classification of Organic Compounds

IUPAC nomenclature, structural isomerism, Cis-trans isomerism, shapes and molecular orbital structures of compounds containing C,N and O conformation of alkanes, structures of dienes, pyridine, pyrrole, aromatic compounds, delocalization, concept of aromaticity, stability of cycloallanes, resonance concept, inductive and mesomeric effects, directive effects, activating and deactivating group, hydrogen bonding, organic reagents and reaction intermediates.

UNIT II

Chemistry of hydrocarbons

House synthesis halogenations of alkanes, free radical mechanism, cracking effect of structure on physical properties of compounds, alkenes catalytic hydrogenation, dehydration of alcohols, dehydrogenation, Sayteff rule, electrophillic addition reactions, peroxide effects, mechanism of allylic substitution, acidity of 1-alkynes conjugated dienes, 1,2 and 1,4 additions, free radical and ionic mechanisms of addition polymerization reactions. Ring opening reactions of cyclopropane and cyclobutane, chemistry of benzene and alkyl benzenes. Aromatic electrophillic substitution reaction Friedel-Crafts reaction.

UNIT III

Chemistry of functional groups

Alkyl and aryl halides, nucloephilic substitution, synthetic utility of Grignard reagents and alkallithiums, mechanism of Gringartion of alcohols, Benzyl alcohol, Benzaldhyde, Acetophene, benzophenone, aldol condensation, acidity of acids, alkyl and aryl amines

UNIT IV

Synthetic utility of diazonium salts

Basicity of amines, multistep synthesis.

Text Books

1. Text book of organic chemistry by B.S.Bahl and Arun Bahl, S.Chand and company LTD. Delhi
2. Fundamentals of organic chemistry by T.W.G.Solomons, John Wiley and sons, Inc. NewYork.

Paper ID	Paper	L	T	P	Credit
98101	HS-101 Communication Skills I	2	1	0	3

I. Remedial Grammar

(a) Simple sentences – their phrase structure
(b) Parts of speech
(c) Tense and concord
(d) Gerunds, Participles & Infinitives
(e) Complex and Compound sentences (use of connectives)
(f) Conditional clauses
(g) Question tags & short responses
(h) Common errors

II. Vocabulary and Usage

(a) Synonyms & Antonyms
(b) One word substitutions
(c) Words often confused
(d) Idioms/ Idiomatic expressions
(e) Foreign Phrases (Greek and Latin)

III. Presentation of Technical Information Technical description of

(a) Simple objects, tools, appliances
(b) Processes and operations
(c) Scientific principles

IV. Composition:

(a) Comprehension – Unseen passages
(b) Dialogues – Creation of mock situations.
(c) Debates –Discussing the pros and cons of a given topic.
(d) Thematic Appreciation Exercises/ Development of situational outlines.

V. Prose

Selected prose pieces from prescribed texts.

Paper ID	Paper	L	T	P	Credit
98119	HS-119* Impact of Science & technology on Society	1	0	0	1

*NUES: The course shall depend on the teacher and will be delivered through semester presentation.

Paper ID	Paper	L	T	P	Credit
15105	IT-105 Introduction to Computers	3	0	0	3

UNIT I

Introduction

Overview of computer organization and historical perspective computer applications in various fields of science and management.

Data representation: Number systems, character representation codes, Binary, hex, octal codes and their inter conversions. Binary arithmetic, Floating point arithmetic, signed and unsigned numbers. Data Storage: Primary and Secondary storage, Introduction to various computer devices such as keyboard, mouse, printers, disk files, floppies etc. Concept of computing, contemporary, Operating Systems such as DOS, Windows'95, UNIX etc. (only brief user level description). Introduction to organization and architecture of mainframe, mini and micro systems. Introduction to E-mail, ftp, login and other network services, world wide web, MS-Office.

UNIT II

Introduction to Programming

Concept of algorithms, Flow charts, Example of Algorithms such as how to add ten numbers, roots of a quadratic equation. Concept of sequentially following up the steps of a algorithm. Notion of program, programmability and programming languages, Structure of programs, Object codes, compilers.

Introduction to the Editing tools such as vi or MS-VC editors. Concepts of the finite storage, bits, bytes, kilo, mega and gigabytes, Concepts of character representation.

UNIT III

Programming with C

The emphasis should be more on programming techniques rather that the language itself. The C programming language is being chosen mainly because of the availability of the compilers, books and other reference materials. Example of some simple C program. Dissection of the program line by line, Concepts of Variables, program statements and function calls from the library (printf for example)

- C data types, int, char, float etc.
- C expressions, arithmetic operations, relational and logic operations.
- C assignment statements, extension of assignment to the operations. C primitive input output using getchar and putchar, exposure to the scanf and printf functions.
- C statements, conditional executing using if, else. Optionally switch and break statements may be mentioned.
- Concepts of loops, example of loops in C using for, while and do-while, Optionally continue may be mentioned.
- One dimensional arrays and example of iterative programs using arrays, 2-d arrays. Use in matrix computations.
- Concept of Sub-programming, functions, Example of functions, Argument passing mainly for the simple variables.
- Pointers, relationship between arrays and pointers, Argument passing using pointers, Array of pointers, Passing arrays as arguments.
- Strings and C string library
- Structures and Unions. Defining C structures, passing strings as arguments, programming examples.
- File I/O, Use of fopen, fscanf and fprintf routines

Paper ID	Paper	L	T	P	Credit
15107	IT-107 Electrical Science	3	1	0	4

I. **Properties of Conductors and Insulators:** Basic laws of Electrical Engineering, Temperature Resistance Coefficients

II. **D.C. Circuits:** Network theorems and applications, Division of Current, Potentiometer, Circuit Parameters, Energy and Power, Superposition, Thevenin and Reciprocity theorems, Star Delta Formations

III. **Alternating Currents:** Peak, Average and RMS values for alternating currents, Power and Power factor, Resistance, Inductance and Capacitance, Resonance, Q Factor

IV. Electromagnetism: Magnetic Induction, Permeability, Hysteresis

V. **Measuring Instruments:** Moving Coil and Moving Iron Instruments, Construction of Instruments, Attraction and Repulsion type, Permanent Magnet and Eletrodynamics, Dynamometer type

VI. **D.C. Generators & Motors:** Principle of operation of Generators & Motors, Speed Control of shunt motors, Flux control, Rheostatic control, voltage control, Speed control of series motors

VII. **A.C. Generators & Motors:** Principle of operation, Removing Magnetic field, Squirrel cage and phase wound rotor, Starting of Induction motors, Direct on line and Star Delta starters, Synchronous machines

VIII. **Transformers:** Construction, Regulation and efficiency calculations, Open and short circuit tests

Paper ID	Laboratory	L	T	P	Credit
99163	BA-163 Organic Chemistry Lab	0	0	3	2

1. **Technical and preparation:** Lab safety, melting points, recrystallisation, distillation and reflux, drying agents, percentage yield, preparation of benzamide, aspirin, midnitobenzene dyes

2. **Identification of organic compounds:** Hydrocarbons, halogen compounds, phenols, aldehydes and ketones, carboxylic acids, amides, amines, formation of derivate, identification of unknowns.

Text / Reference Books

1. Experimental organic Chemistry by William Kemp and Arun Bahl, S.Chand and company Ltd. Delhi
2. Experimental organic chemistry by Charles A. Mackenzie, Prentice Halll, Inc., New Jersey(USA)

Paper ID	Laboratory	L	T	P	Credit
99153	BA-153 Physics I Lab	0	0	2	1

Practical based on BA 109

Paper ID	Laboratory	L	T	P	Credit
15155	IT-155 Computer Programming Lab	0	0	2	1

Practical based on IT-105

Paper ID	Laboratory	L	T	P	Credit
15157	IT-157 Engineering Graphics I	0	0	2	1

1. General

Importance, Significance and scope of engineering drawing, Lettering, Dimensioning, Scales, Sense of proportioning, Different types of projections, Orthographic projections, B.I.S. Specifications.

2. Projections of Points and Lines

Introduction of planes of projection, Reference and auxiliary planes, projections of points and lines in different quadrants, traces, inclinations, and true lengths of the lines, projections on auxiliary planes, shortest distance intersecting and non-intersecting lines.

3. Planes Other than the Reference Planes

Introduction of other planes (perpendicular and oblique), their traces, inclinations etc., projections of points and lines lying in the planes, conversion of oblique plane into auxiliary plane and solution of related problems**.**

4. Projections of Plane Figures

Different cases of plane figures (of different shapes) making different angles with one or both reference planes and lines lying in the plane figures making different given angles (with one or both reference planes). Obtaining true shape of the plane figure by projection.

5. Projection of Solids

Simple cases when solid is placed in different positions, Axis, faces and lines lying in the faces of the solid making given angles.

6. Development of Surface

Development of simple objects with and without sectioning.

7. Nomography

Basic concepts and use

Paper ID	Laboratory	L	T	P	Credit
15159	IT-159 Electrical Science Lab	0	0	2	1

Practical based on IT-107

SECOND SEMESTER EXAMINATION

L	T	P	Credits
15	7	10	27

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
99106	BA-106	Inorganic Chemistry	3	1	0	4
99108	BA-108	Mathematics II	3	1	0	4
99112	BA-112	Life Sciences	2	1	0	3
99116	BA-116	Physics II	2	1	0	3
15104	IT-104	Engineering Mechanics	3	1	0	4
98102	HS-102	Communication Skills II	1	2	0	3
98126	HS-126*	Impact of Science & technology on Society	1	0	0	1
Practical/Viva Voce						
99156	BA-156	Physics II Lab	0	0	2	1
99158	BA-158	Life Sciences Lab	0	0	2	1
99160	BA-160	Inorganic Chemistry Lab	0	0	4	2
15154	IT-154	Engineering Graphics II Lab	0	0	2	1
		Total	**15**	**7**	**10**	**27**

***NUES**

Paper ID	Paper	L	T	P	Credit
99106	BA-106 Inorganic Chemistry	3	1	0	4

Quantum Theory and Atomic Structure
Introduction to wave mechanics. The Schrödinger equation. The Schrödinger equation as applied to hydrogen atom. The origin of quantum numbers and shapes of orbitals.
Long Form Periodic Table: Classification on the basis of electronic configuration, s,p,d, and f block elements, periodic trends, ionization potential, atomic and ionic radil, electron affinity and electronegativity.
f-Block Elements: Properties of lanthanides and actinides w.r.t.i) electronic configuration, ii) oxidation state iii) magnetic properties, iv) colour and spectra) contraction effects and vi) complex ion formation. Principles and separation by ion exchange and solvent technological applications.
Comparative chemistry of sand p block elements for group IA,IIA,VA and VIA.

Chemical Bonding
Ionic Bond-Energy changes, lattice energy, salvation energy, Bornhaber Cycle (problems) expected), characteristics of ionic compounds. Covalent Bond-Energy changes, potentioal energy curve for H2 molecule, characteristics of covalanet cpo mpunds. Co-ordinate bond-Werner's theory, effective atomic number, stability of complexes, isomerism in coordinate cpompunds. Hydrogen Bonding, Vender Walls forces, hybridization and resonance. Valence shell electron repulsion theory (VPSER)- Discussion of structures of H2O, NH3, BrF4, SF4, p-Halides etc. Molecular orbital theory, Linear combination of atomic orbitals (LCAO) method, structures of simple homonuclear diatomic molecules like H_2,N_2,O_2,F_2

Solid State: Symmetric properties, close packing of spheres, structures of ionic solids (NaCl, CsCl,ZnS,CaF2) and crystal defects.

Transition Metal Chemistry: Structure of Coordinates compounds corresponding to coordination numbers up to 6 Tyupes of ligands, Isomerism (geometrical, optical, ionization, linkage and coordination). Theories of bonding in coordination compounds, Octahedral and distroed octahedral crystal fields. Thermodynamics aspects of coordination cpompounds (substirution reaction in complexes with coordination number 4 and 6 and their mechanism (SN1,SN2)

Organometallic Chemistry and Catalysis: Nomenclature, types of legends, Structure and bonding in organometallic complexes, the sixteen and eighteen electron rules. Homogeneous catalysis, the role of metals in catalytic cycle during some chemical reactions (e.g.) hydroformyaltion, hydrogenation etc.) Role of metals in biology, oxygen carrier, electron transfer.

Metal Carbonyis: General methods of preparation and properties of metals carbonysis, structure of mono and polynuclear carbonyls of iron.

Inorganic Air and Water Pollutants: Oxide of S,N, and C (w,r,t) source of emission, ii) reaction iii) Contorl and iv) health hazards.Primary and secondary air pollutants, gree house effects, thermal inversion, causes and consequences of depletion of ozone layer. Heavy metal pollutants w.r.t. sources, distribution of Hg, Pb, Cd, and Cu their toxic effect and permissible levels.

Paper ID	Paper	L	T	P	Credit
99108	BA-108 Mathematics II	3	1	0	4

Linear Algebra

Linear Independence and dependence of vectors, Systems of linear equations- consistency and inconsistency. Gauss elimination method, rank of a matrix, Bilinear, Quadratic, Hermitian, Skew- Hermitian Forms, Eigenvalues and Eigenvectors of a matrix, diagonalization of a matrix, Cayley- Hamilton Theorem (without proof).

Ordinary Differential Equations

Formation of ODE's, definition of order, degree and solutions. ODE's of first order : Method of separation of variables, homogeneous and nonhomogeneous equations, exactness and integrating factors, linear equations and Bernoulli equations. General linear ODE's of nth order : solutions of homogenous and nonhomogenous equations, operator method, method of undetermined coefficients and variation of parameters. Solutions of simple simultaneous ODE's. Power series method of solution of DE, Legendre's Equation, Legendre's Polynomials, Bessel's equation, Bessel's function.

Complex Variables

Curves and Regions in the Complex Plane, Complex Functions, Limits, Derivative, Analytic Function, Cauchy-Riemann Equations, Laplace's Equation, Linear Fractional Transformations, Conformal Mapping, Complex Line Integral, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivatives of Analytic Function, Power Series, Taylor Series, Laurent Series, Methods for obtaining Power Series, Analyticity at Infinity, Zeroes, Singularities, Residues, Residue Theorem, Evaluation of Real Integrals.

Probability

Definition of Sample Space, Event, Event Space, Conditional Probability, Additive and Multiplicative law of Probability, Baye's Law theorem, Application based on these results.

Text Books

1. Differential Equations by N.M. Kapoor, Pitamber Pub. Co.
2. Algebra by M. K Singhal and Asha Singhal, R. Chand & Co.
3. Complex Variables; Schaum Outline Series; Mc. Graw Hill.
4. Probability; Schaum Outline Series; Mc. Graw Hill.

Reference Books

1. Matrices by Shanti Narayan, S. Chand & Co.
2. Calculus and analytical Geometry by G. B. Thomas and R. L. Finey, Add. Wesley/Naroa
3. Advanced Engineering Mathematics by E/ Kreysiz, Wiley Eastern Ltd
4. Differential Equations; Schaum Outline Series; Mc. Graw Hill.
5. Linear Algebra; Schaum Outline Series; Mc. Graw Hill.

Paper ID	Paper	L	T	P	Credit
99112	BA-112 Life Sciences	2	1	0	3

UNIT I

Origin of Life

History of earth, theories of origin of life, nature of earliest organism

Diversity of life

Basis rules of classification and nomenclature, Classification-two kingdom, five kingdom-brief introduction to kingdoms, three domain Introduction and structure of viriods, prions and virus (HIV, TMW , Bacteriophage), Structure and reproduction of bacteria and their economic importance.

UNIT II

Chemical basis of life

Biomolecules - carbohydrates, proteins, facts and lipids, nucleic acids (DNA and RNA)

Enzymes

Definition, Properties, Types Mechanism of action, factors affecting kinetics and their industrial applications

Cell – Structure and function

Prokaryotic and eukaryotic calls, plant animal cells, structure and function of cell membrane, nucleus chloroplast, mitochondria, golgi apparatus, endoplasmic reticulum.

UNIT III

Histology Plants

Meristm (apical, interchalary and lateral), simple tissues
(Parenchyma, collenchymas, and sclerenchymal), complex fissue (xylem and phloem) – structure and function, Tissue systems (epidermal, ground and vasculary); primay body and growth (root , sterm and leaf), secondary growth.

Animals

Epithelial, connective, muscular, and nervous tissue – structure and function

Economic Biology

Food – Cereals(Wheat, rice , Maize) Beverages (tea, coffee, cocoa, Sugracane, Medicinal plants (Taxus, Caatharanthus, Salix, AZadirachta); and Rubber (Hevea), Apiculture, Sericulture, Vermiclture, and Leather

Books/ References:

1. Talyor, D.J. Green, N.P.O. and Stout G.W. 2000. Biological Science. Cambridge low price edition.
2. Singleton, P.1999. Bacteria. John Wiley and Sons, Ltd.
3. Power C.B. 2003. Cell Biology. Himalayan Publication.
4. Berry A.K. 1993. Animal History. Emkay Publications.
5. Nelson, D.L. and M.M. Cox. 2000. Lehninger Principles of Biochemistry W.H. Freeman Costom Pub.

Paper ID	Paper	L	T	P	Credit
99116	BA-116 Physics II	2	1	0	3

UNIT I **8 Hrs**

Quantum Mechanics

Wave particle duality, deBroglie waves, evidences for the wave nature of matter – the experiment of Davisson and Germer, electron diffraction, physical interpretation of the wave function and its properties, the wave packet, the uncertainty principle

The Schrodinger wave equation (1 – dimensional), Eigen values and Eigen functions, expectation values, simple Eigen value problems – solutions of the Schrodinger's equations for the free particle, the infinite well, the finite well, tunneling effect, simple harmonic oscillator (qualitative), zero point energy.

UNIT II **8 Hrs**

Quantum Statistics

The statistical distributions: Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac statistics, their comparisons, Ferminos and Bosons Applications: Molecular speed and energies in an ideal gas. The Black body spectrum, the failure of classical statistics to give the correct explanations – the applicatons of Bose-Einstein statistics to the Black body radiation spectrum, Fermi-Dirac distribution, free electron theory, electronic specific heats, Fermi energy and average energy – its significance.

UNIT III **8 Hrs**

Band Theory of Solids

Origin of energy bands in solids, motion of electrons in a periodic potential – the Kronig – Penny model. Brillouin zones, effective mass, metals, semi-conductors and insulators and their energy band structures. Extrinsic and Intrinsic semiconductors, doping – Fermi energy for doped and undoped semiconductors, the p-n junction (energy band diagrams with Fermi energy), the unbiased diode, forward and reverse biased diodes – tunnel diodes, zener diode, photo diode its characteristics, LED, Introduction to transistors.

UNIT IV **4 Hrs**

Overview of Electro – Magnetism

Maxwell's Equations: The equation of continuity for Time – Varying fields, Inconsistency in ampere's law Maxwell's Equations, conditions at a Boundary Surface, Introduction to EM wave.

Text Books

1. Concept of Modern Physics: A. Beiser
2. Electronic Principles: Malvino

Reference Books

1. Modern Physics: Kenneth Krane
2. Solid State Physics by Kittle
3. Statistical Mechanics by Garg Bansal and Ghosh (TMH)

Paper ID	Paper	L	T	P	Credit
15104	IT-104 Engineering Mechanics	3	1	0	4

1. **Force System**: Introduction, force, principle of transmissibility of force, resultant of a force system, resolution of a force, moment of force about a line. Varigon's theorem, couple, resolution of force into force and a couple, properties of couple and their application to engineering problems.
2. **Equilibrium:** Force body diagram, equations of equilibrium and their applications to engineering problems, equilibrium of two force and three force member
3. **Structure:** Plane truss, perfect and imperfect truss, assumption in the truss analysis, analysis of perfect plane trusses by the method of joints, method of section and graphical method.
4. **Friction:** Static and Kinetic friction, laws of dry friction, co-efficient of friction, angle of friction, angle of repose, cone of friction, frictional lock, friction of flat pivot and collered thrust bearings, friction in journal-bearing, friction in screws, derivation of equation. $T_1 / T_2 = \lambda_e$ A and its application.
5. **Distributed Forces:** Determination of center of gravity, center of mass and centroid by direct integration and by the method of composite bodies mass moment of inertia and area moment of inertia by direct integration and composite bodies method, radius of gyration, parallel axis theorem, Pappus theorems, polar moment of inertial., Dynamics.
6. **Kinematics of Particles:** Rectilinear motion, plane curvilinear motion-rectangular co-ordinates, normal and tangential coordinates
7. **Kinetics of Particles:** Equation of motion, rectilinear motion and curvilinear motion, work energy equation, conservation of energy, impulse and momentum conservation of momentum, impact of bodies, co-efficient of restitution, loss of energy during impact.
8. **Kinematics of Rigid Bodies:** Concept of rigid body, types of rigid body motion, absolute motion, introduction to relative velocity, relative acceleration (Corioli's component excluded) and instantaneous center of zero velocity, Velocity and acceleration polygons for four bar mechanism and single slider mechanism.
9. **Kinetics of Rigid Bodies:** Equation of motion, translatory motion and fixed axis rotation, application of work energy principles to rigid bodies conservation of energy
10. **Vibrations:** Classification, torsional free vibrations-single rotor and two rotor system, Spring mass system-its damped (linear dash pot) and undamped free vibrations, spring in series and parallel, simple problems

Text Books

1. Engineering Mechanics by U.C. Jindal, Galgotia Publication.
2. Engineering Mechanics (Statics and Dynamics) by A.K.Tayal

Paper ID	Paper	L	T	P	Credit
98102	HS-102 Communication Skills II	1	2	0	3

1. **Some Key Concepts:**

Communication as Sharing; context of communication the speaker/writer and the listener/reader; medium of Communication; barriers to communication; accuracy, brevity, clarity and appropriateness in communication.

2. **Writing**:

Selecting material for expository, descriptive and argumentive pieces, business letters; formal report; summarising and abstracting; expressing idea within a restricted word limit; paragraph division, introduction and the conclusion; listing reference material; use of charts, graphs and tables; punctuation and spellings; semantics of connectives, modifiers and modals variety in sentences and paragraphs.

3. **Reading Comprehension:**

Reading at various speeds (slow fast very fast) reading different kinds of text for different purposes (e.g. for relaxation for information, for discussion at a later stage, etc.); reading between the lines.

4. **Speaking:**

Achieving desired clarity and fluency; manipulating paralinguistic features of speaking, (voice quality , pitch ,tone etc.); pausing for effectiveness while speaking, task oriented, interpersonal, informal and semi informal speaking, making a short classroom presentation .

5. **Group Discussion:**

Use of persuasive strategies including some rhetorical devices for emphasising (for instance; being polite and firm; handling questions and taking in criticism of self; turn taking strategies and effective intervention; use of body language).

6. **Listening Comprehension:**

Achieving ability to comprehend material delivered at relatively fast speed; comprehending spoken material in standard Indian English, British English and American English, intelligent listening in situations such as an interview in which one is a candidates.

Text Books

1. Kaul, Asha, Business Communication, New Delhi: Prentice Hall of India Pvt. Ltd.

Reference Books

1. Bansal, R.K and J.B Harrison, Spoken English, Orient Longman (rpt) (Chapter 1-5, 8)
2. Lesikar and Flatley, Business Communications, New Delhi, Biztantra Press.

Paper ID	Paper	L	T	P	Credit
98126	HS-126* Impact of Science & technology on Society	1	0	0	1

*NUES: The course shall depend on the teacher and will be delivered through semester presentation.

Paper ID	Laboratory	L	T	P	Credit
15154	IT-154 Engineering Graphics II Lab	0	0	2	1

1. **Basic Concepts**
   I.S. drawing conventions, line symbols, kinds of line, drawing sheet lay-out, rules of printing, preferred scales.

2. **Projections**
   Perspective, orthographic, isometric and oblique projections, isometric scale, isometric drawing, Technical sketching.

3. **Shape Description (External)**
   Multiplanar representation in first- and third angle systems of projections, glass-box concept, sketching of orthographic views from pictorial views, precedence of lines.

   Sketching of pictorial (isometric and oblique) views from Multiplanar orthographic views, Reading exercises, Missing line and missing view exercises.

4. **Shape Description (Internal)**
   Importance of sectioning, principles of sectioning, types of sections, cutting plane representation, section lines, conventional practices.

5. **Size Description**
   Dimensioning, tools of dimensioning, Size and location dimensions, Principles of conventions of dimensioning, Dimensioning exercises.

6. **Computer Aided Drafting**
   Basic concepts and use.

Text / Reference Books

1. Engineering Drawing by N.D.Bhatt and V.M.Panchal, Publication: Charota Pub. House
2. Engineering Drawing by P.S.Gill

Paper ID	Laboratory	L	T	P	Credit
99156	BA-156 Physics II Lab	0	0	2	1

Practical based on BA-110

Paper ID	Laboratory	L	T	P	Credit
99158	BA-158 Life Sciences Lab	0	0	2	2

List of experiments:

1. To study and sketch the different life forms specimens, slides and photographs
   - i. Virus - TMV, HIV, Bacteriophage
   - ii. Bacteria - Cell structure,Binary fission, Conjugation
   - iii. Algae - Paramecium (Slide)
   - iv. Fungi - Spirogyra (Slide)
   - v. Flowering Plants - Dicot: Mustard
     - Monocot: Wheat
   - vi. Vertabrate Animals - Pisces (Labeo)
     - Amphibia (Frog/ Toad)
     - Reptile (Lizard)
     - Aves (Flock Pigeon)
     - Mammalia (Rat)
2. Qualitative estimation of carbohydrates, proteins and fats (lipids) and Vitamin C in biological system.
3. To test the activity of enxymes –catalase, amylase and urease.
4. Identification and blood groups of students.
5. Estimation of RBSc and WBCs from human blood.
6. Estimation of haemoglobin percentage in blood.
7. To study anatomy of root, stem and leaf of dicot and monocot plants by sectioning them and making temporary preparations.
8. To investigate the effect of light intensity on the rate of photosynthesis.
9. To investigate the need of CO_2 in photosynthesis.

Paper ID	Laboratory	L	T	P	Credit
99160	BA-160 Inorganic Chemistry Lab	0	0	4	2

Practical based on BA-106

THIRD SEMESTER EXAMINATION

L	T	P	Credits
15	5	12	28

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
99211	BA-211	Physical Chemistry	3	1	0	4
99213	BA-213	Applied Mathematics III	3	1	0	4
14201	CT-201	Chemical Process Calculations	3	1	0	4
14203	CT-203	Fluid Mechanics	3	1	0	4
14205	CT-205	Unit Operations-I	3	1	0	4
Practical/Viva Voce						
99261	BA-261	Physical Chemistry Lab	0	0	3	2
14251	CT-251	Unit Operations-I Lab	0	0	3	2
14253	CT-271	Workshop	0	0	3	2
15275	IT-275	Computer Programming Lab	0	0	3	2
		Total	**15**	**5**	**12**	**28**

Paper ID	Paper	L	T	P	Credit
99211	BA-211 Physical Chemistry	3	1	0	4

UNIT I **12 Hrs**

Gaseous state: Kinetic theory, molecular velocity, probable distribution of velocities, mean free path, collision frequency, distribution of molecules translational, rotational and vibrational, law of equapertition of energy; Equation of state of a real gas, Critical phenomenon and principle of corresponding states.

Phase rule: Derivation of phase rule; significance of various terms involved in the definition of phase rule, phase diagram of one component system (water, sulphur, CO2). Two component system: Eutectic. Congruent and incongruent systems with examples Partial miscible liquids: Lower and upper consulate point.

UNIT II **6 Hrs**

Chemical kinetics: Rate, mechanism, steady state concept, kinetics of complex reactions, concept of energy barrier/ energy of activation. Theories of reaction rates. Eindermann theory of unimolecular reaction and reaction in flow systems.

UNIT III **10 Hrs**

Electro chemistry: Concept of electrolysis, electrical current in ionic solutions, Kohlrausch's law and migration of ions, Transference number, Hittroffs and moving boundary methods, applications of conductance measurements

Strong electrolytes: Onsager equation: Activity and activity coefficients of strong electrolyte.

UNIT IV **20 Hrs**

Surface chemistry: Adsorption, adsorbate and adsorbents, types of adsorption, Freundlich adsorption isotherm, Langmuir adsorption isotherms, B.C.T Isotherm: surface area of the adsorbent, changes in entropy, enthalpy and free energy on adsorption, Gibb's adsorption equation. Catalysis Types of catalysis, homogenous heterogeneous, enzyme catalysis, acid / base catalysis and their kinetics, mechanism of heterogeneous catalysis, kinetics of surface reactions: unimolecular and bimolecular, pH dependence of rate constants of catalyzed reactions autocatalysis Colloids: Classification of colloids color of sols, electrochemical properties of sols, molecular weight v/s particle of colloidally dispersed particles, viscosity and plasticity, Gels and their properties: isobars and adsorption, isotherms, synersis, thisotropy and diffusion in jellies. Emulsions, emulsifiers, theory of emulsification, properties and stability of emulsions.

Text Books

1. Principles of physical chemistry, Puri B.R., Sharma I.R. and Pathania Mada.
2. A text book of physical chemistry, Atkins P.W., Oxford University Press, Oxford
3. A textbook of physical chemistry, Negi A.S and Anand, S.C, eastern LTD. New Delhi.

Reference Books

1. Principles of physical chemistry, Maron Samuel H, Prutton, Carl. E., Oxford and IBH Publishing Co. Pvt. , New Delhi
2. Text books of physical chemistry, Glasstone Samuel, Macmillan and Co. ltd.
3. Physical Chemistry, Moore W.I., Orient Longman
4. D.Tabor: Solids, liquids and gases, Penguin Press Paper back
5. Introduction to chemical reaction Engineering and kinetics, Missen, Ronald W. Mims Charles, A. Sacelli, Bradley A. John Wiley and Sons., NY

Paper ID	Paper	L	T	P	Credit
99213	BA-213 Applied Mathematics III	3	1	0	4

UNIT I **12 Hrs**

Laplace Transformation Laplace transform, Inverse Transforms, Laplace Transform of Derivatives and integrals, Shifting Theorems, Differentiation and Integration of Transforms, Convolution, Periodic Functions, Solutions of ODE's using Laplace Transform.

UNIT II **10 Hrs**

Fourier series and Integrals Periodic Functions, Fourier series, Euler Formulas, Even and ODD Functions, Half- Range Expansions, Harmonic Analysis, Fourier Integral.

UNIT III **15 Hrs**

Partial Differential Equations Formation, solution of linear partial differential equations of 1^{st} order, non-linear p.d.e of 1^{st} order, Charpit's mehod (without proof), Classification of linear 2^{nd} order equations, linear equations with constant coefficients, method of separation of variables, Wave equation, Heat equation, Laplace Equation.

UNIT IV **14 Hrs**

Numerical Methods

Solution of Equation by iteration:- Bisection method, Newton Raphson method

Interpolation**:-** Lagrange Interpolation, Difference operators, Newton's Forward and backward interpolation, Error formulae. Numerical Integration & Differentiation: Trapezoidal rule, Simpson's one third rule including error formula, Numerical differentiation. Systems of Linear Equation: Gauss- Siedel iteration. Numerical Methods for Differential Equations:- Runge method, Runge-Kutta method, Adams- Moulton method.

Text Books

1. Higher Engineering Mathematics, Grewal B.S., Khanna Pub., New Delhi
2. Numerical methods for Scientific and engineering Computations, Jain, Iyenger, Jain, Wiley Publishers

Reference Books

1. Differential and Integral calculaus, Vol-I & II Piskunov, Mir Publishers, Moscow
2. Advanced Engineering mathematics, Kreyszing Erwin, John Wiley and Sons
3. Elements of Partial differential Equations, Ian N. Sneddon, McGraw Hill Book Company, Inc.
4. Numerical Analysis, Akai T J, Jihn Wiley & Sons
5. Elementary Numerical Analysis, Atkinson K., Wiley & Sons
6. Introductory Methods of Numerical Analysis, Sastry, Prentice Hall of India Pvt Ltd

Paper ID	Paper	L	T	P	Credit
14201	CT-201 Chemical Process Calculations	3	1	0	4

UNIT I **12 Hrs**

Stoichiometric and composition relationship, behavior of ideal gases, gaseous mixtures, vapor pressure, humidity and humidity chart.

Units and dimensions, applications of laws of conservation of mass and energy to single and multistage process.

UNIT II **12 Hrs**

Material balance for (a) Non-reacting systems- recycle, bypass etc.
(b) Reacting systems- recycle, bypass, purging etc.

UNIT III **10 Hrs**

Energy balance for non reacting and reacting systems, flame temperature, adiabatic reaction temperature, combustion, heat capacity, heat of reaction etc.

UNIT IV **8 Hrs**

Material and energy balances for unit operations and processes, integrated balances for manufacturing processes.

Text Books

1. Stoichiometry, Bhatt V.I. and Vora S.M., Tata McGraw Hill
2. Basic Principles of Calculations in Chemical Engineering, Himmelblau D.M., Prentice Hall.
3. Elementary Principles of Chemical Processes, Felder R.M. and Rousseau R. W., John Wiley & sons, Inc.

Paper ID	Paper	L	T	P	Credit
14203	CT 203 Fluid Mechanics	3	1	0	4

UNIT I **12 Hrs**

Fluid Statics : Pressure measurement, forces on submerged bodies.

Properties of fluid: Equation of continuity and motion, Bernoulli's Equation and its applications. Newtonian and non-Newtonian fluids, Laminar and Turbulent flows. Pressure drop calculations and friction factor.

UNIT II **8 Hrs**

Measurement and Control of Flowing Fluids: Principles and operation of variable head meter and variable area meter.

Fluid moving machineries such as pumps, blowers. Application and selection of valves.

UNIT III **12 Hrs**

Boundary layer flow: Flow past immersed bodies, drag and lift forces, motion of solids through a fluid.

Dimensional Analysis : Flow of Incompressible fluids: Laminar and turbulent flow in pipes, velocity distribution in pipes, frictional losses in pipes and fittings, Fanning Equation, Estimation of economic pipe diameter, derivation of Hagen Poiseulli and f=16/Re equations.

UNIT IV **14 Hrs**

Agitation and mixing of liquids

Fluidization: Conditions of fluidization, aggregate and particulate fluidization, Ergun's and Kozeny Equation. Flow through packed and fluidized Beds

Flow of compressible fluid: Basic equations, Flow through ducts, venturimeter, convergent-divergent nozzle. Laval Nozzle, fanno flow.

Books & References:

1. Unit Operations of Chemical Engineering, McCabe W.L, Smith J.C. and Harriott P.,McGraw Hill International Edition, Singapore, 5th Ed., 1993.
2. Chemical Engineering, Vol .1, Coulson J.M. and Richardson J.F, Butterworth Heinemann, Oxford 6th Ed., 1999.
3. Introduction to Chemical Engineering, Badger W.L. and Banchero J.T.,Tata McGraw Hill, 1997
4. Unit Operations of Chemical Engineering, Vol .1, Chattopadhya, P, Khanna 2nd Ed., 1998
5. Fluid Mechanics, Douglus J. F., Gasiorek J.M., Swaffield J.A., Addison-Wesley Longman, 3rd Ed., 1995
6. Fluid Mechanics for Chemical Engineers, Nevers N. D., McGraw Hill, New York, 2nd Ed., 1991.

Paper ID	Paper	L	T	P	Credit
14205	CT-205 Unit Operations-I	3	1	0	4

UNIT I **8 Hrs**

Size Reduction : Size reduction of solids, energy for size reduction, law's of crushing and grinding, work index, particle size distribution.

Mechanical Separation: Screening: stationary screens, Trommel and vibrating screens

UNIT II **8 Hrs**

Filtration: plate and frame filter press, continuous rotary vacuum filter, filter aids etc

Sedimentation: One dimensional motion of particles through fluid. Batch and continuous thickeners

Centrifuge: Tubular bowl centrifuge, disks centrifuge, and batch basket centrifuge. Cyclone separators, electrostatic and magnetic precipitator.

UNIT III **4 Hrs**

Conveying Mechanical and pneumatic conveying system, storage and handling of materials, design and power requirement.

UNIT IV **8Hrs**

Crystallization Theory of solubility and crystallization, phase diagram (temp solubility relationship), population balance analysis, method of moments for rate expression. For volume area and length growth., crystal size distribution, Mixed suspension mixed product removal operation, programmed evaporative and cooling (rate expressions), most dominant size ideal classified bed, melt crystallization, process design of crystallizers and their operation, selection and specification of crystallizers like OSLO, Swenson Walker, agitated type etc, performance evaluation of crystallizers.

Text Books

1. Unit Operations of Chemical Engineering, McCabe W.L Smith J.C. and Harriott P., McGraw Hill, Singapore

Reference Books

1. Chemical Engineering, Vol.1, Coulson J.M. and Richardson J.F, Butterworth Heinemann, Oxford
2. Introduction to Chemical Engineering, Badger W.L. and Banchero J.T.,Tata McGraw Hill
3. Unit Operations of Chemical Engineering Vol .1, Chattopadhya, P., Khanna Publishers

Paper ID	Laboratory	L	T	P	Credit
99261	BA-261 Physical Chemistry Lab	0	0	3	2

List of experiments:

1. Draw calibration graph between concentration and viscosity of glycerol and hence evaluate the concentration of the unknown.
2. Study the distribution of I_2 between water and carbon tetrachloride.
3. Study of distribution of benzoic acid between water and benzene
4. To study the kinetics of hydrolysis of methyl acetate with Sodium hydroxide and calculate its order.
5. To study the kinetics of saponification of ethyl acetate at room temperature
6. To study the adsorption of acetic acid on activated charcoal at room temperature.
7. Determine the concentration of H_2SO_4/ HCl and CH_3COOH present in a mixture by conductometric titration.
8. Verify Lambert Beer's law for copper sulphate solution.
9. Perform Photometric titration of Acid v/s base
10. Complemetric titration of $Ca^{2+/}Mg^{2+}$
11. To evaluate transition temperature of the reaction $SrCl_2$ +$H2_O$

Paper ID	Laboratory	L	T	P	Credit
14251	CT-251 Unit Operations Lab I	0	0	3	2

List of experiments:

1. Studies on crystallization
2. Experiment based on Sedimentation
3. Experiment on Leaf Filter
4. Experiment on Rotary Vacuum Filter.
5. Experiment on Plate & Frame Filter Press.
6. Experiment on Screen Separation.
7. Experiment on Size reduction by Jaw Crusher.
8. Experiment on Size reduction by Grinder
9. Solid particle separation by cyclone separator
10. Studies on pneumatic conveying system

Paper ID	Laboratory	L	T	P	Credit
14271	CT-271 Workshop	0	0	3	2

List of experiments:

1. Working of lathe, shaper, milling and drilling machines, power hacksaw, shearing machine and grinding wheel.
2. Simple turning, threading, drilling, boring and knurling operations on a lathe.
3. Use of arc welding and gas welding in making different types of joints.
4. Sheet metal work practice.
5. Hands on training on chemical engineering equipment like pumps, valves, compressor, blower, heat exchanger etc.

Books & References:

1. Workshop Technology, Part I, II & III, Chapman, W.A.J., CBS publishers and distributors, 5th edition 1996.
2. Manufacturing Processes, Amstead B.H, Ostwald P.F., and Begeman M.L., John Wiley Sons, Inc., New York, 8th edition 1986.
3. Workshop Technology, Vol I, II and III, Chandola S.P., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1998.
4. Elements of Workshop Technology, Vol I & II., Hajra Choudury S.K., Bose S.K., Hajra Choudury A.K. and Roy N., Media Promoters and Publishers Pvt. Ltd., Mumbai, 7th edition 1984.

FOURTH SEMESTER EXAMINATION

L	T	P	Credits
16	6	10	28

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
99212	BA-212	Applied Mathematics-IV	3	1	0	4
99214	BA-214	Material Science	3	1	0	4
99216	BA-216	Physico Organic Chemistry	3	1	0	4
14202	CT-202	Chemical Eng. Thermodynamics I	2	1	0	3
14204	CT-204	Unit Operation-II	3	1	0	4
14206	CT-206	Heat Transfer -I	2	1	0	3
Practical/Viva Voce						
99262	BA-262	Physico organic chemistry Lab	0	0	3	2
14252	CT-252	Fluid Mechanics Lab	0	0	3	2
14254	CT-254	Unit Operations Lab-II	0	0	3	2
		Total	**16**	**6**	**10**	**28**

Paper ID	Paper	L	T	P	Credit
99212	BA-212 Applied Mathematics IV	3	1	0	4

UNIT I **14 Hrs**

Probability statistics

Elementary probability theory, Random variables: discrete and continuous, distribution and density functions, Expectation, Moments, Moment generating function, Skewness, Kurtosis, Binomial, Poisson and Normal distribution, method of least square for linear and parabolic curves, correlation of a bivariate distribution, Linear regression, properties of regression coefficient, sampling distribution of mean and variance, Testing of statistical hypothesis, F-TestT, T-test and Chi square test.

UNIT II **14 Hrs**

Linear programming

Mathematical preliminaries, Formulation of the problem and solution by graphical method, Simplex method, Dual problem formulation and solution, Dual simplex method, application to Transportation and Assignment problems.

UNIT III **8 Hrs**

Optimization

Search and gradient methods (Fibbonaci method, Golden section method, Steepest decent method) and Lagrange multipliers, K. K. T. necessary and sufficient optimality conditions

UNIT IV **6 Hrs**

Network scheduling PERT and CPM

Rules of Network construction, Critical path analysis, Probability condition in PERT .

Text Books

1. Operational research, Kanti Swaroop, Gupta P.K., Manmohan, Sultan Chand and sons.
2. Fundamentals of mathematical statistics, S.C.Gupta and V.K.Kapur, Sultan Chand and sons

Reference Books

1. Probability and statistics for Engineers, Irwin Miller and John E.Freund, PHI
2. Probability and statistics, Murray R Speigel, John J. Schiller, R. Alu Srinivasan , Schaum series, Mc Graw Hill.
3. Operational research- an introduction, H.A Taha, McMillan Publising company, NY

Paper ID	Paper	L	T	P	Credit
99214	BA-214 Material Science	3	1	0	4

UNIT I **8 Hrs**

Introduction: Classification of engineering materials: Structure properties relationship. Magnetic behavior of material. Dielectric properties of piezopyro –and ferrielectric materials; and its control

UNIT II **10 Hrs**

Crystal structure: Lattice translation vector, Lattice with a basis –central and non- central elements; reciprocal lattice, Types of lattices. Structure determination by X- ray diffraction; Bragg Law, measurement of lattice parameters for Cubic lattice.
Introduction to Crystal imperfections and dislocations

UNIT III **8 Hrs**

Fractures: Theory of Facture, types and temperature dependence of fractures.

UNIT IV **8 Hrs**

Oxidation and Corrosion: Mechanism of oxidation, oxidation resistant materials, principles of corrosion; protection against corrosion.

UNIT V **10 Hrs**

Superconducting materials: Introduction to BCS theory; properties of conventional and high temperature superconductors; and soft superconductors; superconducting magnets, thin films and bulk superconductor.

Suggested Text Books & References

1. Material Science and Engineering, V. Raghavan, Prentice Hall Pvt. Ltd. (1999).
2. Elements of Material Science & Engineering, Van Vlack, 6th Ed. Addison Wesley.
3. The Structure and Properties of Materials Vol 1, W.G. Moffat , G.W. Pearsall and J. Wultt, Wiley Eastern, Pvt. Ltd.
4. The Structure and Properties of Materials, Vol.2, W,G. Moffat G.W. Pearsall and J. W.G. Moffat, G.W. Pearsall and J.Wultt, Wiley Eastern, Pvt. Ltd.
5. The Structure and Properties of Materials Vol. 3, H.W. Hayden, W.G. Moffat, G.W. Pearsall and J.Wultt Eastern, Pvt. Ltd.
6. Introduction to Material Science for Engineering, 2nd E, J.F. Shackelford, McMillan Pub. Co.

Paper ID	Paper	L	T	P	Credit
99216	BA-216 Physico Organic Chemistry	3	1	0	4

Note: Student may be asked to attempt five questions in all, at least two questions from each section.

Section –A

UNIT III **4 Hrs**

Chemical Bonding and Polymer Structure:

Chemical bonding: Dipole, Induction and Vander Waals (Dispersion) Forces. Polarity of Monomers, Configuration, Conformation, Cohesive energy density, crystalline& amorphous structure of polymers, Morphology of crystalline polymers, Crystallinity and Ploymer properties.

UNIT II **12 Hrs**

Polymerization

(i) Step Ploymerization:
Mechanism, Kinetics & Statistics of Linear Stepwise Polymerization, Polyfunctional step –reaction polymerization.

(ii) Chain Polyerization
Free radical Polymerization, lonic & Co –ordination Polymerization examples of chain ploymerization)

(iii) Ploymerization of Cyclic Organic Compounds and Dienes.

UNIT III **4 Hrs**

Copolymerization

Free -Radical copolymerization, lonic Copolymerization & Copolycondensation.

Section -B

UNIT IV **9 Hrs**

Polymer in Solution

i. Criteria for Polymer Solubility, Thermodynamics of polymer solutions, Flory –Huggins theory & its limitation, Phase equilibrium in polymer solutions, Fractionation of Polymers, Polymer – Polymer mixtures.

ii. Molecular weight & its determination: Concept of molecular weight in colloids, molecular weight of ploymes, methods of determining molecular weight: Chemical & Physical Methods.

UNIT V **6 Hrs**

Introduction of surfactants &Surfactant micellization

Nature, raw materials, classification, dermatological & ecological aspects of surfactants & their development. CMC its dependence on Chemical structure, temperature solubility of surfactants, driving force of micelle formation& thermodynamic models, micelle size & structure.

UNIT IV **(5 Hrs)**

Surfactants –Polymer Systems:

Polymer & surfactants, surfactant interaction with active polymers, phase behaviour of polymer – surfactant mixtures, Technical applicants of polymer surfactant mixrures.

References:

1. Text book of Polymer Science: F.W. Billmayer, Jr. Wiley 2002
2. Principles of polymerization: Order G.John Wiley & Sons, 2002 (3rd ed.)
3. Principles of Polymer Science: P. Bahadur & N.V. Sastry, Narosa, 2003
4. Surfactants and Polymers in aqueous solution: K. Holmberg, B. Jonsson, B.Kronberg & B. Lindman, John Wiley & Sons, (2nd ed.) 2002

Paper ID	Paper	L	T	P	Credit
14202	CT-202 Eng. Thermodynamics-I	2	1	0	3

UNIT I **8 Hrs**

The first law and other basic concepts

Dimensions, units, work, heat, energy, the first law of thermodynamics, enthalpy, equilibrium, phase rule, heat capacity, PVT behavior of pure substances, ideal gas, real gas, heat effects.

UNIT II **8 Hrs**

Second law and Entropy

statements, heat engines, Kelvin-Planck and Clausious statements and their equality, reversible and irreversible processes, Carnot cycle, thermodynamic temperature scale, entropy, entropy calculations, T-S diagrams, properties of pure substances, use of steam tables and Mollier diagram.

UNIT III **6 Hrs**

Refrigeration and liquefaction

The Carnot refrigerator, the vapor–compression cycle, comparison of refrigeration cycles, liquefaction processes, heat pump. Rankine power cycle.

UNIT IV **6 Hrs**

Thermodynamic properties of fluids

Fluid property relations for homogenous phases, thermodynamic diagram, generalized property correlation for gases. **Thermodynamics of flow processes**: flow of compressible fluids through ducts, compression processes, turbines.

Text Books

1. Introduction to Chemical Engineering Thermodynamics, Smith J.M , Van Ness H.C., Abbott M. M The McGraw Hill Companies, Inc., USA
2. Chemical and Engineering Thermodynamics, Sandler S.I. John Wiley and Sons, Inc., New York

Reference Books

1. Introductory Chemical Engineering Thermodynamics, Elliott J. R. and Lira C. T., Prentice Hall
2. Applied Thermodynamics for Engineering Technologists, Eastop T. D. and McConkey A., Addison Wesley Longman Ltd., England

Paper ID	Paper	L	T	P	Credit
14204	CT-204 Unit Operation-II	3	1	0	4

UNIT I **12 Hrs**

Fundamentals of Mass Transfer

Molecular diffusion in fluids, mass transfer coefficients and interphase mass transfer, steady state theories of mass transfer, analogy.

UNIT II **10 Hrs**

Absorption

Equilibrium solubility of gases in liquids, choice of solvent, co-current and counter- current multistage operation, absorption equipment design and performance evaluation. Concept of ideal stage, stage efficiency, operating line. Concepts of HTU and NTU.

UNIT III **10 Hrs**

Humidification/Dehumidification

Use of psychometric charts (temperature/ humidity and enthalpy/humidity charts). Method of changing humidity. Estimation of air quality. Mass and heat balances in bulk and at interface - counter current, co-current and cross current. Design of cooling towers.

UNIT IV **10 Hrs**

Drying

Wet bulb, dry bulb and adiabatic saturation temperatures, humidity, drying mechanism, drying rate curves, estimation of drying time and process design of dryers e.g. spray, rotary, tunnel, tray, fluid bed and thin film, performance evaluation of dryers.

Text Books

1. Mass-Transfer Operation, Robert E. Treybal, McGraw Hill

.

Reference Books

1. Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C. and Harriott P. McGraw Hill International edition, Singapore
2. Principles of Unit Operations, Foust A.S. John Wiley & Sons, Singapore.
3. Introduction to Chemical Engineering, Badger W.L. and Banchero J.T., Tata McGraw Hill Edition.
4. Chemical Engineering, Vol. I, Coulson J.M. and Richardson J.F. Butterworth Heinemann, Oxford.

Paper ID	Paper	L	T	P	Credit
14206	CT-206 Heat Transfer-I	2	1	0	3

UNIT I **8 Hrs**

Steady State Conduction:

Fourier law, Concepts of resistance to heat transfer, Heat transfer coefficient, Insulation, Critical radius, extended surfaces of uniform thickness, Fin effectiveness and efficiency

UNIT II 8 **Hrs**

Radiation:

Stefan Boltzman law, Kirchoff's law and applications

UNIT III 8 **Hrs**

Convection:

Convection boundary layer, Heat transfer in laminar & turbulent flow in circular pipe, Boundary layer analogy, Mechanism of heat flow by natural convection

UNIT IV **8 Hrs**

Heat exchangers:

Heat exchangers, types of heat exchangers, Unsteady state heat transfer in agitated vessels, Heat transfer fluids, Process Design and Performance Evaluation of Double Pipe and Shell and Tube Heat Exchanger,

Text Books

1. Heat Transfer, Holman J. P., McGraw Hill, New York.
2. Process Heat Transfer, Kern D. Q., Tata Mc Graw Hill Edition.
3. Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C. and Harriott P. McGraw Hill International edition, Singapore.

Reference Books

1. Transport Processes and Unit Operations, Geankoplis C.J., Prentice Hall of India
2. Fundamentals of Heat and Mass Transfer, Dewitt et al., John Willey & Sons
3. Chemical Engineering Vol.1, Coulson J.M. and Richardson J.F. Butterworth Heinemann, Oxford
4. Heat Transfer, Chapman A. J., Mac millan, New York
5. Fundamentals of Momentum, Heat and Mass Transfer, Welty J.R., Wilson R.E., and Wicks C.E., John Wiley & Sons, Inc. New York

Paper ID	Paper	L	T	P	Credit
99262	BA-262 Physico Organic Chemistry Lab	0	0	4	2

List of experiments:

1. Preparation of Polysulphide Rubber (ThiokoL).
2. Identification of Polymers (Chemical Analysis)
3. Preparation of U –F resin.
4. Determination of melting point, storing time and gel time of Phenolic resins.
5. Determination of Mv by dilute Solution viscosity method.
6. Preparation of Polyvinyl alcohol.
7. Preparation of solid Epoxy resin.
8. Determination of Mn by End group analysis.
9. To study the degradation behaviour of a polymer.
10. To find interfacial tension for benzene and water at room temperature.
11. To determine the critical miscelle concentration of surface active – material by surface tension method.

Reference:

1. Principles of Polymer Science : P. Bahadur & N.V. Sastry, Narosa, 2003
2. Practical Physical Chemistry: B. Viswanathan & P.S . Raghavan .
3. Senior Practical Physical Chemistry: B.D. Khosla, V. C. Garg, Adarsh Gulati.

Paper ID	Laboratory	L	T	P	Credit
14252	CT-252 Fluid Mechanics Lab	0	0	3	2

List of experiments:

1. Calibration of orifice meter.
2. Performance of venturi meter.
3. Pump characteristics
4. Power consumption in agitated vessel.
5. Pressure drop in pipe.
6. Bernoulli′s experiment.
7. Verification of Stokes′ Law
8. Flow through packed bed.
9. Flow through fluidized bed.

Paper ID	Laboratory	L	T	P	Credit
14254	CT-254 Unit Operation Lab-II	0	0	3	2

List of experiments:

1. Fractional distillation
2. Studies on drying characteristics
3. Experiments on humidification and dehumidification in a packed column.
4. Studies on batch distillation.
5. Determination of diffusion co-efficient of carbon tetrachloride in air.
6. Determination of diffusion co-efficient of naphthalene in air.

FIFTH SEMESTER EXAMINATION

L	T	P	Credits
16	5	6	25

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
14301	CT-301	Chem. Eng. Thermodynamics II	2	1	0	3
14303	CT-303	Chem. Reaction Eng I	3	1	0	4
14305	CT-305	Heat Transfer-II	2	1	0	3
14307	CT-307	Mass Transfer	3	1	0	4
14309	CT-309	Process Control-I	3	1	0	4
14311	CT-311	Chem. Process Industries-I	3	0	0	3
Practical/Viva Voce						
14351	CT-351	Mass Transfer Lab	0	0	3	2
14353	CT-353	Heat Transfer Lab	0	0	3	2
		Total	**16**	**5**	**6**	**25**

Paper ID	Paper	L	T	P	Credit
14301	CT-301 Chemical Engineering Thermodynamics II	2	1	0	3

Solution Thermodynamics: chemical properties, partial properties, ideal gas mixture, fugacity, fugacity coefficient for a pure species and for species in solution and correlation for the fugacity coefficients, excess properties. Liquid phase properties from vapour liquid equilibrium data. Models for the excess Gibb's energy. Change of properties due to mixing, heat effect of mixing process

Phase Equilibria: Phase rule. Vapour-liquid equlibria at low to moderate pressures. High pressure vapour-liquid equilibria. Liquid-liquid equilibria. Osmotic equilibria and Osmotic pressure.

Chemical

Equilibrium: Chemical equilibrium in homogenous and heterogeneous chemical reactions. Combined chemical and phase equilibrium. Balance equation for Tank-type and Tubular reactors.

Thermodynamic Analysis of Processes: Work and energy functions, availability, heat exchange, mixing and separation processes.

Books & References:

1. Introduction to Chemical Engineering Thermodynamics, Smith J.M , Van Ness H.C., Abbott M. M The McGraw Hill Companies, Inc., USA, 5th Ed., 1996.
2. Chemical Engineering Thermodynamics, Sandler S.I. John Wiley and Sons, Inc., New York, 3rd Ed., 1999.
3. Chemical Engineering Thermodynamics, Balzheiser R.D, Samuels M.R. and Eliassen J.D., Prentice Hall, Englewood Cliffs, 1972.
4. Introductory Chemical Engineering Thermodynamics, Elliott J. R. and Lira C. T., Prentice Hall, 1999.
5. Applied Thermodynamics for Engineering Technologists, Eastop T. D. and McConkey A., Addison Wesley Longman Ltd., England, 5th Ed., 1999.

Paper ID	Paper	L	T	P	Credit
14303	CT-303 Chemical Reaction Engineering I	3	1	0	4

Review of kinetics for homogeneous reactions.

Classification of reactors, design equations for batch, flow and semi batch reactors and their performance. Collection and interpretation of rate data using batch and flow reactors. Residence time distribution concepts and modeling of non-ideal reactors.

Energy balance and design of ideal, single phase flow reactors with heat effects.

Books & Reference:

1. Chemical Reaction Engineering, Levenspiel O., John wiley & Sons (Asia), 3rd Ed., 2000.
2. Chemical Engineering Kinetics, Smith J.M., , McGraw Hill 3rd Ed., 1980.
3. Elements of Chemical Reaction Engineering, Scott Fogler H., Prentice Hall of India, 2nd Ed., 1999.

Paper ID	Paper	L	T	P	Credit
14305	CT-305 Heat Transfer-II	2	1	0	3

UNIT I **12 Hrs**

Conduction: Two-dimensional steady State Conduction: Analytical & Numerical Methods. Unsteady State unidirectional Heat Conduction.

UNIT II **8 Hrs**

Boiling and Condensation: Dropwise and film Condensation, Horizontal & vertical Condensers, condensation of a vapour from a non-condensable gas.

UNIT III **3 Hrs**

Reboiler: Natural Circulation & Forced Circulation reboiler arrangement.

UNIT IV **4 Hrs**

Evaporation: Evaporator types, Single and multiple effect evaporators. Calculation of surface area requirements.

UNIT V **12 Hrs**

Heat transfer to fluidized and packed beds: Heat transfer to the containg wall, Heat transfer within a packed bed, Determination of effective thermal conductivity of a packed bed of solid particles. Heat transfer between the bulk fluid and external surface of solid particles.

Books & References:

1. Heat Transfer, Chapman A. J., Macmillan, New York, 2nd Ed. 1967
2. Heat Transfer, Holman J. P., McGraw Hill, New York, 8th Ed 1997.
3. Process Heat Transfer, Kern D. Q., Tata McGraw Hill Edition, 1997.
4. Fundamentals of Heat and Mass Transfer, Dewitt et al., John Wiley & Sons, 4th Ed. 1998.
5. Fundamentals of Momentum, Heat and Mass Transfer, Welty J.R., Wilson R.E., and Wicks C.E., John Wiley & Sons, Inc. New York, 4th Ed., 2000.

Paper ID	Paper	L	T	P	Credit
14307	CT-307 Mass Transfer	3	1	0	4

UNIT I **14 Hrs**

Distillation : Fundamentals of vapor liquid equilibrium, Henery's, Raoult's and Dalton's laws, x-y and T-x-y diagrams, partial vaporization/condensation, performance evaluation of distillation column including reboiler and condenser, flash, differential and steam distillation. Number of plate's calculation using McCabe-Thiele and enthalpy-concentration diagram. Relation of HTU to HETP.

UNIT I I **10 Hrs**

Liquid-Liquid Extraction: Extraction process and equipment, equilibrium diagram, choice of solvent, single and multistage co-current, countercurrent extraction.

UNIT I II **14 Hrs**

Solid - Fluid Operations: Adsorption. Nature of adsorbents- silica gel, activated alumina, molecular sieves, activated carbon. Structure of adsorbents – surface area, pore size etc. Adsorption equilibria. Multi-component adsorption. Isotherms – Langmuir, BET, Gibb's. Potential theory. Design of fixed bed and moving bed adsorbers.

UNIT I V **4 Hrs**

Ion Exchange & Leaching: Theory and operation.

Text Books

1. Mass-Transfer Operation, Robert E. Treybal, McGraw Hill

Reference Books

1. Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C. and Harriott P. McGraw Hill International edition, Singapore
2. Principles of Unit Operations, Foust A.S. John Wiley & Sons, Singapore.
3. Introduction to Chemical Engineering, Badger W.L. and Banchero J.T., Tata McGraw Hill Edition.
4. Chemical Engineering, Vol. I, Coulson J.M. and Richardson J.F. Butterworth Heinemann, Oxford.
5. Separation Processes, King C.J., Tata McGraw Hill
6. Transport Processes and Unit Operations, GeanKoplis, C.J. Prentice Hall

Paper ID	Paper	L	T	P	Credit
14309	CT-309 Process Control-I	3	1	0	4

Concept of measurement: error, accuracy, sensitivity.
Instrumentation for process variables such as pressure, temperature, level and flow of fluids.

Concept of automatic control, feed back control, control loop and its components.

Dynamic behavior of first order and second order, interacting, non interacting & higher order systems. Distance velocity lag. Transfer function. Response of distributed systems.

Laplace domain analysis of closed loop systems, Routh stability and Root Locus Diagrams.

Frequency response analysis. Bode and Nyquist stability criterion.

Choice of controller and controller settings. Simple cases of single variable control system design.

Books & References:

1. Process Dynamics & Control, Seborg D. E., T. F. Edger and D. A. Mellichamp, John Wiley & Sons, 1989..
2. Process Systems Analysis and Control, Coughanowr D.R., McGraw Hill, 2nd Ed., 1991.
3. Chemical Process Control-an introduction to theory and practice, Stephanopoulos, G. Prentice Hall of India, 1984.
4. Process Control, Harriott P., McGraw Hill.

Paper ID	Paper	L	T	P	Credit
14311	CT-311 Chemical Process Industries-I	3	0	0	3

Salient features of manufacture of commodity chemicals.

Status of chemicals and chemical industry in India.

Engineering aspects of the manufacture of basic inorganic chemicals such as sulphuric acid, caustic soda , chlorine, hydrogen, soda ash, ammonia, nitric acid and urea. Solid, liquid and gaseous fuels. Carbonisation and gasification of coal.

Books & References:

1. Chemical Process Industries, Shreve, R.N. and Brink, J.A.McGraw Hill
2. Chemtech I, II, III, and IV, Indian Institute of Technology, Madras
3. Outlines of Chemical Technology, Dryden, C. Rao, M.G. and Sitting, M., Affiliated East West Press Pvt. Ltd., New Delhi

Paper ID	Laboratory	L	T	P	Credit
14351	CT-351 Mass Transfer Lab	0	0	3	2

List of experiments:

1. Absorption in a bubble column.
2. Absorption in packed column.
3. Packed column extraction.
4. Spray extraction column.
5. Studies on leaching.
6. Studies on ion-exchange.

Paper ID	Laboratory	L	T	P	Credit
14353	CT-353 Heat Transfer Lab	0	0	3	2

List of experiments:

1. Heat transfer in agitated vessel.
2. Heat transfer in shell & tube heat exchanger.
3. Heat transfer in double pipe heat exchanger.
4. Heat transfer in plate type heat exchanger.
5. Heat transfer in finned tube heat exchanger.
6. Heat transfer in vertical condenser.
7. Heat transfer in horizontal condenser.
8. Triple effect evaporator.

SIXTH SEMESTER EXAMINATION

L	T	P	Credits
17	5	8	27

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
14302	CT-302	Chemical Process Control-II	3	1	0	4
14304	CT-304	Chemical Reaction Eng.-II	3	1	0	4
14306	CT-306	Computational Methods for Chemical Engineers	2	1	0	3
14308	CT-308	Chemical Process Industries-II	3	0	0	3
14310	CT-310	Safety, Hazards & Environment	3	0	0	3
39312	MS-312	Organization Behavior & Industrial Management	3	0	0	3
Practical/Viva Voce						
14352	CT-352	Chemical Reaction Eng. Lab	0	0	3	2
14354	CT-354	Process Control Lab	0	0	3	2
14356	CT-356	Seminar	0	2	0	2
14358	CT-358	Computational Lab	0	0	2	1
		Total	**17**	**5**	**8**	**27**

Paper ID	Paper	L	T	P	Credit
14302	CT-302 Chemical Process Control II	3	1	0	4

Complex control system: Multiple loop control systems; Cascade control; Ratio control; Feed forward control

Multivariable process control: Design of controllers for interactions, Loop interaction, Decoupling of interacting loops.

Tuning of feed back controllers — Quarter Decay Ratio Response, Minimum error Integral Criterion, IAE, ISE, ITAE, ITSE

Design strategies for common industrial processes such distillation, heat exchangers, etc.

Batch Process: Introduction to advanced control strategies, use of microprocessors in process control.

Books & References:

1. Industrial Instrumentation, Eckman. D.P,Wiley Eastern Ltd.
2. Process Instrumentation and Controls Handbook, Considine,D.N., McGraw Hill.
3. Process System Analysis and Control, Coughanowr, D.R. and Koppel, L.B.,McGraw Hill.
4. Chemical Process Control- An introduction theory and practice, Stephanopolous, G., Prentice Hall of India.
5. Principals and Practice of Automatic Process Control, Carlos A. Smith and Armando B. Corripio, John Willy & Sons, 2nd Ed.

Paper ID	Paper	L	T	P	Credit
14304	CT-304 Chemical Reaction Engineering II	3	1	0	4

Introduction to heterogeneous reactions
Gas-solid catalyzed reactions, rate equations, laboratory reactors, collection and interpretation of rate data.

Diffusion in porous catalysts.

Kinetics of fluid-fluid and fluid solid non catalytic reactions.

Modeling and Design of gas-solid catalytic reactors.

Books & Reference:

1. Chemical Reaction Engineering, Levenspiel O., John wiley & Sons (Asia), 3rd Ed., 2000.
2. Chemical Engineering Kinetics, Smith J.M., , McGraw Hill 3rd Ed., 1980.
3. Elements of Chemical Reaction Engineering, Scott Fogler H., Prentice Hall of India, 2nd Ed., 1999.
4. Chemical Reactor Analysis and Design, Froment G.F. & Bischoff, John Wiley & Sons, 2nd Ed 1990.

Paper ID	Paper	L	T	P	Credit
14306	CT-306 Computational Methods for Chemical Engineers	2	1	0	3

Mathematical formulation of the physical problem Formulation of the differential equation
Application of law of conservation of Mass;
Application of law of conservation of Momentum;
Application of law of conservation of energy;
Solution of simulation differential equations;
Mathematical formulation of finite difference equation
Finite difference methods in analysis of stage wise processes, numerical solution of partial differential equation: linear parabolic P.D.E, Elliptic equation:

- Crank Nicolson method, tri diagonal matrix and the Thomas algorithm.
- Relaxation method.

Analytical solution of linear and non linear O.D.E. using Laplace Transform-espcially for chemical engineering problems.

Books & References :

1. Applied Mathematics in Chemical Engineering, Mickley, H.S., Sherwood, T.K., and Reed, C.E., McGraw Hill, N.Y.
2. Numerical Methods for Engineers, Gupta, S.K., New Age Publishers, 1995.
3. Carnahan, B., Luther, H.A and Wilkes, J.O., Applied Numerical Methods, Wiley N.Y 1969.

Paper ID	Paper	L	T	P	Credit
14308	CT-308 Chemical Process Industries-II	3	0	0	3

UNIT I **8 Hrs**

Engineering aspects of the manufacturing of cement, sugar, vegetable oil and pulp & paper, ethylene oxide and esters.

UNIT II **8 Hrs**

Energy aspects of the manufacture with consideration for alternative routes of basic organic chemicals, such as Ethylene, Propylene, Olefins, Acetylene, and Butadiene.

UNIT III **8 Hrs**

Engineering aspects of the manufacturing of benzene and alkyl benzene, vinyl chloride, styrene, phenols, amines.

UNIT IV **8 Hrs**

Engineering aspects of the manufacturing of alcohols (methanol), aldehydes (formaldehyde), ketones, carboxylic acid, phthalic anhydride, terephthalic acid.

Books & References:

1. Chemical Process Industries, Shreve, R.N. and Brink, J.A.McGraw Hill
2. Chemtech I, II, III, and IV, Indian Institute of Technology, Madras
3. Outlines of Chemical Technology, Dryden, C. Rao, M.G. and Sitting, M., Affiliated East West Press Pvt. Ltd., New Delhi

Paper ID	Paper	L	T	P	Credit
14310	CT-310 Safety, Hazards & Environment	3	0	0	3

UNIT IV **12 Hrs**

Types of Ecosystems, Factors responsible for the distribution on Hydrologic cycles, Nutrient cycles (carbon, nitrogen, phosphorous, sulfur).

Introduction to ISO standards (ISO 14001) with reference to chemical industry.

Industrial hygiene and safety aspects related to toxicity, noise, radiation: Identification, Evaluation, Control

UNIT II **8 Hrs**

Fires and Explosions: Flammability Characteristics of liquids & vapors, minimum oxygen concentration (MOC), Ignition Energy, Ignition sources, Explosions: Detonation & Deflagration, combined explosions, BLEVE, Blast Damage due to overpressure.

UNIT III **8 Hrs**

Hazard identification: Various Techniques, HAZOP.

Consequence analysis: Flow of liquid/vapors through hole, flashing liquid, Pool evaporation.

UNIT IV **8 Hrs**

Design to prevent fire & explosions: Inerting, controlling static electricity, explosion proof equipments & instruments, ventilation, sprinkler systems.

Hazards / Risk Assessment: Event trees, fault trees, reliability, probability

UNIT V **6 Hrs**

Emergency planning: Elements of emergency planning, on-site/ off-site emergency plans.

Case studies: Bhopal Tragedy, Flixborough Disaster, Mexico Disaster

Books & References:

1. Chemical Process Safety Fundamentals with Applications: Daniel A Crowl, Joseph F. Lovvar
2. Safety in Process Plant Design, Wells, G.L.
3. Loss Prevention in Process Industries, Lees, F.P.
4. Environmental Protection, Chanleft, E.T.
5. Strategy of Pollution Control, Berthowex, P.M., and Rudd, D.F.
6. Safety for Chemical Engineers, A.I.Ch.E. Publications (1976-77).

Paper ID	Paper	L	T	P	Credit
39312	MS-312 Organization Behavior & Industrial Management	3	0	0	3

UNIT I **10 Hrs**

Nature of Organizations, Structure of Organization. Organizational Behavior. Organizations in Indian Context. Role Responsibilities of a Manager.

UNIT II **10 Hrs**

Individual and Organization: Perception, Attitude, Motivation, Personality, Values of Sets, Stress and its Management.

UNIT III **10 Hrs**

Interpersonal communications, Group dynamics, Decision Making. Organizational change and Development.

UNIT IV **12 Hrs**

Economic Planning and Policy in India, Industrial Policy, Industrial Development in India. Position and Problems of Chemical Industries in India.

Text Books:

1. Organization Behavior by Robbing, S.P.:

Reference books

1. Management by Stonier
2. Managemnet behavior by Euthans, Fred, McGraw Hill

Paper ID	Laboratory	L	T	P	Credit
14352	CT-352 Chemical Reaction Engineering Lab	0	0	3	2

List of experiments:

1. Batch Reactor
2. Tubular flow reactor
3. C S T R
4. P F R
5. Residence time distribution.
6. Flow Analogy for series and parallel reactors.
7. Kinetics of non catalytic Gas-Solid reaction.
8. Performance of non ideal reactor.
9. Kinetics of gas liquid reaction.

Paper ID	Laboratory	L	T	P	Credit
14354	CT-354 Chemical Process Control Lab	0	0	3	2

List of experiments:

1. Flow control system.
2. Air pressure control system
3. Temperature control system.
4. Level control system.
5. Dynamics of a first order system.
6. Dynamics of a second order system.
7. Dynamics of distributed parameter system.

Paper ID	Laboratory	L	T	P	Credit
14356	CT- 356 Seminar	0	2	0	2

Student will required to prepare a critical reviews of selected topics in Chemical Engineering and allied subjects and submit in the form of a standard typed report. The student will also be required to make an oral presentation of the review.

Paper ID	Laboratory	L	T	P	Credit
14358	CT- 358 Computational Lab	0	0	2	1

Exercises and practice problems on topics covered in the theory course CT-309, Computational Methods for Chemical Engineers. Students will be required to write computer program as well as gain experience in the use of commercially available software.

SEVENTH SEMESTER EXAMINATION

L	T	P	Credits
14	4	11	25

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
14401	CT-401	Process Equipment Design	2	2	0	4
14403	CT-403	CAD and Simulation	3	1	0	4
14405	CT-405	Introduction to Biochemical Eng,	3	1	0	4
98411	HS-411	Introduction to Economics	3	0	0	3
		Elective-I/IDS	3	0	0	3
Practical/Viva Voce						
14451	CT-451	CAD & Simulation Lab	0	0	3	2
14453	CT-453	Project Work I	0	0	8	4
14455	CT-455	Industrial Training / Visit Report	-	-	-	1
		Total	**14**	**4**	**11**	**25**

IDS: Inter disciplinary subject

Paper ID	Paper	L	T	P	Credit
14401	CT-401 Process Equipment Design	2	2	0	4

UNIT I **6 Hrs**

Introduction to various codes (ASTM, API, Japanese, German etc.) and Material specification used in chemical process industries and their application.

UNIT II **12 Hrs**

Basic Engineering design approach and selection of pressure vessel components such as Head, closure, flanges, gasket, nozzles etc,

UNIT III **12 Hrs**

Design of process vessel and process vessel supports used in chemical process industries

UNIT IV **12 Hrs**

Mechanical design of process equipment such, shell & tube Heat Exchanger, plate and packed tower, reactors.

Books & References :

1. Introduction to Chemical Equipment Design, Mechanical Aspects, Bhattacharya, B.C., CBS Publisher and Distributor, Ist Edition 1985.
2. Process Equipment Design, Joshi, M.V.,Mahajani,V.V., Rajiv Beri for Macmillan India Ltd, 3rd Ed, 1996.
3. Perry's Chemical Engineer's Hand Book, Robert H.Perry, Don W.Green, McGraw Hill, 7th Ed., 1998.
4. Plant Design and Economics for Chemical Engineers Max S.Peters, Klaus D. Timmerhaus McGraw Hill., 4th 1991.
5. Chemical Process Equipments selection and design, Stanley M.Walasss, Butterworth Heinemann, Ist Ed., 1990.

Paper ID	Paper	L	T	P	Credit
14403	CT-403 CAD & Simulation	3	1	0	4

Mathematical Modelling: Basis of mathematical model, types of mathematical model, fundamental laws of modeling, model building, modelling difficulties, differential and population balance models, use and importance of mathematical models in process design.

Fundamental laws: Continuity equations, energy equations, equation of state, equilibrium, & Chemical Kinetics.

Simple examples of process models ie reactors (plug flow, CSTR, Batch etc.), mass transfer equipments (distillation column, humidifier, dehumidifiers, absorber etc.), heat transfer equipments (evaporators, condensers, heat exchanger etc), crystalliser etc and their combinations.

Application of numerical methods in digital simulation: Interactive convergence methods, interval halving, Newton raphson method, false position, explicit convergence method, wegstein method, muller method, numerical integration of ordinary differential equations; explicit numerical integration algorithms, euler method, runga-kutta method, implicit method

Process flow simulation: Steady state simulation, concept of unit computation, block diagrams development, signal flow graph, partition, tearing convergence block and control block concept, process matrices, identification of recycle sets through process matrices.

Use of generic software for steady state material and energy balance flow sheet simulation. Review of thermodynamics, Correlation for estimates of physical properties of liquid/gaseous mixture like phase equilibrium, bubble point, dew point.

Software development for design of chemical engineering equipments

Books & References:

1. Luyben, W.L. Process Modelling, Simulation and Control, McGraw Hill Book Co., 1990.
2. Franks, R.G.E., Modelling and Simulation in Chemical Engineering, Wiley Inter science.
3. Mi Schka, C., Computer Aided Design, Prentice Hall.
4. Hussain Asgher, Chemical Process Simulation, Wiley eastern Ltd., New Delhi, 1986.

Paper ID	Paper	L	T	P	Credit
14405	CT- 405 Introduction to Bio-chemical Engineering	3	1	0	4

Enzyme & kinetics of enzyme-catalytic Reactions

Enzyme ------- Basic knowledge, Physico-chemical properties, Micro-organism as a source of enzyme.

Enzyme kinetics - Single & double substrate steady state kinetics, effect of pH & temperature, inhibition. Down stream processing of commercial enzymes. Enzyme purification techniques.

Bioprocess Engineering

Microbial growth in a batch and continuous bioreactor; substrate utilization and product formation kinetics. Estimation of cell mass; Study of different phase of microbial growth, concept of limiting nutrient and effect of its concentration on cell growth; Study of growth inhibition kinetics, study of product formation kinetics in a fermentation process; comparison between aerobic and anaerobic bioconversion process; estimation of K_La in fermentation process.

Air Sterilization; Media Sterilization; Batch, continuous and fed batch processes Aeration and agitation.

Books & References:

1. Biochemical Engineering Fundamentals by James E.Bailey & David F.Ollis, Publishers: McGrew-Hill.
2. Bioprocess Engineering by Shuler & Kargi, Prentice Hall
3. Encyclopedia of Chemical Engineering by Kirk & Othmer,

Paper ID	Paper	L	T	P	Credit
98411	HS-411 Introduction to Economics	3	0	0	3

UNIT I **8 Hrs**

Basic Economic Problems Alternative Economic Systems and their Functioning. Micro and Macro Economics. Basic Elements of Demand and supply Analysis.

UNIT II **10 Hrs**

i. **Consumer's Equilibrium:** Marginal Utility and Indifference Curve Analysis, Elasticity of Demand and Supply.
ii. **Theory of Production:** Production Functions, Law of Variable Proportions Law of Returns to Scale, Isoquants, Expansion Path, Equilibrium of the Firm.

UNIT III **15 Hrs**

i. **Theory of Costs:** Social and Private Costs, Short run and long run costs, economies and diseconomies of scale.
ii. **Market Equilibrium under alternative forms of market:** Perfect competition, Monopoly, Monopolistic competition and oligopoly

UNIT III **15 Hrs**

i. **Factor Pricing:** Determination of rent, wages, profit and interest.
ii. **National Product and Income:** Basic concepts and its measurement Basic elements of monetary and fiscal policy.

Text Books

1. Principal of Economic, Lipsey & Crystal, Oxford University Press.
2. Samuelson Nordhans Economic, Tata Mc Graw Hill, Ed, New Delhi.

Reference Books

1. Economic Analysis. Theory and Application, Ferguson and Maurice, Richard D. Inwin Inc.
2. Economics, John Slowman, Financial Time, Prentice Hall, Prarson Education Ltd
3. Micro Economics: Principles and Policy. William J. Baumol and S. Binder

Paper ID	Laboratory	L	T	P	Credit
14451	CT-451 CAD & Simulation Lab	0	0	3	2

Application of the following software packages to assigned problems:

1. ASPEN PLUS
2. ASPEN DYNAMICS
3. ASPEN CUSTOMER MODELER
4. MATLAB-SIMULINK

Paper ID	Laboratory	L	T	P	Credit
14453	CT-453 Project Work I	0	0	8	4

Each student shall be assigned a specific project. He/she shall select most appropriate process from various available alternatives and design the plant. A cost analysis, plant layout etc. may also form part of the total exercise. The final report will be examined by a panel. Experimental projects with well-defined aims may also be offered subject to the availability of the facilities.

Paper ID	Laboratory	L	T	P	Credit
14455	CT-455 Industrial Training / Visit Report	0	0	0	1

Students should obtain training in chemical industries for a period of two months in summer and get acquainted with operation of commercial scale plants. The trainees should familiarize with all aspects such as purchase, quality control, operation and maintenance, R&D, finishing and packaging etc.

i. Each student will be given an evaluation format, which student will give to the HR of the industry and that format after evaluation will be send back to USCT confidentially by the industry
ii. At the end of the training period, each student should submit a report for assessment by a panel of examiners

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EIGHTH SEMESTER EXAMINATION

L	T	P	Credits
12	1	18	22

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
14402	CT-402	Chemical Process Eng,	3	0	0	3
98412	HS- 412	Project Writing	3	0	0	3
Electives						
14420	CT-420	Petroleum Engineering	3	0	0	3
14422	CT-422	Polymer Engineering	3	0	0	3
14424	CT-424	Biomass for Energy and Chemicals	3	0	0	3
		Elective –III / IDS	3	0	0	3
Practical/Viva Voce						
14452	CT-452	Project Work II	0	0	18	9
		Total	12	0	18	21

* Any one of the above Elective can be selected as by the students

Paper ID	Paper	L	T	P	Credit
14402	CT-402 Chemical Process Engineering	3	1	0	4

System and subsystem in chemical process engineering. System analysis. Economic degree of freedom - various algorithums.
Economic design criteria. Terms involved in profitability analysis. Capital cost and manufacturing cost estimation methods.

Strategy of scale-up and design of chemical processes; Role of pilot plant, process validation, salient features of patent literature.
Process evaluation and selection with special reference to eco-friendly technologies. Preparation of process specifications for typical equipment. Choice of batch v/s continuous process. Concept of dedicated and multiproduct plant facilities. Time cycle for batch processes. Development and evaluation of alternative flow sheets; efficient utilisation of energy; heat exchange net-works. Preparation of process and instrumentation diagrams. Conceptual. Project implementation-stagewise.

Books and References:

1. Strategy of Process Engineering, Rudd and Watson,.
2. Chemical engineering handbook, Perry, J.H., Mc GrawHill.
3. Plant design and economics for Chemical engineers, Peters , M.S. and Timmerhaus, K.D, Mc GrawHill.

Paper ID	Paper	L	T	P	Credit
98412	HS-412 Project Writing	3	0	0	3

UNIT I **10 Hrs**

Writing Skills: Descriptive, Narrative, Argumentive and Discursive, Reflective and Literary-Evaluative Writing. Technical Writing: Definition, Purpose and Characteristics of Technical Writing.

UNIT II **10 Hrs**

The Technical Writing Process: Prewriting Stage, The Writing Stage and the Postwriting stage. Technical Writing Skills: Researching, Summarizing and Outlining, Visual Aids, Definition, Description, Set of Instructions.

UNIT III **10 Hrs**

Formal Formatting: Arrangement of Formal Elements, Front Material, Format Devices in the Body of Formal Report-Heading, Pagination, End Material—Citations, References and Bibliography, Appendix.

UNIT IV **12 Hrs**

Technical Writing Applications: Memorandums and Informal Format, Formal Format, Recommendations and Feasibility Reports, Proposals, Progress Reports, Analysis Reports Professional Communication, Letters and Job Applications. Presentation and Meetings.

Text books

1. Forsyth, Sandy and Lesley Hutchison, “Practical Composition”, Edinburgh Oliver and Boyd,

Reference books

1. Sides, Charles H., “How to Write and Present Technical Information”, Cambridge, Cambridge University Press,
2. Guffey, Mary Ellen, “Business Communication, Cincinnati”, South-Western College Publishing,

Paper ID	Paper	L	T	P	Credit
14420	CT-420 Petroleum Engineering	3	0	0	3

Transportation and storage of crude oil, Characterization of Crude oil, crude selection for refining processing. (**8 Hrs)**

Classification and composition of petroleum, Evaluation of Crude oil and Chemical compositions, Non hydrocarbons compounds in petroleum. Physical and thermal properties of TBP distillation of crude petroleum. **(8 Hrs)**

Quality control of petroleum products, LPG, Naphtha, Motor Sprit, Kerosene, ATF, Diesel fuels, Fuel oil, Petroleum Waxes, Bitumen properties and test methods. Properties and applications of all petroleum products. **(10 Hrs)**

Distillation methods, Atmospheric distillation, Vacuum distillation.
Thermal cracking and catalytic cracking.
Introduction to reforming, Isomerization and alkylation processes (14 Hrs)

Course Objectives :

- A brief knowledge about chemical composition, characterization and evaluation of Crude Oil.
- To introduce the various processes of refinery and get familiarized with properties and composition of various petroleum products.

Books and References:

1. Modern Petroleum Refining Processes, B.K. BhaskarRao Oxford and IBM Pub. Co. Pvt Ltd, N.Delhi, 1990
2. Petroleum Refining Technology and Economics, J.H. Gary, G.E. Handiwerk, Marcel and Dekker INC., New York.
3. The Chemistry and Technology of petroleum, J.G. Speight, Marcel Dekker, 1991

Paper ID	Paper	L	T	P	Credit
14422	CT-422 Polymer Engineering	3	0	0	3

Fundamentals: Polymer structure-properties, molecular weight and its distribution. **(6 Hrs)**

Polymer Reaction Engineering: Polymerization Processes, Polymerization reactors, Reaction engineering of step growth and chain growth polymerization.

(18 Hrs)

Thermodynamics of Polymer solution and mixtures, Diffusion through polymeric materials, Flow behaviour of polymeric fluids. **(10 Hrs)**

Unit operations of polymer processing, Properties of commodity and engineering polymers, Polymer product and its applications. **(6 Hrs)**

Books and References:

1. Polymer Science and Technology, Ebewele R.O., CRC, 196.
2. Plastics Engineering, Crawford, P.J., Butterworth, Heinemam, 3rd Ed., 1998.
3. Fundamentals of Polymers, Kumar A., and Gupta R.K., McGraw-Hill, 1998.
4. Polymer Science and Technology, Fried J.R., Prentice Hall of India, 1999.
5. Plastics Materials, Brydson J.A., Butterworth Scientific, current edition.
6. Encyclopedia of Polymer Science and Technology, Herman F. Mark, Norman G.Gaylord, and Norbert M. Bikales, Wiley-Interscience, New York. 3rd Edition.
7. Fundamental Principles of polymeric Material, Rosen L. Stephen, Wiley Interscienc, New York, current edition.
8. Principles of Polymerization, Odian George, 3rd Edition, John Wiley & Sons.

Paper ID	Paper	L	T	P	Credit
14424	CT-424 Biomass for Energy and Chemicals	3	0	0	3

Biomass as a source of energy, feed stock, food stuff.

Biomass characterization. Solid, liquid and gaseous products from biomass.

Sources of biomass-agricultural residue, forestry waste, industrial waste.

Overview of conversion technologies – in particular, thermo chemical conversion of biomass.

Combustion, pyrolysis and gasification of biomass.

Design of gasifier for biomass conversion.

Electricity generation and charcoal production from biomass.

Useful chemicals and energy from rice husk.

Books & References:

1. Biomass Application, Nicholas P. Cheremisinoff, Paul N. Cheremisinoff, Fred Ellerbusch, Technology and Production, Marcel Dekker, inc. NY
2. Developments in Thermochemical Biomass Conversion, A.V. Bridgwater and D.G.B. Boocock , Editors, Vol I & II , Blackie Academic and Professional Publisher, London, ed.1997
3. Biomass Conversion Processes for Energy and Fuels, S.S.Sofer and O.R. Zaborsky, editor, Plenunm Press N.Y.
4. Advances in Thermochemical Conversion , A.V.Bridgwater, editor, Blackie Academic and Professional Publisher, London

Paper ID	Laboratory	L	T	P	Credit
14452	CT-452 Project Work II	0	0	18	9

Each student shall be assigned a specific project. He/she shall select most appropriate process from various available alternatives and design the plant. A cost analysis, plant layout etc. may also form part of the total exercise. The final report will be examined by a panel. Experimental projects with well defined aims may also be offered subject to the availability of the facilities.

The minimum number of credits to be earned for the award of the B.Tech degree should be 200 credits as per university's norms.