Proposed Syllabus

For

B.Tech Program

in

Chemical Engineering

By

C.S.J.M.University,Kanpur

Department of Chemical Engineering

B.Tech program curriculum

Semester-wise breakup of courses

Semester-1

		L	T	P	Cr
HSS-S101	Communicative English	3	0	0	4
MTH-S101	Mathematics-I	3	2	0	4
PHY-S101T	Physics-I	3	1	0	3
PHY-S101P	Physics Lab-I	0	0	3	2
ISC-S101T	Programming & Computing	3	0	0	3
ISC-S101P	Programming Lab	0	0	3	2
TCA-S102T	Workshop Concepts	1	1	0	2
TCA-S102P	Workshop Practice	0	0	3	3

Semester-II

CHM-S101T	Chemistry-I	3	0	0	3
CHM-S101P	Chemistry Lab-I	0	0	3	2
ESC-S101T	Basic Electrical &Electronics Engg.	0	0	3	2
ESC-S101P	Basic Electrical &Electronics Engg. Lab	3	1	0	4
MTH-S102	Mathematics-II	3	2	0	4
TCA-S101	Engineering Drawing	2	1	3	5
PHY-S102T	Physics-II	3	1	0	3
PHY-S102P	Physics Lab-II	0	0	3	2

Semester-III

MTH-S201	Mathematics-III	3	2	0	4
ESC-S202	Thermodynamics	3	1	0	4
ESC-S201	Engineering Mechanics	3	1	0	4
CHE-S201	Process Calculations	3	1	0	4
CHE-S202	Transport Processes & Unit Operations-I (Fluid Mechanics)	3	1	0	4

Semester-IV

CHE-S203	Chemical Engg. Thermodynamics	3	1	0	4
CHE-S204	Transport Processes & Unit Operation-II (Heat Transfer)	3	1	0	4
CHE-S205	Chemical Process Industries-I	3	1	0	4
CHE-S206	Transport Processes & Unit Operation-III (Mechanical Operations)	3	1	0	4
HSS-S401	Industrial Economics	3	0	0	4

Semester-V

		L	T	P	Cr
CHE-S301	Transport Processes & Unit Operation-IV (Mass Transfer-I)	3	1	0	4
CHE-S302	Chemical Process Industries-II	3	1	0	4
CHE-S303P	Transport Process & Unit Operations Laboratory -I	0	0	4	4
CHE-S304	Chemical Reaction Engineering-I	3	1	0	4
CHM-S301	Chemistry-II	3	1	0	4
HSS-S301	Professional Communication	1	1	1	2

Semester-VI

CHE-S305	Transport Processes & Unit Operations-V (Mass Transfer-II)	3	1	0	4
CHE-S306	Instrumentation & Process Control	3	1	0	4
CHE-S307	Chemical Engg. Design-I	3	1	0	4
CHE-S308P	Transport Process & Unit Operations Laboratory-II	0	0	4	4
CHE-S50*	Departmental Elective	3	0	0	4

Semester-VII

CHE-S401	Chemical Engg. Design-II	3	1	0	4
CHE-S402	Chemical Reaction Engineering -II	3	1	0	4
CHE-S405P	Instrumentation & Process Control Lab	0	0	4	4
PRT-S401	B.Tech Project-I	0	0	6	4
HSS-S201	Industrial Management	3	0	0	4
SST-S301	Summer Training	0	0	2	2

Semester-VIII

CHE-S404	Transport Phenomena	3	1	0	4
CHE-S403P	Chemical Reaction Engg Lab	0	0	4	4
CHE-S50*	Departmental Elective	3	0	0	4
CHE-S50*	Departmental Elective	3	0	0	4
PRT-S402	B.Tech Project-2	0	0	6	4
SSM-S401	Student Seminar	0	0	3	2

Note: Total No. of Lectures in each course should in the range of 40 to 45 per semester if per week three lectures are allotted.

Departmental Electives:

1. Polymer Engineering (CHE-S501)
2. Safety in Chemical process Industries. (CHE-S502)
3. Petroleum Engineering. (CHE-S503)
4. Environmental Pollution & Control (CHE-S504)
5. Non conventional energy sources (CHE-S505)
6. Numerical methods for Chemical Engineers(CHE S506)
7. Advanced Separation Processes (CHE S507)
8. Optimization Techniques (CHE S508)
9. Biochemical Engineering (CHE S509)
10. Process Modelling and Simulation (CHE S510)

Course Code: HSS-S101 **Breakup: 3 –1 – 0 – 4**

Course Name: Communicative English

Course Details:

Unit 1: Basics of Technical Communication: Technical Communication: features; Distinction between General and Technical communication; Language as a tool of communication; Levels of communication: Interpersonal, Organizational, Mass communication; The flow of Communication: Downward, Upward, Lateral or Horizontal (Peer group); Barriers to Communication.

Unit 2: Constituents of Technical Written Communication: Word formation, Prefix and Suffix; Synonyms and Antonyms; Homophones; One Word Substitution; Technical Terms; Paragraph Development: Techniques and Methods -Inductive, Deductive, Spatial, Linear, Chronological etc; The Art of Condensation- various steps.

Unit 3: Forms of Technical Communication: Business Letters: Sales and Credit letters; Letter of Enquiry; Letter of Quotation, Order, Claim and Adjustment Letters; Memos, Notices, Circulars; Job application and Resumes. Reports: Types; Significance; Structure, Style & Writing of Reports. Technical Proposal; Parts; Types; Writing of Proposal; Significance.

Unit 4: Presentation Strategies: Defining Purpose; Audience & Locale; Organizing Contents; Preparing Outline; Audio-visual Aids; Nuances of Delivery; Body Language; Space; Setting Nuances of Voice Dynamics; Time- Dimension.

Unit 5: Value- Based Text Readings: Following essays form the suggested text book with emphasis on Mechanics of writing,

(i) The Language of Literature and Science by A.Huxley
(ii) Man and Nature by J.Bronowski
(iii) The Mother of the Sciences by A.J.Bahm
(iv) Humanistic and Scientific Approaches to Human Activity by Moody E. Prior
(v) The Effect of Scientific Temper on Man by Bertrand Russell.

Text Books and References:

1. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, New Delhi.
2. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press 2007, New Delhi.
3. Effective Technical Communication by Barun K. Mitra, Oxford Univ. Press, 2006, New Delhi
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., New Delhi.
5. How to Build Better Vocabulary by M.Rosen Blum, Bloomsbury Pub. London.
6. Word Power Made Easy by Norman Lewis, W.R.Goyal Pub. & Distributors; Delhi.
7. Developing Communication Skills by Krishna Mohan, Meera Banerji- Macmillan India Ltd. Delhi.
8. Manual of Practical Communication by L.U.B. Pandey & R.P. Singh; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, Delhi.

Course Code: MTH-S101 **Breakup: 3 – 1 – 0 – 4**

Course Name: Mathematics-I

Course Details:

Unit I

Applications of Integrals : Areas between curves, Methods of finding volume : Slicing, Solids of revolution, Cylindrical shell, Lengths of plane curves, Areas of surface of revolution, Moments and Center of mass, Improper integrals .

Unit II

Sequences: Definition, Monotonic sequences, Bounded sequences, Convergent and Divergent Sequences**.**

Series: Infinite series, Oscillating and Geometric series, their Convergence, Divergence. Tests of Convergence: n^{th} Term test of divergence, Integral test, Comparison Test, Limit Comparison test, Ratio test, n^{th} root test (Cauchy root test), Alternating series, Absolute and Conditional convergence.

Power Series: Power series and its convergence, Radius and interval of convergence, Term by term differentiation, Term by term integration, Product of power series, Taylor and Maclaurin series, Convergence of Taylor series, Error estimates, Taylor's Theorem with remainder .

Unit III

Vector Calculus: Vector valued functions, Arc length and Unit Tangent vector, Curvature, Torsion and TNB frame **.**

Partial Derivatives: Function of two or more variables (Limit, Continuity, Differentiability , Taylors Theorem) , Partial derivatives, Chain Rule, Partial Derivatives of higher orders, , Maxima and Minima and Saddle Point, Lagrange Multipliers, Exact differential, Leibniz Theorem.

Directional derivatives, Gradient Vectors, Divergence and Curl, Tangent planes .

Unit III

Multiple Integrals: Double and triple integral, Change of order, Jacobian, Change of variables, Application to area and volume, Dirichlet integral and Applications.

Line, surface integrals , Path independence, Statement and problems of Green's, Stoke's and Gauss divergence theorems (without proof).

Text Books and Reference :

1. G.B.Thomas and R.L.Finney : Calculus and Analytical Geometry, 9^{th} edition, Pearson Educaion

B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005

Course Code: PHY-S101T **Breakup: 3 – 1 – 0 – 3**

Course Name: Physics-I

Course Details:

Unit-I: Newton's laws and their applications, Friction, conservative forces and potentials, Work energy theorem, conservation of energy and linear momentum, variable mass system (rocket), impulse, system of particles and collision, Elementary rigid body kinematics, rotation motion, moment of inertia, and Gyroscopic motion.

Unit-II: Rigid body motion, angular momentum, fundamental of classical mechanics, Lagrangian and Hamiltonian formulation.

Unit-III: Motion in non-inertial frames, fractious forces, special theory of relativity, central forces, Gravitation motion under central forces and Kepler's Laws.

Unit-IV: Simple harmonic motion (SHM), small oscillations and resonance; Wave particle duality, de-Broglie matter's waves, Phase and group velocities, Davisson-Germer experiment, Heisenberg uncertainty principle and its applications.

Unit-V: Wave function and its significance, Schrödinger equations (time dependent and independent), Schrödinger's wave equation for particle in one dimensional box, diffraction of X-rays by crystal planes, Bragg's spectrometer, Compton's effect.

Text Books and References:

1. Mechanics: D. S. Mathur
2. A textbook of Mechanics: J. C. Upadhyay
3. Concept of physics (I & II): H. C. Verma
4. Introduction to Mechanics: R. D. Kleppner and J. Kolenkow
5. Physics: Resnick, Halliday and Krane
6. Vector analysis: M. R. Spiegel
7. Classical Mechanics: Goldstien
8. Modern Physics: Author Beiser

Course Code: PHY-S101P **Breakup: 0 – 0 – 3 – 2**

Course Name: Physics Lab-I

Course Details:

1. Graphical Analysis (Ref. UIET Laboratory Manual)
2. Trajectory of projectile (Ref. UIET Laboratory Manual)

Apparatus Used (Trajectory Apparatus, Metal Balls, Channels, Vernier Callipers, Carbon & Graph Paper)

3. Moment of Inertia of Bicycle wheel (Ref. Book by K. K. Dey, B. N. Dutta)

Apparatus Used (Bicycle Wheel, Masses, Thread, Stopwatch, Meter Scale, Vernier Callipers)

4. Spring Oscillations (Ref. UIET Laboratory Manual)

Apparatus Used (Spring Oscillation Apparatus, Stop Watch, Masses)

5. Coupled Pendulum (Ref. UIET Laboratory Manual)

Apparatus Used (Coupled Pendulum Setup, Stop Watch, Scale)

6. Bifilar Suspension System (Ref. UIET Laboratory Manual)

Apparatus Used (Bifilar Suspension System Setup, Stop Watch, Masses)

7. Frequency of AC Mains by Melde's Method (Ref. Book by K. K. Dey, B. N. Dutta)

Apparatus Used (Electrical Vibrator, String, Pulley, Small Pan, Weight Box & Physical Balance)

8. Kater's(Reversible) Pendulum (Ref. Book by K. K. Dey, B. N. Dutta)

Apparatus Used (Kater's Pendulum, Stop Watch)

9. Inertia Table (Ref. Book by K. K. Dey, B. N. Dutta)

Apparatus Used (Inertia Table, Stop Watch, Vernier Callipers, Split Disc, Balancing Weights, and Given Body (Disc))

Course Code: **ISC – S101T** **Breakup:** **3 – 0 – 0 – 3**

Course Name: **Programming & Computing (C & UNIX)**

Course Details:

Basic concepts of Computers, Basic UNIX Concepts and Vi - Editor
Introduction to C: Basic Programming concepts, Program structure in C, Variables and Constants, Data types, Conditional statements, control statements, Functions, Arrays, Structures, Introduction to pointers, Introduction to File Systems.

Text Books and References:

1. Programming in C, Schaum Series
2. The 'C' Programming, Denis Ritchi (PHI)
3. Programming in C, Venugopal (TMH)
4. Let us C, Yashant Kanetkar (BPB)
5. Programming in C, Balaguruswami (TMH)

Course Code: **ISC – S101P** **Breakup:** **0 – 0 – 3 – 2**

Course Name: **Computer Programming Lab:**

Course Details:

Learning OS Commands
Practice of all Internal and External DOS Commands, Writing simple batch programs, Exposure to Windows environment, Practice of UNIX commands and Vi editor, Writing simple shell script

C Programming:

Practicing programs to get exposure to basic data types, algebraic expressions, Conditional statements, Input Output Formatting, Control structures, arrays, functions, structures, pointers and basic file handling.

Course Code: **TCA – S102T** **Breakup:** **1 – 1 – 0 – 2**

Course Name: **Workshop Concepts**

Course Details:

Historical perspectives; Classification of Manufacturing process.

Machining: Basic principles of lathe machine & operations performed on it. Basic description of machines & operations of shaper-planer, drilling, milling, grinding.Unconventional machining processes , Machine tools.

Casting processes:pattern & allowances. Moulding sands & its desirable properties. Mould making with the use of a core. Gating system. Casting defects & remedies. Cupola furnace. Die-casting & its uses.

Metal forming: Basic metal forming operations & uses of such as-forging, rolling, wire& tube drawing/making & extrusion, & its products/applications, press work & die & punch assembly, cutting & forming, its application. Hot working vs Cold working. Powder metallurgy: powder metallurgy process & its applications, plastic-products manufacturing, galvanizing & electroplating.

Welding: Importance & basics concepts of welding, classification of welding processes. Gas welding, types of flames, Electric arc welding. Resistance welding. Soldering & brazing and its uses. Modern trends in manufacturing, Automation. Introduction to NC/CNC/DNC,FMS,CAD/CAM,CIM and factory of future.

Text Books and References:

1. Chapman,W A J & Arnold ,E "Workshop Technology ; vol. I,II&III" Viva Low Priced Student Edition.
2. Raghuwanshi,B S "Workshop Technology ; vol. I&II" Dhanpat Rai & Sons
3. Chaudhary, Hajra "Elements of Workshop Technology ; vol. I&II" Media Promoters & Publishers.

Course code: **TCA – S102P** **Breakup:** **0 – 0 – 3 – 3**

Course Name: **Workshop Practice**

Course Details:

1. Foundry (1 turn)
2. Welding (3 turns)
   a. Gas Welding (1 turn)
   b. Arc Welding (2 turns)
      (i). Lap Joint (1 turn)
      (ii) Butt Joint (1 turn)
3. M/C Shop (4 Turns)
4. Fitting & Sheet Metal Work (1 turn+1 turn)
5. Carpentry Shop(1 turn)
6. Black-smithy shop(1 turn)

Text Books and References:

1. Chapman,W A J & Arnold ,E "Workshop Technology ; vol. I,II&III" Viva Low Priced Student Edition.
2. Raghuwanshi,B S "Workshop Technology ; vol. I&II" Dhanpat Rai & Sons .
3. Chaudhary, Hajra "Elements of Workshop Technology ; vol. I&II" Media Promoters & Publishers.

Course Code: **CHM – S101T** **Breakup:** **3 – 0 – 0 – 3**

Course Name: **Chemistry - I**

Course Details:

UNIT-I - Atoms and Molecules:

1. Need for wave mechanical picture of atomic structure [Photoelectric effect, de Broglie concept of matter waves], Derivation of schrodinger wave equation [as an example particle moving in unidimensional potential well]

2. Chemical Bonding- Orbital concepts in bonding, V.B. and M.O. theory, M.O. diagrams, Intermolecular interactions.

UNIT-II - Reaction Dynamics:

Order, Molecularity, Rate law, Integrated rate equations, Methods of determining of order of reaction, Complex reaction kinetics- chain reactions and reversible reactions in detail, Catalysis and enzyme catalysis

UNIT-III - Electrochemistry:

Arrhenius theory of electrolytic dissociation, Transport number, Kohlrausch's law, Solubility product, Redox reaction, Electrochemical and concentration cells.

UNIT-IV- Stereochemistry:

Introduction, Chirality, Enantiomers, Diastereomers, Projection formula of a tetrahedral carbon, Geometrical isomerism, Conformers

UNIT- V- Spectroscopic Techniques:

General introduction to IR, NMR and Mass spectroscopy

UNIT-VI - Organic Reactions:

Introduction, Electron displacement effects, Organic intermediates, Types of reactions [addition, elimination and substitution reactions]

UNIT-VII - Photochemistry:

Photoexcitation of organic molecules, Jablonski diagram, Laws of photochemistry and quantum yield, Some examples of photochemical reactions, Chemistry of vision and other applications of photochemistry.

UNIT-VIII - Transition Metal Chemistry:

Stucture of coordination compounds corresponding to coordination number up to 6, Tpes of ligands, Isomerism [geometrical, optical, ionization, linkage and coordination], Theories of bonding in coordination compounds- crystal field theory, Valence bond theory, Chelation.

UNIT-IX - Laboratory Practical Classes:

Text Books and References:

Physical Chemistry- 1. P.W. Atkins
2. Puri & Sharma

Organic Chemistry- 1. Morisson & Boyd
2. Bahl and Bahl

Inorganic Chemistry- 1. J.D. Lee
2. R.P. Rastogi

Engineering Chemistry- Shashi Chawla

Course Code: **CHM – S101P** **Breakup:** **0 – 0 – 3 – 2**

Course Name: **Chemistry Lab- I**

Course Details:

Exp. 01. To estimate the strength of the given unknown solution of Mohr's salt (Ferrous ammonium sulphate ($FeSO_4(NH_4)_2SO_4.6H_2O$) using $KMnO_4$ solution as an intermediate.

Exp. 02. To prepare a sample of p-nitroacetanilide.

Exp. 03. To prepare a sample of Aspirin.

Exp. 04. Preparation of Tris (Thiourea) Copper (I) sulphate.

Exp. 05. Preparation of Hexamine Nickel (II) chloride $[Ni(NH_3)_6]Cl_2$.

Exp. 06. Estimation of commercial caustic soda: Determination of the amounts of sodium carbonate and sodium hydroxide present together in the given commercial caustic soda.

Exp. 07. Estimation of calcium ions present in tap water.

Exp. 08. To determine the partition coefficient of acetic acid between n-butanol and water.

Exp. 09. To study the photochemical reduction of a ferric salt (Blue printing).

Exp. 10. To determine the viscosity of a given liquid (30% sugar solution) at room temperature using Ostwald's viscometer.

Exp. 11. To separate Ag(I), Hg (I) and Pb (II) ions by paper chromatography and calculate their RF values.

Exp. 12. Understanding reaction kinetics and calculating the rate and order of a reaction.

Exp.13. To study the kinetics of methyl acetate hydrolysis catalyzed by 0.5N HCl solution.

Course Code: ESC-S101T **Breakup: 3 –1 – 0 – 3**

Course Name: Basic Electrical & Electronics Engineering

Course Details:

Unit – I

Sinusoidal steady state circuit analysis, voltage, current, sinusoidal & phaser presentation single phase AC circuit – behavior of resistance, inductance & capacitance & their combination, impedance concept of power, power factor. Series & parallel resonance – band width & quality factor. Three phase circuits – phase voltage & current, line & phase quantities, phasor diagram, balanced & unbalanced loads, Measurement of R, L, and C.

Unit –II

Network Theory: Network theorems – Thevenin's, Norton, maximum power transfer theorem, star delta transformation, circuit theory concept – mesh & nodal analysis.

Unit – III

Magnetic circuit concepts: self inductance , magnetic coupling analysis of single tuned & double tuned circuit involving mutual inductance , introduction to transformer.

Unit – IV

Basic Instruments, electrical measurement – measurement of voltage , current , power & energy, voltmeters & ammeter , wattmeter , energy meter , three phase power measurement , electronics instrument – multimeter, CRO(analog & digital),An overview of voltage regulator.

Unit – V

Introduction to basic electronics devices – junction diode, BJT, amplifier, op-amps & instrumentation amplifier with mathematical operation.

Number System: Introduction to binary, octal, decimal & hexadecimal systems, representation of negative numbers, 1's, 2's, 9's, 10's complement and their arithmetic.

Text Books and References:

1. W.H.Hayt & J.E. Kemmerly : Engg. Circuit Analysis , Mc Graw Hill.
2. N.N. Bhargava : 'Basic Electronics',Tata McGraw Hill.
3. Malvino, A.P. / "Electronics Principles" / Tata McGraw-Hill / 6th Ed.
4. Morris Mano, "Digital Computer Design" PHI

5 Del Toro : Principles of Electrical Engg. – PHI

6 Boylstad & Neshishkey, "Electronic devices & circuits" , PHI

1. Malvino & Leech "Digital Principle and application", TMH

Course Code: ESC-S101P **Breakup: 0 –0 – 3 – 2**

Course Name: Basic Electrical & Electronics Engineering Lab

Course Details:

1. Familiarization with the Electronic Instruments.
2. Familiarization with electronic components and Bread board.
3. To verify the Thevenin theorem.
4. To verify the Superposition theorem.
5. Measurement of voltage and frequency with CRO.
6. To study half wave rectifier.
7. To study full wave bridge rectifier.
8. To study full wave bridge rectifier with filter.
9. To study and verify the truth table of different logic gates using digital IC.
10. To study different type of transformer and there operation.
11. To study basic wiring and design a switchboard/extension board.
12. To study the polarity test of a single phase transformer.
13. To study the open & short circuit test of a transformer and calibration losses.
14. To study the load test and efficiency of a single phase transformer.

Course Code: MTH-S102 **Breakup:** 3 – 1 – 0 – 4

Course Name: Mathematics-II

Course Details:

Unit-I

Linear Algebra
Matrices, Elementary row and Column operations, Echelon form, Determinants, Rank of matrix, Vector spaces, Linear dependence and Independence, Linear transforms and matrices, Consistency of linear system of equations and their solution, Special Matrices : Symmetric, Hermition etc, Characteristic equation, Cayley-Hamilton theorem(statement only), Eigen values and Eigen vectors, Diagonalization .

Unit-II

Differential Equations : Separable, Exact Differential Equation , Integrating Factors, Linear differential equations with constant coefficients, Homogeneous Linear differential equations, Bernoulli Equation, Simultaneous linear differential equations, Clairaut's equation, Homogeneous linear differential equations of second order with constant coefficients, Complex root case, Differential operators, Euler-Cauchy equation , Wronskian, Nonhomogeneous equations,
Solution by undetermined coefficients, solution by variation of parameters.
Series solution: Ordinary differential equations of 2^{nd} order with variable coefficients (Frobenius Method).

Unit-III: Laplace Transform

Laplace transform, Existence Theorem, Laplace transform of derivatives and integrals, Inverse Laplace transform, Unit step function, Dirac Delta function, Laplace transform of periodic functions, Convolution Theorem, Applications to solve simple linear and simultaneous differential equations.

Text Books and Reference :

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.
3. C. Ray Wylie & Louis C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill Publishing Company Ltd. 2003.

G.F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Ltd. 1981.

Course Code: TCA-S101 **Breakup: 0 –2 – 4 – 5**

Course Name: Engineering Drawing

Course Details:

Introduction- Drawing instruments and their uses, BIS conventions, lettering dimensioning and free hand practicing.

Orthographic projections: Lines, planes and surfaces of objects, Sectional views, Auxiliary views, Space geometry: lines and planes, True lengths and shapes, Properties of parallelism, Perpendicularity and intersections of lines and planes, Simple intersections of solids and development of lateral simple solids**.**

Isometric Projections: Introduction , isometric scale, isometric projection of simple plane figures, isometric projection of tetrahedron, hexahedron (cube), right regular prisms , pyramids, cylinders, cones, spheres, cut spheres and combinations of solids.

Introduction to computer graphics: Some problems on above topics on computer graphics.

Text Books and References:

1. Narayana,K.L. & Kannaiah,P. "Engg.Graphics". Tata McGraw Hill, New Delhi.
2. Bhatt,N.D. "Elementary Engg. Drawing" Charotar Book stall. Anand.
3. Lakshminarayanan ,V and Vaish Wannar , R. S. "Engg.Graphics".Jain Brothers , New Delhi.
4. Chandra, A.M. & Chandra Satish, "Engg.Graphics".Narosa.
5. French & Vireck, "The Fundamental Of Engg. Drawing & Graphic Tech.". McGraw Hill.
6. Gill, P.S. "A Text Book Of Machine Drawing" Katson Publishing House, Ludhiana.

Course Code: PHY-S102T **Breakup: 3 – 1 – 0 – 3**

Course Name: Physics-II

Course Details:

Unit-I: Vector analysis: scalars, vectors, vector differentiation, gradient, divergence and curl, vector, integration, Gauss divergence and Stoke's theorem, co-ordinate systems (spherical polar & cylindrical), Electrostatics: electric fields, potentials, Gauss's law, electric dipoles and multipoles, polarization, bound charges, linear dielectrics and force on dielectrics, electric displacement, boundary condition of E and D, work and energy of electrostatics, Laplace's equation and uniqueness theorem, image theory.

Unit-II: Motion of charge in electric and magnetic field, Magnetostatics: current density, magnetic fields, Ampére's law, Faraday's law, magnetic potential, magnetic polarization, bound current, magnetic properties of materials (para, dia and ferro), boundary condition of B and H, basic idea of superconductor.

Unit-III: Displacement current, Maxwell's equations for free space and matter (dielectric and conductor), Electromagnetic waves, Poynting vector.

Unit-IV: Origin the refractive index, Interference: division of wave-front and division of amplitude; diffraction: Fraunhoffer, Grating, Resolving power (grating, prism, telescope and microscope); polarization: Phenomena of double refraction, Nicol prism, optical activity Production and analysis of plane, circular and elliptical polarized light, Frenels theory of optical activities and Polarimeters.

Unit-V: Fiber optics and photonics: Fundamental ideas about optical fiber, types of fibers, Total Internal Reflection (TIR), critical angle, acceptance angle and application, basic principal of Laser and Holography and fundamental ideas about photonics.

Text Books and References

1. Optics: Ajoy Ghatak
2. A textbook of OPTICS: Subrahmanyam, Brijlal and Avadhanulu
3. Electrodynamics: David J. Griffith
4. Classical electrodynamics: J. D. Jackson
5. Modern Physics: Author Beiser
6. Photonic Crystals: J. D. Joannopoulos, R. D. Meade, and R. D. Winn

Course Code: PHY-S102P **Breakup: 0 – 0 – 3 – 2**

Course Name: Physics Lab-II

Course Details:

1. Newton's Ring (Ref. Book by K. K. Dey, B. N. Dutta)
Apparatus Used (Traveling Microscope, Support for Glass Plate inclined at 45^0 to the Vertical, Short Focus Convex Lens, Sodium Lamp, Plano Convex Lens, An Optically Plane Glass Plate)
2. Prism Spectrometer (Ref. Book by K. K. Dey, B. N. Dutta)
Apparatus Used (Spectrometer, Glass Prism, Reading Lens, Mercury Lamp)
3. Plane Transmission Grating (Ref. Book by K. K. Dey, B. N. Dutta)
Apparatus Used (Spectrometer, Diffraction Grating, Mercury Lamp)
4. Ballistic Galvanometer (Ref. Book by K. K. Dey, B. N. Dutta)
Apparatus Used (Ballistic Galvanometer, Morse key, Damping key, Condenser, Rheostat, Volt Meter, Storage Battery, Connection Wires)
5. Carey Foster's Bridge (Ref. Book by K. K. Dey, B. N. Dutta)
Apparatus Used (Carey Foster's Bridge, Laclanche cell, Resistance Box, Galvanometer, Plug Key, Copper Strip)
6. Fresnel's Biprism (Ref. Book by K. K. Dey, B. N. Dutta)
Apparatus Used (Sodium Lamp, Biprism, Convex Lens, Optical Bench with Four Uprights)
7. Variation of Magnetic Field (Ref. Book by K. K. Dey, B. N. Dutta)
Apparatus Used (Stewart and Gee type Tangent Galvanometer, Storage Battery, Commutator, Ammeter, Rheostat, One way Plug Key, Connection Wires)
8. Polarimeter (Ref. Book by K. K. Dey, B. N. Dutta)

Apparatus Used (Sodium Lamp, Polarimeter, Physical Balance)

Course Code: MTH-S201 **Breakup: 3 – 1 – 0 – 4**

Course Name: Mathematics - III

Course Details:

Unit – I : Function of a Complex variable
Complex numbers- power and roots, limits, continuity and derivative of functions of complex variable, Analytic functions, Cauchy-Reimann equations, Harmonic function, Harmonic conjugate of analytic function and methods of finding it, Complex Exponential, Trigonometric, Hyperbolic and Logarithm function.

Unit – II : Complex Integration
Line integral in complex plane(definite and indefinite), Cauchy's Integral theorem, Cauchy's Integral formula, Derivatives of analytic functions, Cauchy's Inequality, Liouville's theorem, Morera's theorem, Power series representation of analytic function and radius of convergence,Taylor's and Laurent's series, singularities, Residue theorem, Evaluation of real integrals, Improper Integrals of rational functions, Fourier integrals.

Unit – III : Fourier Series
Periodic functions, Trignometric series, Fourier series of period 2π , Eulers formulae, Functions having arbitrary period, Change of interval, Even and odd functions, Half range sine and cosine series, Complex fourier series.

Unit – IV : Partial Differential Equations
Linear partial differential equations with constant coefficients of second order and their classifications - parabolic, elliptic and hyperbolic with illustrative examples. Methods of finding solutions using separation of variables method. Wave and Heat equations up to two dimension (finite length)

Unit – V : Probability and Statistics
Basics of probability, Bayes theorem, Random variables, Probability and density fuctions, Binomial, Poisson and Normal distributions.

Text Books and Reference :
1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.

Course Code: ESC-S202 **Breakup: 3 – 1 – 0 – 4**

Course Name: Thermodynamics

Course Details:

Fundamental concepts: System , Property, Work and Heat interactions.
Zeroth law: Zeroth law of thermodynamics, Temperatutre & its measurement & scales.
First law: Thermodynamic processes, calculation of work in various processes, non flow work & flow work. Joule's experiment, First law of thermodynamics applied to open systems, study flow system and their analysis. Applications to closed systems and flow processes. Analysis of unsteady processes. Limitations of first law of thermodynamics, PMM1.Thermodynamics properties of fluids.
Second law: Devices coverting heat to work, Thermal reservoir, heat engines efficiency, Devices converting work to heat, heat pump, refrigerator, COP, Reversed heat engine, Kelvin planck statements, Clausius statement,reversible & irreversible processes, Carnot cycle ,PMM2, Entropy , Availability , equilibrium Criterion , Maxwell Relations Thermodynamics relations , Clapeyron equation , Gibb's Phase rule.
Properties of steam & thermodynamic cycles: pure substance, properties of steam, Phase Diagram, Power & Refrigeration cycles ,Psychrometry. Adiabatic flame temperature , Equilibrium conversion, Statistical definition of entropy Kinetic theory of Ideal Gases.

Text Books and Reference :

1. Y. A. Cengel and M. A. Boles, Thermodynamics-An Engineering Approach, McGraw Hill
2. Y. V. C. Rao, Introduction to Thermodynamics, Universities Press
3. Nag ,P.K. " Engg. Thermodynamics". Tata McGraw Hill.
4. D.B. Spalding & E.H. Cole " Engg. Thermodynamics". Edward Arnold.
5. G.A. Hawkins,. " Engg. Thermodynamics" .John Wiley & Sons.
6. G.H. Van Wylen, & R.E. Sonntag, "Fundamentals of Classical Thermodynamics". .John Wiley & Sons.
7. Hollman ,J.P. " Thermodynamics". McGraw Hill

Course Code: ESC-S201 **Breakup: 3 – 1 – 0 – 4**

Course Name: Engineering Mechanics

Course Details:

General Coplanar force systems : Basis concepts, Law of motions, principle of transmissibility of forces, Transfer of a force to parallel position, Resultant of a force system, simplest resultant of two dimensional concurrent & non concurrent force systems, free body diagrams, equilibrium & its equations, applications.

Trusses & Cables : Introductions, simple truss & solutions of simple truss, method of joints & method of sections.

Friction : Introductin , Laws of coulomb friction, equilibrium of bodies involving dry friction, belt friction, applications.

Centre of gravity , centroid, Moment of Inertia : Centroid of plane, curve, area ,volume & composite bodies, moment of inertia of plane area, parallel axis theorem, perpendicular axis theorem, principal moment inertia, mass moment of inertia of circular ring, disc, cylinder, sphere and cone about their axis of symmetry.

Beams: Introductions, shear force and bending moment , differential equations for equilibrium, shear force & bending moments diagrams for statically determinate beams.
Kinematics of rigid body: Introduction, plane motion of rigid bodies, velocity & acceleration under translation & rotational motion, Relative velocity, projectile motion.

Kinetics of rigid bodies: Introduction, force, mass & acceleration, work & energy, impulse & momentum, D'Alembert principles & dynamic equilibrium. Virtual work.

Text Books and Reference :

1. Beer F.P. & Johnston ,F.R. " Mechanics For Engineers", McGraw Hill.
2. Shames, I.H. " Engg. Mechanics" , P H I.
3. Meriam , J. L. " Statics" , J. Wiley.
4. Meriam , J. L. " Dynamics" , J. Wiley.

Course Code: CHE-S201 **Breakup: 3 –1 – 0 – 4**

Course Name: Process Calculations

Course Details:

Introduction-Units, their dimensions and conversions, Dimensional consistency of equations, Dimensional and dimensionless constants, Mass and volume relations, Stoichiometric and composition relations, Excess reactants, Degree of completion, Conversion, Selectivity and Yield.

Gas laws-Ideal gas law, Dalton's Law, Amagat's Law, and Average molecular weight of gaseous mixtures.

Vapour pressure-Effect of temperature on vapour pressure, Vapour pressure plot (Cox chart), Vapour pressures of miscible and immiscible liquids and solutions, Raoult's Law and Henry's Law.

Relative Humidity and percent saturation; Dew point, Dry and Wet bulb temperatures; Use of humidity charts for engineering calculations

Material balances for systems with and without chemical reactions, species and elemental balance. Analysis of systems with by-pass, recycle and purge.

Heat capacity of gases, liquids and solutions, Heat of fusion and vaporisation; Steady state energy balance for systems with and without chemical reactions; Calculations and application of heat of reaction, combustion, formation, neutralisation and solution; Enthalpy-concentration charts; Combustion of solids, liquids and gaseous fuels, Calculation of theoretical and actual flame temperatures. Degrees of freedom in steady state processes, solution of simultaneous material and energy balance problems using flow sheeting codes; Unsteady state material and energy balance

Text Books and References:

1. D.M.Himmelblau, Basic Principles and calculations in Chemical Engineering, Printice-Hall.
2. O.A. Hougen,K.M.Watson & R.A.Ragatz, Chemical process principles, John Willey & sons.

Course Code: CHE-S202 **Breakup: 3 –1 – 0 – 4**

Course Name: Transport Processes & Unit Operations-1 Fluid Mechanics

Course Details:

Properties of fluid - fluid and its properties, Newton's law of viscosity, Newtonian & non- Newtonian fluids, surface tension and its effect
Fluid pressure and its measurement: mercury barometer, bourden pressure gauge, Piezo meter, differential & inclined manometer, micro manometer etc.
Kinematics of fluid flow- various types of flow, Reynold's experiment, Reynold's no., boundary layer theory and moody's chart.
Buoyancy & floatation- Archimedes principle, centre of buoyancy.
Dynamics of fluid motion- Continuity equation, Euler's equation, Bernoulli's equation, correction in Bernoulli's equation for effect of solid boundaries, pump work in Bernoulli's equation.
Flow measurement- venturi meter, orifice meter, pitot tube for velocity measurement, variable area meter(rotameter), flow nozzles.
Flow over notches & weirs; discharge over a triangular & rectangular notch.
Flow through pipe- pipes & tubes, energy losses in pipes, head loss due to sudden enlargement, contraction, vena contracta, entrance and exit losses
Dimentional analysis- Rayleigh's method and its draw back, Buckingham pi theorem
.

Text Books and References:

1. McCabe & Smith, Unit Operations in Chemical Engineering, Mc Graw Hill.
2. V. Gupta & S.K. Gupta, Fluid Mechanics & Application, New Age International Pvt. Ltd.

Course Code: CHE-S203 **Breakup: 3 –1 – 0 – 4**

Course Name: Chemical Engineering Thermodynamics

Course Details:

Introduction-Macroscopic and microscopic approaches; Units; Basic concepts of system, property, force, temperature, pressure, work, energy, heat and equilibrium

Review of First and Second law of thermodynamics for closed & open system,

P-v-T behaviour of pure substance- graphical, tabular and mathematical representation Ideal gas, Cubic equation of state; Virial equation of state, laws of corresponding states, compressibility factor, accentric factor, Generalized correlation for gases and liquids;

Thermodynamic Potentials and Thermodynamic Property relations-Postulates; Intensive properties; Criteria of equilibrium; Euler relation Gibbs Duhem relation; Potentials-A,G,H,U; Property relations for homogeneous phases; Maxwell's relation,

Thermodynamic Properties of Real Gases, Departure functions; Evaluation of departure functions; Partial Molar Property, fugacity and fugacity coefficient, estimation of fugacity coefficient, Thermodynamic Properties of Real Gas mixtures – mixing rules, prediction of P-v-T behaviour, departure functions, fugacity coefficients for real gases;

Fugacity of a component in a mixture, Fugacity of liquid and solid

Ideal solution; phase equilibrium problems; excess properties, excess Gibbs free energy models;Henry's law Basic equation for vapour liquid equilibrium; VLE at low to moderate pressures and high pressures-excess Gibbs free energy models, azeotropic data, bubble, dew point and flash calculations; Dilute Solution laws

Chemical Reaction Equilibrium- standard Gibbs free energy change and equilibrium constant, effect of temperature on equilibrium constant; homogeneous gas and liquid phase reactions;

Text Books and References:

1. Y.V.C. Rao, Chemical Engineering Thermodynamics, University Press.
2. Smith & van Ness, Introduction to Chemical Engineering Thermodynamics, McGraw Hill

Course Code: CHE-S204 **Breakup: 3 –1 – 0 – 4**

Course Name: Transport Processes & Unit Operations-II Heat Transfer

Course Details:

General Principals of heat transfer by conduction, convection, radiation heat transfer.
Conduction- Fourier's law of heat conduction, steady state conduction in one dimension with out heat source e.g. Through plain wall ,cylindrical & spherical surfaces, thermal insulations, properties of insulating materials.
Convection- Natural & forced convection, concept of thermal boundary layer, laminar & turbulent flow heat transfer inside and out side tubes, dimensional analysis, determination of individual & overall heat transfer coefficients and their temperature dependency.
Heat exchangers- Types of heat exchangers like double pipe, shell & tube, plate type, extended surface, their construction and operation, basic calculations on heat exchangers.
Radiation- Basic laws of radiation heat transfer, black body & grey body concepts, view factor, combined heat transfer coefficients by convection and radiation.
Introduction to unsteady state heat transfer.
Heat transfer with phase change- condensation of pure and mixed vapours, film wise and drop wise condensation, calculations on condensers, heat transfer in boiling liquids, nucleate & film boiling.
Evaporation- elementary principals, types of evaporators, simple calculation on single and multiple effect evaporators, classification, principals, and design criteria.
Furnaces, their classification, applications and calculations on them

Text Books and References:

1. D.Q. Kern, Process Heat Transfer, Mc Graw Hill.
2. J. P. Holman, Heat Transfer, Mc Graw Hill.

Course Code: CHE-S205 **Breakup: 3 –1 – 0 – 4**

Course Name: Chemical Process Industries-1

Course Details:

Overview-Typical chemical processes: unit operations and unit processes; classification of Indian chemical process industry;inorganic chemical industry; study aspects of a CPI- raw materials, process, chemical reactions, process and block flow diagram, major engineering issues and uses;
Water conditioning and treatment processes, softening and demineralization of water; air conditioning and treatment processes, air liquefaction: *Claude* and *Linde* processes.
Chemicals from sea, common salt (NaCl) manufacture: solar and vacuum evaporation methods.
Coal gasification technologies: *Lurgi, Winkler* & *Kopper Totzek* processes; various types of fuel gases: producer, water, coke oven, synthesis, LPG & natural gases, various industrial gases: carbon dioxide, hydrogen, oxygen, nitrogen, helium, acetylene, carbon monoxide, sulphur dioxide, their sources and applications.
Amorphous and crystalline forms of carbon, manufacture and applications of lamp black, carbon black and graphite; activated carbon and its manufacture by gaseous oxidation and chemical activation methods.
Various kinds of cements and their major constituents, cement manufacture by cement rock (limestone) beneficiation and *Portland* process.
Nature, types, composition and uses of glass, its manufacture: melting, shaping, annealing and finishing operations; *Fourcalt* and *float glass* processes.
Products and raw materials of chlor-alkali industry, *Trona* ore; Solvay process of manufacturing soda ash, caustic soda and chlorine manufacture by electrolytic process: mercury, diaphragm and membrane cells.
Major phosphorous products; *Fluorapatite* mineral; dry (electric furnace) method of recovering elemental phosphorus; phosphoric acid manufacture by dry and wet (sulphuric acid leaching and *IMI* or HCl digestion) methods; manufacture of phosphatic fertilizers: calcium phosphates, ammonium phosphate, nitro phosphate and sodium phosphate.
Manufacture of ammonia, urea, nitric acid and ammonium nitrate.
Sulphur-its forms, properties and sources, sulphur mining by *Frasch* process, sulphur recovery from pyrite ore by *Finnish* process, sulphur recovery from natural gas and petroleum refinery streams by *Claus* process; sulphuric acid manufacture by *Contact* process.

Text Books and References:

1. Dryden's Outlines of Chemical Technology, Edited by M. Gopala Rao, M. Sittig, Affiliated East-West Press Ltd
2. G.T. Austin, Shreve's Chemical Process Industries, Mc Graw Hill.

Course Code: CHE-S206 **Breakup: 3 –1 – 0 – 4**

Course Name: Transport Process & Unit Operation-3 Mechanical Operations

Course Details:

Solid handling- Introduction, particle shape, size, sphericity ; size reduction- Energy and power required in size reduction, Laws of crushing, Work index, Size reduction equipments- crusher, grinders, mills; Solid-solid separation- Screening, jigging, Tabling, Magnetic separation, Electrostatic separation, Flotation; Solid-liquid separation- Settling and sedimentation, Centrifugal separation, Filtration; Fluidization- Introduction, Flow through packed bed, Ergun equation, types of fluidization, Superficial velocity, Entrainment and Elutriation; Mixing and agitation- Introduction, Uses of mixing, Agitation equipment- Turbine, Impeller, Paddle, Flow pattern in agitated vessels, Prevention of swirling, Turbine design; Crystallization

Text Books and References:

1. Mc Cabe & Smith, Unit Operation in Chemical Engineering, Mc Graw Hill.
2. J.M.Coulson & J.F.Richardson, Chemical Engineering, Pergamon Press.

Course Code: **HSS-S401** **Breakup:** **3 – 1 – 0 – 4**

Course Name: **Industrial Economics**

Course Details:

Unit -I
Definition and scope of engineering economics
Concept of supply and demand
Price elasticity and cross elasticity of demand
Production
Engineering costs and cost estimation
Concept of time value of money
Cash flow analysis

Unit-II
Perfect competition
Monopoly
Monopolistic competition

Unit-III
National Income, GDP
Inflation, Deflation and treatment

Unit-IV
Functions of RBI
Indian Tax System

Text Books and References:

1. Henderson, M. James and Quandt, E. Richards, "Microeconomic Theory: A Mathematical Approach".
2. Koutsoyiannis, A., "Modern micro economics".ardwick, Philip., Khan Bahadure., Langmeed, John, "An Introduction to modern economics".
3. Samuelson, A. Paul, "Economics".
4. Shapiro, Edward. "Macro economics".
5. Newnan, G. Donald, Eschenbach, G.Ted, Lavelle, P. Jerome, "Engineering Economic Analysis".

Course Code: CHE-S301 **Breakup: 3 –1 – 0 – 4**

Course Name: Transport Process & Unit Operation-4 Mass Transfer I

Course Details:

Vapour liquid equilibria; Raoult's law ; Relative volatility; minimum and maximum boiling mixtures; enthalpy concentration diagrams for binary systems;Flash, Differential and Steam Distillation; Azeotropic and Extractive Distillation;
Multistage tray towers; Graphical methods using Mc Cabe-Thiele and Ponchon – Savarit analysis; minimum reflux, total reflux and optimum reflux ratio, open steam, multiple feed and side stream
Multi component Calculations using Short-cut methods;
Absorption- Equilibrium, co-current operation, counter current multistage operation, dilute gas mixtures, Multicomponent absorption, tray efficiency;
Liquid-liquid Extraction-, choice of solvent, equilibria on triangular coordinates, single stage and multistage single cross current extraction, continuous counter current multistage extraction, insoluble liquids;
Solid-liquid Extraction- Method of operation, Shank's system and other systems, equilibrium curve, single stage and multistage single cross current leaching, multistage counter current leaching using rectangular and triangular method,
Adsorption- Adsorbents, adsorption equilibria, adsorption for dilute solutions, single stage and multistage single cross current operation, multistage counter current operation using Freundlich equation for equilibria,

Text Books and References:

1. R.E. Treybal, Mass Transfer Operations, Mc Graw Hill.
2. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd ed. Prentice Hall.
3. A. S. Foust et.al., Principles of Unit Operations John Wiley (1980)

Course Code: CHE-S302 **Breakup: 3 –1 – 0 – 4**

Course Name: Chemical Process Industries-2

Course Details:

Classification of organic and natural product industries, Basic sources of raw materials;
Common pesticides, Manufacture of DDT, 2,4-D, BHC and parathion,
Important oil seeds, Extraction process, Physical and chemical refining of vegetable oil and by products, Hydrogenation of vegetable oils.
Difference between soaps and detergents, Classification of cleansing compounds, Kettle and Twithcell process of soap manufacture, Glycerol recovery, Manufacture of detergents: sulphated fatty alcohols and alkyl – aryl sulphonates.
Important features of Indian sugar industry, Major unit operation of sugar industry, Alcohol fermentation, Production of 95% alcohol and anhydrous or absolute alcohol from fermentation broth, Pollution problems.
Raw materials for pulp making, Kraft and Sulphite pulping methods, Semi-chemical pulping, Fourdrinier process of paper making, Pollution aspects
Basic principles of polymerization reactions: stepwise and chain polymerization, general polymerization systems: bulk, solution, suspension and emulsion polymerisation, Synthesis of phenol formaldehyde, polyethylene, polystyrene and PVC, Various polymer processing techniques, Additives, Plastic recycling, Rubbers, their classification and processing, Specialty polymers.
Natural and synthetic fibres, Fibre properties important in textile production, Fibre spinning processes: melt, dry and wet spinning, Manufacture of nylon 6,6 and nylon 6 fibres, viscose rayon and polyester fibres.
Composition and characteristics, Formation theories, Petroleum exploration, enhanced oil recovery by water and steam injection technologies, Offshore drilling, Petroleum refining: Basic distillation, thermal cracking, alkylation and catalytic cracking, other refining unit processes: reforming, hydrodealkylation, isomerisation, hydrogenation, desulphurisation polymerisation etc. Important refinery products or fractions, Indian petroleum refineries
Important petrochemicals, Feed stock, Common unit processes: cracking, alkylation-dealkylation and hydroalkylation, halogenation, oxidation, hydrogenation-dehydrogenation; hydration-dehydration, nitration, amination, esterification, hydrolysis, hydroformylation or oxo process.

Text Books and References:

1. Dryden's Outlines of Chemical Technology, Edited by M. Gopala Rao, M. Sittig, Affiliated East-West Press Ltd
2. G.T. Austin, Shreve's Chemical Process Industries, Mc Graw Hill.

Course Code: CHE-S303P **Breakup: 0 –0 – 4 – 4**

Course Name: Transport Process & Unit Operation Laboratory -1

Course Details:

Screen Analysis; Crushing efficiency for jaw crusher; Crusher rolls; Disintegrater; etc.; Sedimentation and Thickners; Viscosity measurement; Flow through pipes
(Reynold'S experiment); Flow-Through Open Channels; Flow Through fitting and Joints; Orifice meter; Venturi meter; Rotameter; Verification of Bernoulli's Theorem; Characteristics of Centrifugal pumps; Fluidized bed; Spouted bed; Plate and Frame filter press; Rotary drum; Vacuum filter; Agitator and mixing.

Course Code: CHE-S304 **Breakup: 3 –1 – 0 – 4**

Course Name: Chemical Reaction Engineering-1

Course Details:

Introduction and overview of chemical reaction engineering
Rate equation of homogeneous reactions, concentration dependent term and temperature dependent term of the rate equation, rate expressions from mechanisms; non elementary homogeneous reactions;
Constant volume batch reactor; varying volume batch reactor; collection and analysis of batch data – integral and differential method; reversible reaction data, temperature and reaction rate;
Ideal batch reactor; steady state continuously stirred tank reactor; steady state plug flow reactor; size comparison of single reactions; multiple reactor systems; recycle reactor; autocatalytic reactions;
Design for parallel reactions- product distribution, fractional yield;
Design for series reactions; Series-Parallel reactions, Denbigh reactions
Non isothermal reactors, effects for single and multiple reactions, equilibrium conversions, adiabatic and non-adiabatic operations
Non ideal Reactors-Residence time distribution, E,C, F curves, segregation model, dispersion model, chemical reaction and dispersion, tank-in- series model;

Text Books and References:

1. O. Levenspiel, Chemical Reaction Engineering, John Willey & Sons.
2. H.S. Fogler, "Elements of Chemical Reaction Engineering", 3rd ed. Prentice Hall
3. J. Smith, "Chemical Engineering Kinetics ", 3rd edition. McGraw-Hill, (1990).

Course Code: **CHM-S301** **Breakup:** **3 – 1 – 0 –4**

Course Name: **Chemistry - II**

Course Details:

UNIT-I - Chemistry of Materials:

Solid state- Classification, Band theory, Crystal lattice and unit cells, Coordination number, Crystal imperfections, Packing, Liquid crystals, Miller indices, Conducting properties of solids.
Phase Rule- Gibb's phase rule, one and two component systems, Eutactic system, Alloy system.
Electronic materials- Composites, Materials related to nanotechnology.

UNIT-II- Polymers:

Introduction, Classification, Structures of organic and inorganic polymers of industrial importance, Liquid crystalline and star polymers etc.

UNIT-III- Chemistry of cells:

Proteins, Nucleic acids, Enzymes, Lipids, Genome

UNIT-IV- Corrosion:

Introduction, Dry and wet corrosion, Atmospheric and Graphitic corrosion, Preventive methods

UNIT-V- Water Treatment:

Hardness of water, Softening of water, Reverse osmosis, Treatment of boiler feed water by Calgon process, Ion-exchange resins and Zeolites.

UNIT-VI- Fuels:

Coal, Biomass, Biogas, Determination of net calorific values using Bomb calorimeter, Solar energy.

UNIT-VII- Environmental Pollution:

Types of pollution and pollutants, Air pollution, Formation and depletion of ozone, Smog and acid rain

UNIT-VIII- Clusters:

Introduction, Types of clusters- Vanderwaals clusters, Molecular clusters, Nanoclusters, Macroscopic clusters.

Text Books and References:

Engineering Chemistry- Vol I & II by Kuriacose & Rajaram

Engineering Chemistry- 1. Dara
2. B.K. Sharma

Course Code: HSS – S301 Breakup: 1 – 1 – 1 – 2

Course Name: Professional Communication

Course Details:

Unit 1- Presentation Techniques

- Meaning and importance of presentation technique
- Use of presentation techniques in everyday life
- Presentation skills required for business organization
- Types of business presentations-meetings, seminars, Conferences

Unit 2-Oral presentations

- Effective oral presentation techniques
- Tips for good oral delivery; debates, elocution, impromptu speeches
- Levels and models of organizational Communication
- Interviews-types of interviews
- Group discussions

Unit 3- Written communication

- Style and tone of writing business messages and Documents.
- Writing for websites, internet e-mails and short messages
- Applications, letters, memos
- Proposals and report writing

Unit 4 - Nonverbal presentations

- Nonverbal communication techniques
- Business manners, ethics and personality development
- Audio/visual presentations, power point presentations
- Art of delivery

Unit 5- Literary concepts

- Stories, essays, comprehension
- Reading techniques-skimming and scanning methods
- Listening skills

Text Book and References:

1. "Business Communication Today", Bove'e, Thill and Schatzman: Pearson Education(Singapore),2003
2. "Business Communication-a framework of success", H.Dan O'Hair, James S.O'Rourke and Mary John O' Hair: South Western College Publishing 2001.
3. "Basic Business Communication", Raymond V.Lesikar, Marie E.Flatley: Tata McGraw Hill Publishing Company Ltd., 2002.

Course Code: CHE-S305 **Breakup: 3 –1 – 0 – 4**

Course Name: Transport Process & Unit Operation-5 (Mass Transfer II)

Course Details:

Molecular diffusion: Diffusivity, flux J and N, steady state diffusion in fluid at rest and laminar flow, molecular diffusion in gases in non-diffusing and equimolal counter diffusion, Pseudo steady state diffusion through a stagnant gas film, steadystate diffusion in multicomponent mixtures, molecular diffusion in liquid, diffusivity of gases and liquids, diffusion through varying cross- sectional area

Diffusion in solids-through polymers, porous solids, unsteady state diffusion in slabs, cylinders and spheres, transient mass transfer in semi infinite medium

Mass transfer coefficient in different units, mass transfer from a gas into a falling liquid film, eddy diffusion, Prandtl mixing length;

Film theory: Lewis, Penetration and Surface Renewal theory; dimensionless numbers

Flow past solids, Interphase mass transfer

Combination of resistances, overall coefficient, correction applied to individual coefficient, heat, mass and momenteum transfer analogies, j_H and j_D factor

Gas Absorption: Packed towers, pressure drop and flooding in opacked towers, Design of packed towers, Height of Transfer Unit, concept of H_{tG}, H_{tL} , H_{tOG} and H_{tOL}, desorption, Mass transfer coefficient in packed beds

Drying: Definition, drying operation, recycle of air, rate of batch drying, constant and falling rate, mechanism of batch drying, tray drying with varying air conditions continuous dryers, Introduction to rotary dryers, rotary drum dryers and spray dryers

Humidification and Dehumidification: Psychrometric chart, wet bulb and adiabatic saturation temperation, design of cooling towers and dehumidifiers

Adsorption: Adsorption in continuous column, breakthrough curve

Text Books and References:

1. R.E. Treybal, Mass Transfer Operations, Mc Graw Hill.
2. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd ed. Prentice Hall.
3. A. S. Foust et.al., Principles of Unit Operations John Wiley (1980)

Course Code: CHE-S306 **Breakup: 3 –1 – 0 – 4**

Course Name: Instrumentation & Process Control

Course Details:

Introduction to control aspects their needs & application in industries ,Classification of variables, control aspects of a chemical plant, stirred tank heater, flow in tank & their control aspects

Introduction to mathematical modeling, state variables and state equations, dead time, modeling with dead time, degree of freedom, linearization of nonlinear system, deviation variables, multivariable system linearization.

Laplace transform of step, impulse , pulse ,ramp, trigonometric functions, Laplcae transform of derivative and integral functions, initial value theorem , Final value theorem, Dirac delta functions, Inverse Laplace transform, solution of linear differential equation using Laplace transform, transfer function and input – output model.

Poles & zeros of system, dynamic behavior of first order system, Time constant, steady state gain,

Dynamic behaviors of second order system, overdamped, critically damped, underdamped response their characteristics, overshoot ,decay ratio, period of oscillation ,rise time , ultimate period , delay time, study of interacting & noninteracting response, Inverse response, multicapacity process,

Concept of Feedback system , types of controller , on-off, P,PI,PID controller, introduction to measuring sensors, transmission lines, final control elements, signal flow graph theory to solve feedback loop,

Criteria for stability, characteristic equation, Routh –Hurwitz criteria of stability,Root-Locous analysis,

Design of controllers, Simple performance criteria, Time Integral performance criteria, Frequency response analysis of linear processes, Bode stability criteria, Nyquist stability criteria , gain margin, phase margin, Ziegler Nichols tuning technique , Cohen –coon tuning technique

Text Books and References:

1. D.R. Coughnour, Process system Analysis & Control, Mc Graw Hill.
2. George Stenphanopolous, An Introduction of Process Dynamics & Control.

Course Code: CHE-S307 **Breakup: 3 –1 – 0 – 4**

Course Name: Chemical Engineering Design-1

Course Details:

Stages involved in design, Chemical Engg. Plant design,Process design, Development General overall design consideration,

Cost estimation, Factors affecting Profitability of Investments, Optimum design, Optimum economic design, Optimum Operation design, Practical considerations in design, Design approach.

Flow- sheeting presentation, manual Flow- sheet calculation, Computer –aided Flow- sheeting-simple material balance program.

P and I diagram, Valve selection, pumps, control and instrumentation, typical control systems, data acquisition

Types of design, Feasibility survey, Process development, Design construction & operations, Safety analysis, Selection of size, Plant layout, Cost & asset accounting, Cost estimation, Interest & investments costs, Taxes, Depreciation & Depletion, Profitability, Alternative investments & replacements, Optimum design & Design strategy.

Text Books and References:

1. M.S.Peters and K.D.Timmerhaus, Plant Design and economics for chemical Engineering, Mc Graw Hill.

Course Code: CHE-S308P **Breakup: 0 –0 – 4 – 4**

Course Name: Transport Process & Unit Operations Lab-2

Course Details:

Heat conduction through rods of different materials; Thermal conductivity of insulating materials; Boiling and Condensation; Double pipe Heat Exchanger; Shell & Tube Heat Exchanger; Long tube evaporator; Distillation; Batch & Continous column; Absorption with and without chemical reaction; Liquid-liquid extraction/leaching; Adiabatic humidifier, Water cooler; Driers; Tray, Rotary, Spray; Ion exchange, Reverse osmosis.

Course Code: CHE-S401 **Breakup: 3 –1 – 0 – 4**

Course Name: Chemical Engineering Design-2

Course Details:

Introduction, nature of design, anatomy of a chemical manufacturing process,
organisation of a chemical engineering project, project documentation, codes and standard, factor of safety, degree of freedom and design variables, optimisation.

Fundamentals of material balances, Fundamentals of Energy balances
Equipment selection, specification and design: Separation processes, solid- solid separations, screening, liquid-solid cyclones, hydro separators and seizers, hydraulic jig , tables, classifying centrifuges, flotation separators, Electrostatic separators, liquid solid separators- thickeners and classifiers, filtration, centrifuges, hydro-cyclones, separation of dissolve solids- Evaporation and crystallisation, liquid- liquid separation- Decanters, centrifugal separators, gas – solid separation, gas –liquid separation.
Separation columns: Continuous distillation : process description , reflux considerations , feed-point location, selection of column pressure, stage equations, dew point – bubble points, Equilibrium flash calculations, design variable in distillation,
design method for binary system: basic equations, McCabe –Thiele method, low product concentration s, Smoker equations

Multicomponent distillation ; Key component , number of column s, short –cut method for stage and reflux requirement s, pseudo- bninary systems, Smith –Brinkley method, Empirical correlations, rigorous solution procedures, batch distillation , Plate efficiency,
Column sizing, Plate hydraulic design, Packed columns
Heat transfer Equipment : Overall heat transfer coefficient , fouling factors , shell and tube heat exchangers, tube count, shell type; Baffles support plate and tie rods tube sheet shell and headers nozzles, mean temperature difference
General design consideration ; Fluid allocation shell and tube fluid velocity stream temperature pressure drop, Shell side heat transfer and pressure drop : flow pattern , design methods, Kern's Method, Bell's method, shell and bundle geometry, Effect of fouling on pressure drop, Condensers , Reboilers and Vaporisers, Pressure vessels

Text Books and References:

1. J.M. Coulson & J.F. Richardson, Chemical Engineering, Pergammon Press.
2. M. V. Joshi & V. V. Mahajan , Process Equipment Design, Macmillan

Course Code: CHE-S402 **Breakup: 3 –1 – 0 – 4**

Course Name: Chemical Reaction Engineering -II

Course Details:

Introduction to heterogeneous reaction , solid catalyzed reaction , rate equation for surface kinetics , preparation & characterization of catalyst , performance equation for reactors containing porous catalyst particle, Experimental methods for finding rates, product distribution in multiple reaction,
Fluid particle reaction kinetics -selection of a model , shrinking core model for spherical particle of changing & unchanging size, comparison of various model selected, determining controlling resistances and rate equation, fluied particle reactor design , instantaneous reaction ,
Adsorption -Physical & chemical Adsorption, Langmuir & freundlich isotherms, rate equation for physical , surface reaction & desorption mechanism

Gas liquid reactions - Gas –liquid reactor, Thiele modulus, effectiveness factor
Deactivation of catalyst-Mechanism of deactivation of catalyst, rate & performance study of deactivation, Rate equation in fluid –fluid reaction , fluid particle reaction kinetics ,

Text Books and References:

1. J.M. Smith, Chemical Engineering Kinetics, Mc Graw Hill.
2. O. Levenspiel, Chemical Reaction Engineering, John Willey & Sons.
3. H. Scott. Fogler; Elements of Chemical Reaction Engineering

Course Code: CHE-S405P **Breakup: 0 –0 – 4 – 4**

Course Name: Instrumentation & Process Control Lab

Course Details:

Calibration and response of a thermocouple; Calibration of pressure gauge by dead weight loster; Calibration of flow measuring devices; Viz. Orifice meter, venturimeter Etc. Calibration of diaphragm control valve; Calibration of levelling measuring device, pressure type; Calibration of moisture meter, Viz; IR moisture meter, Rapid moisture meter, Innersal moisture meter, etc.; Measurement of humidity by hair-hygrometer, Wet & Dry Bulb thermometer; Study of On-Off Controller; Study of PID controller; Dynamic response of liquid heating system; Dynamic response of interacting non interacting first ordsr system; Dynamic response of heat exchanger/Distillation column.

Course Code: PRT-S401 **Breakup: 0 –0 – 6 – 4**

Course Name: Design Project-I

Course Details:

Equipment design to be done by groups of students

Course Code: HSS-S201 **Breakup: 3 – 0 – 0 –4**

Course Name: Industrial Management

Course Details:

Introduction to Industrial management, Brief history of industries in India, Brief definition of management, organization and administration. Characteristics of management, Principle of management, Function of management like, planning, organization, direction, co-ordination etc.

Level of management, skills of management, inter relation between skills and levels of management, scientific management, Introduction to Schools of Management thoughts, introduction to organization, study of basic type of organization for ex. Line and staff organization, project organization, metrics organization, Informal organization, Introduction to industrial Psychology, Motivation theory and study of Maxlow, Need, Hierarchy Theory, Planned Location, Planned Layout. Study of different forms of layout like line layout, process layout, product layout, combinational layout, sixth position layout etc.

Objective of planned layout, introduction to material management, scope of material management, study of inventory control method, introduction to different types of inventory control techniques, introduction to work study, motion study etc, introduction to conflict management.

Text Book and References:

1. Khanna O.P.: Industrial Engineering
2. T.R. Banga : Industrial Engineering and Management
3. Mahajan : Industrial and Process Management

Course Code: CHE-S301 **Breakup: 0 –0 – 0 – 2**

Course Name: Summer in Plant Training

Course Details:

A written report and an oral presentation/ interview during the (following) semester after successful completion of an 8-week industrial in-plant training with a chemical industry taken during the summer break.

Course Code: CHE-S404 **Breakup: 3 –1 – 0 – 4**

Course Name: Transport Phenomena

Course Details:

Introduction, Analogies between momentum, heat and mass transfer and defining of dimensionless number, Reynolds transport theorem, Eulerian and Lagrangian approach, Navier stokes equation; Introduction of Fluids kinematics vorticity; Introduction of molecular and convective flux.

Momentum Transport Phenomena-Newton's law of Viscosity, , Prediction of viscosity and its dependence on temperature, pressure, Non– Newtonian models at steady state for Newton's law of Viscosity, Momentum transport in laminar flow, Boundary conditions and shell balance approach for stress distribution; profiles for flow of a falling film, flow through circular tube, flow through an Annulus, Adjacent flow of two Immiscible fluids.

Equation of continuity, motion and mechanical energy their applications in fluid flow problems for isothermal system

Energy Transport Phenomena-Energy transport in laminar flow: Fourier's law of heat conduction,thermal conductivities and its dependence on temperature, pressure, Boundary conditions, Shell balance approach for different types of heat sources, Heat conduction through composite walls, Principle of extended surfaces, free and forced convection.

Equation of change for Non-isothermal systems, The Equations of energy, Equation of motion for free and forced convection in Non-isothermal flow, steady flow of a non-isothermal film, Transpiration cooling , free convection from a vertical plate.

Mass Transport Phenomena-Fick's law of diffusion, Prediction of diffusivity and its dependence on temperature and pressure for gas, liquids and solids, Boundary conditions, Shell balance approach for mass transfer problems, Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalyst and the effectiveness factor, equation of continuity for binary mixtures, equation of change to set up diffusion problems for simultaneous heat and mass transfer, thermal diffusion, pressure diffusion, forced diffusion.

Text Books and References:

1. Bird Stewart & Lightfoot, Transport Phenomena.

Course Code: CHE-S403P **Breakup: 0 –0 – 4 – 4**

Course Name: Chemical Reaction Engineering Lab

Course Details:

Batch reactor- Reaction Rate Constant; Semi Batch Reactor- Reaction Rate Constant;
Continuous Stirred Tank Reactor; Plug Flow reactor; Differential, Integral; Residence Time Distributions in non- ideal Reactors; Fluid Particle Reaction for Shrinking Spherical Particle; Recycle reactor;
Characteristics of heterogeneous catalysts (BET method, HE-Hg method); Basket type mixed reactor solid catalytic reactions; Catalytic gas-phase reactions in constant volume bomb; Catalytic liquid phase reaction; Fluidized bed reactor.

Course Code: PRT-S402 **Breakup: 0 –0 – 6 – 4**

Course Name: Design Project-I

Course Details:

Detailed plant design project to be done by groups of students.

Departmental Electives

Course Code: CHE-S501 Breakup: 3 –0 – 0 – 4

Course Name: Polymer Engineering

Course Details:

Introduction – defining polymers, classification, molecular weight distributions, conformations
Addition polymerization or chain growth polymerization, radical, ionic and Ziegler-Natta polymer, kinetics
Step growth polymerization, kinetics
Techniques of polymerizations; Characterisation- measurement of molecular weight, thermal behaviour, morphology, viscoelastic behaviour, mechanical properties
Polymer processing; rubbers, plastics and fibres

Text Books and References:

1. George Odian, Principles of Polymerization, John Wiley & Sons
2. Fred W. Billmeyer, Polymer Science and Engineering, John Wiley & Sons

Course Code: CHE-S502 Breakup: 3 –0 – 0 – 4

Course Name: Safety in Chemical Process Industries

Course Details:

Concept and definitions, safety culture, storage of dangerous materials, plant and plant layout, safety system, technology and process selection, scale of disaster.
Vapour cloud, explosion, control of toxic chemicals, run away reactions, fire and explosion, high pressure relief system, hazardous properties of chemicals.
Risk and hazard management, safety Vs production, risk assessment and analysis, hazard models and risk data, identification, minimization and analysis of hazard.
Tackling disaster, plant of emergency, risk management routines, emergency shutdown systems, Role of computer in safety, prevention of hazard, human element, technology and process selection, design of safety audit system and disaster management.

Text Books and References:

1. D. A. Crowl, J.F. Louver, Chemical Process Safety: Fundamentals and Applications, Prentice Hall
2. G. L. Wells, Safety in Chemical Process Industries, McGraw Hill

Course Code: CHE-S503 **Breakup: 3 –0 – 0 – 4**

Course Name: Petroleum Engineering

Course Details:

Introduction to mineral oils, their origin and mode of occurrence; Oil resources and refineries in India Composition of petroleum, refinery products and their test methods Evaluation of oil stacks introduction to processing of petroleum; general processing & crude distillation, refinery products and their application, natural gas, gasoline, naphtha kerosene, fuel oil and gas oil, petroleum waxes, lubricating oils, tar and asphalts.

Petroleum refining processes and operation: thermal cracking, catalytic cracking, hydro- forming, catalytic reforming, alkylation, polymerization, isomerization and other auxiliary process e.g vis-breaking, de-waxing and de-asphalting operations.
Manufacture of paraffins wax and microcrystalline waxes.

Introduction to lubricants: liquid, solid and gas lubricants and their application.
Lubricating oils: liquids mineral lubricants, synthetic liquids lubricants; Physical properties, additives, manufacture of lubrication oils; Analysis of lubricating oils;
Lubricating Greases: properties, types, ingredients, additives, analysis of lubricating greaser as per BIS test methods; Manufacture of lubricating greases-processes and equipments.

Introduction to petrochemicals; manufacture of alkyl aryl compounds, ethylene oxide; condensation products benzene, toluene, xylene, butadienes, vinyl chloride and styrene etc

Text Books and References:

1. Petroleum Refinery Engineering, Nelson, McGraw Hill
2. Petroleum Refining Technology, Dr. Ram Prasad, Khanna Publishers

Course Code: CHE-S504 **Breakup: 3 –0 – 0 – 4**

Course Name: Environmental Pollution and Control

Course Details:

Introduction and importance of Environmental Pollution, case studies;
Air Pollution – sources, causes, effects; meteorological and natural purification processes; control of air pollutants – particulates and gases –design aspects ; automobile pollution;
Water Pollution – classification and characterization of water pollutants, sources, causes, effects of water pollution; control processes : physical- design of equalization tanks, sedimentation tanks clarifiers etc., chemical- coagulation, disinfection, adsorption etc., biological – introduction to bacterial growth and kinetics, BOD estimation, aerobic and anaerobic treatment methods, activated sludge process, trickling filters- design aspects, sludge disposal, clarified water disposal,
Solid-waste management, Noise Pollution, Radioactive Pollution

Text Books and References:

1. Metcalf & Eddy, Waste Water Engineering- Treatment Disposal and Reuse, Tata McGraw Hill
2. Noel De Nevers, Air Pollution Control Engineering, McGraw Hill
3. K. Wark, C. F. Werner and W. T.Davis, Air Pollution: Ita origin and control, a Dun- Donnelley Publisher, New York
4. C. S. Rao, Environmental Pollution Control, CBS Publishers
5. H. S. Peavy, D. R. Rowe, G. Tchobanoglous, Environmental Engineering, McGraw Hill

Course Code: CHE-S505 **Breakup: 3 –0 – 0 – 4**

Course Name: Non conventional Energy Sources

Course Details:

Introduction to energy sources- energy consumption as a measure of prosperity, Indian energy future, renewable energy sources, prospects of renewable energy sources;
Solar Radiation and its measurement, solar energy collectors-flat plate, concentrating collectors, solar pond etc.;
Wind energy- principle of wind energy conversion, site selection considerations, WECS, types of wind machines;
Biomass-conversion technologies, biogas generation, biogas plants, pyrolysis
Geothermal energy- sources, vapour dominated, liquid dominated systems, applications and advantages
Energy from the oceans- OTEC, tidal energy, closed cycle and open cycle OTEC, Magneto Hydro Dynamic power generation, principle and systems
Chemical energy sources- fuel cells (H_2, O_2 cell), advantages, disadvantages, batteries
Hydrogen energy-methods of production, use as fuel
Solid waste as energy sourse

Text Books and References:

1. G. D. Rai, Non Conventional Energy Sources, Khanna Publishers

Course Code: CHE-S506 **Breakup: 3 –0 – 0 – 4**

Course Name: Numerical Methods for Chemical Engineers

Course Details:

Least Square method and curve fitting of data, cubic spline problems, approximation of functions interpolation and extrapolation of techniques; forward, backward and central difference, error approximation; derivatives from difference tables;
Numerical integration – Newton Cotes Integration technique, Simpson's 1/3 rd and 3/8th rule, trapezoidal rule, Gaussian quadrature;
Multiple Integral solution of Non-linear equation, bisection methods, regular-falsi method, Newton-Raphson methods, Euler's method, Euler's modified iteration technique, Picaed method, Runge-Kutta 4^{th} order technique, Taylor series method;
Solutions of ordinary differential equation (initial and boundary value problem)
Linear programming, simplex method, dual simplex, charne penalty method

Text Books and References:

1. S. K. Gupta, Numerical Methods for Chemical Engineers, New Age International
2. S. Chapra and R. Canale, Numerical Methods for Engineers

Course Code: CHE-S507 **Breakup: 3 –0 – 0 – 4**

Course Name: Advanced Separation Processes

Course Details:

Introduction to membrane separations, advantages and limitations; Equilibrium and Rate Governed Processes; Separation Factor for Rate Governed Separation Processes; Classification of Membranes and Membrane Separation Processes; Principles, Transport Mechanisms, Governing equations, Membrane type and materials , Applications of the following Membrane Separation Processes - Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis, Dialysis, Gas Separation, Pervaporation, Liquid Membranes and Electrodialysis; Membrane modules, Fouling and Concentration Polarization; Membrane Plant configurations and Plant Design;Introduction to Membrane Contactor and Membrane Reactor Chromatographic separation, Molecular Sieve separations, Supercritical Fluid Extraction Technology**.**

Text Books and References:

1. J. D. Seader, E. J. Henley, Separation Process and Principles, Wiley
2. M. Mulder, Basic Priciples of Membrane Technology, Kluwer Academic Publishers
3. K. Scott and R. Hughes, industrial Membrane Separation Technology, Blackie Academic and Professional

Course Code: CHE-S508 **Breakup: 3 –0 – 0 – 4**

Course Name: Optimization Techniques

Course Details:

Analytical method necessary and sufficient conditions for optimum in single and multi-variable unconstrained and constrained problems
Unconstrained one dimensional search, Newton, Quasi-Newton and Secant method for uni-dimensional search, region elimination methods (Golden Section, Fibonacci, Dichotomus etc)
Linear Programming, Graphical simplex method, revised simplex method, duality and transportation problems
Unconstrained multi-variable search, Direct methods, Indirect method, Finite difference approximation
Dynamic Programming, Principle of optimality, Discrete and continuous dynamic programming

Text Books and References:

1. T.E. Edger, D.M. Himmelblau, Optimization of Chemical Processes, McGraw Hill
2. Hameed S. Taha, Operational Research
3. G. C. Onwubolu, B.V. Babu, New Optimization Techniques in Engineering
4. S.S. Rao, Engineering Optimization

Course Code: CHE-S509 **Breakup: 3 –0 – 0 – 4**

Course Name: Biochemical Engineering

Course Details:

Cell Structure and Cell Types, Chemicals of Life (RNA, DNA, enzymes etc.),
Kinetics of Enzyme Reactions, Applied Enzyme Catalysis, Metabolic Stoichiometric and Energetics, Molecular Genetics and Control, Biomass Production,
Transport Phenomena in Biosystems, Design and Analysis of Biological Reactors, Fermentors, Downstream Product Recovery and Purification, Interaction of Mixed Microbial Populations, Biological Wastewater Treatment

Text Books and References:

1. M.L. Shular, F. Kargi, Bioprocess Engineering: Basic Concepts, Prentice Hall
2. J.E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, Mc Graw Hill
3. P.M. Doran, Bioprocess Engineering Principles, Academic Press Limited

Course Code: CHE-S510 **Breakup: 3 –0 – 0 – 4**

Course Name: Process Modelling and Simulation

Course Details:

Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models – Simple vs. rigorous, Lumped parameter vs. distributed parameter; Steady state vs. dynamic, Transport phenomena based vs. Statistical; Concept of degree of freedom analysis. Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, - steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc.; Review of solution procedures and available numerical software libraries. Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based approaches for staged processes; Modeling of differential contactors - distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries. Unsteady state (time dependent) models and their applications; Simple dynamic models of Batch reactors, Adsorption columns, Multistage separation systems; Model reduction through orthogonal collocation; Review of solution techniques and available numerical software libraries.
Introduction to flow sheet simulation; Sequential modular approach; Equation oriented approach; Partitioning and tearing; Recycle convergence methods; Review of thermodynamic procedures and physical property data banks.

Text Books and References:

1. W.L. Luyben, Process Modeling, Simulation, and Control for Chemical Engineering, Wiley.
2. A. Hussain, Chemical Process Simulation", Wiley Eastern Ltd., New Delhi,
3. C.D. Holland, Fundamentals of Modelling Separation Processes", Prentice Hall,