SEMESTER –I

PH-101	PHYSICS-I

1. **Special Theory of Relativity:** Frame of Reference, Galilean Transformation, Inertial and Non-inertial frames, Postulates of Special Theory of Relativity, Michelson-Morley Experiment, Lorentz transformation of space and time, Length contraction, Time dilation, Simultaneity in relativity theory, Addition of velocities, Relativistic dynamics, Variation of mass with velocity, Equivalence of mass and energy.

2. **Thermal Physics:** Maxwell-Boltzmann Law of distribution of molecular velocities, Evaluation of r.m.s.velocity and of average and most probable speeds, Mean free path, Transport phenomena.

3. **Geometrical Optics:** Combination thin lenses, Cardinal points of coaxial optical systems, thick lenses, location and properties of cardinal points, Newton's formula, graphical construction of images. Eye pieces, Aplantic points. Optical Instruments-Spectrometer (Prism and grating), Sextant.

4. **Physical Optics:**
   Interference- Condition of observing interference. Degree of coherence and visibility of fringes. Production of interference fringes and determination of wavelength using Fresnel's Biprism. Michelson interferometer and its uses. Interference due to thin films. Wedge shaped films. Newton's rings.
   Diffraction- Frasnel's Diffraction, Fresnel's Half Period Zone, Zone Plate, Fraunhofer's diffraction by single slit, double slit. Theory of plane grating. Width of principal maxima. Rayleigh's criterion of resolution. Resolving power of prism and grating.
   Polarisation- Unpolarised, polarized and partially polarized lights. Polarisation by reflection. Double refraction by uniaxial crystals, Polaroids, Huygen's theory of double refraction. Half wave and quarter wave plates. Production and analysis of plane elliptical and circularly polarized light. Optical activity. Fresnel's theory of optical rotation, Specific rotation, Biquartz and Laurent half-shade polarimeters.

5. **Holography:** Basic principles, Holography and its applications.

6. **Lasers:** Stimulated and spontaneous emission, Einstein coefficients, relative contribution of stimulated and spontaneous emissions, population inversion, Laser emission, Ruby and He-Ne lasers, characteristic of Laser light.

7. **Acoustics:** Production and detection of Ultrasonics, Measurement of Velocity in Liquids, Applications of Ultrasonics. Accoustics of building.

References

1. Mechanics-D.S.Mathur
2. Optics-A.K.Ghatak
3. Heat and Thermodynamics-Brijlal & Subramanium
4. Thermal Physics-B.K.Agarwal
4. Physics of Oscillations and Waves-R.B.Singh
5. Engineering Physics-A.S.Vasudeva

List of Experiments

Minimum ten experiment to be completed out of the following-

1. To determine the co-efficient of viscosity of water by capillary flow.
2. To determine the co-efficient of viscosity of liquid by rotating cylinder method.
3. To determine the surface tension of water by capillary rise.
4. To determine the surface tension of water by Jager's Method.
5. To determine the co-efficient of thermal conductivity of good conductor by Searle's method.
6. To determine the co-efficient of thermal conductivity of bad conductor by Lee's method.
7. To determine the co-efficient of thermal conductivity of rubber.
8. To determine the value of mechanical equivalent of heat by Callender's & Barne's method.
9. To determine the height of building by Sextant.
10. To determine the focal length of combination of two thin lenses by Nodal slide assembly and its verification.
11. To determine the wavelength of light by Fresnel's biprism.
12. To determine the wavelength of light by Newton's ring method.
13. To determine the wavelength of light by Diffraction Grating.
14. To determine the dispersive power of the given material of the prism.
15. To determine the specific rotation of canesugar using Polarimeter.

MA-101 MATHEMATICS-I

Quadric surfaces in three dimensions, Sequences and series, Power series, Limit, Continuity, Differentiability, Mean value theorem, Taylor's theorem for functions of one and two variables, Transformation of one system of coordinates into another system, Extrema of functions of multi-variables, Definite integrals, Trapezoidal and Simpson rule, Improper integrals, Applications, Vector calculus- Gradient , Directional derivatives, Curl and divergence, Double, triple, line and surface integrals, Green, Gauss, Stoke's theorems and applications.

References

1. Thomas and Finney, Calculus and Analytic Geometry, Narosa Pub. House, New Delhi.
2. N. Piskunov, Differential, and Integral Calculus, Vol I & II, Mir Pub, Moscow.
3. Jain and Iyenger, Advanced Engineering Mathematics, Narosa Pub. House, New Delhi.
4. T. Mazumdar, Engineering Mathematics, New Central Book Agency.
5. Jaggi and Mathur, Higher Engineering Mathematics, Khanna Publishers, New Delhi.
6. Bali and Iyengar, Engineering Mathematics, Khanna Publishers, New Delhi.

CS 101 | Introduction to Engineering Profession

Information Technology portion:

MS WINDOWS, commands, editing and saving files, word processing, file management.

LINUX Commands, editors, Files & Directories, UNIX tools.

Internet and World Wide Web :

Introduction to Internet, www, Internet browsers Netscape & Explorer, Introduction of PINE/ELMN, FTP, Telnet, Search Engines.

Hypertext Markup Language, HTML Tags, Frames, Creating HYML documents, DHTML.

References

1. D.S.Yadav , Foundation of Information technology, New age International 2003
2. S. Dash ,Introduction to unix, TMH

EX 101 | Electrical & Electronics Engineering

A. Electrical Engineering

Introduction to Electrical Engineering

Generation: Types of power Plant, Functional Block diagram of Generating stations (Hydel & Thermal Stations)
Transmission: Standards (AC & DC), Substations, Grids
Distribution: Industrial, Commercial and Domestic Standards.
Utilization: Types of loads, UPS and domestic inverters.
Domestic Wiring: Materials, accessories & ratings of the wiring materials, types of wiring: stare case, fluorescent tube and simple domestic wiring layout, earthing and electricity rules.
Steady-state analysis of AC circuits: Sinusoidal and phasor representation of Voltage & current, single phase ac circuit behavior of R, L and C. Combination of R, L and C in series and parallel. Resonance.
Three Phase AC circuits: Line and phase voltage/current relationship for star & delta connections.
Measuring Instruments: Types of instruments, working principles of Ammeter, Voltmeter, Wattmeter & Energy meter.
Transformer & Rotating Machines: Principle of operation and construction of single-phase transformer, phasor diagram and equivalent circuits, efficiency and voltage regulation. Principle of electromagnetic energy conversion, Starting and speed control of DC and AC motors

B. Electronics Engineering

Junction Diode : p-n junction, v-i characteristics, diode resistance, capacitance, switching time, diode applications. Breakdown mechanism, Zener and avalanche, break down characteristics, Zener diode and its applications voltage regulator.

Bipolar -junction Transistor : Bipolar junction transistor, CE, CB and CC configurations and characteristic curves, Requirement of biasing, types of' biasing.

JFET and MOSFET: The JFET and MOSFET action; characteristics.

Linear IC and its applications

Digital Electronics: Number systems, conversion of bases, Boolean Algebra, logic gates, Concept of universal gate, Flip-Flops and counter**.**

Electronics Instruments :Oscillators, Digital Multimeter and its applications, CRO and its applications.

HS 101 English Language and Composition

1. Remedial Grammar: It is the basic core for the development of the English language and it can be more enhanced through our mini language lab currently, though in future with computerised language lab containing tense busters and other softwares to develop interests in students to learn language through games.

Content: Articles, Prepositions, Tenses, Active and Passive forms.

2. Effective comprehension: In this global era effective comprehension is an attempt to develop in technical students to comprehend different topics relative to varied scientific and social myriad happenings in the world thus bridging the gap from the scientific- technical culture from the liberal arts culture.

Content: Passages from News Papers, magazines and short comprehensions from GRE packages

3. Effective Composition: Liberal space has been devoted to written composition and an overall initiative will be taken to show the students that most effective writing- scientific or literary-adapts certain principles of rhetoric which can be learnt and put into practice through artistic writing.

Content: Discussions on varied topics in tutorials, excerpts from magazines and newspapers.

4. Pronunciation Skill: One of the important aspects in communication and personality impression of the students. This will be enhanced through the aid of language lab and the instructors own drilling exercises. So that availing such a skill can create great space for themselves and for job in this age of globalisation, where overall developed personality is more easily absorbed.

Content: With the help of language lab and instructors drilling exercises.

CH 101 Chemistry

Chemical Bonding
Valence bond theory, molecular orbital theories of bonding in metals and semi-conductors (Band theory), imperfection in solids (6)

Polymers
Classification of polymers, types of polymerisation and their principles, structure property relationship, polymer materials of industrial importance, biopolymers. (6)

Phase rule
Derivation of the phase rule, application of phase rule to one component system (2)

Chemical kinetics
Reaction rates, order and molecularity of reactions, factors influencing reaction rates, complicating factors in reaction kinetics- opposing reactions, consecutive reactions, side reactions and surface reactions. (4)

Water Chemistry
Sources and nature of impurities, characteristics of natural water, water treatment processes, boiler feed water. (6)

Fuels
Classification, calorific value, analysis of solid fuels, carbonisation of coal, gaseous fuels including LPG and natural gases, liquid fuels and its properties, power alcohol, knocking and octane, rating, anti-knocking agents, diesel as a fuel, cetane number. (6)

Corrosion
Theories of corrosion, types of corrosion and its protective measures, detailed account of paints, varnishes and resins. (6)

Lubricants
Definition, functions, mechanisms and classification of lubricants, properties and testing of lubricating oils. (4)

Reference Books

1. A Text Book of Engineering Chemistry, S.Chawla, Dhanpat Rai & Co., New Delhi, 2004.
2. Engineering Chemistry: Theory & Practices, J.N.Gurtu and N.Singhal, Pragati Prakashan, Meerut, 2004.
3. Engineering Chemistrty, Jain & Jain, Dhanpat Rai & Co., New Delhi, 2000

ME 101 | Introduction to Manufacturing Processes

1. **Introduction to Materials and Manufacturing**: Introduction to engineering materials such as metals and alloys and their applications. Art of manufacturing; Classification of manufacturing processes, Guide to processing of metals and alloys.
2. **Machining Processes and Machine Tools:** Classification of machining processes and machine tools; Construction and working of lathe, Drilling machine, Shaper, Slotter and Planer, Boring Machine, Milling Machine, Grinding Machine, Brief introduction of Newer Machining Processes such as EDM, ECM, USM, LBM, WJM etc.
3. **Casting Processes**: Elements of Sand Mould, Method of preparation of Sand Mould, Introduction of casting defects.
4. **Press Working Operations:** Classification of press working operations, Construction of Power Presses, Press working terminology, Types of dies and their operations.
5. **Fabrication Processes:** Classification of welding operations, Types of joints and welding positions. Brief description of Arc, Resistance and Gas welding techniques. Brazing and Soldering.
6. **Modern Trends in Manufacturing:** Automation, Concept of CAD, CAM and CIM; Concept of Micro manufacturing and nano-technology.

MC 101 | Engineering Graphics

General: Importance, significance and scope of engineering graphics, dimensioning, scales, different types of projections, orthographic projections,

Projection 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.

Planes other than reference planes: Perpendicular and oblique planes, 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.

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.

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.

Development of Surfaces: Development of simple objects with or without sectioning.

Machine Drawing: Basic Concepts: IS drawing conventions, line symbols, Kinds of line, drawing sheet layout, rules of printing, preferred scales.

Projections: Perspective, orthographic, isometric and oblique projections, sketching of orthographic views from pictorial views, precedence of lines.

Shape Description (internal): Importance of sectioning, principles of sectioning, types of sections, cutting plane representation, section lines, and conventional practices.

Size Description: Dimensioning, size and location dimensioning, Principles and conventions of dimensioning, dimensioning exercises.

Screwed Fasteners: Introduction, Screw Thread nomenclature, Forms of Screw Threads, Thread series, Multi-start threads, Right hand and left hand threads, Representation of threads, Bolted Joints, Locking arrangements for nuts, foundation bolts.

Computer Graphics: Basic Concepts and use. Methods of constructing objects in computer aided design softwares.

References:

1. N. Sidheswar, P. Kannaiah, V. V. S. Shastry, "Machine Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 1988
2. Bhatt, N. D., 'Elementary Engineering Drawing', Charotar Book Stall, Anand, 1998.
3. Laxminarayanan, V, and Vaish Wanar, R. S., 'Engineering Graphics', Jain Brothers, New Delhi, 1998.
4. French and Vireck, The fundamental of Engineering Drawing and Graphic Technology', McGraw Hill, 4th Edition, 1978.
5. IS 696 (1972); Code of practice for general engineering drawing', BIS, New Delhi.
6. P. S. Gill, ' A Text book of Machine Drawing', Katson Publishing House, Ludhiana, 1980.
7. Giesecke, Mitchell, Spener, Hill and Dygon, 'Technical Drawing', McMillan &Co., 7th Ed, 1980.

SEMESTER-II

PH-201	Physics-II

1. Electrostatics
Background of vector calculus, Quantization and conservation of charge, Coulomb's law (vector form) and superposition principle, concept of electric field lines, flux of E-field, Gauss flux law (Integral and differential form). Simple cases of charge distributions. Energy of charge distribution, Energy as an integral over the field of uniformly charged spherical surface and volume.

2. Electric Current
Current Density Vector, Equation of Continuity, Ohm and Joule's Laws (Integral and differential forms).

3. Magneto statics
Ampere's Law, Biot Savart's Law, Law of Force in magnetic Field on currents and Charged Particles. Magnetic Field due to a Straight Infinite Wire. Magnetic Field due to Circular Loop and Solenoid at Axial points, Variation of Magnetic field with distance along the axis of Helmholtz galvanometer. Vector potential and its Evaluation for Uniform magnetic field and for Straight Infinite Wire. Divergence and curl of **B**. Distant Field due to Loop of Current. Magnetic Moment. Magnetic materials and magnetization. Magnetic Current Field **H,** Curl of **H** and calculation of **H**

5. Time Varying Fields
Displacement Current, Curl H, Faraday's Law(Integral and Differential forms). Self and Mutual Inductances. Energy of Coupled Circuits and Current Distribution. Energy as an Integral over the Magnetic field. Energy of a Solenoid.

6. Electromagnetic Waves in Free-Space
Maxwell equations. Plane Polarized Plane Wave Solution. Characteristics of these Electromagnetic waves. Poynting's Theorem.

7. Atomic & Nuclear Physics
X-rays-Characteristic and continuous X-ray spectra, Mosley's law, X-ray absorption X-ray diffraction, Bragg's law, Laue Spots Bragg's Spectrometer. Compton effect.

8. Magnetic Properties of Materials- Ferro, Para, Dia, Antiferro and Ferri Magnetic Materials. Hysteresis curve and their uses. Larmor's Theory and Diamagnetic Susceptibility. Langevin's Theory and Curie-Weiss Law. Magnetic Circuits.

9. Quantum Concepts -Particle nature of radiation, Wave nature of Particles. De-Broglie Waves, Davission-Germer experiment, Wave Packets, Phase velocity and group velocity, Heisenberg's Uncertainty Principle and its applications, one-dimensional Schrodinger's wave equation and concept of probabilities, amplitude, application to one-dimensional potential well.

10. Particle Physics- Classification of elementary Particles

References

1. Electricity & Magnetism-Brijlal & Subramanium
2. Electricity & Magnetism-K.K.Tiwari

3. Introduction to Electrodynamics-David J.Griffths
4. Modern Physics-Beiser
5. Engineering Physics-A.S.Vasudeva
6. Physics for Engineers-M.R.Srinivasan
7. Quantum Mechanics- Gasirowicz

List of Experiments

Minimum ten experiment to be completed out of the following-

1. To determine the specific resistance of wire by Carry-Foster's Bridge.
2. To determine the reduction factor of Helmholtz Galvanometer.
3. To determine the E.C.E. of copper using voltameter..
4. To convert a galvanometer into a voltmeter of 3 volts.
5. To convert a galvanometer into an ammeter of 200 milliamperes.
6. To determine the variation of magnetic field along the axis of current carrying coil.
7. To determine e/m by magnetic focussing.
8. To Verify Stefan's law.
9. To study the non-Ohmic behavior of the filament of an electric bulb.
10. To compare the illuminating power of two electric bulbs by photometer.
11. To find the resistance of a galvanometer using P.O.Box.
12. To find the internal resistance of a cell using P.O.Box.
13. To find the current sensitivity of a galvanometer using P.O.Box.
14. To calibrate a moving coil galvanometer using P.O.Box.
15. To calibrate an ammeter and voltmeter using Potentiometer

MA-201 | Mathematics-II

Linear vector spaces, Linear transformation and matrices, Determinants, Linear simultaneous algebraic equations, Special matrices, Quadratic forms, Diagonalisation and canonical forms, First order ODE, IVP/BVP, Existence and uniqueness questions, System of linear equations, Higher order ODE, Solutions of homogeneous and non-homogeneous ODE, Variation of parameters, Undetermined coefficients, Laplace transforms and application to solutions of ODE, Series solutions, Strum-Liouville problem, Orthogonal polynomials, Fourier series, Fourier integrals, Generalized Fourier series.

References:

1. E. Kreyszig, Advanced Engineering Mathematics, 8th Edition, Wiley Eastern
2. Jain and Iyengar, Advanced Engineering Mathematics, Narosa Pub. House
3. Jaggi and Mathur, Higher Engineering Mathematics, Khanna Publishers.
4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. Hoffman and Kunj, Linear Algebra, Prentice Hall
6. Bali and Iyengar,' Engineering Mathematics, Khanna Publishers

CS-201 | Computer Programming

Writing a Simple Program: Learning the form of a C program, Declaring variables, designing program flow and control, defining and using functions, using standard terminal I/O functions.

Fundamental Data Types and Storage Classes: Character types, Integer, short, long, unsigned, single and double-precision floating point, storage classes, automatic, register, static and external.

Operators and Expressions: Using numeric and relational operators, mixed operands and type conversion, Logical operators, Bit operations, Operator precedence and associativity.

Conditional Program Execution: Applying if and switch statements, nesting if and else, restrictions on switch values, use of break and default with switch.
Program Loops and Iteration: Uses of while, do and for loops, multiple loop variables, assignment operators, using break and continue.
Modular Programming: Passing arguments by value, scope rules and global variables, separate compilation, and linkage, building your own modules.
Arrays: Array notation and representation, manipulating array elements, using multidimensional arrays, arrays of unknown or varying size.
Structures: Purpose and usage of structures, declaring structures, assigning of structures.
Pointers to Objects: Pointer and address arithmetic, pointer operations and declarations, using pointers as function arguments, Dynamic memory allocation, defining and using stacks and linked lists.
Unions: Components in overlapping memory, declaring and using unions .h vs. private .c files, Hiding private variables and functions.
Controlling Devices: Bit access and masking, pointing to hardware structures.
Operating System Interaction: Reading command line arguments, creating and accessing files, file opening modes, formatted disk I/O.
The Standard C Preprocessor: Defining and calling macros, utilizing conditional compilation, passing values to the compiler.
The Standard C Library: Input/Output : fopen, fread, etc, string handling functions, Math functions : log, sin, alike' Other Standard C functions.

References:

1. Herbert Schield, Complete reference in C,' TMH.
2. Yashwant Kanetkar,' Let US C', BPB.
3. Balaguruswamy, 'Programming in ANSI C,' TMH.
4. Yashwant Kanetkar, Pointers in C.

HS 201 | English Language and Composition

Remedial Grammar: It is the basic core for the development of the English language and it can be more enhanced through our mini language lab currently, though in future with computerised language lab containing tense busters and other softwares to develop interests in students to learn language through games.
Content: Articles, Prepositions, Tenses, Active and Passive forms.

Effective comprehension: In this global era effective comprehension is an attempt to develop in technical students to comprehend different topics relative to varied scientific and social myriad happenings in the world thus bridging the gap from the scientific-technical culture from the liberal arts culture.

Content: Passages from News Papers, magazines and short comprehensions from GRE packages

Effective Composition: Liberal space has been devoted to written composition and an overall initiative will be taken to show the students that most effective writing-scientific or literary-adapts certain principles of rhetoric which can be learnt and put into practice through artistic writing.

Content: Discussions on varied topics in tutorials, excerpts from magazines and newspapers.

Pronunciation Skill: One of the important aspects in communication and personality impression of the students. This will be enhanced through the aid of language lab and the instructors own drilling exercises. So that availing such a skill can create great space for

themselves and for job in this age of globalisation, where overall developed personality is more easily absorbed.
Content: With the help of language lab and instructors drilling exercises.

CH 201 Chemistry

Chemical Bonding
Valence bond theory, molecular orbital theories of bonding in metals and semi-conductors (Band theory), imperfection in solids.
Polymers
Classification of polymers, types of polymerisation and their principles, structure property relationship, polymer materials of industrial importance, biopolymers.
Phase rule
Derivation of the phase rule, application of phase rule to one component system.
Chemical kinetics
Reaction rates, order and molecularity of reactions, factors influencing reaction rates, complicating factors in reaction kinetics- opposing reactions, consecutive reactions, side reactions and surface reactions.
Water Chemistry
Sources and nature of impurities, characteristics of natural water, water treatment processes, boiler feed water.
Fuels
Classification, calorific value, analysis of solid fuels, carbonisation of coal, gaseous fuels including LPG and natural gases, liquid fuels and its properties, power alcohol, knocking and octane, rating, anti-knocking agents, diesel as a fuel, cetane number.
Corrosion
Theories of corrosion, types of corrosion and its protective measures, detailed account of paints, varnishes and resins.
Lubricants
Definition, functions, mechanisms and classification of lubricants, properties and testing of lubricating oils.

References

1. S.Chawla, A Text Book of Engineering Chemistry, Dhanpat Rai & Co., New Delhi, 2004.
2. J.N.Gurtu and N.Singhal, Engineering Chemistry: Theory & Practices, Pragati Prakashan, Meerut, 2004.
3. Jain & Jain, Engineering Chemistrty, Dhanpat Rai & Co., New Delhi, 2000.

AM-201 Engineering Mechanics

Introduction:
Idealisation of Mechanics, concept of Rigid Body, External Forces (Body forces & surface forces), Laws of Mechanics.
Force Systems and Equilibrium
Introduction to vector, Statically Equivalent Force systems (Planar and Spatial), Free Body Diagram, Equations of equilibrium and their applications to various system of forces.
Structures and Machines
Plane Trusses, Space Trusses, Method of Joints, Method of Section, Graphical Method, Method of tension coefficients, Frames and Machines.
Distributed Forces and Moment Of Inertia
Centroid of Composite figures, Area Moment of Inertia, Mass Moment of Inertia, Principle axes and Principle Moment of Inertia.

Friction
Introduction to friction, Laws of friction, wedge, screw, belt, rolling friction.
Beams
Different support & load conditions, SFD, BMD
Kinematics and Kinetics of Rigid Bodies
Velocity and acceleration, Rotation of Rigid bodies, Rolling motion, Plane motion of rigid bodies, Effective Forces on a rigid body, D'Alembert's Principle, Force, Mass and Acceleration, Work and Energy, Impulse and Momentum.
Three Dimensional Dynamics of Rigid Bodies
Introduction, Kinematics and Kinetics, General Motion

References

1. Engineering Mechanics (Statics and Dynamics) J.L. Merriam and L. G. Kraige.
2. Mechanics for Engineers- (Statics and Dynamics) F.B. Beer & E.R. Johnston.
3. Engineering Mechanics- I.M. Shames
4. Engineering Mechanics- S. Timoshenko & T. Yong
5. Engineering Mechanics- Singer
6. Engineering Mechanics- Statics Vol-I & Dynamics Vol-II by V.S. Mokashi. (Tata McGraw-Hill)
7. Engg. Mechanics-Statics & Dynamics by Dr. A.K. Tayal, Umesh Publication, Delhi.

ME-201 | Introduction to Manufacturing Processes

7. **Introduction to Materials and Manufacturing**: Introduction to engineering materials such as metals and alloys and their applications. Art of manufacturing; Classification of manufacturing processes, Guide to processing of metals and alloys.
8. **Machining Processes and Machine Tools:** Classification of machining processes and machine tools; Construction and working of lathe, Drilling machine, Shaper, Slotter and Planer, Boring Machine, Milling Machine, Grinding Machine, Brief introduction of Newer Machining Processes such as EDM, ECM, USM, LBM, WJM etc.
9. **Casting Processes**: Elements of Sand Mould, Method of preparation of Sand Mould, Introduction of casting defects.
10. **Press Working Operations:** Classification of press working operations, Construction of Power Presses, Press working terminology, Types of dies and their operations.
11. **Fabrication Processes:** Classification of welding operations, Types of joints and welding positions. Brief description of Arc, Resistance and Gas welding techniques. Brazing and Soldering.
12. **Modern Trends in Manufacturing:** Automation, Concept of CAD, CAM and CIM; Concept of Micro manufacturing and nano-technology.

MC 201 | Engineering Graphics

General: Importance, significance and scope of engineering graphics, dimensioning, scales, different types of projections, orthographic projections,

Projection 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.

Planes other than reference planes: Perpendicular and oblique planes, 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.

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.

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.

Development of Surfaces: Development of simple objects with or without sectioning.

Machine Drawing: Basic Concepts: IS drawing conventions, line symbols, Kinds of line, drawing sheet layout, rules of printing, preferred scales.

Projections: Perspective, orthographic, isometric and oblique projections, sketching of orthographic views from pictorial views, precedence of lines.

Shape Description (internal): Importance of sectioning, principles of sectioning, types of sections, cutting plane representation, section lines, and conventional practices.

Size Description: Dimensioning, size and location dimensioning, Principles and conventions of dimensioning, dimensioning exercises.

Screwed Fasteners: Introduction, Screw Thread nomenclature, Forms of Screw Threads, Thread series, Multi-start threads, Right hand and left hand threads, Representation of threads, Bolted Joints, Locking arrangements for nuts, foundation bolts.

Computer Graphics: Basic Concepts and use. Methods of constructing objects in computer aided design softwares.

References:

8. N. Sidheswar, P. Kannaiah, V. V. S. Shastry, "Machine Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 1988
9. Bhatt, N. D., 'Elementary Engineering Drawing', Charotar Book Stall, Anand, 1998.
10. Laxminarayanan, V, and Vaish Wanar, R. S., 'Engineering Graphics', Jain Brothers, New Delhi, 1998.
11. French and Vireck, The fundamental of Engineering Drawing and Graphic Technology', McGraw Hill, 4th Edition, 1978.
12. IS 696 (1972); Code of practice for general engineering drawing', BIS, New Delhi.
13. P. S. Gill, ' A Text book of Machine Drawing', Katson Publishing House, Ludhiana, 1980.
14. Giesecke, Mitchell, Spener, Hill and Dygon, 'Technical Drawing', McMillan &Co., 7th Ed, 1980.

MA-301 Mathematics-III

First order PDE, Complete general and particular solutions, Second order linear PDE, Interior and exterior BVP, Functions of a complex variable, The complex plane, Analytic functions, Elementary functions, Multivalued functions, Singularities, Complex integration, Conformal mapping, Probability theory, Axiomatic definition of probability, Conditional probability, Random variables Distribution function, Expectation, Moments, Moment generation function, Special types of Probability distributions, Normal approximation to Binomial distribution.

References:

1. E. Kreyszig, Advanced Engineering Mathematics, 8th Edition, Wiley Eastern
2. Jain and Iyengar, Advanced Engineering Mathematics, Narosa Pub. House
3. Jaggi and Mathur, Higher Engineering Mathematics, Khanna Publishers.
4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. J.N. Kapur, Mathematical Statistics, S.Chand & Co.
6. Zill and Cullen, Advanced Engineering Mathematics, C.B.S.Publishers

CE-301 Environment and Ecology

Introduction and scope

Conservation of natural resources i.e. forest resource, water resource, mineral resource, energy resource, land resource etc. Role of individual for resource conservation and sustainable development.

Ecosystem and its basic concept, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Examples of ecosystems.

Biodiversity and its conservation**:** Introduction - Definition: genetic, species and ecosystem diversity, National and global scenario.

Environmental Pollution, Definition, Causes, effects and control measures of:Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards

Sustainable development**,** Urban problems related to energy**,** Water conservation, rain water harvesting, watershed management**,** Environmental ethics: Issues and possible solutions**,** Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust Case studies**,** Wasteland reclamation**,** Consumerism and waste products, Environmental Management through Acts.

.Human Population and the Environment: Environment and human health, Role of Information Technology in Environment and human health, Case studies

Field Work

- Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain
- Visit to a local polluted site- Urban/Rural/Industrial/Agricultural
- Report submission on field visit

AM-301 | Material Science and Engineering

Structure and properties, relationship of Engineering Materials

Structure of Crystalline Solids: Crystal structures and Systems, Unit Cells, Metallic Crystal Structures, Crystallographic directions and Planes, Density Computations.

Characterization of Materials: Crystallography, Reciprocal Lattice, Stereographic projections, Diffraction methods, Electron microscopy, Metallography, Thermal analysis.

Imperfections in Crystals: Point defects, Dislocations, Interfacial Defects, Bulk defects.

Diffusion: Mechanisms, steady state and non steady state Diffusion, factors influencing diffusion.

Multiphase Structures, Phase Transformations: Unary, Binary, Equilibrium Phase Diagrams, Eutectic, Eutectoid Peritectic and Peritectoid Reactions**,** Iron Carbon Diagram.

Mechanical Behavior of Materials: Elastic and Plastic properties, Creep, Fracture, Heat treatment of steels.

Ceramic Materials: Ceramic Structures, Properties**.**

Electric and Electronic materials: Electrical Conduction, Classification of semiconductor materials, Materials and Technology for integrated circuits, Photonic materials, super conductivity and special super-conducting materials, Ferrites. Quartz crystal, Dielectric materials. Piezoelectric and Ferro-electric materials, Electromechanical materials, Mechanism of polarization, Its measurements.

Magnetic Properties for Applications; 'Diamagnetism, Paramagnetism, ferromagnetism, Antiferromagnetism, Ferrimagnetism, Soft and hard magnetic materials magnetic storage.

Optical properties: Optical properties of Metals and Nonmetals, Luminescence, photoconductivity, Optical Fibers in communications.

References:

1. Callister W. D., Jr., Material Science and Engineering An Introduction, John Wiley & Sons, Inc., 6th Ed., 2003.
2. Raghavan V., Material Science and Engineering, Prentice- Hall of India Private Limited, New Delhi, 5th ed., 2004.

ME-301 | Engineering Thermodynamics

Basic Concepts and Definitions: Definition, Areas of Application of thermodynamics, Thermodynamic System, Surroundings and universe, Types of Systems, Phases, Macroscopic and Microscopic point of view, Concept of Continuum, Density, pressure, Thermodynamic equilibrium, Property, Path, Process, Quasi-static process, Reversible and irreversible processes, Energy and its types, Thermodynamic media, Thermodynamic devices.
Heat and Work: Work, Power, Forms of work, heat, sign convention of various energies.

Temperature and Zeroth law of Thermodynamics: Concept of temperature, Zeroth law of thermodynamics, Measurement of temperature, Temperature Scale, Various thermometers, International temperature scale.

Ideal and Real Gases: Concept of ideal and real gases, gas laws, Characteristic equation of gas, Avagadro hypothesis and universal gas constant, Specific heat, Vander Waals equation of state, Compressibility and law of corresponding states, Deviation of real gases from ideal gases, PVT surface of ideal gas.

First Law of Thermodynamics: Definition and proof for non-flow and cyclic processes, Internal energy and enthalpy. Application of first law for closed system, Flow Process and control Volume, Flow work, First law of thermodynamics applied to open system for steady and unsteady flow process, Mechanical work in a flow system, continuity equation, Throttling process, Joule-Thomson coefficient, Application of Steady and unsteady flow energy equation.

Second Law of Thermodynamics: Limitation of First law and essence of Second law, Thermal reservoirs, Heat engines and thermal efficiency, Heat pump and coefficient of performance, Available and unavailable energy, Statement of Second law, Carnot Cycle, irreversibility, Corollaries of Second law.

Entropy and Third Law of Thermodynamics: Clausius inequality, Entropy, Entropy related corollaries, Entropy generation in a closed and an open system, Temperature entropy-diagram, Application of entropy principle, First and Second law combined Equations, Entropy change for an ideal gas, Physical interpretation of entropy, Isentropic efficiencies, Third law of Thermodynamics.

Properties of Steam and Applications: Pure Substance, Phase transformation, P-V-T surface for pure substance, Quality of Steam, Properties of Steam, Steam property diagrams, Application of first and second law involving steam as working fluid, Methods of determination of dryness fraction.

General Thermodynamic Relation. Helmholtz and Gibbs free energy, Coefficient of volume expansion and isothermal compressibility, Differential relation for U, H, G and F, Maxwell Relations, Generalized Relation for C_p, C_v, K and β, various Tds equations, Clapeyron equation.

Availability, Energy and Irreversibility: High and low grade energy, Aspects of energy concepts, Availability of Heat, quality of energy, Availability of closed and open system, closed and open system energy balance, Irreversibility for closed and open system, Exergetic (or Second law) efficiency, Effectiveness.

Non-Reactive gas mixture: PVT relationship for mixtures of ideal gases, properties of mixture of ideal gases, entropy change due to mixing, mixture of perfect gases at different temperature and pressure.

Gas Power cycle: Air standard cycle, some definition of piston-cylinder arrangement, Carnot, Otto, Diesel, Dual and Brayton cycle.

Vapour Power cycle: Carnot and Rankine cycle, Effect of operating parameters on Rankine cycle, means for improving efficiency of Rankine cycle

Refrigeration cycle: Definitions of refrigeration, Reverse Carnot cycle, Vapor compression and vapor absorption cycle, Gas refrigeration.

Reactive Mixtures: Chemical reaction, classification of fuels, Stoichiometric equation, flue gas analysis, maximum air required for complete combustion of fuel, heating values of fuel, enthalpy of formation and heat of reaction, adiabatic combustion (flame) temperature.

References:

1. Moran, M.J. and Shapiro, H.N., Fundamentals of Engineering Thermodynamics, 4th edition, John Wiley & Sons Inc, New York, 2000.
2. Van Wylen, G.J. and Sonntag, R.E., Fundamentals of Thermodynamics, John Wiley & Sons Inc, New York, 2000.
3. Holman, J.P., Thermodynamics, 4th ed., McGraw-Hill book Co. New York.
4. Spalding, D.B. and Cole, E.H. Engineering Thermodynamics, Edward Arnold.

5. Reynolds, W.C., Thermodynamics, McGraw-Hill Book Co. New York.
6. Nag P.K. Engineering Thermodynamics, 2nd edition, 1995, Tata McGraw Hill Publishing co. Ltd, New Delhi.

AM 307 | Fluid Flow Operations

Introduction: Fluid and continuum, Physical properties of fluids, Rheology of fluids.

Kinematics of Fluid flow: Types of fluid flows: Continuum & free molecular flows. Steady and unsteady, uniform and non-uniform, laminar and turbulent flows, rotational and irrotational flows, compressible and incompressible flows, subsonic, sonic and supersonic flows, sub-critical, critical and supercritical flows, one, two and three dimensional flows, streamlines, continuity equation for 3D and 1D flows, circulation, stream function and velocity potential, source, sink, doublet and half-body.

Fluid Statics: Pressure-density-height relationship, manometers, pressure transducers, pressure on plane and curved surfaces, centre of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to linear acceleration and uniform rotation about an axis.

Dynamics of Fluid Flow : Euler's Equation of motion along a streamline and its integration, Bernoulli's equation and its applications- Pitot tube, notches, weirs, orifice meter, venturimeter and bend meter, Hot-wire anemometer and LDA, notches and weirs, momentum equation and its application to pipe bends.

Dimensional Analysis and Hydraulic Similitude: Dimensional analysis, Buckingham's Pi theorem, important dimensionless numbers and their significance, geometric, kinematic and dynamic similarity, model studies.

Laminar and Turbulent Flow: Equation of motion for laminar flow through pipes, Stokes' law, transition from laminar to turbulent flow, turbulent flow, types of turbulent flow, isotropic, homogenous turbulence, scale and intensity of turbulence, measurement of turbulence, eddy viscosity, mixing length concept and velocity distribution in turbulent flow over smooth and rough surfaces, resistance to flow, minor losses, pipe in series and parallel, power transmission through a pipe, water hammer.

Boundary Layer Analysis: Boundary layer thickness, boundary layer over a flat plate, laminar boundary layer, application of momentum equation, turbulent boundary layer, laminar sub-layer, separation and its control, Drag and lift, drag on a sphere, a two dimensional cylinder, and an aerofoil, Magnus effect.

Introduction to compressible flow: Thermodynamic processes, continuity equation, work done in an isothermal process and adiabatic process, sonic velocity, Mach number, Mach Line, Mach angle and Mach cone, properties at a stagnation point, flow through a convergent nozzle and De Laval nozzle, Normal and oblique shocks, Fanno and Rayleigh lines.

References:

1. Som, S.K. & Biswas G, Introduction to fluid mechanics & Fluid Machines, TMH, 2000, 2nd edition.
2. S.K.Agarwal, Fluid Mechanics & Machinery, TMH, New Delhi.
3. Garde, R.J., 'Fluid Mechanics through Problems', New Age International Pvt. Ltd, New Delhi, 2nd Edition.
4. Hunter Rouse, 'Elementary Mechanics of Fluids', John Wiley & Sons. Omc. 1946.
5. I.H.Shames, 'Mechanics of Fluids', McGraw Hill, Int. Student, Education, 1988.
6. Jagdish Lal, Fluid Mechanics, Metropolitan Book Company Ltd., Delhi.

7. Vijay Gupta and S.K.Gupta, 'Fluid Mechanics and its Applications', Wiley Eastern Ltd, 1984.
8. Modi, P.N., and Seth, S.H., 'Hydrualics and Fluid Machines', Standard Book House, 1989.

FLUID FLOW OPERATIONS LAB

1. To verify the momentum equation using the experimental set-up on diffusion of submerged air jet.
2. To determine the coefficient of discharge of an orifice of a given shape. Also to determine the coefficient of velocity and the coefficient of contraction of the orifice mouth piece.
3. To calibrate an orifice meter, veturimeter, and bend meter and study the variation of the co-efficient of discharge with the Reynolds number.
4. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
5. To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
6. To study the variation of friction factor, 'f' for turbulent flow in commercial pipes.
7. To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness.

CL 302 Chemical Process Principles

STOICHIOMETRY: Introduction- Units and Dimensions - stochiometric principles-composition relations, density and specific gravity.

IDEAL GASES AND VAPOR PRESSURE: Behaviors of Ideal gases -kinetic theory of gases - application of ideal gas law- gaseous mixtures - volume changes with change in composition. Vapor pressure- effect of Temperature on vapor pressure, vapor pressure plots, vapor pressure of immiscible liquids-solutions.

HUMIDITY AND SOLUBILITY: Humidity - saturation - vaporization - condensation - wet and dry bulb thermometry Solubility and Crystallization-Dissolution -solubility of gases.

MATERIAL BALANCE: Material Balance-Process involving chemical reaction-Combustion of Coal, fuel gases and sulphur-Recycling operations - by passing streams - Degree of conversion

ENERGY BALANCE: Thermo chemistry- Hess's law of summation- heat of formation, reaction, combustion and mixing - mean specific heat -Theoretical flame Temperature.

TEXTBOOKS:

1. O.A.Hougen, K. M. Watson and R. A. Ragatz, "Chemical Process Principles", Vol-I, CBS Publishers and Distributors, New Delhi, 1995.
2. D. Himmelblau, '"Basic Principles and Calculations in Chemical Engineering", 5th Edn., Prentice Hall of India Ltd.,N.Delhi,1994.
3. B.I.Bhatt and S.M.Vora, "Stoichiometry", Tata McGraw Hill Publishers Ltd., New Delhi, 1996.
4. V.Venkataramani and N.Anantharaman, "Process Calculations", Prentice Hall of India Ltd., New Delhi, 2003.

ME-401 | Computational and Statistical Techniques

Introduction: Errors in Numerical Computation, Mathematical Preliminaries, Errors and their analysis.

Algebraic and Transcendental Equations: Bisection method, Iteration method, Method of false position, Rate of convergence, Method for Complex Root, Muller's Method, Quotient difference method, Newton-Raphson Method.

Interpolation: Introduction, Errors in Polynomial Interpolation, Finite Difference, Decision of Errors, Newton's Formulae for Interpolation, Gauss, Stirling, Bessel's Everett's Formulae, Interpolation by Unevenly spaced points, Lagrange Interpolation Formula, Divided Difference, Newton's General Interpolation Formula.

Curve Fitting, Cubic Splines and Approximation: Introduction, Method of least square curve fitting procedures, Fitting a straight line, Curve fitting by sum of exponentials, Data fitting with cubic splines, Approximations of Functions.

Numerical Integration & Differentiations: Introduction, Numerical differentiation, numerical integration, Trapezoidal Rule. Simpson 1/3 rule, Simpson 3/8 rule, Booles and Weddles Rule, Euler ' Maclariaun Formula, Gaussian Formula, Numerical Evaluation of Singular Integrals.

Statistical Computation: Frequency Chart, Regression Analysis, Least Square fit, Linear and non-linear regression, multiple regression, statistical quality control methods.

References:

1. Gerald and Wheatley, 'Applied numerical analysis', Addison Wesley.
2. Flowers, 'Numerical Methods in C++', Oxford University Press.
3. Balaguruswamy, 'Numerical Methods'. TMH.
4. Jain, Iyengar, Jain, 'Numerical Methods for Scientific & Engineering Computation', New Age International

CL-401 | Fluid Particle Mechanics and mechanical operations

1. **Properties of Particulate Solid**
2. **Handling of Particulate Solid:** Transportation, conveying and storage of particulate solids
3. **Mechanical Separation:** Size separation, filtration
4. **Size Reduction:** Crushing and Grinding
5. **Size Enlargement**
6. **Crystallization**
7. **Mixing of solids & Pastes**

CL- 402 | Heat Transfer Operations

Introduction to Heat Transfer: Concept of the mechanism of heat flow: conduction, convection and radiation; effect of temperature on thermal conductivity of materials; introduction to combined heat transfer mechanism.

Conduction: One-dimensional general differential heat conduction equation in rectangular, cylindrical and spherical coordinate system; initial and boundary conditions.

Steady state one dimensional heat conduction: Composite system in rectangular, cylindrical and spherical coordinates without energy generation; thermal resistance concept; analogy between heat and electrical flow; thermal contact resistance; critical thickness of insulation. Fins of uniform cross sectional area; error of measurement of temperature in thermometer wells, volumetric internal energy generation, solution of 2D steady state problems using relaxation method.

Transient Conduction: Transient heat conduction with known temperature distribution within the system; lumped heat analysis of transient heat conduction problem, time constant of thermocouples.

Convective Heat Transfer: Newton's Law of Cooling, Types of convective heat transfer, Laminar and Turbulent flows, Hydrodynamic and thermal boundary layers, Navier Stokes Equation, Non-dimensional numbers, Buckingham Pi Theorem.

Forced Convection: Basic concept; hydrodynamic boundary layer; thermal boundary layer; flow over a flat plate; flow across a single cylinder and a sphere; flow inside tubes; empirical heat transfer relations; relation between fluid friction and heat transfer; liquid metal heat transfer.

Natural Convection: Physical mechanism of natural convection; buoyant force; empirical heat transfer relations natural convection over vertical planes and a cylinder, horizontal planes and cylinders, and a sphere.

Thermal Radiation: Basic radiation concept; radiation properties of surfaces; black body radiation laws; Kirchoff's Law, Plank Law and Wein's Displacement Law, view factor concept; view factor determination; black body radiation exchange; radiation exchange between diffuse non black bodies in an enclosure; radiation shields; solar radiations.

Heat Exchangers: Type of heat exchangers; fouling factor; overall heat transfer coefficient; logarithmic mean temperature difference (LMTD) method; effectiveness-NTU method; compact heat exchangers.

Condensation and boiling: Introduction to condensation phenomena; heat transfer relations for laminar film condensation over vertical surfaces and a horizontal tube; pool boiling.

REFERENCES

1. Elements of Heat Transfer by Bayazitouglu and Ozisik, McGraw Hill Book Company.
2. Heat Transfer by J.P.Holman, McGraw Hill Book Company.
3. Principles of Heat Transfer by F. Kreith, and S.B. Marks, A.B.Pvt. Ltd.
4. Fundamentals of Heat Transfer by F.P Incorpera and P.D.Dewitt, John Wiley and Sons, V Ed.

CL- 403 | Mass Transfer - I

DIFFUSION: Fick's law, Diffusion in fluids: Molecular and eddy diffusion measurement and calculation of diffusivities. Ordinary diffusion in multi-component gaseous mixtures. Diffusion in solids.

INTERPHASE MASS TRANSFER: Inter-phase mass transfer: Mass transfer coefficients. Theories of mass transfer. Analogies between momentum heat and mass transfer.

MASS TRANSFER EQUIPMENT: Batch and continuous Stage wise contactors-Differential contactors.

ABSORPTION: Theories of gas absorption-Design of absorption towers. Absorption with chemical reactions.

ADSORPTION: Types of adsorption, nature of adsorbants-Adsorption isotherms-Operation of adsorption columns-Batch and continuous operations-Design of adsorbers, Ion exchange

HUMIDIFICATION OPERATIONS: Psychrometery, Evaporative Cooling, Air conditioning and Refrigeration

REFERENCES:

1. R.E.Treybal, "Mass Transfer Operations", 3rd Edn., McGraw Hill Book Co., New York, 1980.
2. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operations of Chemical Engineering", 5th Edn., McGraw Hill Book Co., New York, 1993.
3. J.M. Coulson and J.F. Richardson, "Chemical Engineering", Vol. I, II, III, Pergamon Press, New York, 1977.

CH- 401 | Organic and Physical Chemistry

REACTIONS AND REAGENTS: Basic ideas relating to addition, substitutions, elimination, oxidation and reduction reactions - Electrophilic and Nucleophilic. Organometallic compounds- Grignard reagent - Synthesis of different types of compounds like alcohol ,aldehyde, acid ,amine and organometallic. Acetoacetic ester - tautomerism- Base hydrolysis - Acid hydrolysis - Malonic ester - cyano acetic esters- synthesis of dicarboxylic acids and Unsaturated acids.

CARBOHYDRATES: Carbohydrates - Classification - Reactions of Glucose and fructose-Inter conversion - Ascending and descending of series. Structure of glucose and fructose. Industrial uses of cellulose and starch .

ALICYCYCLIC COMPOUNDS, AROMATIC COMPOUNDS, FATS AND OILS: Alicyclic Compounds- Nomenclature - synthesis of alicyclic compounds using carbon - acroyloin condensation - Diels Alder reaction Freunds's synthesis - Bayer's strain theory postulates, drawbacks- theory of strainless rings- conformations of cyclohexane. Coal tar distillation, separation of benzene, toluene, phenol and naphthalene- Aromaticity exhibited by these compounds. Fats and oils - Saponification- hydrogenation of oils

AMINO ACIDS, PROTEINS AND DYES: Amino acids and proteins- classification - synthesis of amino acids - reactions of carboxyl group and amino group -peptide linkage-end group analysis-colour reaction of proteins- denaturation. Dyes-colors and constitution - chromophores and auxochromes- Quinine theory and electron theory of dyes- preparation-

colour and application of azodyes-acidic. basic, mordant, direct azodyes-Triphenylmethane dyes - malachite green, crystal violet, Rosaniline, prosaniline mordant dyes- application. vat dyes-indigo-synthesis and application.

HETEROCYCLIC COMPOUNDS AND NATURAL PRODUCTS: Heterocyclic compounds-synthesis and reaction of pyrrole ,furan ,thiophene, pyridine, quinine, isoquinoline and anisole. Alkaloids-Isolation from natural products-colour reaction-structural elucidation of nicotine. Terpenoids- Isolation - Isoprene rule-structural elucidation of citral.

REACTION KINETICS: Law of Mass action. Rate order and molecularity of chemical reactions. Methods for their evaluation. Calculation of rate constants. Consecutive - Parallel and opposing reactions. Chain reactions. Energy of activation - Theories on reaction rates. Heterogeneous reactions - zero order reactions - Catalysis - Theory and applications - Inhibitors - Promotors - enzyme catalysis.

PHASE EQUILIBRIA: Phase rule: Application - to one components system (water, sulphur and carbon dioxide), Two component systems (Eutetic, Intermediate compound formation and solid solutions) and simple three component systems. Solutions: Ideal and non-ideal solutions solubility of gases in liquids. Henry's law. Completely miscible liquids - Rauolt's law - vapour pressure and boiling point diagrams. Partially miscible liquids - Critical solution temperature -completely immiscible liquids - Nerns: distribution law - Dilute solution and their colligative properties. Molecular weight determination using these properties.

ELECTRICAL CONDUCTANCE: Electrolytes - strong electrolytes and weak electrolytes - Arrhenius theory of electrolytic dissociation. Debye - Huckell Onsager theory; Ostwald's dilution law - solubility of electrolytes and solubility product - common ion action - acids, bases - definitions) based on proton transference, dissociation constant, amphoteric electrolyte - pH -Buffer solutions. Salts - water of crystallisation, double salts, complex ions and salts, introduction to co-ordination theory - hydrolysis.

ELECTRODE POTENTIAL: Electrode potential-Hydrogen electrode, reference electrodes, electrochemical series, Faraday's laws of electrolysis. Decomposition potential, over voltage, definitions of current density, current concentration, current efficiency, energy consumption; electrical conductance, oxidation - reduction redox couple; e.m.f. and energy relations. Conductometry, Potentiometry - Their applications.

REFERENCES:

1. K. J. Laidler, "Chemical Kinetics", 3rd Edn., Harper & Row Publishers,1987.I.L. Finar, "Organic Chemistry", (Vol. I & II) 5th Edn., ELBS, London 1975.
2. Morrison and Boyd, " A Text Book of Organic Chemistry", 5th and 6th Edn., Prentice Hall of India, 1996.
3. B. R. Puri and SL. R. Sharma, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co.
4. P.L. Soni, "Text Book of Physical Chemistry ", S. Chand & Co., New Delhi.

CL- 405 | Chemical Technology - I

ALKALIES: Chlor-alkali Industries: Manufacture of Soda ash, Manufacture of caustic soda and chlorine - common salt.

ACIDS: Sulphur and Sulphuric acid: Mining of sulphur and manufacture of sulphuric acid. Manufacture of hydrochloric acid.

CEMENT AND GLASS Cement: Types and Manufacture of Portland cement, Glass: Manufacture of glasses and special glasses. Ceramics: Refractories.

GASES, WATER AND PAINTS: Industrial Gases: Carbon dioxide, Nitrogen, Hydrogen, Oxygen and Acetylene - Water Treatment: Industrial and Municipal water treatment- Manufacture of paints - Pigments.

FERTILISERS: Nitrogen Fertilizers: Synthetic ammonia, nitric acid, Urea, Ammonium Chloride, CAN, Ammonium Sulphate - Phosphorous Fertilizers: Phosphate rock, phosphoric acid, Super phosphate and Triple Super phosphate, MAP, DAP. Potassium Fertilizers: Potassium chloride and Potassium sulphate.

REFERENCES:

1. G.T.Austin, "Shreve's Chemical Process Industries", 5th Edn., McGraw Hill Book Co., New York, 1984.
2. R.Gopal Rao and M.Sittig,"Dryden's Outlines of Chemical Technology", 3rd Edn.,Affiliated East-West Publishers,1997.
3. S.D. Shukla and G.N. Pandey, "Text book of Chemical Technology", Vol. I, 1977.

CL 501 | Chemical Reaction Engineering -I

1. BASICS OF KINETICS: Introduction - Kinetics of homogeneous reactions: Concentration dependent & Temperature dependent term of rate equation. Searching for a mechanism. Interpretation of Batch Reactor data.

2. REACTOR DESIGN: Introduction to Reactor Design, Single Ideal Reactors.

3. DESIGN OF REACTOR FOR MULTIPLE REACTIONS: Design for single and multiple Reactions. Size comparison of single reactors for single reactions. Multiple Reactor system for single reactions. Reactions in parallel, reactions in series and series - parallel reactions of first order. Recycle reactor, auto catalytic reactions.

4. HEAT EFFECTS: Temperature and pressure effects on single and multiple reactions.

5. FLOW BEHAVIOR OF REACTORS: Non - ideal flow: Residence time distribution studies: C,E,F and I curves, conversion calculations directly from tracer studies. Models for non-ideal flow-dispersion and tanks in series multi-parameter models.

REFERENCES :

1. O. Levenspiel, "Chemical Reaction Engineering", 2nd Edn., Wiley Easter Ltd., New York, 1972.
2. J.M.Smith, "Chemical Engineering Kinetics", 2nd Edn., McCraw Hill, New York, 1971.

CL 502 | Chemical Engineering Thermodynamics

1. Vapour liquid equilibrium at low, moderate and high pressures, Compressibility factor.
2. Refrigeration cycle and liquefaction: Definitions of refrigeration, Reverse Carnot cycle, Vapor compression and vapor absorption cycle, Gas refrigeration.
3. Thermodynamics of solutions: ideal and non-ideal solution, Concept of Fugacity and Fugacity coefficient, Fugacity and Activity Coefficient Modes, Solid-liquid equilibrium, solubility of gases in liquids, Liquid-liquid equilibrium
4. Phase Equilibrium, Pure component and mixtures, Latent Heat correlation Van Laar, Margules' equation Gibbs'-Duhem equation, consistency tests, multi-component phase equilibrium, partially miscible and immiscible systems, Azeotropes, retrograde condensation thermodynamic diagram
5. Chemical reaction equilibrium, heat effects, industrial reactions (NH_3 synthesis etc), free energy calculations, Homogeneous and heterogeneous reaction systems, Multiple reactions, Work of separation, Evaluation of Properties,
6. Reactive Mixtures: Chemical reaction, classification of fuels, Stoichiometric equation, flue gas analysis, maximum air required for complete combustion of fuel, heating values of fuel, enthalpy of formation and heat of reaction, adiabatic combustion (flame) temperature.
7. Thermodynamic analysis of processes, Electrochemical cells
8. Introduction to molecular thermodynamics

REFERENCES:

1. J. M. Smith and Van Ness, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill, New York, 1994.
2. S. Sundaram, "Chemical Engineering Thermodynamics", Ahuja Publishers, New Delhi, 1998.
3. B.F. Dodge, "Chemical Engineering Thermodynamics", McGraw Hill, New York, 1971.

CL 503 | Mass Transfer - II

1. DISTILLATION: Vapour Liquid Equilibrium Data. Methods of distillation-batch, continuous, flash, steam, vacuum and molecular distillations.

2. CONTINUOUS FRACTIONATION: Stage - wise and continuous contact operations. Design calculations. Reboilers and condensers.

3. MULTICOMPONENT DISTILLATION: Azeotropic distillation and extractive distillation. Multicomponent flash and differential distillation. Continuous fractionation.

4. LIQUID-LIQUID EXTRACTION: Liquid - Liquid Equilibrium data. Batch and continuous operations. Design of extraction towers.

5. LEACHING: Solid - Liquid extraction. Batch and continuous operations. Equipments.

REFERENCES:

1. R.E.Treybal, "Mass Transfer Operations", 3rd Edn., McGraw Hill Book Co., New York, 1980.
2. W.L.McCabe, J.C.Smith and P.Harriot, "Unit Operations of Chemical Engineering", 5th Edn., McGraw Hill Book Co., New York, 1993.
3. C. J. Geankopolis, "Transport Processes in Chemical Operations", 3rd Edn. Prentice Hall of India, New Delhi, 1996.
4. M. Coulson and J: F. Richardson, "Chemical Engineering", Vol - II, 3rd Edn. Pergamon Press, New York, 1987.

CL 504 | Process dynamics and control

1. FIRST ORDER SYSTEMS: Linear open loop systems - First order and Linearised first order systems - Responce to various disturbances.

2. HIGHER ORDER SYSTEMS: First order in series - Higher order systems - Response to various disturbances.

3. BLOCK DIAGRAM: Controls - Block Diagram - closed loop transfer function -Transient response- Simple alarm Modes of control and controller characteristics.

4. STABILITY ANALYSIS: Stability - Routh analysis - Frequency response - Control system design - Controller tuning.

5. SPECIAL CONTROLS: Cascade - feed forward and ratio control - dead time compensation - Internal Model Control - Control valves - Process identification.

REFERENCES:

1. S. Sundaram and T. K. Radhakrishnan, "Process Dynamics and Control", Ahuja Publishers, 2003.
2. D. P. Coughnowr, "Process Systems Analysis and Control", McGraw Hill, New York,1991.
3. C. A. Smith and A. B. Corripio, "Principles and Practice of Automatic Process Control", Wiley, New York, 1989.
4. P.Harriot, "Process Control", Tata McGraw Hill, New Delhi, 1984.
5. D.P. Eckman, "Industrial Instrumentation", Wiley Eastern Ltd., New York 1990.
6. D.P. Eckman, "Automatic Process Control", Wiley Eastern Ltd., New Delhi.

CL 505 | Chemical Technology - II

1. NATURAL PRODUCTS PROCESSING:

Production of pulp, paper and rayon. Manufacture of sugar, starch and starch derivatives. Gasification of coal and chemicals from coal.

2. INDUSTRIAL MICROBIAL PROCESSES AND EDIBLE OILS:

Fermentation processes for the production of ethyl alcohol, citric acid and antibiotics. Refining of edible oils and fats, fatty acids. Soaps and detergents.

3. PETROLEUM REFINING AND PETROCHEMICAL PRECURSORS:

Petroleum refining to produce naphtha, fuel hydrocarbons and lubricants. Processes for the production of petrochemical precursors: ethylene, propylene, butadiene, acetylene, synthetic gas, benzene, toluene and xylene. (Cracking, Catalytic reforming and separation of products)

4. POLYMER BASED INDUSTRIES AND THEIR CHARACTERISTICS:

Plastics: Production of thermoplastic and thermosetting resins such as polyethylene, polypropylene, phenolic resins and epoxy resins; Polymers and their applications in engineering practice.

5. FIBRE FORMING AND ELASTOMERIC POLYMERS:

Synthetic fibres: polyamides, polyesters and acrylics from monomers. Processes for the production of natural and synthetic rubbers.

REFERENCE:

1. G.T. Austin, " Shreve's Chemical Process Industries", 5th Edn., Mcgraw Hill Book Co., NewYork, 1984.
2. R. Gopal Rao and M. Sittig, " Dryden's Outline of Chemical Technology",3rd Edn., Affiliated East-West Publishers, 1990.
3. S.D.ShukIa and G.N. Pandey, "Text book of Chemical Technology", Vol. I, 1977.

HS 501 | Principles of management

Concept: Definition of management, evolution of management thought, systems approach, process of decision making.
Functions of Management: Planning, types of plans, major steps in managerial planning, Organizing, nature and purpose, process of organization, basic departmentation. Coordination, nature purpose and process of coordination. Supervision, Leadership: purpose, functions, types. Communication, process of communication, effective communication, barriers to communication.

Motivation: what is motivation, factors involved, theories, and motives in organization. Controlling-Nature and purpose.

Management of change: forces of change, strategies of change, resistance to change.

Human Elements in management: Factors in individual behavior, Perception, Learning, Personalty development, Interpersonal relationship & group behavior, Conflict management Stress management, sources of stress,von sequences ,strategies of stress management.

References:

1. Koontz, H & Weihrich, H. Management: A Global Perspective 10th ed., Tata McGraw Hill, New Delhi.
2. Robbins, S. P. Organizational Behaviour, 6th ed. Prentice Hall, New Delhi.
3. Prasad, L M" Principles and Practices of Management", 5th Ed., Sultan Chand & Sons, New Delhi, 1999.

ME 612 | Process equipment design

1. **SIMPLE STRESS & STRAIN:** Stress, Strain, Hook's Law, Elastic Constants, Strain Energy, Statically Indeterminate problems, Thermal Effects, Impact Loading

2. **ANALYSIS OF STRESS & STRAIN (Plane Stress and Plane Strain):** Stress at a Point, Variation of Stress, Stress Transformation (2-D), Analysis of Strain, Strain-displacement relations, Strain transformation, Strain Measurements, Constitutive equations

3. **SIMPLE BENDING & SHEAR STRESS:** Introduction, Pure Bending, Normal stresses in beams, Combined Bending and Direct Stress, Composite Beams, Shear Stress, Shear Centre, Strain energy in bending

4. **TORSION :** Introduction, Torsion of Circular Shaft, Power Transmitted by a Shaft, Compound Shaft,Tapered Shaft, Strain Energy in Torsion, Combined Bending and Twisting, Torsion of Thin Walled Tubes, Open and Closed Coiled Springs

5. **THIN & THICK CYLINDERS & SPHERES:** Introduction, Thin Walled Shells, Thick Shells, Compound Cylindrical Shell

6. **DESIGN OF PIPE FITTINGS AND JOINTS:** Design and schematic of simple bolts and screws. Riveted joints. Design & Drawing of shafts and couplings.

7. **DESIGN OF REACTION VESSEL AND STORAGE TANK:** Design and schematic of storage tank, (vertical and horizontal) supports, agitating vessel.

8. **DESIGN OF PRESSURE VESSELS:** Design of cylindrical vessels and different end closures subjected to internal pressure, Stress analysis of support and pressure vessels, Design of supports and various heads, Design of vertical pressure vessels considering the wind factors, seismic factor, etc. Design of cylindrical vessels operating under external pressure. Design and selection of standard flanges, gaskets and flange facings and their selection. Design of high-pressure vessels and reactors.

9. **DRAWING AND DESIGN OF PHASE SEPARATION EQUIPMENTS:** Drawing of physical separation equipments such as hydro-cyclones, packed towers, plate columns, electro static precipitators. Design of physical separation equipment such as cyclones, centrifuges, thickeners filtration equipment KO drum.

10. **DESIGN OF HEAT TRANSFER EQUIPMENTS:** Design and Drawing of Heat Transfer Equipments such as heat exchangers with and without phase change, evaporators, crystallizes.

11. **DESIGN OF MASS TRANSFER EQUIPMENTS:** Design and Drawing of mass transfer equipments such as distillation columns, absorption columns, extraction columns, dryers and cooling towers.

REFERENCES:-

1. L. E. Brownell and E.H. Young, "Process Equipment Design - Vessel Design", Wiley Eastern Edn. New York, 1968.
2. R. H. Perry, 'Chemical Engineers' Handbook, 7th Edn., McGraw Hill , N York, 1998.
3. M. V. Joshi, "Process Equipment Design and Drawing", Mac Millan Press, New Delhi, 1996.
4. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol-VI, Pergam Press, New York, 1987.
5. JF Harvey, Theory and Design of Pressure Vessels, 2"' Edition, Van Nostrand Reinhold, 1991.
6. IS 2825 Code, Design of Pressure Vessels.
7. R. Smith, "Chemical Process Design", McGraw Hill Book Co., New York 1997.

CL 601 | New Separation Processes

1. THERMAL SEPARATION: Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures. Equipments design and Applications. Zone Melting: Equilibrium diagrams. Controlling factors. Apparatus and Applications.

2. ADSORPTION TECHNIQUE: Types and choice of adsorbents. Normal Adsorption techniques, chromatographic techniques. Equipment and commercial processes, Recent advances and economics, Molecular Sieves.

3. MEMBRANE SEPARATION PROCESS: Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators .Dialysis ,Reverse Osmosis, Ultra Filtration and Economics of Membrane operations, Pervaporation .

4. IONIC SEPARATION: Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion - Exchange, Commercial processes.

5. OTHER TECHNIQUES: Adductive Crystallization: Molecular addition compounds, Clathrate compounds and Adducts, Equipments, Applications, Economics and Commercial processes. Foam Separation: Surface Adsorption, Nature of foams. Apparatus, Applications and Controlling factors.

REFERENCES :

1. H. M. Schoen, " New Chemical Engineering Separation Techniques", Inter Science Publications New York 1972.
2. C. Loeb and R. E. Lacey, "Industrial Processing with Membranes", Wiley Inter Science, 1972.
3. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol.ll, 4th Edn., Butterworth - Heinemann London 1991.
4. R.H. Perry and D.W. Green, "Perry's Chemical Engineers Hand book", 6th Edn.,McGraw Hill. New York, 1990.

CL 602 | Transport phenomena

1. LAMINAR FLOW: Velocity distribution in Laminar flow - Shell momentum balances - Flow through tubes, surfaces. Flow of non - Newtonian fluids.

2. EQUATION OF MOTION: Equation of change for isothermal process - One dimensional equation of motion and continuity - Euler and Navier - Stokes equation. Dimensional analysis of equation of change.

3. TURBULENT FLOW: Velocity distribution in turbulent flow - Semi empirical expressions for Reynolds stress. Interphase transport in isothermal system - Ergun's equation.

4. HEAT TRANSFER ANALYSIS: Temperature distribution in solids and fluids in laminar flow - Equations of change for multi component systems.

5. MASS TRANSFER ANALYSIS: Concentration distribution in solids and in fluids laminar flow - Equations of change for multi component systems.

REFERENCES:

1. J.L. Stuart., 'Transport Phenomena", John Wiley, New York, 1982.
2. R. B. Bird, W. Stewart and E. N. Lightfoot, "Transport Phenomena", Wiley, New York, 1960.
3. C. J. Geankopolis, "Transport Processes in Chemical Operations", 3rd Edn., Prentice Hall of India, New Delhi, 1996.

CL 603 | Environmental Pollution, Monitoring and Control

Introduction: Ecology & Environment, Biodiversity, Interaction of man and environment, Overall picture of environmental pollution, Ambient air and water quality criteria, Standards and Acts-Indian, EPA& EURO, Effects and control of noise, thermal and radioactive pollution.

Air Pollution: Types of pollutants – Natural and man made air pollutants, Dispersion of pollutant in the atmosphere, Gaussian dispersion model, Meteorological factors, Stability and inversion of atmosphere, Plume behaviour, Control of air pollution from stationary and mobile sources, Methods of measuring and sampling of gaseous and particulate pollutants in ambient air and industrial waste gases, measurement of smoke density and visibility. Control of gaseous pollutants - SOx, NOx, H_2S, VOCS, Auto exhaust.
Stack design, Classification, selection and design of equipment's like cyclones, electrostatic precipitators, bag filters, wet scrubbers, settling chambers.

Water Pollution: Waste water characteristics – Physical and chemical composition, Biochemical oxygen demand (BOD), Pathogenic bacteria and chemical toxicity. Types of pollutants in waste water of chemical industries, Methods of sampling, preservation of samples and analysis. Methods for the treatment of liquid wastes to control pollution, Classification viz. physical, chemical and biological methods, Selection and design of equipment like hydrocyclone, settling tanks, filters, ion- exchange.

Solid Wastes Management: Characterisation of solid wastes, Problems of collection and handling, Various processing techniques used in solid waste management such as compaction, incineration, Composting, landfills and biological processing, Solid waste as resource material.

Pollution abatement in important chemical industries like fertiliser, petroleum refineries and petrochemicals, Pulp and Paper, Pharmaceuticals, Tannery, Sugar, Distillery, food processing, cement and electroplating.

REFERENCES:

1. Howard S. Peavy, D. R. Rowe & C. Tchobonoglous "Environmental Engineering", McGraw Hill (1984).
2. Metcalf & Eddy, "Waste Water Engineering Treatment, Disposal & Reuse", Tata McGraw Hill(2003).
3. Werner Strauss, 'Air Pollution Control: Measuring and monitoring air pollutant' Wiley (1978).
4. Werner Strauss, 'Air Pollution Control part –II' Wiley (1978).
5. Pandey G. N. and Carney G. C., "Environmental Engineering ". Tata McGraw Hill (1991).

CL 604 | Chemical Reaction Engineering - II

1. MODES OF CONTACTING DIFFERENT PHASES: Self mixing of single fluids, mixing of two miscible fluids, Introduction, Design for Heterogeneous Reacting Systems.

2. DESIGN OF REACTOR FOR NON-CATALYTIC REACTIONS: Fluid-Particle Systems: Models for non-catalytic heterogeneous reactions, their limitations, selection and their applications to design.

3. DESIGN OF SLURRY REACTOR: Fluid-Fluid Reactions: Rate equations for instantaneous, fast, intermediate, slow, and infinitely slow reactions. Slurry reaction kinetics. Application to design.

4. CHARACTERISTICS OF CATALYST: Catalysis; Introduction. Physical and Chemical Adsorption catalysts. Preparation and properties. Promoters, inhibitors. Poisons. Surface area by BET method. Pore size distribution, mechanism of catalyst deactivation.

5. KINETICS OF HETEROGENEOUS CHEMICAL REACTION: Kinetics and Mechanism of Heterogeneous Catalytic Reactions, Various models, Evaluation and elimination of internal and external diffusion resistances, effectiveness factor, Solid catalyzed reactions, heat effects, controlling resistances, rates of chemisorptions, adsorption isotherms, rates of adsorption and desorption.

REFERENCES:

1. O. Levenspiel, "Chemical Reaction Engineering", 3rd Edn., Wiley Asian New York, 1990.

2. J.M. Smith, "Chemical kinetics",2nd Ed., McGraw Hill, NewYork,1971.

HS 602 | Soft skills workshop

CL 701 | Plant Design and Economics

Material and fabrication selection, Design strategy and optimum equipment design, Economic design criteria, Cost and Asset Accounting, Cost estimation, Interest and Investment cost, Taxes and Insurance, Depreciation, Profitability.
Alternative investments and replacement, Illustrative case studies.

Text Book:

1. M.S. Peters and K.D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw Hill, 1991.

CL 801 | Hazards and Safety in Chemical Industries

1. INTRODUCTION TO CONSEQUENCE ANALYSIS - DISPERSION AND TOXIC MODELS: Risk analysis introduction - Rapid risk analysis - Comprehensive risk analysis - Failure types and release rate calculations - Emission and dispersion - Dispersion models for dense gas - Plume dispersion - Jet dispersion - Toxic dispersion model Evaluation of risk contours.

2. CONSEQUENCE ANALYSIS - FIRE AND EXPLOSION MODELS: Radiation - Tank on fire - Flame length - Radiation intensity calculation and its effect on plant, people & properly, UCVCE - Explosion due to - Deflatration -Detonation - TNT, TNO & DSM model - Over pressure - Effects of explosion -Risk contour - Flash fire - Jet fire - Pool fire - BLEVE - Fire ball.

3. RISK MANAGEMENT: Overall risk analysis - Generation of Meteorological data - Ignition data -Population data - Overall risk contours for different failure scenarios - Disaster management plan - Emergency Planning - on site & offsite emergency planning - Risk management & IS0 14000- EMS models- Case studies-Marketing terminal, gas processing complex, refinery.

4. PAST ACCIDENT ANALYSIS: Hazard identification -Safety Audits-Checklists- What if Analysis-Vulnerability models - Event tree and Fault tree Analysis - Past accident analysis Flixborough -Mexico - Bhopal - Vizak 3 miles - island chernoobyl, feyzih disasters, seveso accident analysis.

5. HAZOPS: HAZOPS- Principles - Risk ranking - Guide word - Parameter - Deviation - • Consequences - Recommendations - Coarse HAZOP study - Case studies Pumping system - Reactor System - Mass transfer system.

REFERENCES:

1. K. V. Raghavan and A. A Khan, "Methodologis in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.
2. V. C. Marshal, "Major Chemical Hazards", Ellis Hawood Ltd., Chichester,United Kingdom.1987.
3. Kletz, "Risk Analysis Hazops " Institute of Engineers, U.K, 1990.
4. Frank P. Less, "Loss Prevention in Process Industries", Vol. I, II & III Butterworth, London, 1980.
5. “A Guide to Hazard Operability Studies", Chemical Industry Safety and Council, 1977.

LIST OF PROFESSIONAL ELECTIVES

Subjects

1. APPLIED MATHEMATICS IN CHEMICAL ENGINEERING
2. ADVANCES IN HEAT TRANSFER
3. INTRODUCTION TO PFD-P & ID
4. BIOCHEMICAL ENGINEERING
5. ELECTROCHEMICAL ENGINEERING
6. FLUIDIZATION ENGINEERING
7. INDUSTRIAL CATALYSIS
8. ENZYME ENGINEERING
9. PROCESS DYNAMICS AND CONTROL-II
10. FOOD TECHNOLOGY AND ENGINEERING
11. FERTILIZER TECHNOLOGY
12. OIL AND FAT TECHNOLOGY
13. CERAMIC TECHNOLOGY
14. POLYMER TECHNOLOGY
15. BIOTECHNOLOGY
16. ENERGY CONSERVATION
17. PILOT PLANTS, MODELS AND SCALE-UP METHODS IN CHEMICAL ENGINEERING
18. INSTRUMENTATION AND MEASUREMENTS
19. TWO-PHASE FLOW AND HEAT TRANSFER
20. PETROCHEMICAL TECHNOLOGY
21. MANUFACTURING AND MAINTENANCE OF PROCESS EQUIPMENTS
22. MODELLING & SIMULATION IN ENGINEERING
23. COMPUTER-AIDED PROCESS CONTROL

APPLIED MATHEMATICS IN CHEMICAL ENGINEERING

1. Design of Engineering Experiments: Application of mathematical methods to solve chemical engineering problems. Treatment of experimental data and interpretation of results. Use of .different types of graph paper. Curve fitting methods and empirical laws

2. Formulation of Physical Problems: The mathematical statement of the problem, introduction. Representation of problem, Simple problems formulation on solvent extraction in single and multistage. Radial heat transfer through a cylindrical conductor. Salt accumulation in stirred tank .Summary of the method of formulation.

3. Linear and non-linear Algebraic Equations: Numerical solutions of linear and non - linear algebraic equations in Chemical engineering, Interpolation and extrapolation.

4. Numerical solution of Ordinary Differential Equations: Numerical solution of initial value and boundary value, ordinary different equation problems in chemical engineering.

5. Numerical Solutions of Partial Differential Equations: Finite differences, Orthogonal Collocation technique, Finite Element Method, Numerical solution of partial differential equations in chemical engineering- elliptic, parabolic and hyperbolic equations.

REFERENCES:

1. S.K.Gupta, "Numerical Techniques for Engineers", Wiley Eastern Ltd.,NewYork,1995.
2. H.S. Mickley, T. K. Sherwood rod C.E. Reid, "Applied Mathematic in Chemical Engineering", II Edn., Tata McGraw Hill, New Delhi, 1978.
3. O.F.Hanna and O.C. Sandall, "Computational Methods in Chemical Engineering", Prentice-Hall, 1995.
4. W.F.Ramirez, "Computational Methods for process Simulation",Butterwortlia, 1989.
5. V. Q. Jenson and G. V. Jeffreys, "Mathematical Methods in Chemical Engineering" 2nd. Edn., 1977.

ADVANCES IN HEAT TRANSFER

1. TRANSIENT HEAT CONDUCTION: Transient heat condition, Extended surfaces and generalized expressions for fins or spines. Effectiveness of fins. Numerical solution for one dimensional and two dimensional steady state heat conduction problems. Relationship between thermal and electrical conductivity. Temperature- time response of thermocouples, transient heat conduction charts.

2. CONVECTION - THEORY AND PRACTICE: Convective heat transfer-theories and practices, energy equation for thermal boundary layer over a fiat plate. Momentum and heat exchange in turbulent fluid flow (Eddy viscosity and eddy thermal diffusivity). Reynolds analogy between heat and momentum transfer, empirical equations for forced convection based on experimental results.

3. HEAT TRANSFER WITH PHASE CHANGE: Heat transfer with change of phase. Phenomena of Boiling and condensation. Regimes of pool boiling and heat transfer during boiling. Drop wise and film wise condensation, effect of turbulence and high velocity on film wise condensation.

4. ADVANCES IN HEAT EXCHANGER DESIGN: Advances in design of heat exchangers. Regenerators and recuperators. Shell and tube heat exchangers with multiple

shell and tube passes, Use of charts for calculating L.M.T.D. correction factors, Efficiency of heat exchangers and number of transfer units, (N.T.U.) Illustrative examples, Compact heat exchangers.

6. **HEAT TRANSFER IN PACKED & FLUIDIZED BEDS AND NUCLEAR REACTORS :** Heat transfer in liquid metals. Heat transfer in packed and fluidized beds - Basic fundamentals and factors affecting the rate of Heat Transfer in these beds. Heat transfer in nuclear reactors.

REFERENCES:

1. James G. Knudsen and Donald L. Katz, "Fluid Dynamics and Heat Transfer ", McGraw Hill Book Company, 1958.
2. Antony F. Mills, "Heat Transfer", Richard D. lrwin. Inc., 1992, Homewood, IL60430 and Boston, MA021 163.
3. W. M. Rohsenow and H. Y. Choi, "Heat Mass and Momentum Trensfer" PrenticeHall, Inc., 1961.
4. W.H. Mc Adams." Heat Transmissroa", McGraw Hill. New York. 1954.

INTRODUCTION TO PFD-P & ID

1. PROCESS FLOW DIAGRAM: Types of flow sheets - Flow sheet presentation - flow sheet symbols - line symbols and designation ion- Process flow diagram - synthesis of steady state flow sheet-flow sheeting using ASPEN PLUS, DESIGN- II AND PDS software.

2. PIPING AND INSTRUMENTATION DIAGRAM EVALUATION AND PREPARATION: P& I D Symbols - Line numbering - Line Schedule - P & ID development - typical Stages of P & ID - P &ID for rotating equipment and static pressure vessels. Process vessels, P & I D using PDS.

3. CONTROL SYSTEMS AND INTERLOCKS FOR PROCESS OPERATION: Introduction and description - Need of interlock - Types of interlocks - Interlock for rotating and static equipments, Distributes digital control system, programmable logic controller.

4. INSTRUMENT LINE DIAGRAM & INSTRUMENT DATA MANAGER: Line diagram symbols - Logic gates, Representation of line diagram. - IDM.

5. APPLICATION OF P & ID's: Applications of P&ID in design stage - Construction stage - Commissioning stage -Operating stage - Revamping stage, - Applications of P & ID in Hazards and Risk analysis.

REFERENCES :

1. Ernest E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Vol –1, Gulf Publishing Company, Houston, 1989.
2. Max. S. Peters and K. D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw Hill, Inc. New York, 1991.
3. Anil Kumar, "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill Publishing Company Limited, New Delhi - 1981.
4. A. N. Westerberg, et al., "Process Flowsheeting", Cambridge University Press,1979. ISA Hand book ISA Publications, 1995.

BIOCHEMICAL ENGINEERING

1. INTRODUCTION TO BIOSCIENCE: Types of Micro-organisms: Structure and function of microbial cells. Fundamental of microbial growth, batch and continuous culture. Isolation and purification, Enzymes from cells, Assay of Enzymes.

2. FUNCTIONING OF CELLS AND FUNDAMENTAL MOLECULAR BIOLOGY: Metabolism and bio-energetics. Photosynthesis, carbon metabolism, EMP pathway tricarbocyclic cycle and electron transport chain, aerobic and anaerobic meta(pathways. Synthesis and regulation of biomolecules, fundamentals of micro genetics, role of RNA and DNA.

3. ENZYME TECHNOLOGY AND KINETICS: Applied Enzyme catalysis , Applications of enzymes in industry and medicine, Immobilization of enzymes. Kinetics of enzyme catalytic reactions involving isolated enzymes. Reversible inhibition.

4. REACTIONS CATALYSED BY ENZYMES, REACTORS, ANALYSIS: Reactor Design and Analysis for soluble enzyme systems. Cofactor regeneration . Membrane reactor. Effect of mass transfer in immobilised enzyme particle systems. Reactors for immobilised enzyme systems.

5. BIO REACTORS , EFFECT OF TRANSPORT PROCESSES: Introduction to Bioreactor design: Continuously Stirred aerated tank bioreactors. Mixing power correlation. Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption. Multiphase bioreactors and their applications. Downstream processing and product recovery in bioprocesses.

REFERENCES:

1. J. E. Bailey and D. F. Oilis. “Biochemical Engineering Fundamentals", 2nd Edn., McGraw Hill, New York, 1986.
2. Trevan, Boffey, Goulding and Stanbury," Biotechnology", Tata McGraw Hill Publishing Co., New Delhi, 1987.
3. M. L. ShulerandF. Kaigi, "Bio Process Engmeering : Basic concepts", 1st Edn., Prentice Hall, Englewood Cliffs, New Jersey 07632, 1992.

ELECTRO CHEMICAL ENGINEERING

1. INTRODUCTION TO ELECTROCHEMICAL ENGINEERING: Introduction. Methods of measurement - Steady state techniques. Non-steady state techniques. Eliminating IR Drop.

2. ELECTROCHEMICAL TRANSFER PROCESS: Electrochemical Transfer Processes. Mass Transport, Charge Transport and Heat Transfer.

3. ELECTROCHEMICAL REACTION ENGINEERING: Electrochemical Reaction Engineering. Electrochemical Thermodynamics and Electrode kinetics. Kinetics in Electrochemical Reactors.

4. DESIGN AND MODELING IN ELECTROCHEMICAL PROCESSES: Optimization and Factorial Design of Experiments. Experimental Modeling of Industrial Processes.

5. SEPARATION PROCESSES IN ELECTROCHEMICAL CELLS: Separation Systems in Electrochemical Cells. Materials and corrosion.

REFERENCES:

1. Ewald Heitz and Gerhard Kreysa, "Principles of Electrochemical Engineering 1986.
2. T.Z.Fahidy,"Principles of Electrochemical Reactor Analysis", Elsevier 1985.
3. D.J.Pickett,"Electrochemical Reactor Design", Elsevir, 1977.

FLUIDIZATION ENGINEERING

1. INTRODUCTION AND APPLICATIONS: Introduction to Fluidized bed systems. Fundamentals of fluidization. Industrial applications of fluidized beds - Physical operations. Synthesis reaction, cracking and reforming of hydrocarbons. Gasification, Carbonization, Gas - solid reactions , calcining and clinkering.

2. GROSS BEHAVIOR OF FLUIDIZED BED: Gross behavior of fluidized bed. Minimum and terminal velocities in fluidized beds, Types of fluidization. Design of distributors. Voidage in fluidized beds. TDH, variation in size distribution with height, viscosity and fluidity of fluidized beds. Power consumption.

3. ANALYSIS OF BUBBLE AND EMULSION PHASE: Davidson's model. Frequency measurements, bubbles in ordinary bubbling bed model for bubble phase . emulsion phase: Experimental findings. Turn over rate of solids. Bubbling bed model for emulsion phase Interchange co-efficient.

4. FLOW PATTERN OF GAS AND HEAT & MASS TRANSFER IN FLUIDIZED BEDS: Flow pattern of gas through fluidized beds. Experimental findings. The bubbling bed model for Gas inter change Interpretation of Gas mixing data. Heat and Mass Transfer between fluid and solid: Experiment findings on Heat and Mass Transfer. Heat and Mass Transfer rates from bubbling bed model.

5. HEAT TRANSFER BETWEEN FLUIDIZED BEDS AND SURFACE: Heat transfer between fluidized beds and surfaces: Experiment finding, theories of bed heat transfer, comparison of theories. Entrainment of or above TDH, model for Entrainment and application of the entrainment model to elutriation.

TEXTBOOK:

1. D.Kunii and O.Levenspiel ,'Fluidization Engineering " 2nd. Edn.,]ohn Wiley& Sons, 1992

INDUSTRIAL CATALYSIS

1. INTRODUCTION TO CATALYSIS: General properties of homogeneous and heterogeneous catalysis.

2. GEOMETRIC AND ELECTRONIC FACTORS IN CATALYSIS: Adsorption and reaction kinetics in catalytic (heterogeneous) system.

3. CATALYST PREPARATION: Preparation and evaluation of industrial catalysts.

4. KINETICS OF HETEROGONOUS REACTIONS: Reaction engineering applied to catalytic homogeneous and heterogeneous chemical reactions.

5. CATALYST POISONING: Catalyst poisoning and deterioration (sintering) origination of catalyst.

REFERENCE:

1. J. M. Smith, "Chemical Engineering Kinetics", 3rd Edn., 1983.
2. G. Bond, "Heterogeneous Catalysis-Principles and Applications", 2nd Edn., Oxford Univ. Press, 1986.
3. I. Mukhlyonov "Catalyst Technology", Mir Publishers, Moscow, 1976.
4. C.C. Thomas, "Catalytic Processes with Proven Catalysis", Academic Press.

ENZYME ENGINEERING

1. INTRODUCTION TO BIOCHEMISTRY, FUNCTION AND APPLICATIONS: Nature and function of enzyme. Coenzyme/ Cofactor. Classification of enzymes. Assay methods and units. Examples of applications of enzymes in industry. analytical techniques medicine and Pharmaceuticals.

2. KINETICS AND MECHANISM OF ENZYME CATALYSIS: Enzyme catalysis and controlling factors. Kinetics of enzyme catalyzed reactions in solution. Immobilized enzyme reaction kinetics. Effect of mass transfer resistance.

3. ENZYME PRODUCTION ON LARGE SCALE TECHNOLOGY: Isolation and purification of enzyme, protein , protein fractionalization methods.

4. IMMOBILIZATION TECHNOLOGY AND DEVELOPMENTS: Immobilization technique for enzymes . Characteristics and uses for immobilized enzyme systems.

5. INDUSTRIAL BIOREACTORS UTILIZING ISOLATED ENZYMES AND BIOSENSORS DEVELOPMENT AND APPLICATIONS: Reactor design and analysis for immobilized enzyme reactors. Applications in biosensors . Some modern developments for enzyme in organic synthesis.

REFERENCES:

1. A. Wiseman, "Hand book of Enzyme Biotechnology", Ellis-Horwood,1983.
2. E.K.Pye and L.B.Wingard, "Enzyme Engineering II", Plenum Press, 1974.
3. I.E. Bailey and D. F. Oilis, "Biochemical Engineering Fundamentals" 2nd Edn., McGraw -Hill Pulilishing Company New York, 1986.

PROCESS DYNAMICS AND CONTROL- II

1. FREQUENCY RESPONSE: Review of control system design in Laplace, time, and frequency domains, controller design using Laplace, time and frequency response-Analysis of some common loops.

2. DESIGN OF CONTROLLERS FOR DIFFICULT & COMPLEX DYNAMICS: Inverse response systems - controller design - design of inverse response compensator. Time delay systems - controller design - Smith predictor method. Dynamics and Control of

complex processes. Theoretical analysis of complex processes like jacketed kettle, absorber and heat exchanger.

3. MULTIVARIABLE SYSTEMS: Feed forward control, cascade and ratio control - Introduction to stage space methods-Design of controllers using state-space methods - Introduction to multiloop systems- Relative gain analysis.

4. CONTROLLERS DESIGN AND ART OF PROCESS CONTROL: Degrees of freedom analysis - Introduction to distillation system - Controller design for mutliloop systems. Interaction and pairing of control loops. The art of process control.

5. DESIGN OF DIGITAL CONTROLLERS: Supervisory control systems-Digital computer control - sampling & filtering of continuous measurements. Developments of discrete time models - Dynamic response of discrete time systems. Analysis of sampled data control System-Design of digital controllers

REFERENCES:

1. D. R. Coughanowr, "Process System Analysis and Control", 2nd Edn. McGraw Hill, 1991.
2. G Stephanopopulas, "Chemical Process Control", Prentice-Hall India, 1984.
3. D. E.Seborg, T.F. Edgar and D.A. Mellichamp, "Process Dynamics Control", John Wiley and Sons, 1989.
4. Ogunnauike and W.H.Ray, "Process Dynamics, Modeling and Control" Oxford Press. 1994.

FOOD TECHNOLOGY AND ENGINEERING

1. FOOD PROCESS ENGINEERING -FUNDAMENTALS: Fundamentals of food process engineering, application of quantitative methods of material and energy balance in food engineering practice.

2. UNIT OPERATIONS IN FOOD INDUSTRIES: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.

3. FOOD CANNING TECHNOLOGY: Fundamentals of food canning technology. Heat sterilization of canned food, containers - metal, glass and flexible packaging. Canning procedures for fruits, vegetables, meats, poultry marine products.

4. MECHANICAL OPERATIONS IN FOOD PROCESSING: Conversion operations, Size reduction and screening of solids, mixing and emulsification and membrane separation , centrifugation , extraction.

5. FOOD BIOTECHNOLOGY: Food Biotechnology, Dairy and cereal products, Beverages and food ingredients, High fructose corn syrup, Single Cell protein.

REFERENCES:

1. R.T. Toledo, "Fundamentals of food process engineering " ,AVI publishing Co., 1980.
2. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology" AVI Publishing Co.,1978.
3. J. G. Bernan, J. R. Butters, N. D. Cowell and A.E.V.Lilley, "Food engineering operations", 2nd., Edn., Applied Science, 1976.

4. R. Angold, G.Beech and J.Taggart, " Food Biotechnology", Cambridge University Press 1989
5. Briggs and Galloway, "Nutrition and Physical Fitness", 11th Edn., Holt Rinehart Winston, 1984.

FERTILIZER TECHNOLOGY

.**1. INTRODUCTION TO CHEMICAL FERTILIZERS:** Chemical inorganic Fertilizers and Organic manures. Types of fertilizer-, Mixed, complex and granulated, plant nutrients.

2. PROCESSES FOR RAW MATERIALS: Processes for manufacture of ammonia, nitric acid, phosphoric acid and

3. NITROGENOUS AND POTASSIC FERTILIZERS: Processes for urea and di - ammonium phosphite. Recovery of Potassium salts processes for ammonia chloride and ammonium phosphate.

4. COMPLEX FERTILIZERS: Processes for nitro - Phosphorous and complex NPK fertilizers, liquid fertilizers.

5. PHOSPHATIC FERTILIZERS AND INDIAN FERTILIZER INDUSTRY: Single and Triple super phosphate, bio-fertilizer. Fertilizer Industry in India.

REFERENCES:

1. Strelizoff, "Technology and Manufacture of Ammonia", 2nd. Edn.,Wiley, 1981.
2. L. J. Carpentire, "New Developments in Phosphate Fertilizer Technology", Elsevier, 1971.
3. M. E. Pozin, "Fertilizer Manufacture", MIR Publishers, Moscow, 1986.
4. "Handbook on Fertilizer Technology", Fertilizer Association of India, near JNU, New Delhi 1992.
5. A. V. Slack, "Phosphoric Acid", 2nd Edn., Marcell Dekkar, 1968.

OIL AND FAT TECHNOLOGY

1. INDUSTRIAL OILS AND FATS: RAW MATERIAL PROPERTIES: Sources,composition,properties,classification and analysis of oils and fats.

2. RECOVERY AND REFINING OF OILS FROM RAW MATERIALS: Extraction of oils, Mechanical and solvent extraction methods. Refining and hydrogenation of oils, Edible oil processing.

3. MANUFACTURE OF FATTY ACIDS, GLYCERIN AND SOAP: Fat splitting and hydrolysis. Manufacture of glycerine and fatty acids. Soap manufacture.

4. TECHNOLOGY OF OIL BASED DETERGENTS: Oil based raw material for detergents. Detergents manufacturing processes. Oleo-Chemicals for other applications.

5. MODERN DEVELOPMENT IN DETERGENTS: Indian oils, fats and detergents industries.Alpha Olefin from natural oils and conversion to sulphonate.Fatty alchohols and thier sulphates form natural oils.

TEXT BOOKS:

1. D.Swern, "Baileys Industrial Oils and Fat Products",4th Edn., Vol. I & II, Wiley, 1982.
2. Edgar Woollatt, "The Manufacture of Soaps, Other Detergents and Glycerine", 1st Edn., Ellis Horwood,1985.

CERAMIC TECHNOLOGY

1. INTRODUCTION TO CERAMICS: Importance of ceramics and lines of ceramic development, structure and properties of ceramics, electronic configuration of atoms, Bonding, Physical, Thermal, Electrical, Magnetic and Optical properties of ceramics, Mechanical properties and their measurements.

2. CERAMIC PROCESSING: Processing of ceramics, powder processing, powder sizing and preconsolidation, shape forming processes. Pressing, casting, plastic forming and other forming processes. Densitification and theory of sintering.

3. CERAMIC FORMATION: Drying ceramic ware. Internal flow of moisture, surface solid state reactions, setting methods, finishing fired ware.

4. APPLICATION OF CERAMICS: Fine ceramics-Bodies for electrical and electronics uses. Refractories and Insulators. Heavy refractories,Insulating firebrick, pure oxide refractories, non-oxide refractory bodies, Refractory plastics, concrete and mortar, insulating materials.

5. TYPES OF CERAMICS: Ceramics building materials, building brick, sand-lime brick, lime, portland cement, high alumina cement, gypsum plaster, oxychloride, silicate and phosphate cements, Glass compositions, mechanism of melting and glass products.

REFERENCES:

1. F.Singer and S.S.Singer,"Industrial Ceramics",Chapman and Hall Co., London,1982.
2. David W., Richardson and Basel," Moder Ceramic Engineering, Properties, Processing and use in design",Macell Dekkar,Inc,Newyork,1962.
3. F.H.Norton,"Elements of ceramics",2nd Edn.,Addison-Wesley Publishing Co., London,1974.
4. Enginnering application of Ceramic Materials Source Books of American Society for materials.

POLYMER TECHNOLOGY

1. CHARACTERISTICS AND ANALYSIS OF POLYMERS: The science of large molecules. Theory of polymer solutions. Measurement of molecular weight and size. Analyzing and testing of polymers.

2. POLYMER MATERIAL STRUCTURE AND PROPERTIES: Deformation, flow and melt characteristics. Morphology and other in crystalline polymers. Rheology and mechanical properties of polymers. Polymer structure and physical properties.

3. POLYMER SYNTHESIS AND REACTION ENGINEERING: Condensation polymerization, Addition polymerization, Ionic and Coordination polymerization, copolymerisation, polymerization conditions and polymer reactions.

4. INDUTRIAL POLYMERS, MANUFACTURING PROCESSES AND APPLICATIONS: Hydrocarbon plastics and elastomers, other carbon chain polymers, Heterochain thermoplastics, Thermosetting resins

5. PROCESSING OF POLYMERS: PLASTICS, FIBERS AND ELASTOMERS: Polymers developed for synthetic plastics, fibers and elastomer applications. Plastics technology. Fiber technology and Elastomer Technology.

REFERENCES:

1. F.W. Billmeyer, "Text Book of Polymer Sciences", 3rd Edn., Wiley Inter Science, 1984.
2. F. Rodriguez, "Principles of polymer systems",4th Edn., Taylor and Francis, Washington, 1996.
3. "Encyclopedia of Polymers Science and Technology", John Wiley-Inter Science.

BIO-TECHNOLOGY

1. RATES AND PATTERNS OF CHANGES IN CELL CULTURES: Kinetics of substrate utilization, biomass and product formation in cellular cultures. Stoichiometry of growth and product formation.

2. PHYSICAL PARAMETERS IN BIOREACTORS AND DOWNSTREAM SEPARATIONS: Transport phenomena and modeling in Bioprocesses. Product Recovery operations. .

3. SENSORS, MONITORING AND CONTROL SYSTEMS IN BIOPROCESSES: Instrumentation and process control in bioprocesses.

4. BIOCHEMICAL REACTION ENGINEERING AND BIOREACTOR DESIGN: Design and analysis of Bioreactors. Dynamic models and stability, non-ideal mixing, residence time. Sterilization reactors. Immobilised bio-catalysts and multiphase bio reactors.

5. FERMENTATION TECHNOLOGY AND r-DNA TECHNOLOGY: Bio-process Technology and Genetic Engineering.

TEXT BOOKS:

1. J.E. Bailey and D.F. Ollis, "Biochemical Engineering Fundamentals", 2nd Edn., McGraw Hill, New York,1986.
2. M.D. Trevan, S. boffly, K.H. Golding and P.stanbury, "Biotechnology", Tata McGraw publishing Company, New Delhi 1987.
3. R. Lovitt and M. Jones, "Biochemical Reaction Engineering in Chemical Engineering", Vol. III, 3rd Edn., Edited by J.F. Richardson and Peacock, Pergamon, London, 1994.
4. Smith "Biotechnology" cambridge University, 2nd Edn., 1990.

ENERGY CONSERVATION

1. Introduction: The energy crisis and options: the energy conservation option, energy intensity of developed and developing economies, energy auditing – basic requirements, scope and purpose, process energy and gross energy requirements.

2. Efficient energy conversion: efficient combustion, waste as a fuel, combined cycles for efficient power generation, combined heat and power plants, combined cooling and power plants.

3. Energy recovery: insulation: insulating materials, economic thickness of insulation; heat recovery heat exchangers: recuperative heat exchangers, run-around coil systems, regenerative heat exchangers; heat pumps; and heat-pipes.

4. Process integration: basic concepts of pinch technology, stream networks, significance of the pinch, design of energy recovery system.

5. Energy conservation in buildings: degree-days, steady state loads and comfort. Conditioning the air for process requirements and human comfort, thermal performance monitoring, efficient lighting systems, solar passive features.

6. Economics of energy saving schemes and case studies.

REFERENCES:

1. Eastop and Croft, 'Energy efficiency', Longman Scientific and Technical, 1990.
2. Gordon A Payne, 'Managing energy in commerce and industry', Butterworths, 1984.

PILOT PLANTS, MODELS AND SCALE-UP METHODS IN CHEMICAL ENGINEERING

1. INTRODUCTION TO PILOT PLANTS AND MODELS: Introduction to pilot plants and Models, Process Development, Process study, the principle of similarity and similarity criteria, dimensional analysis and its application in scaling-up or scaling-down the chemical process plant.

2. MATHEMATICAL EQUATIONS: Mathematical Equations representing the Mechanical, Thermal, Diffusional and chemical processes and derivation of the dimensionless groups from these differential equations. Rate of chemical reaction of Homogeneous and Heterogeneous chemical reactions.

3. THE REGIME CONCEPT: The Regime Concept, Laupichleir's study of catalytic water gas reaction, chemical dynamic and mixed regime, Effect of temperature on physical and chemical reactions. Similarly criteria for the principle types of regime and scale equations.

4. SCALE UP OF HEAT TRANSFER EQUIPMENTS: Scale-up methods for Heat-Transfer equipment e.g.-Heat Exchangers, Steam or vapour Heaters, Evaporators, Condensers and Coolers.

5. SCALE-UP OF MISCELLANEOUS EQUIPMENT: Scale-up methods for mixing equipment and other miscellaneous equipment used in chemical process industries.

REFERENCES:

1. R.E. Johnstone and M.W. Thring, "Pilot Plants, Models and Scale-up methods in Chemical Engineering ",McGraw Hill Book Company, New York,1957.
2. Bisio & Kabel, "Scale-up in Chemical Industry".
3. D.G. Jordan, "Chemical Process Development", Vol. I & II, Interscience Publishers, 1988.

INSTRUMENTATION AND MEASURMENTS

1. CONCEPTS AND INSTRUMENTATION OF OPTICAL METHODS: Introduction to optical methods and various Instruments. Visible and UV Spectrophotometer. IR Spectrophotometer, Fluorescence.

2. NUCLEAR MAGNETIC RESONANCE (NMR) AND X-RAY ANALYSIS: Introduction-Instrumentation-analysis, X-ray methods

3. ELECTRO CHEMICAL ANALYSIS: Electro chemical Methods of analysis.pH and conductometric titration

4. THERMAL ANALYSIS: Thermo analytical methods. Differential scanning. Calorimeter. Thermogravimetric analyser. Thermo mechanical analysers.

5. CHROMATOGRAPHY: Chromatography-various types. Construction and working. Analysis of sample.

REFERENCES:

1. C.W. Ewing, "Instrumental methods of chemical analysis", 4th edn., McGraw Hill, 1985.
2. H. H. Willard, L.L. Merit, and J.A. Deanm, "Instrumental Methods of Analysis", 5th Edn.

TWO PHASE FLOW AND HEAT TRANSFER

Introduction to two phase flow, simple momentum and energy balances and their related empirical correlations, basic equation for two phase flow modelling, annular two phase flow, introduction to two phase heat transfer, nucleate boiling heat transfer, forced convection boiling, burnout, heat transfer in condensation, measurement technique in two phase flow, introduction to two phase flow problems in process industry.

REFERENCES:

1. Jean J. Ginoux, Two phase flow and heat transfer.
2. Bergles, Collier & Hewitt, Two phase flow and heat transfer in the power and process industries.

PETROCHEMICAL TECHNOLOGY

1. PRIMARY PROCESSING OF CRUDE OIL :

Classification of crude oil, Atmospheric distillation .Vacuum distillation of residue-products and distillation practice.

2. SECONDARY PROCESSING OF CRUDE OIL :

FCCU, Hydro cracking, Visbreaking, Thermal cracking. Coking, Reforming, Alkylation, Polymerization and Isomerisation process.

3. TREATMENT-TECHNIQUES: Treatment techniques for removal of objectionable gases. Odours, to improve performance, .Storage stability. Extraction of aromatics, Olefins and recovery operations from petroleum products.

4. PETROCHEMICALS: Chemicals from methane and synthetic gas: Ammonia, Methanol and Hydrogen Cyanide, Chemicals from olefins; Ethviene derivatives, Propylene derivatives and Butylene derivatives, Aromatics, intermediates for synthetic fibers. Plastics and rubber.

5. ENVIRONMENTAL AND SAFETY ASPECTS IN REFINERY AND PETROCHEMICALS: Waste water and effluent gases treatment from alkylation units and petrochemical units, safely aspects in the above industries.

REFERENCES:

1. W.L. Nelson, "Petroleum Refinery Engineering", 4th Edn., McGraw Hill , New York 1985.
2. B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Edn., Oxford and IBH Publishing Company, New Delhi, 1990. Khanna Publishers.
3. G. D. Hobson and W. Pohl., "Modem Petroleum Technology", Gulf Publishers 2nd. Edn., 1990.
4. R. A. Meyers, "Handbook of Petroleum Refining Processes", McGraw Hill , 1st Edn., 1980.
5. F. Hatch md Sumi Malar, "From Hydrocarbons to Petrochemicals", Gulf Publishing Company, 1st Ed. 1981.

MANUFACTURING AND MAINTENANCE OF PROCESS EQUIPMENTS

Manufacturing: Manufacturing methods of process equipments

Bulk Metal Deforming: Elastic and Plastic deformation, Yield and Flow, Classification of Deforming Processes,
Drawing: Classification, Process Geometry, Geometrical Relationship; Analysis of Wire/ Sheet/Tube Drawing- Stresses, Load and Power, Maximum Reduction Possible. *Extrusion*: Classification, Process Geometry, Geometrical Relationship; Analysis of Extrusion-Stresses, Load and Power, Maximum Reduction Possible; Working and Application of Indirect Extrusion, Hydrostatic Extrusion, Pipe and Tube Extrusion, Defects in Extruded Parts.

Forging: Classification, Strip and Disc Forging- Process Geometry, Geometrical Relationship, Analysis- Pressure Distribution, Forging Load and Power; Defects in Forged Products.

Sheet metal working: Roll of sheet components, *Bending:* Classification, Process Geometry, Geometrical Relationship, Analysis- Bend Allowance, Spring Back and Bending Force; Other Bending Related Operation- *Deep Drawing*: Process Geometry, Measures of Drawing, Forces and Power, Blank Size Determination, Redrawing and Defects in Deep Drawing.

Cutting Operations: Fundamentals of Shearing, Blanking and Piercing –Clearance, Cutting Foces; Other Sheet Metal Cutting Operations, Concept of Nesting.

Unconventional Deforming: Explosive Deforming, Electro-Hydraulic Deforming, and Electro-Magnetic Deforming; Laser bending; Concept of Micro-Deforming.

JOINING PROCESSES: Classification of Welding Processes;

Arc Welding- Principle of Arc, Metal Transfer, Arc Characteristics; Working and Applications of SMAW, GTAW, GMAW, SAW, ESW and AHW;

Resistance Welding- Spot, Seam, Projection and Flash Butt;

Gas Welding: Oxy Acetylene and Oxy Hydrogen;

Thermit Welding; Solid State Welding Processes. Fusion Welding Pool and Welding Defects.

Allied Processes- Brazing and Soldering, Surfacing and Spraying, Electro-Plating and Electro-Forming, Deposition Processes-PVD and CVD.

UNCONVENTIONAL WELDING: Principle of Working and Applications of Beam Welding Processes- LBW and EBW, Ultra-Sonic Welding and Under Water Welding; Concept of Micro-Welding

Maintenance: Types of maintenance such as Preventive maintenance, predictive maintenance, schedule maintenance, Corrective maintenance, Failure-finding maintenance, etc.

Monitoring of processing equipments for degradation such as Erosion, corrosion, and erosion-corrosion. Protection of equipment against such degradation.

REFERENCES :

1. **Groover, M.P.,** Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley Student Edition, John Wiley and Sons, 2005.
2. **Ghosh, A., and Mallik, A.K.,** Manufacturing Science, EWP Pvt. Ltd., New Delhi.
3. **Jain, V.K.,** Advance Machining Processes, Allied Publisher, Bombay.

MODELLING & SIMULATION IN ENGINEERING

Fundamental aspect of modeling:
Technical and Commercial aspects, types of modeling- Analytical, experimental, mechanistic, numerical, AI based and stochastic.
Model testing, Principles of simulation, Discrete event simulation. Applications in design and manufacturing.

COMPUTER-AIDED PROCESS CONTROL

Hardware, Analog and digital interfacing, Sensors and transducers, System software: Realtime programming, Application software: data logging, filtering, Digital Control: Z-transforms, discrete time dynamics systems, adaptive control, introduction to MIMO control systems.