

## COURSE BRIEF

### Bachelor of Technology (B.Tech.)

#### Branch - CHE

#### Year/Sem: Ist Year/I Sem

##### **Mathematics-I (Credits: 4)**

Partial differentiation, Taylor's series, Maxima and Minima, Jacobians, Double integrals Equations to a line, plane, curve and surfaces, Line and surface integrals, Gradient, divergence and curl, Normal and tangent to a surface, Gauss and Stokes theorems, Differential Equations with constants coefficients, Laplace transforms, Algebra of matrices, Determinants, Gauss elimination method, Rank, Eigen values and vectors, Quadratic forms.

##### **Physics-I (Credits: 4)**

Analytical treatment of interference, Intensity distribution of fringe system, Fresnel's biprism, Newton's rings, Diffraction from Single slit, double slit and Diffraction grating, Polarization, Phenomenological understanding of Birefringence, Principles of use of uniaxial crystals in practical polarizers, compensators and wave plates, Optical activity, Relativity: Michelson-Morley experiment, Lorentz transformations, Addition of velocities, Mass variation with velocity, Mass-energy relation. Radiation: Black body radiation, Wein's law, Rayleigh Jean's law, Planck's law of radiation, Compton scattering. Atomic Structure: Origin of spectral lines, spin and orbital angular momentum, Quantum numbers, Atoms in magnetic field, Zeeman Effect. Statistical Distributions: Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distributions and their applications. Lasers: Principle and working of laser, Different types of lasers (He-Ne Laser, Ruby Laser, Semiconductor Laser), Holography.

##### **English (Credits: 3)**

Definition of Communication, Process & Stages of Communication, Barriers to Communication, Channels of Communication, The listening process, Importance of listening, Purpose and types of listening, Hearing and listening, Listening with a purpose, Barriers to listening. Importance of acquiring oral skills, Visual aids, Body Language, Delivery, Pronunciation, Use of connectives Organization of matter: Meta-discourse features, Textual organization, 7 C'S of effective communication, Reading comprehension, Some important synonyms and antonyms, Etiquettes & grooming, Skimming and Scanning, Intensive and extensive reading, SQ3R Technique, Business letters, Memo, Circulars, Notices, Report writing, resume writing, Agenda & Minutes writing, Technology based communication tools, Committee types, Advantages, Conferences, Audio-video conferencing, Barriers and overcoming negative impact, Speech Preparation, Tips for successful job interview, Do's and don'ts while appearing for interview, Mock interview, Some interview questions, Telephonic interview tips, Resume writing.

##### **Software Development Fundamentals (Credit: 4)**

Introduction to Programs, Processing programs, Types of Programming Languages, Programming Design tools (Pseudo code and Flowcharts), Program Design, Structured Programming, Problem solving and programming, Quality aspects of structured programs, Testing and Debugging Techniques, Self Learning of Pascal. Introduction to Programs, Processing programs, Types of Programming Languages, Programming Design tools (Pseudo code and Flowcharts), Program Design, Structured Programming, Problem solving and programming, Quality aspects of structured programs, Testing and Debugging Techniques, Loop Control and Case Control Structures, Arrays and Strings, Functions and Pointers, Structures and Union, Recursion, Dynamic Memory Allocation, linked-lists, File I/O, C Library.

##### **Physics Lab-I (Credits: 1)**

### **Experiments List-**

1. To study the variation of magnetic field along the axis of Helmholtz Galvanometer and to determine its reduction factor. [set-up no.1 & 11]
2. To determine the specific rotation of cane sugar solution using Biquartz polarimeter. [set-up no.2 & 12]
3. To observe Newton's rings and to determine the wavelength of sodium light [Set-up no. 3 & 13]
4. To determine the wavelengths of spectral lines Red, Green and Violet of mercury using plane transmission grating. [set-up no.4 & 14]
5. To study the presence of energy levels in an atom by Franck-Hertz Experiment.[set-up no. 5 & 15]
6. To determine the resistance per unit length of a Carey Foster's bridge and to obtain the specific resistance of a given wire. [set-up no.6 & 16]
7. To determine the Planck's constant using solar cell. [set-up no. 7 & 17]
8. To determine the wavelength of sodium light with the help of Fresnel's biprism.[set-up no. 8 & 18]
9. To draw hysteresis loop of a ferromagnetic material & calculate its retentivity and coercivity.[set-up no.9 & 19]
10. To study ultrasonic waves in aluminium and to obtain Young's modulus for it. [set-up no. 10 & 20]

### **Software Development Lab (Credit: 2)**

Initial exercises on MS office, Familiarity with Microsoft word, Familiarity with Microsoft power point, Familiarity with Microsoft excels, Pattern generating problems, Loop Control and Case Control Structures, Arrays and Strings, Functions and Pointers, Structures and Union, Recursion, Dynamic Memory Allocation, linked-lists, File I/O, C Library.

### **Workshop Lab (Credits: 1.5)**

#### **List of Experiments:**

#### **Carpentry Shop**

1. To study about various tools and equipments used in carpentry shop.
2. To make a cross lap joint as per given specification

#### **Foundry Shop**

3. To study about various tools used in foundry shop.
4. To prepare a green sand mould with the help of a given pattern.
5. To perform permeability test on sand mould.

#### **Machine Shop**

6. To study various machine tools such as lathe, milling, shaper, drilling, grinding, EDM drill and cutting tools used by them.
7. To perform straight turning, step turning and taper turning operations on lathe machine
8. To perform threading operation on the lathe machine

#### **Fitting Shop**

9. To study about various tools used in fitting shop.
10. To make a fitting job as per given drawing.

#### **Welding Shop**

11. To study various types of welding processes available in the workshop such as arc welding, gas welding and resistance welding.
12. To prepare a welded joint by using arc welding.
13. To prepare a welded joint by using Resistance Spot welding
14. To prepare a welded joint by using gas welding.

### **Year/Sem: Ist Year/II Sem**

### **Mathematics- II (Credits: 4)**

Second order linear differential equations. Convergence of series, Solution in series, Bessel and Legendre functions, Chebyshev polynomials. Partial differential equations, Equations of vibrating string, one dimensional wave and heat conduction equations Functions of a complex Variable, Analytic functions, Cauchy- Riemann equations Conformal mapping Poles and Singularities, Complex Integration, Taylor's and Laurent's series, Cauchy residue theorem and applications.

#### **Chemistry (Credits: 4)**

Atomic Structure and Chemical Bonding: ionic bond, covalent bond, ionic crystals, covalent compound, diamond, graphite, VBT, VSEPER, MOT. Thermodynamics: 1<sup>st</sup> law, 2<sup>nd</sup> law, 3<sup>rd</sup> law, entropy, enthalpy. Electrochemistry: Electrochemical cell, Galvanic cell and concentration cells, equilibrium potential, corrosion and protections of corrosion. Solid State: types and properties, Bravais lattices, common crystal structures, atomic packing factor and density, Miller indices, XRD, defects. Liquid: properties, viscosity, surface tension. Gaseous State: gas law, ideal gas, real gas, Van der Waals equation. Fuel: classification, HCV, LCV, Bomb Calorimeter, renewable and non-renewable fuels. Metal and alloys: properties, metallurgy, other alloy, steels and its applications. Ceramics and Polymer: clays, silica, feldspars, method for fabrication of ceramic ware, bio-degradable polymers and their utility. Coordination Chemistry: Werner's theory, CFT, Chemical Kinetics: 1<sup>st</sup>, 2<sup>nd</sup> and zero Order, molecularity. Environmental Chemistry: water and its treatment, MSW. Green Chemistry: biogas, biomass, bio-ethanol, energy crops, waste to wealth. Organic Chemistry: Alkane, Alkene, Alkyne.

#### **Electrical Circuit Analysis (Credits: 4)**

Kichhoff's Circuit Laws; Loop-Current Analysis, Supermesh; Mesh Analysis; Node-Voltage Analysis; Nodal Analysis; Choices of Method of Analysis. Superposition Theorem; Thevenin's Theorem; Norton's Theorem; Maximum Power Transfer Theorem; Millman's Theorem; Reciprocity Theorem. Simple RL Circuit, Time Constant, Decay and Growth of Current; Simple RC Circuit, Discharging of a Capacitor, Charging of a Capacitor. Impedance, Admittance, Hybrid, Equivalent Networks. Half-wave and full-wave (centre tap and bridge) rectifiers, PIV rating of diode, Performance of half-wave and full-wave rectifiers, Shunt capacitor filter. Clippers: Series and Parallel, Limiters, Clampers. Zener diode and its application as a voltage regulator. Basics of Light emitting diode, Varactor diode, Schottky diode and Photodiode. BJT and its working, The three configurations, CB and CE input and output characteristics, Conversion of bases, Representation of negative numbers, Complement, Binary arithmetic, BCD code, Excess-3 code, Gray Code and Alphanumeric code. Logic gates and Boolean algebra, Standard and canonical representation and minimization of Boolean expressions using Karnaugh Map, Combinational & Sequential circuit, Introduction to microprocessor.

#### **Engineering Mechanics (Credits: 4)**

Introduction: Idealization 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, Variational mechanics. Structures and machines: Plane trusses, Space trusses, Method of joints, Method of section, Graphical method, Frames and machines. Distributed forces and moment of inertia: Centroid of composite figures, Area moment of inertia, Mass moment of inertia, Principal axes and principal moment of inertia. Friction: Introduction of friction, Laws of friction, Wedge, Screw, Belt, and Rolling friction. Beams: Different support & loading conditions of Beam, Shear force diagram (SFD), Bending moment diagram (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.

#### **Chemistry Lab (Credits: 1)**

List of experiments:

1. To prepare the standard solution of N/10 HCl by double titration method.
2. To determine the relative viscosity of given unknown liquid.
3. To determine the relative surface tension of given unknown liquid.
4. To determine the temporary, permanent and total hardness of given water samples.
5. Identify the element (N, S, Cl, Br, and I) in given organic compound.
6. To determine the pH and conductivity of given water samples.
7. To determine the chloride content in given water sample by argentometric titration method.
8. To determine the DO in given water sample by Winkler method.
9. To determine the HCV and LCV of given fuel by Bomb calorimeter.
10. To determine the function group of given organic compound.
11. To determine the flash point of given fuel.
12. To determine the inversion of sugar by polarimeter.

### **Electrical Circuit Analysis Lab (Credits: 1)**

List of experiments:

1. Simplify complex network using Thevenin theorem and verify it.
2. State Superposition Theorem and verify.
3. Perform and verify Maximum Power Transfer Theorem.
4. Perform Clipper Circuit.
5. Design Clamper Circuit.
6. Half wave rectifier with and without filter circuit.
7. Full wave rectifier with and without filter circuit.
8. Transistor as an Amplifier.
9. Implementation of logic gates
10. K-map and Boolean function simplification for efficient implementation of digital systems
11. Implementation of Binary Adders and Subtractor
12. Implementation of code converters (Gray-to-Binary & Binary-to-Gray)

### **Engineering Mechanics Lab (Credits: 1)**

List of experiments:

1. To verify the law of triangle of forces.
2. To verify the law of parallelogram of forces.
3. To verify the law of polygon of forces.
4. To verify Lami's theorem.
5. To determine the co-efficient of friction between wood and other surfaces.
6. To find the moment of inertia of flywheel.
7. To determine the mechanical advantage, velocity ratio and efficiency of a screw jack.
8. To determine the mechanical advantage, velocity ratio and efficiency of the Worm and Worm Wheel.
9. To determine the mechanical advantage, velocity ratio and efficiency of the Winch Crab.
10. To find the forces in a member of a Triangular Truss.
11. To find the forces in a member of a Warren Truss.
12. To find the forces in a member of a Pratt Truss.
13. To find the forces in a member of a Joint Roof Truss.

### **Engineering Drawing and Design (Credits: 1.5)**

List of Experiments:

1. Study and construction of lines, lettering, dimensioning, plane scales and diagonal scales.
2. Study and construction of different methods used for the construction of conic curves.

3. Study and construction of geometrical construction.
4. Study and construction of cycloidal curves, involute and helix etc.
5. Orthogonal projection of point in all possible position.
6. Study and construction of projection of line and its applications (inclined to both planes).
7. Study and construction of projection of planes (inclined to both planes).
8. Study and construction of projection of solids (right circular cone, prism, pyramid and cylinders).
9. Study and construction of true shape of sections.
10. Study and construction of oblique projection and development of surface.
11. Study and construction of isometric view using orthogonal projection on isometric scales.
12. Introduction to basic and editing command of CAD software.
13. Introduction of 2-D drafting.
14. Introduction of surface modelling.
15. Introduction of 3-D geometrical model.

### **Year/Sem: II Year/ III Sem**

#### **Chemical Process Calculations (Credits: 4)**

Concept of unit operations and unit processes, Units and Dimensions, stoichiometric relations. Composition of mixture and solutions. Material balance in systems involving physical changes, material balance in systems involving chemical reactions. Phase diagram, ideal gas law, relationships for real gases and compressibility factor charts, vapour pressure of liquids. Humidity and saturation, psychrometric charts. Material and energy balance involving condensation and vaporization. Heat capacity, calculation of enthalpy changes. The general energy balance. Energy balance for systems involving chemical reactions. Material and energy balances in unsteady state systems.

#### **Fluid and Fluid Particle Mechanics (Credits: 4)**

Fluid statics, Newtonian and non-newtonian fluid behaviour. Turbulence, Reynolds number, Boundary layer theory. Equation of continuity. Equations of motion. Bernoulli's equation. Flow of incompressible fluids, Laminar flow of Newtonian fluids. Hagen-Poiseuille equation. Turbulent flow in pipes. Von-Karman equation. Friction factor. Friction loss in non-newtonian fluid flow. Flow through non-circular cross-section. Fluid flow through coils. Basic relationships for compressible flow, adiabatic and isothermal flow of compressible fluids through orifices and pipes. Flow past immersed bodies, fluidization, agitation and mixing of fluids, gas/liquid and liquid/liquid two phase flow. Properties of solids and screen analysis, particle size distribution, size reduction of solids, settling and sedimentation, filtration.

#### **Organic Chemistry (Credits: 4)**

Fundamentals of organic chemistry, types of bonds in organic compounds, inductive effect, electromeric effect, mesomeric effect, hyperconjugative effect, resonance and resonance energy, substitution reactions, addition reactions, elimination reactions. Industrially important organic chemistry, organic compounds of nitrogen: nitro compounds, diazonium salts, amines. Sulphonation, chlorosulphonation, o-alkylation, acylation, halogenations, oxidation, carboxylation. Important named reactions: Aldol condensation, Cannizaro, Reformatsky, Friedel-Crafts, Diels-Alder, Ullmann, Wurtz reaction. Mechanism and industrial application of rearrangements such as Claisen, Curtius and Fries. Stereochemistry: chirality, concept of stereoisomerisms, classification of stereoisomers, enantiomers and diastereoisomers, geometrical isomerism, E-Z nomenclature. Photochemistry.

#### **Chemical Engineering Thermodynamics (Credits: 4)**

Scope and laws of thermodynamics. Concepts of open and closed systems, state and path functions, reversible

and irreversible processes, equilibrium, phase rule. PVT behaviour of pure substances. Equations of state. Standard heats of formation, reaction and combustion. Entropy. Applications of first and second laws to steady / unsteady processes in open / closed systems. Compression and expansion processes. Thermodynamic properties of fluids. Refrigeration and liquefaction. Solution thermodynamics, chemical potential and phase equilibria. Partial properties. Excess properties. Fugacity in solution. Concept of activity and activity-coefficient. Property changes of mixing. Vapor-liquid equilibrium in miscible binary and multicomponent systems, azeotropy, liquid-liquid equilibrium. Solubility of gases and solids in liquids, chemical reaction equilibria in homogeneous and heterogeneous systems.

### **Managerial Economics (Credits: 3)**

Introduction to Managerial Economics & Macro-economic Concepts: Definition of Economics, Meaning & Scope of Managerial Economics, Micro & Macro Economics, Concept of economic profit, (Opportunity Cost), Concept of Presentvalue. Demand Analysis: Law of demand, Individual & market demand, Determinants of market demand, Marginal Utility theory, Elasticity of demand- Price, Income, Cross, Advertising Theory of Consumer choice using Indifference Curve analysis, Demand forecasting techniques, Delphi, Survey, Time series analysis. Production Theory and Analysis: Production with one variable, optimal employment of a factor of production, Cobb Douglas production function, Production with two variable inputs, Production Isoquants, Production Isocosts, Optimal employment of two inputs, the expansion path, Basics of Supply, Market Equilibrium. Cost Theory and Analysis: Cost concepts - Opportunity, Explicit, Marginal, Incremental and Sunk, Relation between Production & Cost, Short run cost function, Long run cost function, Special topics -Profit contribution analysis, - Break Even analysis, Operating Leverage. Pricing under Different Market Structures: Perfect Competition - Determination of Price output relationship in short run, long run, Monopoly Determination of Price output relationship in short run & long run, Price discrimination, Monopolistic Competition-Determination of Price output relationship in short run & long run, Product Differentiation, Oligopoly- Types, Determination of Price output relationship, Kinky demand curve {Stickiness of Price}, Price leadership model

### **Fluid Mechanics Lab (Credits: 1)**

List of experiments:

1. Verification of Bernoulli's Theorem.
2. Determination of Frictional Losses in Pipes of different diameters.
3. Determination of Minor Losses in Pipe.
4. Reynolds Dye Experiment for Flow Characterization.
5. Calibration of Venturimeter.
6. Calibration of V- Notch and Rectangular Notch.
7. Calibration of Orifice meter.
8. Calibration of Pitot Tube.
9. Determination of Metacentric Height.
10. Determination of  $C_c$ ,  $C_v$  and  $C_d$  of an Orifice.

### **Fluid Particle Mechanics Lab (Credits: 1)**

List of experiments:

1. To find out Rittinger's Constant, Kick's Constant and Bond's Constant. By Jaw Crusher.
2. To determine Rittinger's Constant, Bond's Constant, Kick's constant and Work Index by Hammer Mill.
3. To find the specific surface and critical speed of Ball Mill.
4. To determine the terminal velocity, collective efficiency and cut diameter by a Cyclone Separator.
5. To study the effect of the froth floatation in the recovery of given sample from the mixture.
6. Evaluation of Specific cake resistance ( $\alpha$ ) and medium resistance (R) by Plate and Frame Filter Press.
7. To determine the specific cake resistance for the given slurry by Vacuum Leaf Filter.

8. To determine the screen effectiveness by performing a sieve analysis.
9. To determine terminal setting velocity of solids by Elutriator.
10. To study the operation of sigma mixer.

### **Organic Chemistry Lab (Credits: 1)**

List of experiments:

1. Preparation of sodium extract and element detection e.g. Cl, Br, I, N, S.
2. Identification of aromatic organic arenes compounds e.g.
  - a. Benzene
  - b. Toluene
  - c. Anthracene
  - d. Naphthalene
3. Identification of aromatic organic phenols compounds a. Resorcinol                      b.  $\alpha$ -Naphthol.
4. Identification of aromatic carboxylic acid compounds e.g.
  - a. Salicylic acid
  - b. Benzoic acid
  - c. Phthalic acid
5. Identification of aliphatic organic compounds e.g.
  - a. D-Glucose
  - b. Sucrose
6. Synthesis of aromatic organic compounds.
  - a. Aspirin (Drug)
  - b. Glucosazone
  - c. Benzamide
  - d. Benzanilide
  - e. Phenol Benzoate
7. Estimation of aromatic organic compound by titration method  
Phenol

### **Year/Sem: II Year/ IV Sem**

#### **HSS elective-1**

##### **Digital Marketing (Credits: 3)**

Unit 1: Introduction to Digital Marketing, Strategies in Digital Marketing Search Engine Optimization – (Understand the search engine as default entry point to internet. Learn how to get website listed among top search engine results) - Search Engine working, Crawlers, ranking algorithm and techniques, Types of search engines, white hat SEO, black hat and grey hat SEO, on page optimization and techniques. Unit 2: Search Engine Marketing – Basics of marketing, Inbound and outbound marketing, Appreciate the role of pay per click in website listing. Learn how to effectively run ads on Search Engines. Email Marketing– Learn how to effectively build your users lists, deliver e-mails & generate relevant clicks. Unit 3: Social Media Marketing– Learn how to build brand, generate leads & aggregate audience on Social Media. Inbound Marketing– Learn how to attract & convert customers by earning their trust through various techniques such as content marketing. Unit 4: Web Analytics – Basic web analytics process, web analytics technologies, log file analysis, Best Web Analytics Tools: Clickstream Analysis Tools, Content and Blog Marketing– Increasing audience engagement through content marketing. Learn to use white paper, brochure, and case studies for unique interaction. Unit 5: Mobile Marketing– Strategizing marketing through smart devices. Learn App-based marketing, QR codes, Location-based marketing, SMS marketing.

##### **Financial Management (Credits: 3)**

Unit 1: Nature of Financial Management and Concepts of Values and Return Definition of Financial Management, Scope of Finance, Finance Functions, Financial Manger's Role, Financial goal, Agency problem, Future Value of a Single Cash Flow, Future value of an Annuity, Sinking Fund, Present Value of a Single Cash Flow, Present Value of an Annuity, Capital Recovery, Present Value of an Uneven Cash Flow, Value of an Annuity Due, Long Term Sources of Finance – Definition, Types, Advantages and Disadvantages. Unit 2: Investment Decisions Nature of Investment Decisions, Types of Investment Decisions, Investment Evaluation Criteria – NPV, IRR, Profitability Index, Payback Method, Discounted Payback Period and Accounting Rate of Return, NPV versus IRR, Definition, measurement of specific costs, computation of Overall Coast of Capital, Valuation of bonds and stocks, Concepts of Risk and Return, Significance of Cost of Capital, Cost of Debt, Cost of Preference Capital, Cost of Equity Capital, Cost of Equity and Capital Asset Pricing Model, CAPM Versus Dividend-Growth Model, Weighted Average Cost of Capital Unit 3: Financing and Dividend Decisions Capital Structure, Meaning of Financial Leverage, Measures of

Financial Leverage, Financial Leverage and Shareholders' Return, Combining Financial and Operating Leverages, Financial Leverage and Shareholders' Risk, Objectives of Dividend Policy, Practical Considerations in Dividend Policy, Stability of Dividends, Forms of Dividend, Share Split, Buyback of Shares. Unit 4: Financial and Profit Analysis Balance Sheet, Profit and Loss Account, Changes in Financial Position, Funds Flow Statement, Cash Flow Statement, Uses of Statement of Changes in Financial Position, Users of Financial Analysis, Nature of Ratio Analysis, Liquidity Ratios, Leverage Ratios, Activity Ratios Unit 5: Long Term Financing and Working Capital Management Ordinary Shares, Rights Issue of Equity Shares, Preference Shares, Debentures, Concepts of Working Capital Management, Operating and Cash Conversion Cycle, Permanent and Variable Working Capital, Balanced Working Capital Position, Determinants of Working Capital, Issues in Working Capital Management, Estimating Working Capital Needs, Policies for Financing Current Assets.

### **Project Management (Credits: 3)**

Unit-I: Introduction to Project Management Defining project management, Project life cycle, Project management maturity model, Project selection and criteria of choice, Types of project selection models, the management of risks, Project portfolio process. Project management and the project manager, Special demands on the project manager. Project as a part of functional organization, pure project organization, matrix organization & mixed organization. Unit-II: Project Planning Initial project coordination, Sorting out the project, Work break down structure, linear responsibility chart. Estimating project budgets, improving the process of cost estimation. Unit-III: Project Scheduling Discussion of scheduling techniques – PERT & CPM. Resource allocation problems, crashing of project, Resource loading, Resource leveling, Multiproject scheduling and resource allocation. Unit-IV: Project Monitoring & Control Planning-monitoring –controlling cycle, Information needs and reporting process, Earned value analysis, Project management information system, three types of control processes, Control of change and scope creep, Project auditing, Project audit life cycle. Unit-V: Project Termination Varieties of project termination, when to terminate a project, The termination process, Final report.

### **Business Environment (Credits: 3)**

Introduction to Business, Meaning of Business Environment : Economic and non economic factors influencing Business, Environmental Scanning, Process of environmental scanning, Economic systems: basic philosophies of Capitalism and Socialism with their variants, Concepts of Mixed Economy, Constitutional Framework of state control of Business : The relationship between Business and Government in India, Definition of Security, Securities Exchange Board of India- Composition Stock Exchange-BSE-NSE, Securities ,Competition Act 2002: Objective, Anti Competitive Agreements : Competition Commission of India –Composition, Powers and Functions. Exchange Board of India-Powers and Functions MRTP Act : Abuse of Dominant Position, Regulation, The Foreign Exchange Management Act, 1999- Objective and Applicability of the Act FEMA Vs FERA ,Fiscal Policy Instruments – taxation, Monetary Policy: Types of Monetary Policy Instruments, Philosophy and strategy of planning in India, Industrial Policy in recent years , Policy with regard to e-business - objectives, trends and practical uses small scale industries, Corporate Social responsibility, FDI Policy, EXIM Policy ,WTO & GATT, Make in India , Digital India campaigns

### **Human Psychology (Credits: 3)**

Unit-I: Introduction to psychology: Definition, Perspectives, Schools of psychology, Methods of psychology, Application of psychology for engineers, Unit-II: Basic Concepts: Perception, Learning, Intelligence, Motivation, Unit-III: Cognitive Processes: Memory (sub-processes, major models), Thinking, Problem-solving, Decision making, Role of Language in cognitive process. Unit-IV: Organizational Psychology: Leadership, Personality, Unit-V: Engineering/ Environmental Psychology: Stress, Emotions & coping, Psychological disorders

### **Professional Ethics (Credits: 3)**

Unit 1. Values of Liberal Society, Introduction, The nature and characteristics of professions, Obligations and professional services, Obligation to clients, professions and third parties. Unit 2. Introduction to Professional Ethics, The foundations and norms of professional ethics. The need for separate code of conduct for professionals. The relation between professional and general ethics. Moral conflict and the issue of autonomy of professional ethics.



Certain specific issues pertaining to medical ethics, legal ethics, computer ethics and business ethics , Unit 3. Indian Value System and Values,Teaching from scriptures and tradition (Geeta, Ramayana, Mahabharata, Upanishads, Vedas, Bible and Quran),Unit 4. Ethics impact in Business,Ethical Issues in Capitalism and market systems, Ethics and social responsibility,Ethics and marketing, Ethics in finance, Ethics and human resource, Ethics and Information Technology, Intellectual property rights like designs, patents, trade marks, copy rights,

### **Macro Economics (Credits: 3)**

Introduction: Introduction to macroeconomics. Macroeconomic issues in an economy, Circular flow of money , National Income Accounting Concepts of GDP and National Income; measurement of national income and related aggregates; nominal and real income; limitations of the GDP concept. Concept of aggregate expenditure: Aggregate demand and its components - Consumption function; savings function ; investment function; equilibrium GDP; concepts of MPS, APS, MPC, APC; autonomous expenditure; Concept of multiplier , Short run equilibrium output Fiscal & Monetary policy: Govt. Budget & Economy, Business Cycle, Fiscal Policy: impact of changes in government expenditure and taxes, Concept of money in a modern economy; monetary aggregates; monetary policy; money supply and credit creation. Inflation and Unemployment: Concept of inflation; determinants of inflation; relationship between inflation and unemployment: Phillips Curve in short run and long run. Derivations of the IS and LM functions; IS-LM and aggregate demand; shifts in the AD curve. Balance of Payments & Exchange Rate : Balance of payments: current account and capital account; foreign exchange; determination of exchange rate

### **Heat Transfer Operations (Credits: 4)**

Mechanisms of heat flow: Conduction, natural and forced convection, Radiation. Concept of resistance to heat transfer. Insulation and critical radius. Extended heat transfer. Dimensional analysis and dimensionless numbers. Heat transfer by natural and forced convection. Heating and cooling of fluids in forced convection. Heat transfer in agitated vessels. Heat transfer to fluids with phase change: Heat transfer from condensing vapors, heat transfer to boiling liquids. Black body radiation. Stefan-Boltzmann law. Planck's law. Wein's displacement law. Kirchoff's law. Gray body radiation. Radiation between surfaces. View factors. Radiation from non-luminous gases and luminous flames. Combined conduction, convection and radiation. Design of furnaces. Types of heat exchange equipment. Design of shell and tube heat exchangers, Kern's method, NTU method, Effectiveness. Types of evaporators. Design of single effect evaporator and multiple effect evaporators.

### **Mass Transfer Operations (Credits: 4)**

Mass transfer operations and their importance. Diffusion and mass transfer between phases, equipment for gas-liquid operations, distillation, vapour-liquid equilibrium. Relative volatility. Flash vaporization. Differential distillation. Continuous rectification of binary systems. Steam distillation, gas absorption. Absorption in plate columns, humidification and dehumidification. Drying, wet bulb, dry bulb and adiabatic saturation temperatures, humidity, drying mechanism, drying rate curves. Crystallization, solubility curves, population balance method.

### **Numerical Methods (Credits: 4)**

Solution of linear system of equations- Direct and iterative methods. Eigen values and Eigen vectors, Jacobi and Householder methods. Interpolation. Approximation. Numerical differentiation, Numerical Integration, Gauss quadrature Solution of a system of non-linear equations; Initial and boundary value problems in ODE. Numerical solution of PDE by finite difference method. Method of weighted residuals (MWR).

### **Environmental Science (Qualifying)**

The multidisciplinary nature of environmental studies: Definition, Scope and importance. Natural Resources: Renewable and non-renewable, resources and associated problems, Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems: Concept of Ecosystem. Structure and function of an ecosystem, producers, consumers and decomposers, Energy flow in ecosystem. Biodiversity and its conservation: genetic, species and ecosystem diversity. Biogeographically classification of India, Value of biodiversity, Threats to biodiversity, Endangered and

endemic species of India. Conservation of biodiversity. Environmental Pollution: Definition, Causes, effects and control measure of-Air pollution, Water pollution, soil pollution marine pollution, noise pollution, thermal pollution nuclear hazards, Solid Waste Management. Social Issues and the Environment: From unsustainable to sustainable development, urban problem related to energy, Water conservation, rainwater harvesting. Human Population and the Environment: Population growth, variation among nations, population explosion-Family Welfare Programme. Field Work.

### **Heat Transfer Operations Lab - I (Credits: 1)**

List of experiments:

1. To find out the emissivity of a test plate.
2. To study the temperature distribution along of a pin fin under free and forced convection.
3. To determine the thermal conductivity of a liquid.
4. To determine the thermal conductivity of the composite wall.
5. To find out the heat transfer coefficient of a vertical cylinder in natural convection.
6. To find out the heat transfer coefficient in forced convection.
7. To determine the thermal conductivity of metal bar.
8. To calculate overall heat transfer coefficient for double pipe heat exchanger.
9. To calculate overall heat transfer coefficient for shell and tube heat Exchanger.
10. Boiling heat transfer.

### **Mass Transfer Operations Lab (Credits: 1)**

List of Experiments:

1. To determine diffusion coefficient or diffusivity, of given liquid (acetone) in air by using ARNOLD's cell.
2. To find the absorption efficiency of the mechanical agitator vessel.
3. To verify Rayleigh's Equation by carrying out differential distillation of Binary Mixture.
4. To determine the effective interfacial area  $a$ , as a function of the superficial liquid velocity,  $V_L$ , in a packed column using the theory of Gas Absorption accompanied by fast chemical reaction.
5. To study the operation of a packed bed batch rectification column under constant or total reflux condition.
6. To carry out steam distillation.
7. Wetted Wall Column.
8. Diffusion coefficient of solid in air.
9. Rotary Dryer.

### **Life Skills (Credits: 2)**

Introduction to Organizational Behavior: Ability, Personality, Myers-Briggs Type Indicator (MBTI), Learning, Perception, Values, Terminal Values, Instrumental Values, Importance, Attitude and Job Satisfaction, Assertiveness, Emotional Intelligence. Group: Foundation of group behavior, Models of group development, Group structure, Group Processes, managing change, managing conflict. Teams: Teams vs. Groups, Types of teams, Contemporary issues in managing teams. Motivation: Basic concepts & theories of motivation, Motivating group members, Implications for engineers. Leadership: Basic concepts & theories of leadership, leading a team, Implications for engineers.

### **Year/Sem: IIIInd Year/V Sem**

#### **HSS elective -2**

#### **Business Analysis Techniques (Credits: 3)**

Unit-1:Data classification and its statistical Features/ Business statistics: introduction and background:Classification of data, Secondary data, Primary data, Designing of questionnaire, Tabulation of data, Charting of data, Sampling Techniques, simple random sampling, Non probability sampling,

Sampling and non sampling errors. Introduction to descriptive statistics, Arithmetic Mean, Median, Mode, Relationships of the Mean, Median and Mode, Measure of Central Tendency, Geometric Mean, Harmonic Mean, Quadratic Mean, Measures of Dispersion, Range, Interquartile Range or Quartile Deviation, Mean Deviation, Standard Deviation, Lorenz Curve, Skewness, Kurtosis. Unit-2: Probability: Approaches to Probability Theory, Probability Rules, Bays' Theorem, Some Counting Concepts Discrete Probability Distribution, Binomial Distribution, Poisson distribution, Continuous Probability Distribution, The Normal Distribution Relevance, Bayes Theorem, Probability on line and probability on Area, Unit-3: Sampling and sampling methods, Census Vs. sampling method, Probability samples vs. non-probability samples, Probability sampling methods, Non-probability sampling methods, Determination of sample size, Sampling Distribution of the Mean, Sampling Distribution of the Proportion, Sampling Distribution of the Difference of Sample Means, Sampling Distribution of the Difference of Sample Proportions, 7 Small Sampling Distributions, Sampling Distribution of the Variance, *F* Distribution, *t*-Distribution, Unit-4: Index Numbers, Uses of Index Numbers, Types of Index Numbers, Simple Index Numbers, Composite Index Numbers, Simple Aggregative Price/Quantity Index, Index of Average of Price/Quantity Relatives, Weighted Aggregative Price/Quantity Index, Index of Weighted Average of Price/Quantity Relatives, Test of Adequacy of Index Numbers, Special Issues in the Construction of Index Numbers, Problems of Constructing Index Numbers Unit-5: Statistical Inferences: Karl Pearson's coefficient of correlation, regression equation, Point estimation, Testing of Hypothesis or tests of significance, relationship between confidence interval and testing of hypothesis, Unit-6: Forecasting Methods and Estimation: Introduction, Good forecasting, Methods of Forecasting, Time series Analysis, Decomposition of past data/series into various components, Types of Estimates, Criteria of a good estimator, Method of Maximum Likelihood, Point Estimation, Interval Estimation, Sample size Determination

### **Social Media Marketing (Credits: 3)**

Unit 1 introduction and syllabus review: Introduction to social media and its role within marketing goals and strategies. unit 2 social media marketing overview : social channels as part of the broader marketing plan. Unit 3: content marketing : what is content marketing and why is it important? Microblogging, blogs as content, blogs as a marketing channel, content creation. unit 4: video marketing, social media marketing planning: setting objectives through measuring success unit 5: monitoring social media, social media marketing planning, mobile and location marketing unit 6: monitoring performance – measurement & analytics key principles of monitoring performance measurement tools and techniques, management tools • tools for managing social marketing channels

### **Social and Legal Issues (Credits: 3)**

Contract Act, Sales of Good Act, Consumer Protection Act, Factory Act, Labour Law, Social Structure and Institutions, Social Stratification, Social Inequalities, Intellectual Property Act and Patent, IT Act 2000, Right to Information Act, Environmental Protection Act, Corporate Governance, Public Policy for Technology, Social impact on information system and technology, Corporate Social Responsibility, Ethics,

### **Professional ethics (Credits: 3)**

Unit 1. Values of Liberal Society. Introduction, The nature and characteristics of professions, Obligations and professional services, Obligation to clients, professions and third parties. Unit 2. Introduction to Professional Ethics The foundations and norms of professional ethics. The need for separate code of conduct for professionals. The relation between professional and general ethics. Moral conflict and the issue of autonomy of professional ethics. Certain specific issues pertaining to medical ethics, legal ethics, computer ethics and business ethics Unit 3. Indian Value System and Values Teaching from scriptures and tradition (Geeta, Ramayana, Mahabharata, Upanishads, Vedas, Bible and Quran) Unit 4. Ethics impact in Business Ethical Issues in Capitalism and market systems, Ethics and social responsibility, Ethics and marketing, Ethics in finance, Ethics and human resource, Ethics and Information Technology, Intellectual property rights like designs, patents, trade marks, copy rights

### **Marketing Management (Credits: 3)**

Unit-1- Understanding Marketing Management, Defining Marketing for the 21st Century, Developing Marketing Strategies and Plans  
Unit-2- Capturing Marketing Insights, Gathering Information and Scanning the Environment, Conducting Marketing Research and Forecasting Demand  
Unit-3- Connecting with Customers, Creating Customer Value, Satisfaction, and Loyalty, Analyzing Consumer Markets,  
Unit-4 Analyzing Business Markets, Identifying Market Segments and Targets, segmentation criteria, role and use of segmentation, competitive strategies of the organizations, strategies of the market leader, strategies of the market challenger, strategies of the market follower

### **Fundamentals of Financial Markets (Credits: 3)**

Introduction to Financial Markets: Financial system structure and functions, Financial markets and their economic functions, Financial intermediaries and their functions, Financial markets structure & regulation; Determination of interest rates, Valuation of cash flows, Money & Capital Markets: Money market purpose and structure, Money market instruments, Money market interest rates and yields, Capital market structure and instruments, Debt Market: Debt market instrument characteristics, Bond market, Bond valuation, Bond Analysis, Equity Market: Equity instruments, Primary equity market, Secondary equity market, Equity market characteristics, Stock valuation, Derivatives Market: Description of derivatives markets, Forward and futures contracts, Swaps, Options Foreign Exchange Market: Determination and fluctuation of exchange rate, Exchange control, Foreign exchange market – Feature, Functions, Structure and Participants.

### **Chemical Reaction Engineering (Credits: 4)**

Examples of various types of reactions. Formulation and solution of rate equations for simple and complex reactions in batch reactor. Effect of thermodynamic equilibrium. Integral and differential method of analysis of data. Ideal batch reactor and concept of batch time. Flow reactors and concepts of space time/space velocity and holding time/residence time. Ideal mixed flow reactor (MFR) and plug flow reactor (PFR), Irreversible reactions and reversible reactions in series/parallel applications. Effect of temperature on thermodynamic equilibrium and heats of reaction. Optimum temperature progression. Non catalytic heterogeneous reactions. Catalytic heterogeneous reactions: Langmuir-Hinshelwood model.

### **Instrumentation and Process Control (Credits: 4)**

Concept of feed back and feed forward control, process dynamics in time, Laplace and frequency domains. Concept of stability and optimal control. General performance and characteristics of instruments, Errors and their types. Calibration standards. Different types of sensors. Types of valves, Valve characteristics selection and sizing of valves. Models for first and second and higher order systems. On-off, proportional, integral, derivative and their combinations. Closed loop transfer functions for servo and regulator problems. Use of root locus and frequency response analysis. Gain margin and phase margin in controller tuning. Performance criterion-IAE, ISE and IATE. Ziegler-nichols and Cohen-Coon rules. Fundamentals of digital control. Introduction to Z-transforms. Ratio control, cascade and adaptive controls. Control strategies for common industrial operations.

### **DE-1 Process Modelling and Simulation (Credits: 3)**

Introduction to process modelling and simulation, Fundamental laws, Application of principles of conservation and types of boundary conditions for various reactors. State space models, Cayley-Hamilton theorem, Sylvester's formula, Gram Schmidt orthogonalization procedure. Numerical solution by power method and polynomial method. Staged-process models: modelling of multiple, Numerical solution techniques for solving single and systems of non-linear algebraic equations. Dynamic and steady state model of a staged gas absorber, distillation column, and extraction column, Multiple effect evaporator. Population balance models, Deterministic approach, Expected value, Moment of probability density function.

### **DE-1 Transport Phenomena (Credits: 3)**

Governing equations in fluid mechanics: conservation of mass, continuity equation, conservation of linear momentum. Navier-Stokes equations, unidirectional flows, flow down an inclined surface. Governing equations in heat transfer: energy balance equations, conservation of energy law, heat flux at any point, mechanical energy balance, steady state conduction through a composite wall, temperature profile in an electric wire, unsteady state conduction in a slab. Governing equation in mass transfer: species mass balance, concentration, velocities and mass fluxes, boundary conditions. Diffusion through stagnant film.

### **Science Elective**

#### **Chemistry of Cement**

What is cement, History of cement development, Cement raw materials, Chemistry of cement manufacture, Size reduction, Pre-blending of limestone, Homogenization of raw meal, All the process of cement manufacture, wet, dry, semi dry, dry with pre-heater and pre-calciner, Utilization of alternative raw materials and waste fuels, Type of cements, their quality requirements, Sample collection of raw materials and cement at grinding and packing stage, chemical and physical testing of cement, Cement standards- BIS, EN and ASTM standards, SIT in cement, Energy and Environmental issues in cement industry.

#### **Chemical Reaction Engineering Lab (Credits: 1)**

##### **LIST OF EXPERIMENTS**

1. To study a non-catalytic homogeneous reaction in a plug flow reactor (PFR).
2. To study a non-catalytic homogeneous reaction in a coil type plug flow reactor under ambient conditions.
3. To study a non-catalytic homogeneous reaction in a CSTR under isothermal conditions.
4. To study a second order saponification reaction (between Ethyl acetate and NaOH) in a Semi Batch Reactor under isothermal condition (i.e. at a fixed temperature).
5. To study a non-catalytic homogeneous reaction in an isothermal Batch Reactor.
6. To study a non-catalytic homogeneous second order liquid phase reaction in a CSTR under ambient conditions.
7. To study the performance of a cascade of three equal volumes CSTRs in series for the saponification of Ethyl acetate with NaOH.
8. To study a non-catalytic homogeneous reaction in a series arrangement of PFR and CSTR.

#### **Instrumentation and Process Control Lab (Credits: 1)**

##### **LIST OF EXPERIMENTS**

1. Two Tank Interacting System
2. Two Tank Non-Interacting System
3. Measurement of Temperature using Thermocouple
4. Measurement of Temperature using RTD
5. Temperature Control Trainer using PID
6. Time Constant of Thermometer
7. Water Level Measuring Tutor
8. Dead Weight Pressure Gauge
9. Level Control Trainer using PID
10. Temperature Measurement using RTD
11. Study of PID Controller
12. Characteristics of Control Valve
13. Armfield Process Control Trainer

#### **Process Modelling and Simulation Lab (Credits: 1)**

### **LIST OF EXPERIMENTS**

#### **A) SECTION I: EXPERIMENTS ON CHEMCAD**

1. Overview of CHEMCAD and its Uses
2. CHEMCAD Products and Features
3. Introduction to CHEMCAD
4. Problems on Flowsheet
5. Problems on Flash Calculations, distillation columns, heat exchangers.

#### **B) SECTION II: EXPERIMENTS ON POLYMATH**

1. Introduction to Polymath
2. Problems on Linear Equations
3. Problems on Non-Linear Equations
4. Problems on Ordinary Differential Equations

#### **C) SECTION III: EXPERIMENTS ON MATLAB**

1. Introduction to MATLAB
2. Problems on Euler's Method
3. Problems on Runge-Kutta Fourth Order Method
4. Problems on Newton Rapson Method

### **Heat Transfer Operations Lab-II (Credits: 1)**

#### **LIST OF EXPERIMENTS**

Experiments on double pipe and shell & tube heat exchangers, Evaporators.

Design problems on various types of heat exchangers like double pipe, shell and tube, plate type.

Design problems on various types of evaporators such as single effect, multiple effect (forward and backward feed)

Design problems on condensers.

### **Minor Project - I (Credits: 2)**

A topic will be allotted to the student following which relevant literature survey will be done. Based upon the literature survey, it is expected from the student to conduct experiments, collect data, and analyze it to arrive at some concrete conclusion.

### **Year/Sem: IIIrd Year/VI Sem**

#### **HSS Elective -3**

##### **Social Integrated Marketing Communications (Credits: 3)**

Social Integrated Marketing Communications (IMC) and Marketing Communication, IMC and Brand Communication, Concept and Process of Integrated Marketing Communications (IMC), Elements of IMC, IMC and Planning, SWOT Analysis, Suppliers in IMC, Public Relations, Media Planning, Print and Broadcast Media, IMC Message Design, AIDA model - Considerations for creative idea visualization, IMC and Communication Planning, Message Planning, Creative Concept, Message Execution Ethical and Social responsibility in IMC campaigns, Evaluating Marketing Communication Programmes, Marketing of Social Services of Non profit Organizations

##### **Social Network Analysis (Credits: 3)**

Unit 1: Basics Overview on Network Analysis, The Network Analysis Process and Methodology, Network Visualization, When images do not suffice: Network analytical measures, Concepts: nodes, edges, adjacency matrix, one and two-mode networks, node degree. Unit 2: Networks: Structures, Models, Processes Models and Simulation of Network Evolution, Models and Simulation of Diffusion in Networks, Erdos-Renyi and Barabasi-Albert Concepts: connected components, giant component, average shortest path, diameter, breadth-first search, preferential attachment Unit 3: Network centrality Concepts: betweenness, closeness, eigenvector centrality (+ PageRank), network centralization Unit 4: Groups Subgroups and Cliques, Clustering, Block models Unit 5: Dyads and Individuals Ego networks,

Reciprocity, Social capital, structural holes, equivalence Unit 6: Data collection Manual and ethnographic methods, automated methods, Cognitive Social Structures, Missing data: criminal networks, ethics & privacy Unit 7: Network positions and social roles The analysis of equivalence, Structural equivalence, Automorphic equivalence, Regular equivalence Unit 8: SNA and online social networks concepts: how services such as Facebook, LinkedIn, Twitter, CouchSurfing, etc. are using SNA to understand their users and improve their functionality

### **Cyber Laws and ethics (Credits: 3)**

Unit 1: Introduction Computers and its Impact in Society ,Overview of Computer and Web Technology ,Need for Cyber Law ,Cyber Jurisprudence at International and Indian Level,What ethics is and is not ,Explore differences between laws and ethics ,Ethical ,viewpoints 1. Virtue (deontology) 2. Utilitarianism 3. Natural Rights 4. Fairness (Justice) 5. Common good ,Ethical decision making process,Contract act and cyber laws,Unit 2: IT Act 2000 & Impact of other related acts (Amendments),Salient features of the IT Act, 2000.,Various authorities under IT Act and their powers.,Penalties & Offences, amendments under IT act.,Amendments to Indian Penal Code.,Amendments to Indian Evidence Act.Amendments to Bankers Book Evidence Act.Amendments to Reserve Bank of India Act.Unit 2: Cyber-Law - International PerspectivesEDI: Concept and legal Issues UNCITRAL Model Law Electronic Signature Law's of Major Countries Cryptography Laws Cyber Law's of Major Countries EU Convention on Cyber Crime Unit 3: Cyber-crime law in India Cyber Crimes against Individuals Institution and State Hacking Digital Forgery Cyber Stalking/Harassment Cyber Pornography Identity Theft & Fraud Cyber Terrorism Cyber Defamation Right to Privacy and Data Protection on Internet IT Act, 2000 Unit 4: E-commerce Legal Issues Digital / Electronic Signature in Indian Laws E - Commerce; Issues and provisions in Indian Law E - Governance; concept and practicality in India E - Taxation issues in Cyberspace E - Contracts and its validity in India Cyber Tribunal & Appellate Tribunal Cyber Regulations Unit 5: Intellectual property Issue in Cyber Space Interface with Copyright Law Interface with Patent Law Trademarks & Domain Names Related issues Dispute Resolution in Cyberspace

### **Logical and Quantitative Techniques (Credits: 3)**

Unit 1: Number system, Percentages, Profit & Loss, Interest, Ratio, Proportion and Variation, Time and Work, Time, Pipes and cisterns Unit 2: Data Interpretation, Data Sufficiency, Mixture and Allegations, Important concept in logical reasoning, Logical reasoning based on arrangements, Logical reasoning based on rankings, Logical reasoning based on arrangements and rankings, Team formation, Calendar, Speed and Distance, Trains, Boats and streams.Unit 3: Set theory, Venn Diagrams, Permutation & Combinations, Probability, Quantitative reasoning, Unit 4: Puzzle test, Syllogism, Logical deduction, Binary Logic, Critical Reasoning, Blood Relations. Unit 5: Reading comprehension, Verbal Analogies, Closet test, Jumbled Paragraph Questions

### **Brand Management (Credits: 3)**

Unit-I: Opening Perspectives ,Brands & Brand Management,Unit-II: Identifying and Establishing Brand Positioning and Values ,Customer-Based Brand Equity ,Brand ,Positioning , Planning and Implementing Brand Marketing Programs ,Choosing Brand Elements to Build Brand Equity , Unit -III : Designing Marketing Programs to Build Brand Equity , Integrating Marketing Communications to Build Brand Equity ,Leveraging Secondary Brand Associations to Build Brand Equity,Unit-IV: Measuring and Interpreting Brand Performance. Developing a Brand Equity Measurement and Management System , Measuring Sources of Brand Equity: Capturing Customer Mindset , Measuring Outcomes of Brand Equity: Capturing Market Performance,Unit-V: Growing and Sustaining Brand Equity,Designing and Implementing Branding Strategies , Introducing and Naming New Products and Brand Extensions , Managing Brands over Time , Managing Brands over Geographic Boundaries and Market Segments.

### **Human Resource Management (Credits: 3)**

Human Resource Management: Meaning, Nature and Scope,HRM functions and objectives, evolution of HRM environment, Human resource development in India: evolution and principles of HRD,HRD Vs

personnel functions, Role of HR managers. Strategic Human Resource Management: Nature of strategies and strategic management, strategic management process., Environment scanning, strategy formulation, implementation and evaluation. Human Resource Planning: Definition, purposes, processes and limiting factors; Human resources information system (HRIS): HR Accounting and audit, Job analysis: job description, job specification. Training and Development: purpose, methods and issues of training and management development programmes. Performance Appraisal: definition, purpose of appraisal, procedures and techniques including 360 degree performance appraisal. Job evaluation and Compensation administration: nature and objectives of compensation, components of pay structure in India, Wage policy in India Discipline and Grievance Procedures: definition, disciplinary procedure, grievance handling procedures. Industrial relations: nature, importance and approaches to industrial relations.

### **Total Quality Management (Credits: 3)**

Unit-I Introduction, Meaning & Definitions of Quality, Basics of Total Quality, Product Quality Vs. Service Quality, Dimensions of Quality, Quality Control, Quality Management, TQM: Fundamentals, Meaning and Definition, TQM: Basic tenets, TQM: History and Evolution, TQM: Thinkers and Thoughts, Quality Awards, Unit-II Features of TQM, Characteristics & Pre-requisites of TQM, Implementation of TQM, TQM: Obstacles, TQM: Cultural change, Cost of Quality (COQ), Total Employee Involvement, Team work for Quality, Customer Satisfaction-Models, Quality Function Deployment (QFD), Unit-III Continuous Improvement, Quality Circles, Kaizen, 5S method, Six Sigma-Meaning & Methodology, Infrastructure & Impementation, DMAIC Cycle, Re-engineering, FMEA-Reliability Analysis, Determination of reliability for combined systems, Calculations of reliability for combined systems (Numericals), Benchmarking, JIT, Unit-IV Basic Statistical Concepts, Statistical Process Control & Process Capability, 7 Tools of Quality, Histograms, Flow Charts, Scatter Dia., Pareto Dia., Check sheets, Contol charts for Attributes, Contol charts for Variables, Contol charts for Variables, Design of Experiments (Taguchi Technique), Total Productivity Maintenance (TPM), Unit-V Quality Standards & Certifications: Principles, Auditing and certification, NCR (Non-Compliance Report), Corrective action cycle, ISO: 9000 series, ISO: 14000 series, EMS (Environmental management systems).

### **Design of Separation Processes (Credits: 4)**

Design of sieve plate columns. Design of packed columns. Fractionation of multi-component mixtures. Multiple feeds and withdrawals. Performance evaluation of packed and plate columns. Cooling tower process design. Performance evaluation of crystallizers. Process design of dryers, Performance evaluation of dryers. Solvent selection for extraction. Ternary liquid equilibria and ternary diagrams. Solid-liquid equilibria, single and multi-stage leaching. Staged calculations and efficiency. Performance evaluation. Supercritical fluid extraction. Adsorption and ion exchange process. Adsorption and ion exchange equilibria, various isotherms. Design of fixed bed adsorber. Types of membranes and modules for membranes. Transport through membranes. Ultra-filtration. Reverse osmosis. Electrodialysis. Liquid membranes. Equipment and operations.

### **Chemical Reactor Design (Credits: 3)**

Review of different types of reactors. Non ideal flow reactors. Concept of residence time distribution (RTD). Segregation mixing in reactors. Models of non-ideal flow dispersion model. Effect of dispersion. Tanks in series model. Multi parameter models. Diagnostic methods of analysis of flow patterns in reactors. Application to design of continuous solid flow reactors. Various design considerations of fluid bed reactors and their design consideration. Heat transfer effects. Phenomena observed in operation of packed, fluid bed, slurry and such reactors. Product distribution in multiple and complex reactions. Phenomena of stability, instability. Strategies for stable operations of reactors. Design considerations of fluid/solid catalytic reactors. Fluid bed reactors. Heterogeneous reactors. Bubble heterogeneous reactors. Co-current and counter-current flow packed bed reactor.

### **Environmental Engineering (Credits: 4)**



Importance of environmental pollution control, concept of ecological balance, Pollution control aspects, Environmental legislation & Regulations. Classification, sources and effect of water pollutant, Pretreatment: Bar racks, grit chambers, Comminutors, equalization (theory) Primary treatment, Secondary treatment, Tertiary treatment. Air pollutants, sources & effect in man and environment, The Gaussian plume model, air pollution sampling and measurement. Review of equipment, system, and processes correction methods for air pollution control. Solid waste including plastic waste, nuclear waste; Hazardous waste, Noise pollution.

### **DE-2 Chemical Processes (Credits: 3)**

Salient features of manufacture of commodity chemicals. Status of chemical industry in India. Nitrogen industries, Phosphorus industries, Chlor-alkali industries, manufacture of soda ash. Manufacture of sulphuric acid, Oleum, and sulphur trioxide, Manufacture of lime and cement. Manufacture of oxygen, nitrogen, argon and helium. Manufacture of synthesis gas. Manufacture of acetylene. Manufacture of aluminium, and sodium and sodium chlorate. Outlines of operations and processes in petroleum refining. Engineering aspects of the manufacture with consideration for alternative routes of basic organic chemicals. Outlines of synthesis of polymers. Manufacture of soaps and detergents, dyes and intermediates, agrochemicals, perfumery and specialty chemicals.

### **DE-2 Industrial Organic Synthesis (Credits: 3)**

Process involved during organic synthesis: Nitration, halogenations, sulphonation, amination. Synthesis of natural products: carbohydrate, terpenes, alkaloids, steroids. Pigments and their synthesis. Synthesis for industrially important polymers: polyethylene, polystyrene, PVC, polyisobutylene, polyester, nylon, Bakelite, Teflon. Synthesis of important materials for industry: ceramics, glasses, zeolites.

### **DE-3 Equipment Design and Drawing (Credits: 3)**

Nature of process equipment. General design procedure. Review of stresses, temperature effects. Theories of failure. Materials of construction. Code and standards for pressure vessels (IS: 2825-1969). Materials of construction. Pressure vessel subjected to internal pressure. Storage vessels for volatile and non-volatile liquids, gases. Various types of roofs. Nozzles and mountings. Various types of agitator, Power requirement, Reaction vessel classifications, materials of construction and design of vessel. Design of jackets (IS 2825) and coils. Classification of supports. Design of skirt support considering stresses due to dead weight, wind load, seismic load and period of vibration. Design of base plate, skirt bearing plate, anchor bolts, bolting chairs and skirt shell plates. Design of Lug or bracket supports. Codes and standards for heat exchangers. Design of shell and tube heat exchangers as per IS: 4503 and TEMA standards. Basic features of distillation and absorption columns. Stress in columns.

### **DE-3 Food Process Engineering (Credits: 3)**

Introduction to food industry, opportunities for the Indian processed food industry, Engineering challenges in the food processing industry, Basic food biochemistry and microbiology: Food constituents, water activity enzymes, D & Z values food safety. Indian laws regulating foods and food processing. Raw material preparation. Size reduction of solid fibrous foods and in liquid foods, Theory and equipment, heat processing using water, air and hot oil, heat processing by direct and radiated energy, processing by removal of heat, food preservation and storage, post processing applications.

### **DE-3 Solid and Hazardous Waste Management (Credits: 3)**

Environment and development, Solid, liquid and gaseous emissions, Environmental standards and legal framework, Hazardous wastes, Solid waste management, Hazardous waste management, Site remediation: Quantitative risk assessment, Site and sub surface characterization, Remedial technologies,

Remedial actions and corrective measures, Solid waste utilization options: Concept of waste to wealth, Case studies of solid waste utilization, Byproducts, Land fill management, Ash management, Incineration, Biological sludge disposal.

### **Design of Separation Processes Lab (Credits: 1)**

#### **LIST OF EXPERIMENTS**

1. LIQUID-LIQUID EXTRACTION IN A PACKED BED
2. ADSORPTION IN PACKED BED
3. PERFORMANCE OF WATER COOLING TOWER
4. BATCH CRYSTALLIZATION
5. BINARY DISTILLATION IN A SEIVE PLATE COLUMN
6. FORCED DRAFT TRAY DRYER
7. HUMIDIFICATION-DEHUMIDIFICATION COLUMN
8. LIQUID-LIQUID EXTRACTION IN A SPRAY COLUMN
9. SOLID-LIQUID EXTRACTION UNIT (BONNOTTO TYPE)
10. FLUIDIZED BED DRYER

### **Environmental Engineering Lab (Credits: 1)**

#### **LIST OF EXPERIMENTS**

1. pH, Turbidity, Electrical Conductivity
2. Acidity and Alkalinity
3. Total Hardness, Calcium and Magnesium
4. Solids (total, suspended and dissolved)
5. Settleable solids (by Imhoff Cone)
6. Optimum coagulant dose (Jar Test)
7. Dissolved oxygen
8. Biochemical oxygen demand
9. Chemical oxygen demand (COD)
10. Gas liquid mass transfer characteristics (aeration apparatus)
11. Softening or demineralization of water (ion exchange column)

### **Term Paper (Credits: 1)**

A student is expected to select one topic based on which he/she would collect research papers. Student shall prepare a report at the end of the semester after critically analyzing the collected research papers on a particular topic, indicating the work so far done in the area and future scope of work.

### **Year/Sem: 4th Year/VII Sem**

#### **DE-4 Process Engineering and Safety (Credits: 3)**

Primary process selection, Economic evaluation. Environmental footprint. Safety analysis and controlability. Flexibility. Selection of process steps. Identification of individual process steps. Development and alternative routes. Selection criterion for modules. Determination of flow sheet based on heuristics. Development of P & ID. Estimation of capital and cost of product. Factors affecting the estimation-taxes, inflation, Concepts of break even, optimality of design, optimality of operation, cost benefit analysis, marginal rate of return . Profitability, alternative investments and replacements options. Types of accidents. Causes and direct & indirect effects of accidents, Role of safety considerations in chemical plant design & operations. Managerial aspects of safety. Typical toxins and their biological effects. Source Models, Dispersion models, HAZOP, HAZAN and such methods, safety review & other methods, Learning from accidents. Methods of investigating and diagnosing. Aids for recommending case studies of well known accidents.

#### **DE-4 Energy Sources and Energy Conservation (Credits: 3)**

Introduction; Classification of energy sources and resources, present and future energy demands. Solid fuels, liquid fuels, gaseous fuels, combustion fuels, alternative energy sources, waste heat recovery, energy conservation in process industry.

#### **DE-4 Polymer Engineering (Credits: 3)**

Defining polymers; Basic chemistry of polymers; Classification and types, Examples of industrial and high-performance polymers, step growth (condensation) polymerization, free radical addition (chain growth) polymerization, ionic and coordination chain (addition) polymerization, copolymerization, polymerization system such as bulk polymerization (quiescent and stirred) Solution polymerization; suspension polymerization, emulsion polymerization, Comparison of various processes, Advantages and disadvantages; Heat transfer and mixing in polymerization reactors. Characterization of molecular weight, polymer rheology and morphology, polymer processing like Blow molding, injection molding, compression molding; Extrusion; Calendaring.

#### **DE-5 Petroleum Refining (Credits: 3)**

Origin, formation and composition of petroleum, refinery products and feed stocks, fractionation of petroleum, dehydration and desalting of crudes, treatment techniques and product specification, catalytic cracking and thermal cracking process, asphalt technology, feed stock for petrochemicals.

#### **DE-5 Project Engineering (Credits: 3)**

Definition of project. Project management. Constituents, Capita-Fixed, working. Estimation of capital and cost of product. Feasibility reports of various types. Project Licensing. Basic & Detailed Engineering. Various laws & regulations. Intellectual property rights. Patents need for clearances & its influence on project management. Various forms like pure project, matrix and mixed type. Project team, WBS & responsibility charts, Contracts of various types. CPM, PERT, GANTT charts, LOB, resource allocation, material management, ABC analysis, VED analysis. Project termination, Commissioning, Start-up. Stabilization, Close out.

#### **DE-5 Pharmaceutical Technology (Credits: 3)**

Chemical properties of drugs of importance to drug formulation, and how these are characterized, Principles of drug formulation and the release of drugs from pharmaceutical dosage forms, Recipients and their properties, Important pharmaceutical unit operations, Manufacturing and packaging of pharmaceutical dosage forms, Quality assurance and quality evaluation including good manufacturing practices.

#### **DE-5 Multiphase Reactor Design (Credits: 3)**

Introduction to multiphase reactions and multiphase reactors and design considerations, catalyst deactivation and regeneration, industrial reactors: Trickle bed, bubble column, segmented bed, agitated slurry, fluidized bed and slurry reactors. Residence time distribution (RTD) and macro mixing models. Review of methods for obtaining RTD, Problems in scale-up. Models for gas liquid solid reactors, Brief description of laboratory reactors and significance of laboratory data for reactor design and scale-up. Intrinsic kinetics: Catalysis, Lanmuir-Hinshelwood model, Determination of limiting steps from reaction data. Introduction to chemical vapour deposition reactors.

#### **DE-6 Membrane Process Design (Credits: 3)**

Introduction to membrane processes, history, definition of membrane, importance of processes, membranes and their applications, Liquid membranes supported and unsupported liquid membranes, application and mathematical modelling, Materials and material properties polymers and effect of various properties of polymers such as  $T_g$ , thermal, chemical and mechanical stability, elastomers and their properties, inorganic membranes, biological membranes, Characterization of membranes, Preparation of synthetic membranes, spiral wound, tubular, capillary, hollow fiber modules and their comparison, system design, application of membrane reactors in biotechnology, comparison of membrane technology, scope in the future, current and existing industrial application.

#### **DE-6 Industrial Catalysis (Credits: 3)**

Catalytic reactions, homogeneous catalysis, heterogeneous catalysis, analysis of external and internal transport processes, design of heterogeneous catalytic reactors: Global rates and experimental reactors; Design calculations for ideal reactors operating at isothermal, adiabatic and non-adiabatic conditions; Deviations from ideal reactor performance; Design of industrial fixed bed, fluidized bed and slurry reactors; Examples from petro-refinery, pharmaceutical and fine chemical industry; DeNox and DeSO<sub>x</sub> technologies.

#### **DE-6 Advanced Process Control (Credits: 3)**

Advanced control systems: Introduction to multiple loop control systems, Cascade control, Feed forward control; Inferential control; Adaptive and ratio control, Multivariable process control: Introduction, Design of controllers for multivariable processes: Selection of manipulated and controlled variables, Pairing controlled and manipulated variables, BLT tuning, Load rejection performance, Decoupling control systems, Introduction to model predictive control, Sampled data control systems: Introduction; Sampling, Z transforms and stability; Stability analysis of sampled data systems; Process identification, State space methods: State space representation of physical systems, Transfer function matrix.

#### **DE-6 Fluidization Engineering (Credits: 3)**

Fluidization phenomena, behaviour of fluidized beds, industrial applications, packed beds: flow of fluids, Darcy's law and permeability, specific surface and voidage, general expressions for flow through packed beds; Carman-Kozeny equation, Fluidized beds: Properties of gas fluid and liquid solid systems, onset of fluidization, minimum fluidization velocity, terminal velocity, slugging, channelling, bed expansion, distributors, voidage, entrainment and elutriation, Bubbles in dense phase. Pneumatic and hydraulic conveying: Pneumatic and hydraulic conveying of solids in horizontal and vertical pipelines, choking and saltation velocity, hydraulic conveying of solids.

#### **Major Project Part - I (Credits: 4)**

Student will make a complete survey of the relevant literature and collect information from different sources. The student will do the process selection from the available alternate processes; give detailed description of the selected process with process flow diagram and P&ID. The student shall append MSDS of the hazardous chemicals. A suitable plant capacity and plant location shall be discussed.

#### **Year/Sem: 4th Year/VIII Sem**

#### **DE-7 Fertilizer Technology (Credits: 3)**

Need for use of fertilizers and micronutrients. Nutrient requirements of plants; Nature of chemical fertilizers, Nitrogen fertilizers; Ammonia, urea, ammonium nitrate, ammonium sulphate and other nitrogen based fertilizers. Production process with special reference to engineering aspects, Ordinary (Single) super-phosphate, triple super-phosphate, di-ammonium phosphate and other phosphorus based fertilizers; Production process with special reference to engineering aspects, Potash fertilizers: Potassium chloride, potassium sulphate and potassium nitrate and other potassium based fertilizers. Production process.

**DE-7 Petrochemical Technology (Credits: 3)**

Introduction to petroleum refining and bulk petrochemicals. Indian and World scenarios. Raw materials: Petrochemical feedstock and production of olefins and aromatics. Chemicals from C<sub>1</sub> compounds (methane and synthesis gas), chemicals from C<sub>2</sub> compounds (ethylene and acetylene), Chemicals from C<sub>3</sub> compounds (propylene), Chemicals from C<sub>4</sub> compounds, Chemicals from aromatics, manufacturing using unit process.

**DE-7 Mixing Technology (Credits: 3)**

Introduction to mixing, classification: Types of impellers and their characteristics. Power consumption for different impellers and correlations, mechanism of mixing, Liquid, solid and gas dispersions in liquid. Three phase dispersions, heat transfer and mass transfer in mixing, Design and scale-up of mixing equipments.

**DE-7 Piping Engineering (Credits: 3)**

Role of piping, Scope of piping engineering, responsibilities of piping engineer, introduction to engineering line diagram, process flow diagram and piping and instrumentation diagram for process plant and utilities including various symbols, material of construction and fabrication of pipes, Statutory rules and regulations, Codes and standards, Introduction to various standard pipe fittings, pipe flanges and gaskets their selection and specifications, valves and other piping components, piping system design, piping layout and drawing, computer aided piping design, application of piping engineering.

**DE-8 Cement Manufacturing (Credits: 3)**

Various types of cement manufacture – dry, semi-dry and wet, overview of various unit operations, Cement raw materials and their quality requirements, Mining of limestone, Size reduction and material handling, Blending and homogenization, Formation of clinker minerals, Different type of cements and their chemical & physical requirements, Quality control in cement, Energy needs of cement industry: basic concerns, energy economy, energy audit, conservation of natural resources, Usage of industrial wastes in cement manufacture, Usage of alternative fuels and technological advancements during cement manufacture.

**DE-8 Plant Utilities and Energy Systems (Credits: 3)**

Identification of common plant utilities. Importance of utilities in India, Raw water storage and treatment, Properties of steam. Steam generation by boilers. Types of boilers and their operations, Compressed air from blowers and compressors. Air drying systems, Refrigeration systems such as compression and absorption refrigeration, Selection of vacuum system and maintenance, flaring and venting, energy audit, engineering integration in process industry, design of heat exchange networks, heat integration in process units, co generation of energy: introduction, renewable sources of energy, introduction of tidal geothermal source of energy.

**DE-8 Co-generation (Credits: 3)**

Introduction, Energy sources, Available energy referred to a cycle, Maximum work in a reversible process, Useful work, Availability in chemical reactions, Concepts of cogeneration, Properties of pure substances: PVT surfaces, Mollier diagram, Steam tables, Thermodynamic properties, Measurement of steam quality, Vapor power cycle, Gas power cycle, Steam generation: Boilers, Construction, Working of different types of boilers, Steam turbines: Types, classification, Co-generation: Characteristics of cogeneration plant, Cogeneration economics.

**DE-8 Thermal Energy Generation Systems (Credits: 3)**

Introduction, Energy needs in Indian scenario, Thermal energy and power. Fuels and combustion, Combustion mechanism and equipments, Steam generators, Analysis of steam cycles, Steam turbines, Condenser, Steam and condensate handling.

### **Major Project Part - II (Credits: 8)**

Student will make a complete survey of the relevant literature and collect information from different sources. The students will do the process selection, mass and energy balances, process design of all the equipments and mechanical design of at least one equipment per student and give information on instrumentation and control, plant layout, safety and environmental aspects and economic evaluation.

### **Minor Specialization (Cement Technology)**

#### **Introduction to cement (Credits: 3)**

What is cement and importance of cement in construction. History of cement manufacture, Historical development of cement manufacturing process and its conversion from wet to dry process. Various unit operations of cement manufacture. Ordinary Portland Cement, Portland Pozzolana Cement, Portland Slag Cement, Sulphate resistant Cement, White Portland Cement, Low Heat Cement and Masonry cement. Indian Cement Industry, Basic data on No. of cement companies and plants in India, World cement scenario and future cement prospects.

Conservation of natural raw materials and use of alternative raw materials / byproducts / industrial wastes, Energy economy in cement production and environmental protection.

#### **Mining, Raw Materials and Raw Mix Design (Credits: 3)**

Sources of lime, limestone, chalk, marl, carbonate sludge from industrial wastes, influence of minor components. Assessment of limestone deposits. Use of limestone as sweetener.

Sources of silica, alumina and iron oxide, clays, shales and effects of coal ash. Additives used as corrective materials. Use of industrial wastes in cement manufacture, as raw materials and corrective materials, as additives in the manufacture of composite cements, viz. fly ash, slag, sludge, their characteristics and properties. Limestone mines, mining equipment, excavation and formation of benches, blasting techniques, latest techniques of limestone mining and transportation. Safety in mining operations. Sampling, preblending of raw materials, methods of proportioning, 2-, 3-, and 4-component mixes. Ash absorption in clinker, effects of coal ash in clinker.

#### **Size Reduction and Material Handling in Cement Industries (Credits: 3)**

Sieve analysis, cumulative and fractional plot, size distribution, size averaging and equivalence, size estimation in sub-micron range. Optimum sizes at various stages from extraction from mines. Influence of size fraction on reactivity of lime stone.

Screening equipments such as grizzlies, stationary, vibrating, curved and DSM screens & screen capacity. Laws of size reduction (Bond's, Rittinger's & Kick's); energy requirement in size reduction; work index. Theory of crushing & grinding; crushing efficiency; size reduction machinery crushers such as Jaw crusher, gyratory crushers, impact crushers, roll crushers and cone crushers; Grinders such as hammer mills, roller mills and ball mills & tube mills. Various systems of material handling; haulage and transportation from mines, trucks, dumpers etc.

Conveyor selection, classification of conveyors, conveyors such as belt, screw, chain, vibratory, apron. Pneumatic and hydraulic transportation of solids; pneumatic conveying systems.

Bins, silos, hoppers & feeders; storage of raw materials in piles. Preparation of cement raw meal as per raw mix design, combined & segregated pre-homogenization, Blending bed theory; batch & continuous homogenization; Fuller's one-eight blending method. Stacking of blending beds namely in longitudinal & circular stockpiles system & their comparison. Equipments used for reclaiming material from stockpiles such as scraper, bucket wheel, bucket wheel with slewing boom and drum re-claimers. Methods of size classification, principles of air separators, and different types of air separators used in cement manufacturing. Wet classification; hydro-cyclones; cyclone material balances in open circuit and closed circuit operations & separating efficiency.

#### **Pyro-processing and Clinker Formation (Credits: 4)**

Types of kilns, different types of clinkerization process, wet process, semi-wet process, dry process, advantages- disadvantages of each process, chain type system in wet process, Lepol grate kiln, heat requirement in each process, L/D ratio. Thermal calculations, sizing of kiln. Heat balance of kiln, air balance of kiln, inlet seal, methods used to feed raw meal to kiln, different types of preheaters, their advantages and disadvantages, selection of preheaters, affect of leakages on kiln operation, optimization of kiln output, factors affecting kiln output and determination of litre weight of clinker. Firing system- different types of firing systems, their advantages and disadvantages, conveying of pulverized coal to kiln, calcinations and its control, process parameters like velocity, temperature and draught at various stages. Preparation of fuel burning, sampling of coal, proximate and ultimate analyses of coal, calorific value of coal and its determination, crushing and grinding of coal, different types of mills, ball mills, vertical roller mills, advantages and disadvantages of each operation, L/D ratio of mills, residue and moisture determination and their control, removal of fine coal from dust-laden gases, different equipments used, cyclones, bag filters and ESPs. Different types of coolers used, their operation and control, planatory coolers; grate coolers, cooling efficiency, air requirement for cooling operation, hammer mill, drag chain, different methods of clinker cooling and their advantages, methods of clinker storage-silo and gantry. Temperature profile inside kilns, functions of refractories, different types of refractories, ceramic phase diagrams, coating and ring formation.

#### **Quality Control in Cement (Credits: 4)**

Treatment of variability, histograms, means, standard deviation, co-efficient of variation, normal distribution, control charts. Control of input at various stages of production, control of raw materials, raw meal and kiln feed, chemical composition and physical characteristics, norms of control. Quality and specification requirements, minimum value specified, average values expected in production, acceptance criteria. BIS, ASTM and EN standards, differences in test methods, comparison of requirements. Detailed requirements of STI issued by Bureau of Indian Standards.

#### **Fuel Testing Lab (Credits: 1)**

List of experiments-

1. Moisture determination of coal
2. VM determination of coal
3. Mineral matter determination of coal
4. Calorific value determination of coal
5. Calorific value determination of liquid fuel
6. Pour point determination of liquid fuel
7. Density determination of liquid fuel
8. Ignition point determination of liquid fuel

#### **Chemical Testing of Cement Lab (Credits: 1)**

List of experiments-

1. Determination of  $\text{SiO}_2$  in Cement
2. Determination of  $\text{Al}_2\text{O}_3$  in Cement
3. Determination of  $\text{Fe}_2\text{O}_3$  in Cement
4. Determination of CaO in Cement
5. Determination of MgO in Cement
6. Determination of  $\text{SO}_3$  in Cement
7. Determination of chloride in Cement
8. Determination of alkalis in Cement
9. Insoluble residue determination of Cement

#### **Physical Testing of Cement Lab-**

List of experiments-

1. Specific surface determination of Cement

2. Normal consistency determination of Cement
3. Initial setting time determination of Cement
4. Final setting time determination of Cement
5. Le-Chatelier soundness determination of Cement
6. Autoclave soundness determination of Cement
7. Compressive strength determination of Cement
8. Lime reactivity determination of pozzolanic materials
9. Drying shrinkage testing of Cement

### **Minor Specialization (Industrial Pollution Abatement)**

#### **Environmental Chemistry (Credits: 4)**

Environment and Surrounding: Components, types, Air, Water, Soil. Chemical Weathering, classification of various layers atmosphere, ocean, soil and glacier. Chemistry of Water Resource: Hydrological Cycle, Hydrogeochemistry, geochemical modeling, hydrogeochemical facies. Chemistry of Soil: Classification of various types of soil, strength, salinity hazard, sodium hazard, stability diagram of minerals, geogenic and anthropogenic source of nutrients. Chemistry of Atmosphere: Variations of the temperature in atmosphere, climate, cloud, weather, wind, aerodynamics brief understanding. Green Chemistry: Green energy, biomass, anaerobic and aerobic digestion, biogas, petrochemicals. Geochemistry: chemistry of minerals, clays, silicate, ferrous and nonferrous minerals.

#### **Air Pollution Control & Monitoring (Credits: 4)**

Introduction to Air Pollution, Sources of air pollution and its classification, Types of air pollutants and their characteristics, Air Pollutants from various industrial sectors. Impact of air pollution on human health and vegetation, Pollutant Dispersion: Concept of atmospheric stability. Adiabatic and Environmental Lapse rate. Plume behavior. Control methods and equipment: control methods and equipment for Control methods and equipment: Introduction to control methods and equipment for particulate matter and gases. Design and working of scrubbers, Electrostatic Precipitator, Gravity settlers, Cyclone separator, Filter bags etc. Other mechanisms of air pollution control such as Biochemical Processes, catalytic processes etc. Stack sampling, instrumentation and methods of analysis of SO<sub>2</sub>, CO etc, legislation for control of air pollution and automobile pollution.

#### **Air Pollution Control & Monitoring Lab (Credits: 1)**

List of Experiments:

1. Demonstration of air pollution monitoring instruments.
2. Determination of SPM; PM10
3. Determination of SO<sub>2</sub> in ambient air.
4. Determination of NO<sub>x</sub> and CO in ambient air.
5. Respirable dust monitoring by GDS.
6. Demonstration of stack monitoring kits; Wind rose diagram.
7. Sampling and analysis of inorganic and organic particulates, Sox, NO<sub>x</sub>, NH<sub>3</sub>.

#### **Waste Water Treatment Processes (Credits: 4)**

Introduction to wastewater; various sources and types of wastewater; Need of wastewater management; Wastewater generation and quantity estimation; Water quality parameters and standards (COD, BOD, DO, Solids, Primary Treatment Processes: Screening; Grit removal; Equalization tank; Sedimentation theory; Rectangular and circular sedimentation tanks. Secondary Treatment Processes: Biological treatment of wastewater; Microbial ecology and growth kinetics; Types of microorganisms; Aerobic and anaerobic processes; Activated sludge process; Tricking filters. Anaerobic treatment; Anaerobic decomposition of organic matter; Sludge Management: The quantity and



characteristics of sewage sludge; Sludge dewatering, drying, and thickening; Sludge digestion; Aerobic and anaerobic sludge, stabilization; Composting.

### **Waste Water Treatment Processes Lab (Credits: 1)**

List of Experiments:

1. pH, Turbidity, Electrical Conductivity
2. Acidity and Alkalinity
3. Total Hardness, Calcium and Magnesium
4. Solids (total, suspended and dissolved)
5. Settleable solids (by Imhoff Cone)
6. Optimum coagulant dose (Jar Test)
7. Dissolved oxygen
8. Biochemical oxygen demand
9. Chemical oxygen demand (COD)
10. Gas liquid mass transfer characteristics (aeration apparatus)
11. Softening or demineralization of water (ion exchange column)

### **Solid and Hazardous Waste Management (Credits: 3)**

Environment and development, Solid, liquid and gaseous emissions, Environmental standards and legal framework, Hazardous wastes, Solid waste management, Hazardous waste management, Site remediation: Quantitative risk assessment, Site and sub surface characterization, Remedial technologies, Remedial actions and corrective measures, Solid waste utilization options: Concept of waste to wealth, Case studies of solid waste utilization, Byproducts, Land fill management, Ash management, Incineration, Biological sludge disposal.

### **Environmental Impact Assessment (Credits: 3)**

Framework for environmental impact assessment – Techniques for assessment of impacts on physical resources, ecological resources, human use values and quality of life values – Impact Assessment methodologies, Strategic environmental assessment. Environmental management planning, Disaster management planning, Concepts of environmental audits. Principles and elements of successful environmental manage