# Proposed Course Structure for Chemical Engg.

(II\textsuperscript{nd} Semester Onwards)

## B. Tech. 2\textsuperscript{nd} Year (Chemical Engineering Branch)

### 3\textsuperscript{rd} Semester

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Subject</th>
<th>Credits</th>
<th>Teaching Load (Hrs.)</th>
<th>Evaluation Scheme</th>
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Total | **28** | **1000** |

## B. Tech. 2\textsuperscript{nd} Year (Chemical Engineering Branch)

### 4\textsuperscript{th} Semester

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### Practical Courses

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Total | **28** | **1000** |
# B. Tech. 3rd Year (Chemical Engineering Branch) 5th Semester

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Total 28 1000

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# B. Tech. 3rd Year (Chemical Engineering Branch) 6th Semester

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Total 28 1000
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### Professional Electives

**TCH 71: Professional Elective – I***
- TCH 711: Non Conventional Energy Resources
- TCH 712: Polymer Science & Technology
- TCH 713: Fertilizer Technology

**TCH 72: Professional Elective – II***
- TCH 721: Safety & Hazard Analysis
- TCH 722: Food Technology
- TCH 723: Hazardous Waste Management

**TPE73: Professional Elective – III***
- TCH 731: Advanced Separation Processes
- TCH 732: Intellectual Property Rights
- TCH 733: Fluidization Engineering

### **Open Elective**

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<td>Non Conventional Energy Resources</td>
<td>TOE014</td>
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** Open Elective course: Offered for other departments.
### B. Tech. 4th Year (Chemical Engineering Branch) 8th Semester

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### Professional Electives

**TCH81: Professional Elective – I***

- TCH811: Fundamentals of Biochemical Engineering
- TCH812: Petroleum Refining Technology
- TCH813: Oil and Fat Technology

**TCH82: Professional Elective – II***

- TCH821: Fermentation Technology
- TCH822: Plant Design & Economics
- TCH823: Catalysis

**TCH83: Professional Elective – III***

- TCH831: Corrosion Engineering
- TCH832: Finite Elements Methods
- TCH833: Process Utility & Piping Design
THU-301: ENGINEERING ECONOMICS AND COSTING

Unit I: Time value of money: Simple and compound interest, Time value equivalence, Compound interest factors, Cash flow diagrams, Calculation, Calculation of time – value equivalences. Present worth comparisons, Comparisons of assets with equal, unequal and infinite lives, comparison of deferred investments, Future worth comparison, payback period comparison.

Unit II: Use and situations for equivalent annual worth comparison, Comparison of assets of equal and unequal life. Rate of return, Internal rate of return, comparison of IIR with other methods, IRR misconceptions.

Unit III: Analysis of public Projects: Benefit/ Cost analysis, quantification of project, cost and benefits, benefit/ cost applications, Cost – effectiveness analysis.

Unit IV: Depreciation, computing depreciation charges, after tax economic comparison, Break-even analysis; linear and non-linear models. Product and Process Costing, Standard Costing, cost estimation, Relevant Cost for decision making, Cost control and Cost reduction techniques.

Text Book:
1. Horn green, C.T., Cost Accounting, Prentice Hall of India

TCH 301: FLUID FLOW OPERATIONS

Unit I: Units and dimensions; Fluid, Properties of fluids; Classification of fluids; Fluid statics, Absolute, Gauge, Atmospheric and Vacuum pressures, Pressure head, Hydrostatic Law and Pressure Measurement.

Unit II: Kinematics of Flow: Types of fluid flow (Laminar flow, Turbulent flow etc.), Stream function, Rate of flow or Discharge, Continuity equation, Conservation of mass and energy; Energy balance, Bernoulli's theorem, Bernoulli's equation and its applications, Minor losses in pipe flow, Loss of energy due to friction, friction factor.

Unit III: Dimensional Analysis: Dimensionless numbers and their physical significance, Methods of Dimensional Analysis, Dimensional Homogeneity; Free and Hindered Settling; Equivalent Pipe, Flow through Parallel Pipe, Pipe fittings and valves.

Unit V: Transport of Fluids: Pumps, Classification, Construction and working of pumps, Centrifugal Pump, Multistage Centrifugal Pumps, Cavitation, Effects of cavitation, Priming; Reciprocating Pump, Single acting and Double acting Reciprocating Pumps, Air vessels; Fans, Blowers and Compressors.

Text Book

References:

TCY 301: ENGINEERING CHEMISTRY

Unit I: Organic Chemistry: Organic reactions of Industrial Significance.
   (i) Alcohols, phenols & ethers: Reactions of alcohols with alkaline earth metals, Iodoform reaction, Oxidation, conversion of alcohols into Mesylates & Tosylates; Crown ethers & epoxides; Reimer-Tiemann reaction, Kolbes-Schmidt reaction mechanisms
   (ii) Aldehydes & Ketones: Oxidation & reduction, Perkin reaction, Claison-Schmidt reaction, Benzoic condensation, Knovenagel reaction, reformatsky reaction, Wittig reaction.
   (iii) Carboxylic acids and their derivatives: Hell-Volhartd Zelinsky reaction, Hoffmann bromide reaction, Curtius and Lorsen Reaction
   (iv) Nitrocompounds: Reduction of nitrobenzene under different conditions
   (v) Amines: Reactions with nitrous acids, Diazotization and reactions of arenedizonium salts

Unit II:
   (i) Concept of aromaticity in benzoid and non-benzoid compounds, aromatic and non-aromatic compounds
   (ii) Organometallic compounds: Applications of Grignard Reagent and Lithium aluminum hydride
   (iii) Stereochemistry: Conformational analysis: various terms, conformational analysis of cyclohexane and 1,2-disubstituted cyclopane. Stereoisomerism of cyclic compounds (cyclohexane), chiral drugs (ibuprofen), the relative and absolute configuration, stereoselective and stereospecific reactions.

Unit III: Surface Chemistry
   (i) Catalysis: Acid base catalyzed reaction, enzyme catalyzed reaction and heterogeneous catalyzed reaction
   (ii) Surface tension determination and Applications
   (iii) Adsorption Isotherms- Freundlich and Langmuir
   (iv) Colloids: General methods of preparation and properties, hydrophilic and hydrophobic sols, Electrical Properties of colloids
   (v) Colligative Properties: Lowering of Vapor Pressure, Elevation in boiling point, lowering in melting point, Osmotic Pressure and their relation with molecular weight
Unit IV: Natural Organic Molecules: Biomolecules: Definition, types of biomolecules-nucleosides & nucleotides (DNA and RNA), saccharides (glucose, fructose, maltose and cellulose), lignin, lipids and amino acids (protein structure of apoenzymes, isoenzymes and vitamins) and their industrial applications.

Text Books
5- Glasstone, S. “Physical Chemistry”
6- Atkin, P. W. “Physical Chemistry”
7- Banwell, C. N. “Fundamentals of Molecular Spectroscopy”
8- Willard Merit & Dean “Instrumental Methods of Chemical Analysis”
9- Skoog & West “Instrumental Methods of Chemical Analysis”

TCH 302: Process Calculations
L T P 3 1 0

Unit I: Unit and dimensions; Conservation of mass and energy; Problem solving techniques; Computer based tools, Sources of data, Ideal gas law, Real gas relationships, Vapour pressure; Vapour-liquid equilibria for binary and multicomponent systems, Saturation, Partial saturation and humidity.

Unit II: Overall and component material balances; Material balance with chemical reactions, Material balance without chemical reactions.

Unit III: Material balance involving multiple subsystems; Recycle, bypass, purge and phase change; Material and energy balance calculations of some selected process plants such as sulfuric acid, ammonia, urea, caustic soda etc.

Unit IV: Enthalpy changes; Energy balance with and without chemical reactions; Reversible process and mechanical energy balance; Heats of solution and mixing; Humidity charts and their use in solving humidification, dehumidification and water cooling problems.

Unit V: Fuels and Combustion; Adiabatic flame temperature. Degrees of freedom in steady-state processes; Simultaneous material and energy balance problems using flow sheeting codes; Unsteady state material and energy balances.

Text Book:

References:

TCS 302: COMPUTER BASED NUMERICAL AND STATISTICAL TECHNIQUES
Solution of Algebraic and Transcendental Equation:
Bisection Method, Iteration method, Method of false position, Newton-Raphson method, Methods of finding complex roots, Muller’s method, Rate of convergence of Iterative methods, Polynomial Equations.

Unit II
Interpolation: Finite Differences, Difference tables Polynomial Interpolation:
Newton’s forward and backward formula Central Difference Formulae: Gauss forward and backward formula, Stirling’s, Bessel’s, Everett’s formula.
Interpolation with unequal intervals: Langrange’s Interpolation, Newton Divided difference formula, Hermite’s Interpolation

Unit-III
Numerical Integration and Differentiation: Introduction, Numerical differentiation
Numerical Integration: Trapezoidal rule, Simpson’s 1/3 and 3/8 rule, Boole’s rule, Waddle’s rule.


Unit-IV
Statistical Computation: Frequency chart, Curve fitting by method of least squares, fitting of straight lines, polynomials, exponential curves etc, Data fitting with Cubic splines, Regression Analysis, Linear and Non linear Regression, Multiple regression, Statistical Quality Control methods.

Text Books:

References:
5. Francis Scheld, ” Numerical Analysis”, TMH
TME- 303: Solid Mechanics

L T P 3 1 0

Unit-I
Introduction. Stress and strain: stress at point, Cauchy stress tensor, equilibrium equations, analysis of deformation and definition of strain components, compatibility relations, principal stresses and strains, stress and strain invariants, Mohr's circle representation.

Unit-II
 Constitutive relations: true and engineering stress-strain curves, Material properties for isotropic materials and their relations. Theories of failures for isotropic materials.

Unit-III
Shear Force and Bending Moment diagrams. Axially loaded members. Torsion of circular shafts
Stresses due to bending: pure bending theory, combined stresses.

Unit-IV
Deflections due to bending: moment-curvature relation, load-deflection differential equation, area moment method, and superposition theorem. Stresses and deflections due to transverse shears.

Unit-V
Torsion of circular shaft. Energy methods: Strain energy due to axial, torsion, bending and transverse shear. Castigliano's theorem, reciprocity theorem etc.

Text Books:

References:
4. Mechanics of Materials by Bear Jhonson

PCH 301: FLUID MECHANICS LAB

L T P 0 0 3

1. To calibrate the venturimeter and to find out its discharge coefficient. Also, to plot a graph between Reynolds number and discharge coefficient.
2. To calibrate the orifice meter and to find out its discharge coefficient. Also, to plot a graph between Reynolds number and discharge coefficient.
3. To calibrate the V-notch and to determine its discharge coefficient.
4. To find out the equivalent length of various pipe fittings (i) Gate valve, fully open (ii) Globe valve, fully open (iii) Elbow (iv) Reducer (v) Socket and (vi) Bend.
5. To verify Bernoulli’s theorem.
6. To study the characteristics of a centrifugal pump (UPSH / NPSH) / compressor
7. To calibrate the Rotameter.
8. To study the flow characteristics using Reynolds’ apparatus.
9. To study the flow curves of fluid’s for Newtonian and Non-Newtonian fluids flow conditions.
10. To calibrate and to find out discharge coefficient using Nozzle flow meter.
11. To find out the viscosity of a given Liquid sample using Falling Ball Viscometer.
12. To calculate the power requirement of mixing.

PCS- 302: Computer Based Numerical Techniques Lab

1. Write Programs in ‘C’ Language:
   1. To deduce error involved in polynomial equation.
   2. To find out the root of the Algebraic and Transcendental equations using
   3. To implement Newton’s Forward and Backward Interpolation formula.
   4. To implement Gauss Forward and Backward, Bessel’s, Sterling’s and Evertt’s Interpolation formula.
   5. To implement Newton’s Divided Difference and Langranges Interpolation formula.
   6. To implement Numerical Differentiations.
   7. To implement Numerical Integration using Trapezoidal, Simpson 1/3 and Simpson 3/8 rule.
   8. To implement Least Square Method for curve fitting.
   9. To draw frequency chart like histogram, frequency curve and pie-chart etc.
   10. To estimate regression equation from sampled data and evaluate values of standard deviation, t-statistics, regression coefficient, value of R2 for atleast two independent variables.

PCY 301: Chemistry Lab

1. Identification of Organic Compounds in the mixture.
2. Estimation of Glucose, phenol, aniline.
3. Applications of TLC in the organic chemistry.
4. Determination of percentage composition of mixture with the help of viscosity measurements.
5. Freundlich adsorption isotherm verification.
6. Distribution of solute between two immiscible solvents (I\textsubscript{2} / water + organic solvent), Distribution law.
7. Conductivity: (i) Conductivity titration strength of strong acid vs. strong base, (ii) Dissociation constant of a weak acid (CH\textsubscript{3}COOH).
8. Determination of molecular weight of a non volatile substance by (i) elevation in boiling point (ii) depression in freezing point.
TMA 401: Chemical Engineering Mathematics

L T P 3 1 0

Unit I: 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


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


Text Book:

References:

TCH 401: MECHANICAL OPERATIONS

L T P 2 0 0

Unit I: Introduction to unit operations and their role in Chemical Engineering industries. Types of Mechanical Operations, Characteristics of particulate solids: sampling
techniques, specification and screen analysis, particle size distribution, particle size measurement, Surface area measurements, statistical mean diameters, relevant equations and problems.


**Unit III:** Conveying of bulk solids, classification of conveyors, selection of conveyors. Storage of solids in bulk protected and unprotected piles, bins, silos, hoppers, mass flow and funnel flow Bins, Flow assisting devices, feeders. Weighing of bulk solids, batch and continuous weighing techniques.

**Unit IV:** Classification of separation methods for different types of mixtures like solid-solid, solid-gas, solid-liquid. Screening, classification of screening equipments. Mechanical classification and classifiers. Rare and dense medium separation, magnetic separation, electrostatic separation. Floatation and elutriation.

**Unit V:** Continuous thickeners, decantation, Phase separation: Centrifugal separation, Electrostatic precipitators. Impingement separators, Gas-solid separation: Gravity settling, Impingement separators, Cyclone separators, bag filters, scrubbers Filtration: classification of filters, theory of filtration, cake resistance

**Text Book**
1. Narayanan C.M. & Bhattacharya B.C. “*Mechanical operations for chemical engineers*”, Khanna Publishers. 3rd Ed. 1999

**References**

**Unit IV:** 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.

**Unit V:** 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.

**Text Book:**

**References:**

**TCH403: CHEMICAL ENGINEERING THERMODYNAMICS**

**L T P 3 1 0**

**Unit I:** Basic Concepts and Definitions: System, Surroundings, Property, Macroscopic and Microscopic Viewpoints, Thermodynamic Equilibrium, Heat and Work interactions; First Law of Thermodynamics, Conservation of energy, Perpetual Motion Machine of the First Kind, First Law analysis of Elementary Processes, Steady and unsteady flow, SFEE; Applications to engineering problems.


**Unit III:** Properties of Pure Substances: Concept of Phase, P-V and P-T Diagrams of a pure substance, Changes in thermodynamic properties and their inter-relationships, Maxwell’s Relations, Specific Heat Relations, Dryness Fraction, Throttling Calorimeter, Steam Tables, Measurement of Steam Quality, Liquid-Vapour mixtures, Equations of State; Applications to systems of engineering interest.
Unit IV: Psychrometry: Properties of Ideal Gas Mixtures, Ideal Gas-Vapor Mixtures, Dew point temperature, Specific humidity, Relative humidity, Adiabatic Saturation Process, Psychrometer, Dry-bulb and Wet-bulb temperatures, Psychrometric chart, Air-conditioning systems; Applications to engineering problems.

Unit V: Reactive Systems: Stoichiometric coefficients, Degree of Reaction, Law of mass action, Heat of Reaction, Temperature Dependence of the Heat of Reaction, Phase Rule and Duhem’s Theorem for Reacting Systems, Chemical Exergy; Applications to engineering problems.

Text Book:

Reference Books
1. Narayanan K. V. “A Textbook of Chemical Engineering Thermodynamics”; Prentice-hall of India Pvt Ltd. 2004

TCH 404: MASS TRANSFER OPERATIONS - I
L T P 3 1 0


Unit II: Absorption and Stripping: Equipments, Gas-liquid equilibria, Henry’s law, Selection of solvent, Absorption in tray column, Graphical and analytical methods, Absorption in packed columns, HTU, NTU &HETP concepts, Design equations for packed column, Absorption with chemical reaction and mass transfer.

Unit III: Humidification and Dehumidification: Vapour liquid equilibrium and enthalpy for a pure substance, vapour pressure temperature curve, Vapour gas mixtures, Definition and derivations of relationships related with humidity Fundamental concept of humidification, Dehumidification and water cooling, Wet bulb temperature, Adiabatic and non-adiabatic operations, Evaporative cooling, Classification and design of cooling towers.

Unit IV: Drying: Solid-gas equilibria, Different modes of drying operations, Definitions of moisture contents, Types of batch and continuous dryers, Rate of batch drying, Time of drying, Mechanism of batch drying, Continuous drying, Design of continuous dryers.
Unit V: Crystallisation: Equilibrium yield of crystallization, Heat and mass transfer rates in crystallization, Theories of crystallization, Factors governing nucleation and crystal growth rates, Controlled growth of crystal, Classification and design of crystallizers.

Text Book

Reference
PCH 401: MECHANICAL OPERATIONS LAB
L  T  P  0  0  2

1. To study the performance of Ball Mill and find out its crushing efficiency.
2. To study the performance of Jaw Crusher and find out its crushing efficiency.
3. To study the performance of Crushing Rolls and find out its crushing efficiency.
4. To study the settling characteristics (Free & Hindered settling) of a given suspension of particles.
5. To study the filtration characteristics of rotary vacuum filter.
6. To study the filtration characteristics of Plate and frame filter press.
7. To study the filtration characteristics of Leaf and sparkle filter.
8. To carry out differential and cumulative screen analysis of given sample of solid particles.
9. To study the pressure drop characteristics through packed beds.
10. To study the pressure drop and porosity in Air fluidized bed.
11. To study the pressure drop and porosity in Liquid fluidized bed.

PCH 404: MASS TRANSFER OPERATIONS LAB-I
L  T  P  0  0  3

1. Study the performance and determination of Equilibrium relationships
2. Mass transfer coefficients,
3. Diffusion coefficients,
4. Separation factors of the experiments with differential distillation,
5. Flash vaporization, vapour liquid equilibrium,
6. Liquid – liquid extraction,
7. Solid – liquid extraction,
8. Ion exchange and membrane separation.

PCH 405: HEAT TRANSFER OPERATIONS LAB
L  T  P  0  0  3

1. To find the thermal conductivity of metallic rod at different temperature and draw the temperature profile for steady and unsteady state conduction.
2. To find out the thermal conductivity of insulating powder.
3. To find the thermal conductivity of liquid / gases.
4. To find the emissivity of grey plate with respect to black plate.
5. To study the critical heat flux behaviour of a liquid
6. To find the heat transfer coefficient for parallel and counter current flow condition for a Double pipe heat exchanger
7. To study the shell & Tube heat exchanger and find the heat duty and Overall heat transfer coefficient for parallel flow condition.
8. To study the shell & Tube heat exchanger and find the heat duty and Overall heat transfer coefficient for counter flow condition.

TCH 501: MASS TRANSFER OPERATIONS – II

L T P 3 1 0


Unit II: Continuous Distillation of Binary Mixtures: Multistage contact operations, Characteristics of multistage tower, McCabe Thiele method, Ponchon Savart method, Reflux, maximum, minimum and optimum reflux, Use of open steam, Tray efficiency, Determination of height and column diameter, Multistage batch distillation; Principles of azeotropic and extractive distillation, Introduction to multicomponent distillation system.

Unit III: Liquid-Liquid Extraction: Ternary liquid equilibria, Triangular graphical representation concept of theoretical or ideal stage, Equipment used for single stage and multistage continuous operation; Analytical and graphical solution of single and multistage operation Super critical fluid extraction.

Unit IV: Solid/Liquid Extraction: Leaching, Solid liquid equilibrium, Equipment used in solid-liquid extraction, Single and multistage cross current contact and counter current operations. Concept of an ideal stage, Overall stage efficiency, Determination of number of stages.

Unit V: Adsorption: Description of adsorption processes and their application, Types of adsorption, Nature of adsorbents adsorption equilibria and adsorption hysterises, Stage wise and continuous contact adsorption operations, Determination of number of stages, Equipments; Ion exchange, Equilibrium relationship, Principle of ion-exchange, techniques and applications, Principles and application of dialysis, osmosis reverse osmosis, thermal diffusion, sweep diffusion.

Text Book:

References:
TCH 502: CHEMICAL TECHNOLOGY -I (ORGANIC)
L  T  P  2  0  0

Unit I: Importance and Overview of Chemical Process Industries. Unit operations and Unit process concept. Sugar, Glucose, Starch, Fermentation products such as Alcohol, Acetic acid, Citric acid and antibiotics.

Unit II: Soap and Surfactants, Glycerin, Fatty acids, Hydrogenation of edible oils, paper and pulp

Unit III: Synthetic and natural fibers: Nylon, Dacron, Terylyne, Polyester and other new products, Viscose rayon, acetate rayon , synthetic rubber with special reference to manufacture, vulcanization and reclaiming of rubber, SBR, Plastics, Thermosetting and Thermo Plastics(PVC, Polyethylene, Polyurethane, Teflon )

Unit IV: Crude oil distillation, Thermal conversion processes (visbreaking, coking), Catalytic conversion processes (fluid catalytic cracking, catalytic reforming, hydro cracking, alkylation, isomerisation, polymerization) Finishing processes, sulphur removal process, lub oil manufacture; Petrochemicals(ethylene, propylene, formaldehyde, methanol, ethylene oxide , ethanolamine, cumene, ethylene glycol, ethyl benzene)

Text Book:

References

TCH 503: ENERGY RESOURCES AND UTILIZATION
L  T  P  3  1  0

Unit I: Energy Scenario: Indian and global, energy crisis, Classification of various energy sources, Renewable and non-renewable energy sources, Remedial measures to some energy crisis.
Energy Conservation: Energy: Biogas plants and their operation, Biomass and its conversion routes to gaseous and liquid fuels. Wind energy, its potential and generation by wind mills,

Unit II: Alternative Sources of Energy: Fuel cell, Solar Energy: Photo thermal and photovoltaic conversion and utilization methods, solar water heating, cooking, drying and its use for other industrial processes, solar cells their material and mode of operation. direct and indirect methods of solar energy storage , sensible heat and latent heat storage materials Solar ponds .
Bio energy, biogas plants and their operation, biomass and its conversion roots to gaseous and liquid fuels, wind energy, its potential and generation by wind mills

Unit III: Hydroelectric potential, its utilization & production, Geothermal energy its potential status and production, Nuclear energy: Status, nuclear raw materials, nuclear reactors and other classification, Generation of Nuclear power, Nuclear installations in India and their capacity of generation, Limitations of nuclear energy, Reprocessing of spent nuclear fuel, Cogeneration of fuel and power, Energy from tidal and ocean thermal sources, MHD systems.
Unit IV: Fossil and Processed Fuel: Coal its origin and formation, Coal analysis, Coal classification, Coal preparation, Coal washing and coal blending, Coal carbonization, Treatment of coal gas and recovery of chemical from coal tar, Coal gasification, liquid fuel synthesis from coal, CBM.

Unit V: Petroleum crude, Types of crude, emergence of petroleum products as energy, Gaseous Fuels: Natural gas, Water gas, producer gas, L.P.G., bio- gas, coke oven gas, blast furnace gas, LNG ,CNG, Gas hydrates ,GTL Technology (gas to liquid), Biodiesel.

Text Book:

References

**TCH 504: CHEMICAL REACTION ENGINEERING - I**

**L T P 3 1 0**

Unit I: Rate of reaction, Elementary and non-elementary homogeneous reactions, Molecularity and order of reaction, Thermodynamic formulations of rates, Mechanism of reaction, Temperature dependency from thermodynamics, Arrhenius collision and activated complex theories.

Unit II: Integral and differential methods for analyzing kinetic data, Interpretation of constant volume batch reactor, data for zero, first, second and third order reactions, Half life period, Irreversible reaction in parallel and series, Auto catalytic reaction.

Unit III: Interpretation of variable volume batch reactions data for zero, first and second order reactions, Design equations for batch, plug flow, back mix flow and semi batch reactors for isothermal, adiabatic homogeneous reaction.

Unit IV: Holding time and space-time for flow system, Design of batch, plug flow and mixed flow reactors for first and second order single reactions, Optimum reactor size, Plug flow reactors in series/parallel. Equal and different size of mixed reactors in series and finding the best system for the given conversion, Recycle reactor, Design of reactors for multiple reactions, parallel and series reaction, series-parallel reactions.

Unit V: Temperature and pressure effects for single reaction, Optimal temperature progression for first order reactions. Residence time distribution of fluid in vessels, E, F and C curve, Dispersion models, Tanks in series model.

Text Book:

References
TCH 505: INDUSTRIAL POLLUTION AND CONTROL

Unit I: Introduction: Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental laws and rules, standards for ambient air, noise emission and effluents

Unit II: Pollution Prevention: Process modification, alternative raw material, recovery of by co-product from industrial emission effluents, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization. Water use minimization, Fugitive emission/effluents and leakages and their control-housekeeping and maintenance.

Unit III: Air Pollution: Sources; Types of air pollutants; Classification of industries and area. Atmospheric dispersion: Micrometeorology; Lapse rate; Atmospheric classes; Plume and type of plume; Dispersion models; Ground and elevated sources with and without reflection; Calculation for plume rise and stack gas flow rates. Gaseous pollutants: Sources; Emission factors and control technology. Particulate pollutants: Major sources; Effects; Emission factor and emission limits; Combustion generated pollutants and control; Particulate emission control equipment- Design and efficiency of centrifugal collectors, electrostatic precipitators, bag filters and scrubbers; Vehicular emission control.

Unit IV: Water Pollution: Sources; Pollution laws and limits; Water quality modeling for streams; Characterization and classification of effluents; Effluent standards; Pretreatment and primary treatment methods; Physico-chemical methods of water pollution control; Biological wastewater treatment processes; Advanced treatment methods; Disinfections; Typical industrial and municipal applications.

Unit V: Noise Pollution: Measurements; Effects; Control methods. Solid waste: Collection, treatment and disposal. Waste recovery system.

Text Book:

References:
PCH 501: MASS TRANSFER OPERATIONS LAB-II
L T P 0 0 3

Study of the performance and determination of equilibrium relationships, mass transfer coefficient, Separation factors of the experiments with gas diffusion, packed bed absorption, bubble gas absorption, humidification and dehumidification, cooling tower, tray dryers, crystallization and adsorption.

PBE 505: INDUSTRIAL POLLUTION & CONTROL LABORATORY
L T P 0 0 3

Selected laboratory experiments based on sampling and analysis of air and water samples, particulate pollutants and control, physico-chemical and biological methods of waste water treatment.

PCH 503: ENERGY RESOURCES LAB
L T P 0 0 3

1. Estimation of net & gross calorific value of coal sample using Bomb Calorimeter
2. Estimation of net calorific value of petroleum sample using Bomb Calorimeter
3. Derivation of kinematic viscosity by Saybolt Viscometer (Universal and Furol)
4. Determination of flash and fire points by Penskey Marten apparatus
5. Estimation of carbon residue
6. Efficiency of solar cell
7. Proximate analysis of Coal
8. Performance of solar water pump
9. Performance of solar regenerator

TCH 601: TRANSPORT PHENOMENA
L T P 3 1 0

Unit I: Introduction to Transport Phenomena, Similarity between momentum, heat and mass transfer, The continuum hypothesis, Basic laws of fluid motion, Newton’s second law of motion, principle of balance between momentum, heat and mass transfer, Principles of conservation of momentum, mass and energy.


Unit III: Unsteady state momentum transport, Flow near a wall suddenly set in motion, Momentum transport phenomena in turbulent flow. Definitions of friction factors, friction factor for flow in tubes, for flow around spheres, for packed bed column.

Unit V: Mass Transport Phenomena: Definitions of concentration, velocities and mass fluxes, Fick’s law of diffusion, Prediction of diffusivity and its dependence on temperature, pressure and composition, Boundary conditions, Shell balance approach for mass transfer problems, Problems of diffusion with homogeneous and heterogeneous chemical reaction, Diffusion and chemical reaction in porous catalyst – the effectiveness factor. The equation of continuity for multicomponent mixtures.

Text Books

Reference Books

TCH 602: CHEMICAL TECHNOLOGY – II (INORGANIC)
L T P 2 0 0

Unit I: Chlor-alkali industry: Common salt, Caustic soda and Chlorine, Soda Ash, Hydrochloric acid.
Unit II: Sulfur Industry: Sulfur and sulfuric acid, Oleum Phosphorus Industry: Phosphorus, Phosphoric acid and super phosphates
Unit III: Nitrogen Industry: Ammonia, Nitric acid, Urea and other nitrogen fertilizers, Mixed fertilizers (SSP, TSP, NPK, KAP, DAP, Nitrophosphate) Bio fertilizers.

References
TCH 603: PROCESS DYNAMICS & CONTROL

Unit I: Introduction to Process control systems, Regulator & Servo control, Feed Forward & Feed backward control, Negative & Positive Feed back Control, variables & Physical Elements of a Control system, Physical, Block & Signal Flow Diagram. Use of Laplace & Inverse Laplace Transformation is study of Process Dynamics.

Unit II: Dynamic Modeling of a Process, Dynamic behavior of First order systems and First order systems in series. Dynamic behavior of second & higher order system for various kind of inputs, Linearization of nonlinear system, Transportation & Transfer Lag.

Unit III: Modes of control action, Controllers & Final control Elements, Reduction of Block & Signal Flow Diagrams, Closed loop transfer function and response of closed loop control system for various type of control actions.


Unit V: Advanced control strategies, cascade control, Feed forward control, Tuning Rules for Feed Forward & Feed backward control, Ratio control, optimum controller Tuning, Ziegler Nichol & Cohen Coon settings.

Text Book:

Reference

TCH 604: CHEMICAL REACTION ENGINEERING - II

Unit I: Reactor Models: Design equations for batch, continuous and semi batch reactors, Selectivity and yield. Non-catalytic heterogeneous reactions; Rate equations for heterogeneous reactions.

Unit II: Heterogeneous Catalysis: Adsorption isotherms, Mechanism of catalytic reactions, Physical properties of solid catalysts. Preparation testing and characterization of catalysts, Catalyst selection, Catalyst poisoning.


Unit IV: Reactor Design: Progressive conversion and un-reacted core model, Determination of rate controlling step, application to design, fluidized bed
reactions. Design of solid catalytic reactor, batch, CSTR and tubular reactor. Design of fixed bed and fluidized bed reactors.

Unit V: Non elementary reactions and reactor design, biochemical reaction system, Reactors for Enzyme fermentation, Microbial fermentation, polymerization.

Text Book:

References

TCH 605: PROCESS MODELING & SIMULATION
L T P 3 1 0

Unit I: Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models – Simple vs. rigorous, Lumped parameter vs. distributed parameter; Steady state vs. dynamic, Transport phenomena based vs. Statistical; Concept of degree of freedom analysis.

Unit II: Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, - steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc.; Review of solution procedures and available numerical software libraries.

Unit III: Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based approaches for staged processes; Modeling of differential contactors – distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries.

Unit IV: Unsteady state (time dependent) models and their applications; Simple dynamic models of Batch reactors, Adsorption columns, Multistage separation systems; Model reduction through orthogonal collocation; Review of solution techniques and available numerical software libraries.

Unit V: Introduction to flow sheet simulation; Sequential modular approach; Equation oriented approach; artitioning and tearing; Recycle convergence methods; Review of thermodynamic procedures and physical property data banks.

Text Book:

Reference
TCH 606: PROCESS INSTRUMENTATION

L T P 2 0 0

Unit I: Importance of measuring of Instruments in Process Control, Classification of Instruments, Elements of an Instruments, Static & Dynamic Characterization of Instruments, Errors in measurements & Error Analysis, Selection of instrument for a particular Measurement, transducers.

Unit II: Measurement of Temperature: Thermocouples, Resistance Thermometer, Expansion Thermometers, Pyrometers.

Unit III: Measurement of Pressure & Vacuum, Hydrostatic type, Elastic Element type, Electrical Type and other type of instruments like MacLeod Gauge, Thermocouple gauge, Knudson Gauge, Ionization Gauge.


Text Book:

References

PCH 602: CHEMICAL TECHNOLOGY LAB

L T P 0 0 2

Preparation and Quality evaluation of following items:-
1. Cement Paint.
2. Dry Distemper.
3. Oil bound Distemper.
5. Polystyrene by Bulk Polymerization Technique.
6. PMMA by Bulk Polymerization Technique.
7. Transparent Soaps
8. Powdered Detergent.
9. Liquid Detergent
10. Washing Soap
PCH604: CHEMICAL REACTION ENGINEERING LAB

1. To determine the relative rates of reaction of iodide ion with hydrogen peroxide at room temperature using different concentrations of the iodide ion.
2. To separate Organic Compounds by Paper Chromatography.
3. To study the effect of temperature, concentration of the reactants and a catalyst on the rate of chemical reaction
4. To study the activity results or oxidation-reduction replacement reaction.
5. To purify water by ion -exchange.
6. To determine the order and rate constant of esterification reaction at room temperature.
7. To determine the order and rate constant of saponification reaction at room temperature.
8. To study the residence time distribution (R.T.D.) in a stirred tank reactor.
10. To study the decomposition of calcium carbonate
11. To determine the energy of activation of a given chemical reaction.

PCH 603: PROCESS DYNAMICS AND INSTRUMENTATION LAB

1. To study the response, time constant of thermocouple/ Bimetallic thermometer.
2. To study the response of a liquid level tank system
3. To study the response of a two tank non-interacting system
4. To study the response of a two tank interacting system.
5. To study the response of a stirred tank heater system
6. To study the characteristics of an on-off controller.
7. To study the characteristics of a PI/PID pneumatic / electronic controller.
8. To study the performance of a closed loop control system containing controller, final control element, measuring element.
9. Calibration of temperature and pressure measuring instruments
10. Analysis of solution by UV/VIS spectrophotometer
15. Calibration of pH meter.

TCH 701: PROCESS EQUIPMENT DESIGN

Unit I: Introduction to various mechanical properties of materials to be used as material of construction, resistance of metals to corrosion under varying conditions of
temperature and pressure etc. Application and use of various codes and standards in design.

Unit II: Design of non-pressure storage vessel, tall vertical vessels, unfired pressure vessels with internal pressure, Design of unfired pressure vessels with external pressures, end closures, flat plates, domed ends, torispherical, ellipsoidal, hemispherical and conical ends. Design of nozzles, openings and reinforcements, Bolts, flanges, gaskets.

Unit III: Bolted flanges, pipe line design and process design of a few equipments like heat exchangers, Evaporators, Distillation columns, Absorbers, Reactors and Dryers.

Unit IV: Mechanical design of selected process equipments such as heat exchangers, Evaporators, Distillation columns, Absorbers, Reactors and Dryers and Crystallizers; Use of softwares (Chem CAD and Pro Sim) for design of equipments.

Unit V: Liquid storage tanks: Storage tank codes; Classification; Design of shell, bottom plates, self supported, and column supported roofs.

Text Book:

Professional Electives

Professional Elective-1*

L T P 3 1 0

TCH 711: NON CONVENTIONAL ENERGY RESOURCES

L T P 3 1 0

Unit I: Introduction to Energy Sources: Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources.
Solar Energy : Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond, solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaics - solar cells & its applications.

Unit II: Wind Energy : Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical
axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.

Energy from Biomass: Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of biogas, utilization of biogas.

Unit III: Geothermal Energy: Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India

Energy from the ocean: Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy.


Reference Books:
1. Non-conventional energy sources by G.D. Rai, Khanna Publishers
4. Alternative Energy Sources by B.L. Singhal Tech Max Publication
6. Fuel Cells by Bockris and Srinivasan; McGraw Hill

TCH 712: POLYMER SCIENCE AND TECHNOLOGY

Unit I: Classification of polymers: Natural and synthetic polymers; Thermosets and thermoplasts; Copolymers; Terpolymers; Degradable and non-degradable polymers.

Addition polymerization; Condensation polymerization; Ring opening polymerization; Copolymerization; Polymerization by coordination catalyst; Molecular weight distribution of polymers.
Unit II: Manufacturing processes of important polymers: Plastics-polyethylene; polypropylene, polyvinyl chloride and copolymers, polystyrene; phenol-formaldehyde, epoxides; urethane; teflon; Rubbers and elastomers; Fibres - cellulosic (rayon), polyamides (6;6 Nylon), polyesters (Dacron), acrylic; Polymeric oils. Micro-structure of polymer chains: Configuration and conformation; Simple and hindered rotation; End-to-end distances;

Unit III: Crystallinity and melting; Glass transition temperature; Physical states of polymers and mode of motion of polymer chains; Measurement of viscosity; Cohesive energy density; Compatibility and solubility parameters; Polymer additives, blends and composites. Flow properties of polymers: Bulk deformation, elongational and shear flow; Non-Newtonian flow.

Unit IV: Polymer fabrication techniques: Formation of flat sheets and films; Laminations; Foam formation; Extrusion, injection molding, blow molding, compression and transfer molding; Spinning of fibres

Unit V: Mechanical properties of polymers: Rheology of polymers; Rubber elasticity; Visco-elasticity; Creep and stress relaxation; Dynamic behavior; Stress and fracture of rubber and glassy polymers. Polymer degradation. Conducting polymers; Smart polymers. Ecology and environmental aspects of polymer industries.

Text Book:

References

TCH 713: FERTILIZER TECHNOLOGY

Unit I: Introduction to chemical fertilizers: Chemical inorganic Fertilizers and Organic manures. Types of fertilizer-, Mixed, complex and granulated, plant nutrients.

Unit II: Processes for raw materials: Processes for manufacture of ammonia, nitric acid, phosphoric acid and


Unit IV: Complex fertilizers: Processes for nitro - Phosphorous and complex NPK fertilizers, liquid fertilizers.


Text Books:

References:
"Handbook on Fertilizer Technology", Fertilizer Association of India, near JNU, New Delhi 1992

Professional Elective-II*
L T P 3 1 0

TCH 721: SAFETY AND HAZARD ANALYSIS

Unit I: History of safety movement; Development of safety programmes in process industry. Accident causation: Heinrich-Domino theory; Human error model; Petersen’s accident/incident model; Epidemiological models; System models; Multiple causation.

Unit II: Systems safety management: Management task; Managerial roles and skills; Management by objective.

Unit III: Hazard: Identification; Occupational hazard; Preliminary hazard analysis; Hazard and operability review (HAZOP) Hazard control: Engineering and management controls; Fault tree analysis; Risk analysis and management.

Unit IV: Fire prevention and protection: Chemistry of fire; Production of fire; Fire development; Severity and duration; Effect of enclosure and heat transfer.

Unit V: Industrial hygiene; Routes of entry of foreign substance; Long term medical disorders and epidemiology; Stress and the workplace; Industrial noise; Hazardous waste. Case studies of safety and hazard assessment in different industries; Disaster management planning; Insurance tariffs in hazardous industries; Design for safety, maintenance and fault diagnosis.

Text Book:

References

TCH 722: FOOD TECHNOLOGY

Unit I: Food process engineering fundamentals: Fundamentals of food process engineering. application of quantitative methods of material and energy balance in food engineering practice.
Unit II: Unit operations in food industries: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.


Unit IV: Mechanical operations in food processing: Conversion operations, Size reduction and screening of solids, mixing and emulsification and membrane separation, centrifugation, extraction.

Unit V: Food biotechnology: Food Biotechnology, Dairy and cereal products, Beverages and food ingredients, High fructose corn syrup, Single Cell protein.

Text Books:

REFERENCES:

TCH 723: HAZARDOUS WASTE MANAGEMENT


Unit2: Non-hazardous Waste Management: Non-hazardous industrial wastes-treatment, disposal, utilization and management. Thermal gasification, combustion and landfill.

Unit3: Hazardous Waste Management: Hazardous wastes – handling, storage. Treatment and disposal methods: Physico-chemical and biological, stabilization and solidification, thermal methods, land disposal, Waste site remediation and clean-up technologies. Wastes from electroplating, lead batteries/cells, soldering and electro winning operations, wastes from refineries and petrochemical units.

Unit4: Risk assessment, Environmental legislation, Dose-response assessment, exposure assessment, Waste minimisation and Value-extraction from the wastes. Medical / biomedical and infectious waste management; Transportation of hazardous waste; Ground water contamination.

Unit5: Case Studies: Case studies of a few real scenarios of hazardous waste management in industries.

Text Books:

References:

Professional Elective-III*

L T P 3 1 0

**TCH 731: ADVANCED SEPARATION PROCESS**

Unit I: Principle of membrane separations process; Classification, characterization and preparation of membrane. Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators. Dialysis, Ultra Filtration and Economics of Membrane operations

Unit II: Reverse osmosis, micro-filtration, nano-filtration and dialysis; Analysis and modeling of membrane separation processes; Membrane modules and application; Ion selective membranes and their application in electro-dialysis; Pervaporation and gas separation using membranes; Electrophorosis; Liquid membranes and its industrial applications.

Unit III: Foam and bubble separation: Principle; Classification; Separation techniques; Column operations. Zone melting, zone refining and zone leveling. Pressure and temperature swing adsorption.

Unit IV: Cryogenic separation; Supercritical extraction. Parametric pumping: Batch, continuous and semi-continuous pumping; Thermal, pH and heatless parametric pumping. Multicomponent separation.

Text Book:

Reference

**TCH 732: INTELLECTUAL PROPERTY RIGHTS**

Unit II: International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.


Text Books:

TCH 733: FLUIDIZATION ENGINEERING

Unit I: Introduction: Importance of fluidization in process industry, comparison of fluidized beds with other modes of contacting, advantages and disadvantages, industrial applications. Fluidization: Fixed bed of particles of one and mixed sizes, fluidization with and without carryover of particles, minimum fluidization, terminal velocity of particles, pneumatic transport of solids.

Unit II: Bubble Behavior and Bed Properties: Single rising bubble models, wake region and solids within bubbles, interaction and coalescence of bubbles, bubble formation, slug flow.

Unit III: Bubbling Fluidized Beds: Emulsion phase, gas flow, bubble properties, physical and flow models. Entrainment and Elutriation From Fluidized Beds: Free boards behavior, gas outlet location, entertainment from tall and short vessels.

Unit IV: High Velocity Fluidization: Turbulent fluidized beds, fast fluidization, pressure drop in turbulent and fast fluidization. Spouted Beds: Hydrodynamics and processing in spouted beds.


Text Books:

References:
Open Electives
Open Elective-III*
L T P 3 1 0

TOE 011: PROCESS UTILITIES AND SAFETY

Unit I: Various process utilities, their role and importance in chemical plants. Water Sources: Sources of water and their characteristics; Treatment storage and distribution of water; water for use in boilers, cooling purposes, drinking and process; Reuse and conservation of water; Water resource management.

Unit II: Steam Generation and Utilization: Steam generation and its application in chemical process plants, distribution and utilization; Design of efficient steam heating systems; steam economy, Steam condensers and condensate utilization Expansion joints, flash tank design, steam traps their characteristics, selection and application, waste heat utilization; Lagging, selection and thickness. Selection and sizing of boilers; waste heat boilers.

Unit III: Compressors, blowers and Vacuum Pumps: Compressors, blowers and vacuum pumps and their performance characteristics; Methods of developing vacuum and their limitations, material handling under vacuum, Piping systems; Lubrication and oil removal in compressors and pumps. Air filters, Air and gas leakage. Inert gas systems, compressed air for process, Instrument air.

Insulation: Importance of insulation for meeting the process requirement, insulation materials and their effect on various material of equipment piping, fitting and valves etc. insulation for high intermediate, low and sub zero temperatures, including cryogenic insulation.

Unit IV: Elements of Safety: Elements of safety, safety and site selection; Plant layout and unit plot planning; Definition of risk and hazard, Identification and assessment of the hazards, distinction between hazards and risk, Hazard operability (HAZOP) hazard analysis (HAZAN);

Assessment of the risk, fault tree, event tree, scope of risk assessment; Control of hazards, controlling toxic chemicals and controlling flammable materials.

Prevention of losses: Prevention of losses, Pressure relief, Provision of fire fighting equipments, Technology selection and transfer, Choosing the right process.

Unit V: Control of Process: Control of process, Prevention of hazardous deviation in process variables, e.g. pressure, temperature flow by provision of automatic control systems- interlocks, alarms, trips together with good operating practices and management.

Regulations: Regulations and legislation, Role of government role, risk management routines and tackling disaster.

Text Books:
TOE 012: INTELLECTUAL PROPERTY RIGHTS


Unit II: International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.


Text Books:

TOE 013: NON CONVENTIONAL ENERGY RESOURCES

TOE 014: BIOINFORMATICS

L T P 3 1 0

Unit I: Primary and secondary databases. Specialized sequence databases of EST, TFB Sites, SNPs, gene expression. Pfam, PROSITE, BLOCK( Secondary databases). Data retrieval with ENTREZ, SRS, DBGET

Unit II: Principles of DNA sequencing (chemical chain termination, Dideoxy chain termination method, Automatic sequencer). RNA sequencing . Protein sequencing ( Edmand degradation method)

Unit III: Sequence alignment (pairwise and multiple, global and local). Sequence alignment algorithm (FASTA, BLAST, Needleman and Wunsch, Smith Waterman ). Database similarity searches (BLAST, FASTA and PSI BLAST). Amino acid substitution matrices (PAM, BLOSUM)

Unit IV: Protein structure prediction ( Chou Fasman method) : Secondary and tertiary structures. Homology Modelling, ORF prediction, Gene prediction, Micro array data analysis. Profiles and motifs.

Unit V: Structure visualization methods ( RASMOL, CHIME etc.). Protein Structure alignment and analysis. Application of Bioinformatics in drug discovery and drug designing.

Text books:
2. Andreas D Boxevanis, “Bioinformatics” Wiley Interscience
3. Dan e. Krane, “Fundamental concept of bioinformatics”

Reference books:
2. Westhead, Parish and Tweman, “Instant notes in Bioinformatics” Bios scientific publishers.

TCH 801: PILOT PLANTS AND SCALE-UP METHODS IN CHEMICAL ENGINEERING

L T P 3 1 0

Unit I: 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.

Unit II: 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.

Unit III: 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.

Unit IV: 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.

Unit V: Scale-up of miscellaneous equipment: Scale-up methods for mixing equipment and other miscellaneous equipment used in chemical process industries.

Text Book:

References
1. Bisio & Kabel, "Scale-up in Chemical Industry".

PROFESSIONAL ELECTIVES

Professional Elective IV*
L T P 3 1 0

TCH 811: FUNDAMENTALS OF BIOCHEMICAL ENGINEERING

Unit I: Introduction to microbiology and biochemistry; Classification and characteristics of microorganism; Essential chemicals of life- lipids, sugars and polysaccharides, RNA and DNA, amino acids and proteins; Cell metabolism; Regulation; Stoichiometry; End products. Cell growth kinetics; Product formation kinetics.
Unit II: Transport phenomena in cellular systems; Oxygen transfer rates; Mass transfer coefficient and interfacial area; Mechanical agitation and power requirement.

Unit III: Thermal death kinetics; Media and air sterilization. Enzymes and their classification; Enzyme kinetics; Immobilization of enzymes and whole cells; Immobilized enzyme kinetics.

Unit IV: Bioreactors: Type, design, operation and scale-up; Instrumentation and control. Down-stream processing

Unit V: Industrial production of ethanol, anti-biotics, single cell protein. Bioleaching.

Text Book

References

TCH 812: PETROLEUM REFINING TECHNOLOGY

Unit I: Petroleum Exploration: Production and Refining of Crude oils; Crude oils: Chemistry and composition (Characteristics and constituents of crude oils, Classification of crude oils).

Unit II: Quality Control of Petroleum Products: Classification of laboratory tests, distillation, vapour pressure, flash and fire points, octane number, performance number, cetane number, aniline point, viscosity index, calorific value, smoke point, char value, viscosity, viscosity index, penetration tests, cloud and pour points, drop point of grease, melting and settling points of wax, softening point of Bitumen, induction period of gasoline, thermal stability of jet fuels, gum content, Total Sulphur, Acidity and Alkalinity, Copper Strip Corrosion Test, Silver – Strip Corrosion Test for ATF, Ash, Carbon Residue (Conradson method, Ramsbottom method) Colour, Density and Specific gravity, Refractive index of hydrocarbon liquids, water separation index (modified) (WSIM), ductility.


Unit IV: Catalytic Converson Process: Fluid catalytic cracking; Catalytic reforming; Hydrocracking Catalytic Alkylation, Catalytic Isomerization; Catalytic
Polymerization. Finishing Process, Hydrogen sulphide removal processes; Sulphur conversion processes; Sweetening processes (Caustic treatment, Solutizer process; Doctor treating process; Copper chloride sweetening, Hypochlorite sweetening; Air and inhibitor treating process; Mer oxide processes; Sulphuric acid treatment; Clay treatment); Solvent extraction processes (Edeleanu process, Ude process, Sulfolane process), Hydrotreating processes.

Unit V: Lube Oil Manufacturing Process: Evaluation of crude oils for lube oil base stocks, Vacuum distillation, Solvent deasphalting Solvent extraction of lube oil fractions (Furfural, NMP and Phenol), Solvent dewaxing, Hydrofinishing, Manufacture of petroleum waxes (Wax sweating, Solvent deoiling)
Manufacture of Bitumens: Selection of crude oil, Methods of manufacture of bitumens, (Distillation, Solvent precipitation, Air blowing).

Text Book:

References

TCH 813: OIL AND FAT TECHNOLOGY

Unit I: Industrial oils and fats: Raw material properties: Sources, composition, properties, classification and analysis of oils and fats.

Unit II: Recovery and refining of oils from raw materials: Extraction of oils, Mechanical and solvent extraction methods. Refining and hydrogenation of oils, Edible oil processing.


Unit V: Modern development in detergents: Indian oils, fats and detergents industries. Alpha Olefin from natural oils and conversion to sulphonate. Fatty alcohols and their sulphates form natural oils.

TEXT BOOKS:

Professional Elective V*
L T P 3 1 0

TCH 821: FERMENTATION TECHNOLOGY
Unit-I: Introduction and scope of microbial processes. Alcoholic fermentation.
Glycerol fermentation, Baker’s yeast production.

Unit-II: Beer production, wine production, vinegar production.

Unit-III: Microbial production of organic acids, biopolymers production.

Unit-IV: Antibiotics production: Penicillin, streptomycin, tetracycline,

Unit-V: Amino acids: Lysine and glutamic acid. Commercial enzymes, Vitamins: B_{12}, Riboflavin etc.

TCH 822: PLANT DESIGN AND ECONOMICS

Plant Design: Design basis, Process selection-Selection of equipment, specification and design of equipment’s, material of construction, Plant location, Plant layout and installation, Safety, Start up, Shutdown and Operating guidelines.

Unit II: Cost Engineering: Time value of money and equivalence, Interest, cost comparisons by present worth, Annual equivalent cost and capitalized cost methods, Uniform gradient and series.
Depreciation, Taxes and Insurances Nature of depreciation, Methods of determining depreciation, depreciation rates in current Indian situation, Types of taxes and insurance’s, Procedure for cost comparison after taxes.

Unit III: Cost Estimation: Types of cost estimation, capital investment cost, fixed capital cost, working capital cost, start-up costs, process equipment cost estimation, cost index, Equipment costs due to inflation, Battery limit investments, estimation of plant cost, Estimation of total product cost, Manufacturing cost, General expenses.
Profitability: Criteria of profitability, Payout period, Return on investment, Present value, Cash flow analysis, Alternative investment analysis, Sensitive analysis in project profitability.

Unit IV: Economic Optimization and Optimum Design: Nature of optimisation, Univariable and multivariable systems, Analytical, graphical and incremental methods of solution, LaGrange multiplier method, Linear programming and dynamic programming establishing optimum conditions, Break even chart for production schedule, Optimum production rates in plant operation, Optimum conditions in batch, cyclic and semicyclic operation, Sensitivity and response analysis.


Text Book
References

TCH 823: SURFACE COATING

Unit I: Survey of paint industry and its scope in India. Pigments and their classification; Methods of manufacture for white, coloured, metallic and luminous pigments.

Unit II: Classification of paints; Oil, emulsion, and water soluble paints and their manufacturing processes; Drying oils; Natural and synthetic resins; Solvents and plasticizers.

Unit III: Definition and classification of varnish; Oleoresinous and spirit varnishes; Manufacture of different types of varnishes.

Unit IV: Ceramic coating; Glazing and enamelling. Metallic coating; Electroplating; Galvanizing; Tinning.

Unit V: Polymeric coating; Protective and decorative coatings. Powder Coating.

Text Books:

Professional Elective VI*
L T P 3 1 0

TCH 831: CORROSION ENGINEERING


Unit II: Forms of corrosion-definition, factors and control methods of various forms of corrosion such as pitting, inter granular, crevice, stress corrosion, corrosion fatigue, hydrogen embrittlement, corrosion processes and control methods in fertilizers, petrochemical and petroleum refineries


Unit V: Corrosion Testing, monitoring and inspection, laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by DC and AC methods, corroctions monitoring methods, chemical and electrochemical removal of corrosion products.

Text Books:

References

TCH 832: FINITE ELEMENTS METHODS

TCH 831: PROCESS UTILITIES AND PIPING DESIGN

Unit I: Various process utilities, their role and importance in chemical plants. Sources of water and their characteristics; Treatment storage and distribution of water; water for use in boilers, cooling purposes, drinking and process; Reuse and conservation of water; Water resource management.

Unit II: Steam Generation and Utilization: Steam generation and its application in chemical process plants, distribution and utilization; Design of efficient steam heating systems; steam economy, Steam condensers and condensate utilization Expansion joints, flash tank design, steam traps their characteristics, selection and application, waste heat utilization; Lagging, selection and thickness. Selection and sizing of boilers; waste heat boilers.

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Insulation: Importance of insulation for meeting the process requirement, insulation materials and their effect on various material of equipment piping,
fitting and valves etc. insulation for high intermediate, low and sub zero temperatures, including cryogenic insulation.

**Unit IV:** Energy losses in pipe lines, concept of equivalent length and equivalent pipes, problems in pipe flow, hydraulic power transmission through a pipe line. Negative pressure in pipe lines, Siphon, Multiple pipe systems, working pressure, design pressure, choice of pipe materials, hydraulic analysis of complex pipe networks.

**Unit V:** Aids in selecting pipe valves and fittings, standards for piping design, Dimensional and mechanical standards for pipe valves and fittings. Pipe fabrication, vibration, its prevention and control in piping systems.

**Text Books**

**Reference Books**

**PCH852: C.A.D LAB**

| Credits | L | T | P | 0 | 0 | 4 |

Recommended to be done using a commercial simulator

1. Design of a Flow network containing Pumps, fittings and Piping (horizontal, vertical, inclined)
2. Process design of simple reactors (CSTR, Tubular) with or without heat transfer.
4. Process design & Rating of TEMA Type Shell & Tube Heat exchangers.
5. Steady state flow sheeting of acyclic processes.
6. Steady state flow sheeting of Processes with recycles /Purge/Bypass etc. Recommended to be done using a Simulation Language/Programming Environment

1. Study of dynamic behavior of simple systems such as tank in series, double effect evaporators, etc.
2. Study of coupling of manipulated and controlled variables using relative gain analysis (RTA).

Recommended to be done using a commercial simulator

1. Dynamic simulation of Simple process systems with controllers
2. Dynamic simulation & controllability analysis of Binary distillation column.

**Recommended Software**
1. Steady state/Dynamic simulator (such as Hysys. Plant or Aspen Plus/Aspen Dynamic)
2. Simulation Language /Programming Environment (MATLAB).