

Elective-I

Open Elective

S.No	Paper Code	Paper Name
1.	TOE-051	BIO Chemical Engineering
2.	TOE-052	Surface Coating Technology
3.	TOE-053	Oil Technology
4.	TOE-054	Environmental Economics
5.	TOE-055	Nanotechnology
6.	TOE-056	Colloid Surface and Interfacial Phenomena
7.	TOE-057	Remote Sensing and GIS Applications
8.	TOE-058	Advanced Computational Methods
9.	TOE-059	Nuclear Chemical Engineering

Elective-II

S.No	Paper Code	Paper Name
1.	TCH-021	Fertilizer Technology
2.	TCH-022	Multiphase Reactor Design
3.	TCH-023	Petroleum Engineering
4.	TCH-024	Polymer Science and Technology

Elective-III

S.No	Paper Code	Paper Name
1.	TCH-031	Piping Design
2.	TCH-032	Advanced Separation Techniques
3.	TCH-033	Standardization and Quality Assurance in Chemical Process Industry

Elective-IV

S.No	Paper Code	Paper Name
1.	TCH-041	Project Engineering and Management
2.	TCH-042	Energy Management
3.	TCH-043	Environmental Impact Assessment
4.	TCH-044	Optimization Techniques in Chemical Engineering

MASS TRANSFER I (TCH – 501)

Unit I

Diffusion

Molecular and turbulent diffusion, diffusion coefficient, Fick's Law of diffusion, Dependence of diffusion coefficient on temperature, pressure and composition; measurement and estimation of diffusivity. Diffusion in multi-component gas mixtures. Diffusion in Solids: Molecular, Knudsen & surface diffusion.

Inter- phase mass transfer: Mass transfer coefficients, Diffusion between phases, Equilibrium solubility of gases in liquids, Mass transfer theories, Mass transfer in fluidized beds, Flow past solids and boundary layers, Simultaneous heat and mass transfer.

[8]

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. [8]

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. [8]

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. [8]

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. [8]

Text Books

1. Treybal, R "Mass Transfer Operations", 3rd ed. New York: McGraw-Hill, (1980).
2. Sherwood T. K., Pigford R. L. and Wilke P. "Mass Transfer" McGraw Hill (1975).

Reference Books

1. Foust A. S. et.al., "Principles of Unit Operations" John Wiley (1980).
2. Geankoplis, C.J.. "Transport Processes and Unit Operations", 3rd ed. Prentice Hall. (1993)

CHEMICAL REACTION ENGINEERING I (TCH – 502)

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. [8]

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. [8]

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. [8]

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. [8]

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 [8]

Text Books

1. Levenspiel, O.. “Chemical Reaction Engineering”, 3rd ed. New York John Wiley (1998)

Reference Books

1. Fogler, H.S. “Elements of Chemical Reaction Engineering”, 3rd ed. Prentice Hall (1997).

2. Smith, J. “Chemical Engineering Kinetics “, 3rd edition. McGraw-Hill, . (1990).

CHEMICAL TECHNOLOGY I (ORGANIC) (TCH – 503)

Unit I

Importance and Overview of Chemical Process Industries .Unit operations and Unit process concept .A study of the following chemical industries in relation to their current status (Indian and Global),Production and Consumption Pattern ,Manufacturing process and flow sheet, latest technological developments, Engineering problems, viz Pollution control, materials of construction, corrosion, kinetic aspects, energy conservation and economical status:

Sugar, Glucose, Starch, Fermentation products such as Alcohol , Acetic acid, Citric acid and antibiotics [8]

Unit II

Soap and Surfactants, Glycerin, Fatty acids, Wood chemicals, Distillation products of hard and soft wood, manufacture of paper and pulp, recovery of various chemicals in waste liquor. [8]

Unit III

Insecticides, Pesticides, BHC, DDT, Malathion, Synthetic and natural fibers: Nylon, Dacron, Terylyne, Polyester and other new products, Viscose rayon, acetate rayon with reference to their spinning methods and applications [8]

Unit IV

Natural rubber and synthetic rubber with special reference to vulcanization and reclaiming of rubber, manufacture of synthetic rubber, SBR, Plastics, Thermosetting and Thermo Plastics(PVC, PVA, Polyethylene, Polyurethane, Teflon) [8]

Unit V

Introduction of Hydrogenation of Edible oils, Dye Intermediates and Azo dyes. Petrochemicals(Formaldehyde, Acetaldehyde, Acetic Anhydride, Ethyleneoxide and ethylene glycol) [8]

Text Books

1. Dryden, C. E. "Outlines of Chemical Technology" (Edited and Revised by M.Gopal Rao and Sittig .M) East West Press.Pvt Ltd,New Delhi,3 rd Edition(1997).
2. Austin G. T » Shreve's Chemical Process Industries", 5th ed., McGraw Hill.(1984).

PROCESS DYNAMICS INSTRUMENTATION AND CONTROL (TCH – 504)

Unit I

Classification of measuring instruments, Elements of measuring instruments, Static and dynamic characteristics of instruments, Error analysis. Instruments for the measurement of temperature, Pressure, Liquid level, viscosity, composition of mixture of solids, liquid and gases , humidity and moisture content. Instrumental methods of analysis: pH meter, Conductivity meter, UV/VIS spectrometer, flame photometer, Mass spectrometer, NMR spectrometer . [8]

Unit II

Model of a system in the form of differential equations, Laplace transform of the model, Fundamental blocks in cascade, block diagram transformations, Multiple inputs and block diagram reductions. [8]

Unit III

Fundamentals, signal flow graph algebra , definition , construction of signal flow graphs, algebra , general input – out put gain formula. Transfer function of cascade components, Block diagram reduction using signal flow graphs. [8]

Unit IV

Study of various kinds of inputs, response to various inputs and transient analysis of simple control system. Approximation at appoint. Non linear chemical kinetics , Time varying coefficients, linearization in simultaneous equations, offset and final value theorem, integral control. [8]

Unit V

Introduction to frequency response. Control system design by frequency response, closed loop response by frequency response methods. Nyquist diagram. [8]

Text Books

1. Coughanower, D.R. “Process Systems Analysis and Control”, 2nd ed. McGraw-Hill, Inc(1991).

Reference Books

1. Ceagalske N.H., “Automatic Process Control for Chemical Engineering” Wiley Eastern.
2. Stephanopoulos, G. “Chemical Process Control: An Introduction to Theory and Practice”. New Jersey: Prentice Hall (1991).

CHEMICAL ENGG. THERMODYNAMICS - II (TCH – 505)

Unit I

Introduction to Molecular Thermodynamics, Molecular theory of fluids, Virial coefficient from potential function, Internal energy of ideal gases, Microscopic view, Thermodynamic properties and statistical mechanics, Hydrogen bonding, Behaviour of excess properties, Molecular basis for mixture behaviour ,VLE by molecular simulation. [8]

Unit II

Vapor-liquid Equilibrium: Introduction, Nature of equilibrium, Phase rule, Duhem theorem, VLE qualitative behavior, Models for Vapor/liquid equilibrium, Raoults law and K value correlation. [8]

Unit III

Solution Thermodynamics: Theory and applications, Fundamental property relation, Chemical potential, Partial properties, Ideal gas mixtures, Fugacity and fugacity coefficient: pure species, species in solution, Generalised correlation, Ideal solution, Excess properties, Models for excess Gibbs Energy. Property changes due to mixing. [8]

Unit IV

Phase Equilibrium Gamma/Phi formulation of VLE, VLE from cubic equation of state, Equilibrium and stability, LLE, VLLE, SLE, SVE, Adsorption of gases on solids, Osmotic equilibrium and osmotic pressure. [8]

Unit V

Heat Effect and Chemical Reaction Equilibria: Sensible heat effects, Latent heats, Heats of reaction, formation, combustion, Heats effects in industrial reactions, Reaction coordinates, Equilibrium criteria to chemical reaction, equilibrium constant and effect of temperature on it and its evaluation, Equilibrium conversion, Theorems for reacting systems, Multi -reaction equilibria. [8]

Text Books

1. Smith, J.M., Van Ness, H.C. & Abbot, M.M. "Intro to Chemical Engineering Thermodynamics", 5th edition. New York: Mc-Graw Hill (1996)"
2. Daubert T.E., "Chemical Engineering Thermodynamics" McGraw Hill (1986).

Reference Books

1. Y.V.C.Rao," Chemical Engineering Thermodynamics" University press (1997).

CHEMICAL REACTION ENGINEERING LAB (TCH – 551)

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.
9. To study the residence time distribution (R.T.D.) in a plug flow reactor.
10. To study the decomposition of calcium carbonate
11. To determine the energy of activation of a given chemical reaction.

PROCESS DYNAMICS AND CONTROL LAB(TCH – 552)

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

SEMINAR (TCH-553)

The students are required to submit and present a dissertation report on the current topics of industrial importance other than the topics of their project

MASS TRANSFER – II (TCH – 601)

Unit I

Distillation

Pressure-composition, Temperature-concentration, Enthalpy-concentration diagrams for ideal and non-ideal solutions, Raoult's law and its application, Maximum and minimum boiling mixtures, concept of relative volatility.

Single Stage Distillation

Differential distillation, Flash vaporization Vacuum, molecular and steam distillation.

[8]

Unit II

Continuous Distillation of Binary Mixtures

Multistage contact operations, Characteristics of multistage tower, McCabe Thiele method, Ponchon Savarit method, Reflux, maximum, min. 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.

[8]

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.

[8]

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.

[8]

Unit V

Adsorption

Description of adsorption processes and their application, Types of adsorption, Nature of adsorbents adsorption equilibria and adsorption hysteresis, 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. [8]

Text Books

1. Treybal, R “Mass Transfer Operations”, 3rd ed. New York: McGraw-Hill, (1980).
2. Sherwood T. K., Pigford R. L. and Wilke P. “Mass Transfer” McGraw Hill (1975).

Reference Books

1. Foust A. S. et.al., “Principles of Unit Operations” John Wiley (1980).
2. Geankoplis, C.J.. “Transport Processes and Unit Operations”, 3rd ed. Prentice Hall. (1993)

CHEMICAL REACTION ENGINEERING - II (TCH – 602)

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.

[8]

Unit II

Heterogeneous Catalysis

Nature of catalysis, Adsorption isotherms, Mechanism of catalytic reactions, Physical properties of solid catalysts. Preparation testing and characterization of catalysts, Catalyst selection, Catalyst poisoning. [8]

Unit III

External Transport Process

Reaction and diffusion within porous catalysts, Effective diffusivity, Thermal conductivity and effectiveness factor. Reactor choice for single and multiple reactor system and recycle reactor

Stability of Reactors

Non - isothermal design of ideal reactor, Hot spot in tubular reactor, Steady state multiplicity and effect of operating variables on the stability of C.S.T.R.

[8]

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. [8]

Unit V

Non elementary reactions and reactor design, biochemical reaction system, Enzyme fermentation, Microbial fermentation, polymerization reactors [8]

Text Books

1. Smith, J. "Chemical Engineering Kinetics", 3rd edition. McGraw-Hill, . (1990).

Reference Books

1. Fogler, H.S. "Elements of Chemical Reaction Engineering", 3rd ed. Prentice Hall (1997).

2. Levenspiel, O.. "Chemical Reaction Engineering", 3rd ed. New York John Wiley (1998)

CHEMICAL TECHNOLOGY – II (INORGANIC) (TCH – 603)

A study of the following chemical industries in relation to their current status (Indian and global), production and consumption pattern, manufacturing process, latest technological developments, engineering problems viz pollution control, material of construction, corrosion, kinetics aspects, energy conservation etc. and economic status. These industries have been distributed in the following units:-

Unit I

Chlor-alkali industry: Common salt, Caustic soda and Chlorine, Soda Ash, Hydrochloric acid. [8]

Unit II

Sulfur Industry: Sulfur and sulfuric acid, Oleum Phosphorus Industry: Phosphorus, Phosphoric acid and super phosphates [8]

Unit III

Nitrogen Industry: Ammonia, Nitric acid, Urea and other nitrogen fertilisers, Mixed fertilisers (SSP, TSP, NPK, KAP, DAP, Nitrophosphate) Bio fertilizers. [8]

Unit IV

Industrial Gases: Oxygen, Nitrogen, Hydrogen Inert gases, Syngas, Ceramic Industry, Cement, Glasses and Refractories. [8]

Unit V

Miscellaneous Industries: Graphite and industrial carbon, Alum, Sodium compounds, Magnesium chloride, Silicon carbide, Potassium salts. Paint, Pigments, Varnishes & intermediates, Iodine, Hydrogen peroxide and Uranium. [8]

Text Books

1. Dryden, C. E. "Outlines of Chemical Technology" (Edited and Revised by M.Gopal

- Rao and Sittig .M) East West Press. ,New Delhi,3 rd Edition(1997).
2. Austin G. T » Shreve's Chemical Process Industries", 5th ed., McGraw Hill.(1984).

Reference Books

1. Faith, W. L., Keyes, D. B. and Clark, R. L., "Industrial Chemicals" John Wiley.(1975).
2. Kirk and Othmer, "Encyclopaedia of Chemical Technology" Wiley (2004).
3. Pandey G.N & Shukla.S.D, "Chemical Technology Vol - I" Vikas publication.

ENERGY RESOURCES AND UTILIZATION (TCH – 604)

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, [8]

Unit II

Alternative Sources of Energy

Fuel cell ,Solar Energy : Photo thermal and photovoltaic conversion and utilisation 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 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 [8]

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. [8]

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. [8]

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), Biodisel. [8]

Text Books

1. Brame J.S.S. and King J.G., Edward Arnold "Fuel Solid, Liquid and Gases" Edward Arnold (1967).
2. Sukhatme S.P, "Solar Energy - Principles of Thermal Collection and Storage", 2nd Ed., Tata McGraw- Hill., (1996).

PROCESS EQUIPMENT DESIGN (TCH – 605)

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.

[8]

Unit II

Design of non-pressure storage vessel, tall vertical vessels, unfired pressure vessels with internal pressure: storage vessels and process vessels.

[8]

Unit III

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.

[8]

Unit IV

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

[8]

Unit V

Mechanical design of selected process equipments such as heat exchangers, Evaporators, Distillation columns, Absorbers, Reactors and Dryers and Crystallizers.

[8]

Text Books

1. Peters Max. S., Timmerhaus Klaus D. and Ronald E West "Plant Design and Economics for Chemical Engineers". 2003 V Edition McGraw Hill.
2. Coulson, J. M. and Richardson J. F. "Chemical Engineering", vol. 6 Pargamon Press. (1989).
3. Brownel and Young, "Process Equipment Design ". Wiley (1968).

Reference Books

1. Indian and American Codes Used in Designing of equipments (TEMA and IS Codes)
2. Evans, F. L., "Equipment Design Handbook", Gulf Publishing Company. (1979).

MASS TRANSFER LAB (TCH –651)

1. To carry out the continuous fractional distillation with the Bubble Cap Distillation Column and to establish the overall efficiency of the column operation and to calculate the number of trays in the column.
2. To determine separation factor for differential distillation.

3. To determine the vapor-liquid equilibrium curve for various systems.
4. To determine the yield and effect of various process variables on the yield in a batch crystallizer.
5. To study the effect of various systems parameters like: solvent temperature, solvent rate and particle size on the % recovery of oil from oil seeds.
6. To calculate the mass transfer coefficient for diffusion of solid in air diffusion.
7. To calculate the mass transfer coefficient for diffusion of liquid in air diffusion.
8. To plot rate of drying curve and determine critical moisture content for drying of solids in a forced draft tray dryer.
9. To study the performance of spray dryer.
10. To determine the mass transfer coefficient and height of packing for a packed bed absorption column.
11. To determine the mass transfer coefficient and number of plate in a sieve plate absorption column.
12. To study the performance of packed bed in liquid-liquid extraction column.
13. To study the performance of an ion exchange resin in a packed bed.
14. To study the effect of operating variable in Reverse Osmosis.
15. To study the effect of operating in Ultra filtration

ENERGY LAB (TCH – 652)

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. Performance of solar water heater
7. Performance of solar air heater
8. Performance of electrochemical storage
9. Performance of solar water pump
10. Performance of solar regenerator

CHEMICAL TECHNOLOGY LAB (TCH-653)

Preparation and Quality evaluation of following items :-

1. Cement Paint..
2. Dry Distemper.
3. Oil bound Distemper.
4. Plastic Emulsion Paint.
5. Polystyrene by Bulk Polymerization Technique.
6. PMMA by Bulk Polymerization Technique.
7. Transparent Soaps
8. Powdered Detergent.
9. Liquid Detergent

10. Washing Soap

ENVIRONMENTAL POLLUTION MONITORING AND CONTROL (TCH –701)

Unit I

Introduction

Ecology & Environment, Biodiversity, Interaction of man and environment, Overall picture of environmental pollution, Ambient air and water quality criteria, Standards and Acts-Indian, EPA& EURO, Effects and control of noise, thermal and radioactive pollution. [8]

Unit II

Air Pollution

Types of pollutants – Natural and man made air pollutants, Dispersion of pollutant in the atmosphere, Gaussian dispersion model, Meteorological factors, Stability and inversion of atmosphere, Plume behaviour, Control of air pollution from stationary and mobile sources, Methods of measuring and sampling of gaseous and particulate pollutants in ambient air and industrial waste gases, measurement of smoke density and visibility .Control of gaseous pollutants-SO_x,NO_x,H₂S,VOCS,Auto exhaust.

Stack design, Classification, selection and design of equipment's like cyclones, electrostatic precipitators, bag filters, wet scrubbers, settling chambers. [8]

Unit III

Water Pollution

Waste water characteristics – Physical and chemical composition, Biochemical oxygen demand (BOD), Pathogenic bacteria and chemical toxicity. Types of pollutants in waste water of chemical industries, Methods of sampling, preservation of samples and analysis. Methods for the treatment of liquid wastes to control pollution, Classification viz. physical, chemical and biological methods, Selection and design of equipment like hydrocyclone, settling tanks, filters, ion- exchange. [8]

Unit IV

Solid Wastes Management

Characterisation of solid wastes, Problems of collection and handling, Various processing techniques used in solid waste management such as compaction ,incineration, Composting, landfills and biological processing, Solid waste as resource material. [8]

Unit V

Pollution abatement in important chemical industries like fertiliser, petroleum refineries and petrochemicals, Pulp and Paper, Pharmaceuticals, Tannery, Sugar, Distillery, food processing , cement and electroplating. [8]

Text Books

1. Howard S. Peavy, D. R. Rowe & C. Tchobonoglous “Environmental Engineering”, McGraw Hill (1984).
2. Metcalf & Eddy, “Waste Water Engineering Treatment, Disposal & Reuse”, Tata McGraw Hill(2003).

Reference Books

1. Werner Strauss, ‘Air Pollution Control: Measuring and monitoring air pollutant’ Wiley (1978).
2. Werner Strauss, ‘Air Pollution Control part -II “ Wiley (1978).’
3. Pandey G. N. and Carney G. C., "Environmental Engineering ". Tata McGraw Hill (1991).

MATERIAL TECHNOLOGY (TCH – 702)

Unit I

Factors affecting the selection of materials for constructional purpose in chemical industries, Metallic and non-metallic materials of construction., Ferrous and non-ferrous metals. [8]

Unit II

Cold and hot working of metals and their effects on mechanical properties.
Binary equilibria involving solid solution, eutectic and peritectic system, Cu-Ni, Cu-Zn, Fe-C diagrams.
Corrosion, types, mechanism and method of prevention and control. [8]

Unit III

Mechanical properties of various materials General principle of heat treatment, TTT curves, annealing, normalizing, hardening, tempering and age hardening
Ferrous Metals:
a) Cast Iron: Gray and white cast iron malleable, mechanite and nodular cast iron.
b) Plain Carbon Steel: Classification properties and applications.
c) Alloy Steels: Stainless steels, ferritic, authentic and martensitic, mechanism of development of corrosion resistance in austenitic stainless steel, application of stainless steel in chemical industries, alloy tool steel, ultra high strength steels. [8]

Unit IV

Non-Ferrous metals:

Copper, brasses, bronzes, aluminium, their mechanical properties, workability and applications, corrosion resistance.

Non-metallic materials of construction

a) Ceramics: Various types specially glasses and refractories, properties and applications.

b) Polymers: Comparison of properties of various polymers and their relationship with chain structure, some application in chemical industries. [8]

Unit V

Innovative & new materials, Optical fibres, Super conductors & Nanomaterials. [8]

Text Books

1. Hazara & Chaudhary, "Material Science & Processes".

Reference Books

1. William D. Callister, Jr., William D. Callister "Materials Science and Engineering: An introduction" 6th Edition Wiley (2002).
2. Van Black "a text book of material science"
3. Charles P. Poole, Frank J. Owens "Introduction to nano technology" Wiley Interscience (May 2003)
4. Perry, R.H., and Green, D.W., "Perry's Chemical Engineers' Handbook", 7 ed., McGraw-Hill, New York, 1997.

PROCESS ENGINEERING COSTING AND PLANT DESIGN (TCH –703)

Unit I

Process Development

Process selection, study of alternative processes, pilot plant, Scale up methods, Flow sheet preparation, sketching techniques, Equipment numbering, Stream designation, Material and energy balances.

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. [8]

Unit II

Cost Engineering

Time value of money and equivalence, Interest, cost comparisons by present worth, Annual equivalent cost and capitalised 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. [8]

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. [8]

Unit IV

Economic Optimization and Optimum Design

Nature of optimisation, Uni-variable 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. [8]

Unit V

Optimisation of Different Process Equipment

Viz., transportation systems, heat exchangers, evaporators, mass transfer equipments and reactors. Determination of height and diameter of different process equipments at conditions of optimum cost .Pinch Technology analysis. Preparation of techno-economic feasibility report. [8]

BIOCHEMICAL ENGINEERING (TOE-051)

Unit I

Biochemical Engineering and its role in the development of modern fermentation process [8]

Unit II

classification of unipollular micro organism. General description of yeasts bacteria, and mold structure of cell. [8]

Unit III

Oxygen supply and demand in serobio fermentation, Kinetics of enzymatic reaction batch and continuos fermentation, Principales and mechanism of thermal sterlization and sterlization by filtration. [8]

Unit IV

A introduction to biological waste treatment. [8]

Unit V

Economic activities of micro organism. Production of industrial and potable alcohol by yeast. Acetic acid and antibiotics such as pencilline and streptomycin. [8]

SURFACE COATING TECHNOLOGY (TOE-052)

Unit I

History and development of paint industry, paint its definition, function and classification. [8]

Unit II

Raw material for industry, drying oils, bodies oils natural and synthetic resins, pigments and extenders. [8]

Unit III

Auxiliaries like driers, plasticisers, softeners, dispersing and flattening agents varnishes and lacquers, [8]

Unit IV

formulation and manufacturing of paints, machinery used in paint manufactures, methods of application, [8]

Unit V

Applications of industrial and architectural finishes. Common defects in paint and varnishes. [8]

OIL TECHNOLOGY (TOE-053)

Unit I

General survey of oils and oil based industries sources of oils and fats, Their classification, General properties and utilization, composition of glycerides. [8]

Unit II

Non-glyceride components of oils & fats, Fatty acids & waxes, Methods of introduction of oil fats, extraction solvents and extraction rendering. [8]

Unit III

Refining and hydrogenation of oils, vanaspati, margarine, Shortening [8]

Unit IV

Soaps raw materials and methods of manufactures, introduction to synthetic detergents [8]

Unit V

Fat splitting, fractionation of fatty acids and recovery of glycerin, Essential oils and cosmetics. [8]

ENVIRONMENTAL ECONOMICS (TOE-054)

Unit I

Economy and Environment

Economic operation and environmental issues, environmental pollution and sources, adversities on the economy.

Markets and Environmental Assets

Incomplete markets, externalities, non-exclusion, non-rivalry and public good, non-convexities, asymmetric information. [8]

Unit II

Economic Incentive and Environmental Protection

- (i) Price rationing: Charges and subsidies
- (ii) Liability rules: Non-compliance fees, bonds and deposit refunds.
- (iii) Quantity rationing: Marketable permits.
- (iv) Evaluation criteria
- (v) Practical Conditions for use of economic incentives. [8]

Unit III

Pollution Taxes

Efficiency properties of a tax on emissions, problems with pollution taxes. [8]

Unit IV

Tradable Pollution Permits

Basic theory of tradable pollution permits, issues in tradable permits.

Transboundary pollution problem, international organizations for environmental protection. WTO agreements on environment.

Agrochemical pollution and measures undertaken: national and international scenario, bio-diversity and economy. [8]

NANOTECHNOLOGY (TOE-055)

Unit 1

Introduction to soft materials, intermolecular forces and surface instabilities in soft materials [8]

Unit II

Soft materials and their properties, ways to control and measure the properties of soft materials. [8]

Unit III

Intermolecular forces, vanderwaals, acid base, double layer and other forces, their decay behavior and measurement. [8]

Unit IV

Surface instabilities, conditions for onset of surface instability. [8]

Unit V

Morphological changes during evolution of instability, ways to tune this evolution to result in desired morphology. [8]

COLLOID SURFACE AND INTERFACIAL PHENOMENA (TOE-056)

Unit I

Introduction and classification of colloidal system, characteristics and kinetics, capillarity, interfacial thermodynamics. [8]

Unit II

Liquid gas and liquid -liquid interfaces, surface and interfacial tension, adsorption and orientation at interfaces, micelle formation, contact angle, wetting and adhesion, floatation. [8]

Unit III

Detergency and surfactants, stability of multiphase system, foam and emulsion. [8]

Unit IV

Colloidal forces, vanderwalls attraction, electrical double layer repulsion, stability and coagulation of colloids, nucleation and growth. [8]

Unit V

Applications of colloids and interfacial phenomena in chemical engineering. [8]

Text book

1. Heimenz , P.C. ,”Principles of surface colloid chemistry”, 2nd Edition, Marcel Dekker, New York.

REMOTE SENSING AND GIS APPLICATIONS (TOE-057)

Unit I

Remote sensing – Introduction, Sources of energy for remote sensing – active and passive sources, electromagnetic radiation, atmospheric windows and their characteristics, interaction of EMR with earth surface – spectral reflection curves. Multi concept of remote sensing, idealisms and real sequence of remote sensing, sensors and orbital characteristics. [8]

Unit II

Various sensing platforms for remote sensing, principle of remote sensing devices (RBV, MSS, LISS), IRS and other sensing systems such as Landsat and Spot, Remote sensing data products and their uses. [8]

Unit III

Geographic Information System (GIS) – Introduction, Geographical concepts and terminology, Components of GIS. Data acquisition, Raster and vector formats, Scanners and digitizers, Methods of digitization, Data pre – processing, form conversion, Data reduction and generalization. [8]

Unit IV

Attribute database: Database structures. Conventional and spatial database management systems. Data merging, Edge matching, registration and resampling, Data manipulation and analysis. [8]

Unit V

Representation of real world problems, Problem solving and spatial modeling. Classification, Aggregation, overlay, buffers and intervisibility. Network Analysis, Application of GIS in planning of utility lines, Water resources, Erosion modeling, Environmental Impact Assessment. [8]

Text Books

1. Sabins, R. F., Remote Sensing, Principles & Interpretation.
2. Lillsend T. M. & Kiefer R. W., Remote Sensing and Image Interpretation.

Reference Books

1. M. Aryreddy, Remote Sensing and Geographical Information System. BSP Publication, Hyderabad.
2. Kang Tsung Chang, Geographical Information System. Tata McGraw Hill Publication.

ADVANCED COMPUTATIONAL METHODS (TOE-058)

Unit I

System of linear algebraic equations: Gauss Elimination and LU Decomposition, Gauss Jordan Elimination, Gauss Seidel and relaxations methods, Jacobian method, Thomas algorithm, special techniques for solution of sparse matrices, stability conditions, Eigen values and eigen vectors of matrices, Faddeev – Leverriers method, power method, householders and Givens method for Computing eigen values of a matrix. [8]

Unit II

Non Linear algebraic Equations : Roots of a single variable equation, Methods of Successive substitution, Newton Raphson, Secant, Regula Falsi, Incremental search, Bisection and Golden search solution of non linear equation- Methods of successive substitution and Newton Raphson for Multivariable problems. Special techniques for obtaining roots of a polynomial, Lin and Bairstows method of finding complex conjugate roots. Catastrophe and singularity theories for finding number of roots of a single variable nonlinear function. [8]

Unit III

Solution of Ordinary Differential equations : Initial value Problems- Explicit Adams Bashforth and Implicit Adams Moulton Techniques, General Multistep integration methods for multivariable Ordinary Differential equations, Predictor corrector techniques Explicit and semi implicit Runge kutta methods. Step size, error, estimation and stability criteria. Stiffness, Gears technique for shift equation. [8]

Unit IV

Boundary Value Problems- Finite difference, Orthogonal collocation, Galerkin finite element and shooting techniques. [8]

Unit V

Solution of partial differential equations (PDEs)-elliptic, parabolic and hyperbolic PDEs
Finite difference technique –method of lines, Crank-nicholson methods orthogonal collocation techniques orthogonal collocation on finite elements and Galerkin finite element methods. [8]

Text book

Gupta S.K. “Numerical methods for Engineers” New age publication

NUCLEAR CHEMICAL ENGINEERING (TOE-059)

Unit I

Nuclear fission and fusion, types and classification of nuclear reactors, nuclear fuels, other reactor materials, fuel processing flow sheet, chemical processes for nuclear power industries, separation of reactor products, nuclides, radioactivity, decay chains, neutron reactions, fission process, growth and decay of fission products in a reactor with neutron burnout and continuous processing. [8]

Unit II

Make up of reactor, reactor fuel process flow sheet, irradiation schemes, neutron balance feed requirements and fuel burn up for completely mixed fuels with no recycle. [8]

Unit III

feed requirements and fuel burn up for completely mixed fuels-plutonium recycle feed requirements and fuel burn up and reactivity changes for unmixed fuel, flow sheets for uranium 235,238 fuel cycle, single region thorium breeder. [8]

Unit IV

Production of uranium feed materials. Solvent extraction of metals. Properties of irradiated fuels. [8]

Unit V

Uses of stable isotopes and methods of isotope separation. Principles of isotope separation. separation of isotopes of light and heavy elements. [8]

Text book

Vanson benedict and Thomas H Pigford “Nuclear chemical Engineering ”Mcgraw hill

FERTILIZER TECHNOLOGY (TCH-021)

Unit I

Introduction of Indian fertilizer industries, types of fertilizers process details. [8]

Unit II

Manufacture of Nitrogenous, Phosphatic, potassic, complex, NPK, mixed, Dio and other fertilizers. [8]

Unit III

Discussion of existing Indian plants pollution and its control, abatement and disposal of waste of fertilizer units. [8]

Unit IV

Retrofits and modernization, computer control and Instrumentation, Energy conservation and diversification. [8]

Unit V

Design of Ammonia converters and other reactors, cooling water, expansion, capacity utilization and other problem of fertilizers industry. [8]

MULTIPHASE REACTOR DESIGN (TCH-022)**Unit I**

Basic data and principles for design, Interpretion of data from laboratory. [8]

Unit II

Batch, C.S.T.R. and Tubular flow reactors, Accuracy of Kinetic Measurements, Thermodynamic aspect of chemical reactions. [8]

Unit III

Summary of catalyst preparation methods, Catalyst characterization. [8]

Unit IV

Establishing global rate of reaction, Mass & Energy balance equation for reactors. [8]

Unit V

Reactor design using Global rates and actual temperature and connection profile. [8]

PETROLEUM ENGINEERING. (TCH-023)**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). [8]

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. [8]

Unit III

Petroleum Products

Composition, Properties & Specification of LPG, Naphthas, motor spirit, Kerosine, Aviation Turbine Fuels, Diesel Fuels, Fuel Oils, Petroleum Hydrocarbon Solvents, Lubricating oils (automotive engine oils, industrial lubricating oils electrical insulating oils, Jute Batching oils, white oils, steam turbine oils, metal working oils, etc.) Petroleum Waxes Bitumens, Petroleum coke.

Crude Oil Distillation

Desalting of crude oils, Atmospheric distillation of crude oil, Vacuum distillation of atmospheric residue.

Thermal Conversion Process

Thermal Cracking Reactions, Thermal Cracking, Visbreaking, (Conventional Visbreaking and Soaker Visbreaking) Coking (Delayed Coking, Fluid Coking, Flexicoking), Calcination of Green Coke. [8]

Unit IV

Catalytic Conversion 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; Merox processes;Sulphuric acid treatment; Clay treatment); Solvent extraction processes (Edeleanu process, Udex process, Sulfolane process), Hydrotreating processes. [8]

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). [8]

POLYMER SCIENCE AND TECHNOLOGY (TCH-024)

Unit I

High Polymeric materials and their micro molecular nature (e.g. plastics, rubber cellulose, starch, protein,etc.),Concept of polymeric structure such as linear network, classification of polymers thermoplastics and thermo sets. Electrical, Mechanical and Thermal properties of polymers. [8]

Unit II

Raw materials for the plastics industry including monomers auxiliaries like fillers, plasticisers, etc. scope of polymeric industries including plastics, rubber paints, feed etc. cost and availability of plastic materials. [8]

Unit III

Principle of addition and condensation polymerization. Different methods of bulk polymerization, solution, suspension, emulsion ect. Chemical & physical methods of processing of polymer. [8]

Unit IV

Chemistry and manufacturing process of some important plastics such as Phenol formaldehyde, urea-formaldehyde polyolefins. [8]

Unit V

Chemistry and manufacturing process of polyvinyls, polystyrene, and polymethacrylates etc. synthetic fibbers. [8]

ENVIRONMENTAL POLLUTION MONITORING AND CONTROL LAB (TCH – 751)

1. To determine the pH and total solids in a given effluent sample
2. To determine the total dissolved solids and total suspended solids in a given effluent sample
3. To determine the hardness in a given water sample.
4. To determine the chloride ion in a given sample.
5. To determine the sulphate ion in a given sample.
6. To determine the chromium (tri & hexa) a given effluent sample.
7. To determine the COD in a given effluent sample.
8. To determine the sulphide ion in a given sample

9. To determine the nickel content in a given sample
10. To determine the iron content in a given sample
11. To determine BOD & DO in a given sample
12. To study the Reduction in solid contents using flocculent's like alum
13. To analyse the automobile/diesel engine exhaust.
14. To monitor noise level in workshops/lecture room/cafeteria.

INDUSTRIAL TRAINING (TCH-752)

The students are required to undergo inplant training in some chemical industry for a six weeks period during their summer vacations following VI semester. He/ she is required to collect information's relating to process details and other information's related to process material, utilities and their properties to prepare a report to be submitted to the department. The student would be assessed in the VII semester through a Viva-voce to be conducted by the teacher incharge training of Chemical Engineering Department.

PROJECT(TCH -753)

The student would be allotted a project in the beginning of the VII semester itself. The project will be based on the industry where he/she has undergone inplant training in industry during summer vacations. He/She would be expected to submit a detailed plant design report later in the (VIII) semester for the project course(CH-851). In this semester he/she will be assessed (out of 50 marks) for the work that he/she does during the seventh semester under the supervision of a faculty of the department.

ELEMENT OF ECONOMICS AND PRINCIPLES OF MANAGEMENT (THU-805)

Unit I

Consumer Behaviour

Concept of utility and principle of utility; Law of demand, elasticity of demand
Indifference curve analysis; consumer surplus.

Production Behavior

Concept of production, factors of production; Law of variable proportions; Law of return to scale; Cobb-Douglas production function ;Structure of cost of production. [8]

Unit II

Monetary and International Economics

Concept of money, demand and supply of money; Inflation and De### measures to control inflation ;Theories of international trade, tariff, globalization and liberalization;World Trade Organization (WTO) and International trade. [8]

Unit III

Management

Concept of scientific management; General and strategic Management; Management techniques. Human Resource Management : Human resource planning, job enrichment, job design, performance management, leadership, motivation. [8]

Unit IV

Financial Management

Limited liability company – concept and formation, private limited and public limited companies; Capital structure of a limited company, shares, debenture and bonds. [8]

Unit V

Marketing Management:

Concept of marketing and product planning; Sales forecasting, Product life-cycle analysis, Data-base marketing, marketing mix.

Operations Management: Concepts of manufacturing system; Computer-aid design; Computer aided manufacturing; Production, planning and control systems; Layout planning; Flexible manufacturing system. Labour laws, legislation & policies. [8]

Text Books

1. Horne, James C. Van “Fundamentals of Financial Management”, Prentice Hall of India Private Ltd. New Delhi (1990).
2. Armstrong Michael, “A Handbook of Management Techniques” Kogan Page Limited (1995).

Reference Books

- 1 Koder P., “Marketing Management” 7th ed., Prentice Hall, Englewood Cliffs (1991).
2. Koufsoyiannis A., “Modern Microeconomics” ELBS, English Language Book Society/
3. Ahuja H.L. “Advanced Economic Theory” New Delhi S. Chands & Co., (1976).
Macmillan, Hongkong.
4. Agarwal S. P. and Jain P. C. “Advanced Financial Accounting: Theory and Practice”
Wiley Eastern Ltd. New Delhi.

PROCESS MODELLING AND SIMULATION (TCH-801)

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. [8]

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. [8]

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. [8]

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. [8]

Unit V

Introduction to flow sheet simulation; Sequential modular approach; Equation oriented approach; Partitioning and tearing; Recycle convergence methods; Review of thermodynamic procedures and physical property data banks. [8]

Text Books

1. Luyben W.L., "Process Modeling, Simulation, and Control for Chemical Engineering", Wiley.
2. M.M. Denn, "Process Modelling", Wiley, New York, (1990).

Reference Books

1. Hussain Asghar, "Chemical Process Simulation", Wiley Eastern Ltd., New Delhi, (1986)
2. C.D. Holland and A.I. Liapis, "Computer Methods for Solving Dynamic Separation Problems", McGraw Hill, (1983).
3. C.D. Holland, "Fundamentals of Modelling Separation Processes", Prentice Hall, (1975)
4. S.M. Walas, "Modelling with Differential Equations in Chemical Engineering", Butterworth, (1991)
5. M.E. Davis, "Numerical Methods and Modelling for Chemical Engineers", Wiley, New York(1984)

PROCESS UTILITIES AND SAFETY IN CHEMICAL PLANTS (TCH – 802)

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. [8]

Unit II

Steam Generation and Utilization

Steam generation and its application in chemical process plants, distribution and utilisation ;Design of efficient steam heating systems; steam economy, Steam condensers and condensate utilisation Expansion joints ,flash tank design, steam traps their characteristics, selection and application, waste heat utilisation.; Lagging, selection and thickness .Selection and sizing of boilers; waste heat boilers. [8]

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. [8]

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. [8]

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. [8]

Text Books

1. Nordell, Eskel, "Water Treatment for Industrial and Other Uses", Reinhold Publishing Corporation, New York.(1961).
2. Crowl, D.A. & Louvar, J.F.. "Chemical Process Safety: Fundamentals with Applications". New Jersey: Prentice-Hall. (1989).
3. Goodall, P. M., "The Efficient Use Of Steam" IPC Science and Technology (1980).

Reference Books

1. Lees, F. P., "Loss Prevention in Process Industries 3 volume set" Butterworth - Heinemann, Oxford (1996).

PIPING DESIGN (TCH-031)

Unit 1

Analysis of pipe flow

Energy losses in pipe lines, concept of equivalent length and equivalent pipes, problems in pipe flow, hydraulic power transmission through a pipe line. [8]

Unit 1I

Negative pressure in pipe lines, Siphon, Multiple pipe systems, working pressure, design pressure, choice of pipe materials, hydraulic analysis of complex pipe networks. [8]

Unit 1II

Aids in selecting pipe valves and fittings, standards for piping design, Dimensional and mechanical standards for pipe valves and fittings. [8]

Unit 1V

Process piping arrangement

plant layout and equipment arrangement, criteria for equipment layout, piping layout and arrangement. [8]

Unit 1V

Pipe fabrication, vibration, its prevention and control in piping systems. [8]

Books Recommended

1. King, R. C. and Croker, S., "Piping Handbook", McGraw Hill.
2. Kellogg, M. W Company., "Design of Piping Systems", Pullman Power Products, New York (1976).

ADVANCED SEPARATION TECHNIQUES (TCH-032)

Unit I

Uses and characterization of separation processes, equilibrium and rate governed multistage processes. [8]

Unit II

ideal cascades total interstage flows, squared off cascades, separative duty and potential, energy requirement for separation processes. [8]

Unit III

Membrane characterization, Gas permeation through polymeric membranes, Liquid membrane separation processes, reverse osmosis , Concentration polarization. [8]

Unit IV

Dialysis, Ultra filtration, Electro dialysis. [8]

Unit V

Chromatographic separation, molecular sieve separations. [8]

STANDARDIZATION AND QUALITY ASSURANCE IN CHEMICAL PROCESS INDUSTRY (TCH-033)

Unit I

Utility of standard; Standards for material consumption; Standards for equipment; Standards for manual work; Standards for financial returns, Qualitative standards. [8]

Unit II

Approach to standardization, Objective of the system, Idealized model for national standard system, Case studies of national standards systems. [8]

Unit III

Inspection and Quality Control:- Objective, Function of inspection, Elements of quality, Objective of statistical quality control; Function of S. Q. C; Control charts, Concept of sampling; Concept of zero defects. [8]

Unit IV

Study of different standards followed by the chemical industry. [8]

Unit V

Role of technology transfer in standardization; Modern trends in standardization. [8]

PROJECT ENGINEERING AND MANAGEMENT (TCH-041)

Unit I

Role of project engineering in project organisation ;Plant location and plant layout; Start up and shut downs of project; Preliminary data for construction projects; Process engineering; Flow diagram, Plot plans, Scheduling the project; Engineering design and drafting. [8]

Unit II

Business and legal procedures **Procurement operations:** Organisation and operation of a procurement department, Contract versus Commodity buying; Procurement requiring engineering participation, Procurement of off-the-shelf materials, Expediting and inspection, Procurement procedure, Bid comparisons, The purchase order inspection, Expediting, General purchaser-vendor practices, Project engineering and procurement. Office procedure: Conferences, Technical writing, Filing systems, Contracts and contractors: Engineering and constructors firms, Selecting the contractor, The basis of contract, Type of reimbursement, The contract form, Exhibits, Overtime payments, Typical engineering and construction contracts, Exhibits for engineering and construction contracts, Lump-sum contract form, Contracts and engineers, Ethics and the contract.

[8]

Unit III

Details of engineering design and equipment selection: Vessels, Heat exchangers, Process pumps, Compressor and Vacuum pumps, Motors and turbines, Other process equipment, Piping design, Thermal insulation, Process instruments, Plant utilities, Foundations, Structures and buildings, Safety and plant design.

[8]

Unit IV

Construction planning: Construction personnel: Jurisdictional disputes and labour relations, Construction labours distribution, Labour rates. Construction operations: Site preparation, Driving of pile, Temporary buildings, Temporary water supply, Road ways and rail road spurs, Excavation operation, Installation of underground facilities, Electrical conduit, Foundation construction, Erection of guyed derrick, Erection of elevated reinforced concrete structures and structural steel, Erection of major equipment, Installation of piping, pipe identification, insulation, Buildings, final stage of construction.

[8]

Unit V

Critical path method (cpm): Events and activities; Network diagramming; Earliest start time and earliest finish time ;latest start time and latest finish time; Float, Advantage of CPM ;Cost to finish the projects earlier than normal cost; Precedence diagramming. Programme evaluation and review technique (pert): PERT network and time estimates; Single versus multiple time estimates; Frequency distribution.

[8]

Text Books

1. Rase F. Howard & Barrows M. H., "Project engineering of process plant" Wiley (1957)

Reference books

1. Peter S. Max & Timmerhaus, Plant design and economics for chemical engineers. Mc Graw Hill (2002).
2. Srinath L. S., "PERT AND CPM." affiliated east press pvt. Ltd., new york (1973)
3. Perry J. H., "Chemical engineering handbook" 7TH ed. Mc Graw Hill (1997).
4. JELLEN F. C., "Cost and optimization in engineering". Mc Graw Hill (1983).

ENERGY MANAGEMENT (TCH-042)

Unit 1

Energy Scenario

Commercial & Non commercial energy, primary energy resources, commercial energy production, final energy consumption, energy need of growing economy, long term energy scenario, energy pricing, energy sector reform, energy & environment, energy conservation and its importance, re- structuring of the energy supply sector, energy strategy for future, energy conservation act. [8]

Unit II

Energy Management & Energy Planning

Definition & significance, energy strategy, energy policy & energy planning, two sides of energy management, sectors of supply side energy management, objective of energy management, hierarchical levels of supply side energy management, trade off b/w energy management, energy strategies & energy planning, energy & economy, essential imperatives & steps in supply side energy planning, energy planning flow for supply side, essential data for supply side energy planning, infrastructure planning, transportation of energy, per capita energy consumption, imperatives & steps in user side energy planning, energy management & control system for demand side, seven principal of energy management, energy policy of a supply organization & demand side organization, organization for energy management, training & human resource development, motivation. [8]

Unit III

Energy Audit & Energy Monitoring, Targeting and Conservation

Introduction, need, types & procedure of energy audits, modern techniques and instruments for energy audit.

Defining monitoring & targeting, element of monitoring & targeting, data & information analysis, techniques- energy consumption, production & cumulative sum of differences (CUSUM).

Energy conservation opportunity, electrical & thermodynamic ECOs, ECOs in chemical process industries, waste management & recycling of discard material and energy. [8]

Unit IV

Advancement In Technologies & Future Energy Alternatives

Recent advancement in energy technology towards 21st century, transport of energy, ethanol as a fuel.

Fusion – introduction potential, condition for fusion, magnetic confinement fusion reactor, cold fusion laser induced fusion.

Biomass –introduction, municipal waste, biomass conversion, wood combustion

Geothermal energy – introduction, origin, nature, resources and exploration, environment impact, low temperature geothermal resources. [8]

Unit V

Case Studies

Energy conservation in alcohol industry.

Energy conservation in fertilizer industry and pulps & paper industry.

Energy conservation in different units of refinery likes FCCU, HCU & ADU. [8]

Text Books

1. Hinrich & Kleinbach "Energy : its use and the environment" III ed. Harcourt.
2. Boyle "Renewable Energy : Power for a sustainable future" Oxford.
3. Rao S. & Parulckar B.B. "Energy technology" khanna publisher
4. Capenart & Turner " Guide to energy management " 6 ed. Keinnedu fairmant press.

ENVIRONMENTAL IMPACT ASSESMENT (TCH-043)

Unit I

Environmental management: Problems, Planning and Processes in India, Ecological modelling of environmental system, Agro climatic regional Planning. [8]

Unit II

Environmental impact assessment: Introduction, Concepts and aims, Impact statement, Methods and Processes, Mitigation processes .Prediction and assessment of impact on air, water and noise. [8]

Unit III

Public participation in environment decision making. Environment education and awareness, Environmental economics, Economics of Pollution control, Cost benefit analysis. [8]

Unit IV

Prediction and assessment of impacts on the biological, cultural and socio-economic environment, Introduction and basic concepts. Environmental impact assessment of major development projects, industries, mining, thermal power plants, atomic power stations, transport (rail, road, highway), tourism (Hotels, beaches and resorts). Disaster management. [8]

Unit V

Environmental audit, introduction, concepts, steps, methodology, EIA of different xenobiotics (chemicals, fertilisers, heavy metals). [8]

Text Books

1. W. Canter " Environmental Impact Assessment" Mc Graw Hill (1996).
2. Peter Watten (Eds.) - `Environmental Impact Assessment Theory and Practice', Unwin Hyman, London (1988)

Reference Books

1. John G. Rau and David C. Woolen (Eds.) `Environmental Impact Analysis Hand Book', McGraw Hill, (1980).

OPTIMIZATION TECHNIQUES IN CHEMICAL ENGINEERING (TCH-044)

Unit I

Analytical Method Necessary and sufficient conditions for optimum in single and multi variable unconstrained and constrained problems. [8]

Unit II

Unconstrained One Dimensional Search

Newton, Quasi-Newton and Secant method for unidimensional search, Region elimination methods (Golden Section, Fibonacci, Dichotomous. etc.) [8]

Unit III

Linear Programming, Graphical simplex method, revised simplex method, duality and transportation problems. [8]

Unit IV

Unconstrained Multi Variable Search, Direct methods, Indirect method, Finite difference approximation. [8]

Unit V

Dynamic Programming, Principle of optimality, Discrete and continuous dynamic programming. [8]

C.A.D LAB (TCH-851)

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.
3. Process design & Rating of stand alone Multi-component Distillation columns.
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).

PROJECT (TCH –852)

This project course is in continuation of project course (CH-754) allotted in the beginning of the VII the Semester .Here the students are supposed to do the detail work as scheduled in the last semester. Finally he/she will be required to submit a detailed project report on which viva-voce examination will be conducted by a committee having one External Examiner.

EDUCATIONAL TOUR (TCH-853)

At the end of VII th Semester during Winter vacation the students are supposed to go for educational tour to visit factories .After this tour students will have to submit a tour report on which their viva –voce examination shall be held by the faculty in charge of educational tour.

U.P. TECHNICAL UNIVERSITY

LUCKNOW



Syllabus

of

CHEMICAL ENGINEERING

3rd Year (V & VI) and 4th Year (VII & VIII

Semester)

B.Tech. Courses