

### SEMESTER I

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### LIST OF ELECTIVES

{Common to M.TECH (CHEMICAL ENGG, PRPC & EST)}

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A candidate will be permitted to register one elective course only under each group*, # and $. 
UNIT I TYPES OF CORROSION AND TESTING METHODS 9
Basic principles of corrosion and its control – Forms of corrosion, uniform, Galvanic, Crevis, pitting, selective leaching, erosion, stress-corrosion, cracking – Cavitation phenomena & their effects – Corrosion testing – Field testing – Electrochemical techniques for measurement of corrosion rates, corrosion detection and components examination – Accelerated salt-spray testing.

UNIT II CORROSION PROTECTION METHODS 9
Corrosion inhibitors, electroplated coatings, conversion coatings, anodizing, hot dipping, spray metal coatings, zinc coating by alloying, electrophoretic coatings and electro painting, powder coating, electrical methods of corrosion protection, composite materials in corrosion minimization – Cathodic and Anodic protections.

UNIT III CORROSION IN SPECIFIC ENVIRONMENTS 9
Corrosion damage to concrete in industrial and marine environments and its protection; biological corrosion, halogen corrosion of metals, environmental degradation of materials, corrosion and inspection managements in chemical processing and petrochemical industries.

UNIT IV CORROSION IN SPECIFIC CASES AND CONTROL 12

UNIT V CORROSION AND COUNTRY’S ECONOMY 6
Corrosion protection management–process maintenance procedures under corrosion Environments

TOTAL : 45 PERIODS

TEXT BOOK

REFERENCE

PP8102 MODELING OF TRANSPORT PROCESSES L T P C 3 0 0 3

UNIT I INTERPHASE TRANSPORT IN ISOTHERMAL SYSTEMS 6

UNIT II MACROSCOPIC BALANCES FOR ISOTHERMAL FLOW SYSTEMS AND POLYMERIC LIQUIDS 12


TOTAL : 45 PERIODS

TEXT BOOK

REFERENCES

PP8103 PETROLEUM REFINERY ENGINEERING L T P C 3 0 0 3

UNIT I Origin, Exploration and production of petroleum, Types of crudes, Composition, characteristics, products pattern and characteristics, indigenous and imported crudes, Availability Vs Demands, Future outlook.
UNIT II
Engineering aspects of refining, Reaction stoichiometry; Chemical kinetics; Thermochemistry and chemical equilibrium; Mixing in flow systems; Reactor design. Crude heating, Primary distillation, principles, Separation of cuts, Gaps/ overlaps, Stripping, Desalting, heat balance in distillation, Energy input and recovery, Vacuum distillation, Types of trays, Draw offs, intermediate product quality control.

UNIT III
Lube oil and wax processing, Solvent extraction, Dewaxing, Deciling, Deasphalting, Clay contacting, principles, technologies, operating parameters, Feed and product qualities and yields. Asphalt Manufacture, product qualities, Air blowing technology, Tankage operations, Storage and handling of crude products.

UNIT IV
Fluid catalytic cracking, principles, recent developments, Feed stocks and product yields and qualities, Catalysts and operating parameters. Hydrocracking, principles, process requirements, product yields and qualities, Residcracking – implications and technology.

UNIT V

REFERENCES

TOTAL : 45 PERIODS

PP8104 PETROLEUM THERMODYNAMICS L T P C 3 0 0 3

UNIT I INTRODUCTION
Behaviour of Gases and Liquids – Gas laws, Density, Mole percent, Weight percent, Volume percent, Specific gravity, Heat, Work Closed and Open Systems, First and Second Laws of thermodynamics, specific heats, Compressibility factor, PVT relationships, Vapour pressure, Clausius – Clapeyron equation, heat of vaporization.

UNIT II CHEMICAL THERMODYNAMICS OF PETROLEUM HYDROCARBONS
UNIT III QUALITATIVE PHASE BEHAVIOUR OF HYDROCARBON SYSTEMS
Calculation of liquid and vapour composition of Bubble point and Dew point pressure for multi component system. Equilibrium constant

UNIT IV HYDROCARBON FLUID CHARACTERISTICS
Gas formation volume factor, Gas solubility, Oil formation volume factor, Viscosity

UNIT V PROPERTIES OF MIXTURES

TEXT BOOK

REFERENCES
1. Jean vidal, Thermodynamics Application in chemical Engineering and the petroleum industry, Institute Francais bu petrole publications,France 2003
4. Rao., Y.V.C., Chemical Engineering Thermodynamics, University Press, Hyderabad, 2005

MA8168 ADVANCED NUMERICAL METHODS

UNIT I ALGEBRAIC EQUATIONS

UNIT II ORDINARY DIFFERENTIAL EQUATIONS – IVPs
Runge Kutta Methods, step size control and estimates of error, numerical stability, solution of stiff ODEs, ODE-IVPs coupled with algebraic equations;

UNIT III ORDINARY DIFFERENTIAL EQUATIONS – BVPs
Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method, shooting technique.
UNIT I V PARTIAL DIFFERENTIAL EQUATIONS – FINITE DIFFERENCE METHOD

12

Parabolic equations – Different explicit and implicit methods, alternating direction explicit and implicit methods; Elliptic equations – Point iterative methods, line iterative methods, ADI methods; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS – FINITE ELEMENT METHOD

12


REFERENCES


TOTAL : 60 PERIODS

CL8161 INSTRUMENTAL METHODS OF ANALYSIS LAB L T P C

0 0 2 1

LIST OF EXPERIMENTS

1. UV-Visible spectrophotometer
2. Laser particle size diffraction analyzer
3. Gas chromatography
4. High performance liquid chromatography
5. Atomic absorption spectrophotometer.
6. Halogen moisture analyzer
7. Thermo gravimetric analyzer
8. Automated capillary microflow porometer
9. Electrochemical workstation

TOTAL : 30 PERIODS

PP8201 NATURAL GAS ENGINEERING L T P C

3 0 0 3

UNIT I INTRODUCTION

12

UNIT II  GAS TREATMENT AND PROCESSING  12
General Hydrodynamic equations for flow of fluids through porous media, two dimensional flow problems and potential theory methods, gravity flow systems, systems of non uniform permeability, multiple well systems using computerized streamline tracking methods.

UNIT III  MULTIPHASE SYSTEMS  11
Use of multiphase flow correlations to determine flow ratio and pressure traverse in flowing oil wells, gas condensate wells, gathering systems and pipe lines, application of correlations to the design of gas system

UNIT IV  GAS TREATMENT  10
Reservoir fluid properties – PVT properties for oil gas systems, phase Behavior of complex hydrocarbon mixtures at high temperature and pressure - thermodynamic property evaluation, packages used in petroleum industry.

TOTAL : 45 PERIODS

REFERENCES
UNIT IV
Separation and utilization of aromatics: catalytic reforming operation-seperation of BTX from Reformate .isolation of benzene, toluene, xylene. aromatics derived from thermal cracking of naptha, pyrolysis gasoline hydrogenation process. Alkylation of benzene. production of pthalic anhydride etc. synthetic detergents: classification of detergents production of KERYL Benzene Sulphonate etc., filter, binders, dyes, perfumes, etc. for detergents. Hard and soft detergents.

UNIT V
Synthetic fibres, rubbers, plastics, resins: method, mechanism and types of polymerization , production of HDPE,LDPE, PP,PVC, polystyrene, poly butadiene, etc., manufacture of polyesters, nylons, acrylic fibres,etc. production of phenoformaldehyde resin, epoxy resin, production principle of ABS plastic, polycarbonates, etc. manufacturing techniques of butyl rubber, SBR, isoprene rubber, etc .

REFERENCES

TOTAL : 45 PERIODS

PP8203 PROCESS DYNAMICS AND CONTROL

UNIT I ADVANCED CONTROL STRATEGIES
Feed forward, cascade, dead time compensation, split range, selective and override control; automatic tuning and gain scheduling

UNIT II INTERNAL MODEL CONTROL
Model based control – IMC structure – development and design; IMC based PID control, MPC

UNIT III MULTIVARIABLE CONTROL
Control loop interaction – general pairing problem, relative gain array and application, sensitivity. Multivariable control – zeros and performance limitations, directional sensitivity and operability, decoupling

UNIT IV DISCRETE SYSTEMS

UNIT V DIGITAL FEEDBACK CONTROLLERS
Design of digital feedback controllers, digital approximation of classical, effect of sampling, Case study of Industrial Instrumentation and Control system, DCS, PLC, shutdown system.

TOTAL : 45 PERIODS
REFERENCES

PP8204 SEPARATION PROCESS TECHNIQUES

UNIT I GENERAL
Review of conventional processes, recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, process concept, theory and equipment used in cross flow filtration, cross flow electofiltration, dual functional filter, surface based solid-liquid separations involving a second liquid, sirofloc filter.

UNIT II MEMBRANE SEPARATIONS
Types and choice of membranes, plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, commercial, pilot plant and laboratory membrane permeators involving dialysis, reverse osmosis, nanofiltration, ultrafiltration, microfiltration and Donnan dialysis, economics of membrane operations, ceramic membranes.

UNIT III SEPARATION BY ADSORPTION TECHNIQUES
Mechanism, types and choice of adsorbents, normal adsorption techniques, affinity chromatography and immuno chromatography, types of equipment and commercial processes, recent advances and process economics.

UNIT IV IONIC SEPARATIONS
Controlling factors, Types of equipment employed for electrophoresis, dielectrophoresis, Ion Exchange chromatography and electrodialysis, Commercial processes and applications.

UNIT V OTHER SEPARATION TECHNIQUES
Separations involving lyophilization, pervaporation and permeation techniques for solids, liquids and gases, industrial viability and examples, zone melting, adductive crystallization, other separation processes, supercritical fluid extraction, oil spill management, industrial effluent treatment by modern techniques.

TOTAL: 45 PERIODS

REFERENCES
LIST OF EXPERIMENTS

1. Determination of flash point and fire point
2. Viscosity Determination
3. Aniline point determination
4. API gravity determination
5. Hydrogen sulphide content determination
6. Doctor’s test
7. Determination of calorific value
8. Bitumen testing
9. Carbon residue determination (Conradson apparatus)
10. Cloud point and pour point estimation
11. Congealing point of wax
12. Foaming characteristics of lube oil
13. Smoke point estimation
14. Corrosion testing of petroleum oil
15. Distillation characteristics
16. Moisture content determination

Minimum of 10 experiments

TOTAL : 30 PERIODS

PP8301 CATALYTIC REACTOR DESIGN AND ANALYSIS

UNIT I INTRODUCTION
Design Principles, Continuous Reaction Model, Intrinsic and Global Rate Concepts

UNIT II CHEMICAL ENGINEERING KINETICS
Heterogeneous Catalysis, Chemical and Physical Characteristics of Solid Catalysts, Activity, Specific Activity, Selectivity

Kinetics of Heterogeneous Catalytic Reactions, Mechanisms and Kinetic Models, Experimental Reactors and Transport Criteria, Determination of Intrinsic Kinetics

UNIT III TRANSPORT PROCESSES IN SOLID-CATALYZED SYSTEMS
External Transport Processes, Internal Transport Processes, Fluidized-Bed Reactors

UNIT IV TWO-PHASE CATALYTIC REACTORS

UNIT V TWO-PHASE STRUCTURED REACTORS
Engineered Catalysts, Micro-structured Catalytic Reactors - Monolith Reactors, Microreactors

TOTAL : 45 PERIODS
TEXTBOOK

REFERENCES

PP8302 MODELING AND SIMULATION OF INDUSTRIAL PROCESSES  L T P C  
3 0 0 3

UNIT I INTRODUCTION
Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS
Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flowsheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS
Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM
Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations.

TOTAL : 45 PERIODS
REFERENCES

PP8311 PROJECT WORK (PHASE I) LT P C 0 0 12 6

Students have to do a research-based project in the department or in an industry and submit a report at the end of Phase I.

PP8411 PROJECT WORK (PHASE II) LT P C 0 0 24 12

Phase II of Project Work is a continuation of Phase I of Project. Students submit a report at the end of Phase II.

CL8068 INDUSTRIAL POLLUTION PREVENTION LT P C 3 0 0 3

UNIT I
Basics of Jurisprudence-Environmental law relation with other disciplines-Criminal law-Common Law-Relevant sections of the code of civil procedure, criminal procedure code -Indian Penal code.

UNIT II

UNIT III

UNIT IV

UNIT V
Relevant notifications in connection with Hazardous Wastes (Management and handling), Biomedical Wastes (Management and Handling), Noise pollution, Eco-labelling, and EIA.

TOTAL : 45 PERIODS

REFERENCES

CL8069 INDUSTRIAL INSTRUMENTATION L T P C
3 0 0 3

UNIT I

UNIT II
Process Variables Measurement – Temperature systems – Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters, Vacuum measurement, Resonant wire pressure Transducer, Flow system – Differential producers, Variable area flow meters, Velocity, vortex, mass, ultrasonic & other flow meters, positive displacement flow meters, Open – channel flow measurements, Force systems, Strain gauges Humidity Moisture system, Humidity Measurement, Moisture measurement system, Rheological system, Viscosity measurement, Radiation system, Nuclear radiation instrumentation.

UNIT III
Analytical instrumentation – Analysis instruments, Sample conditioning for process analyzers, X-ray Analytical methods, Quadrupole mass spectrometry, Ultra violet Absorption Analysis, Infra red process analyzers, Photometric reaction product analysers Oxygen analyzers, Oxidation – reduction potential measurements, pH measuring systems, Electrical conductivity and Resistivity measurements, Thermal conductivity, gas analysis, Combustible, Total hydro carbon, and CO analyzer, Chromatography.

UNIT IV
UNIT V
Sensors, Transmitters and control valves - Pressure, Flow, Level, Temperature and Composition sensors, Transmitters, Pneumatic and electronic control valves, Types, Actuator, accessories, Instrumentation symbols and Labels.

TOTAL : 45 PERIODS

REFERENCES
REFERENCES

CL8071 ADVANCED OXIDATION PROCESSES AND TECHNOLOGY

UNIT I
Introduction to AOP, fundamentals of AOPs for water and wastewater treatment.

UNIT II
Photoinduced AOP, UV Photolysis $\text{H}_2\text{O}_2$, $\text{UV/O}_3$ processes, Ozonation, Fenton processes, Ultrasound processes and principles of sonochemistry.

UNIT III
Photochemistry, photolysis, fundamentals of semiconductor photocatalysis, photochemical processes for water and wastewater treatment, photooxidation reactions, photocatalytic reactions, photo-initiated oxidations, heterogeneous and homogeneous photocatalysis and kinetic studies.

UNIT IV
Fenton processes: homo and heterogeneous process, effect of system composition and process, identification of degradation products.

Photoelectrocatalysis process: photooxidation and photomineralization of organic matter in water and air: aqueous systems, substrate oxidation and mineralization, comparative studies of photo-initiated AOPs, biodegradability and toxicological studies.

UNIT V
Application of AOPs for VOC reduction and odour treatment, case studies – textile, pharmaceutical and petroleum and petrochemical industries.

REFERENCES
UNIT I  INTRODUCTION 9

UNIT II  ATMOSPHERIC THERMODYNAMICS 9

UNIT III  ATMOSPHERIC CHEMISTRY 9
Composition of tropospheric air – Sources, transport and sinks of trace gases – Tropospheric aerosols – air pollution – tropospheric chemical cycles – stratospheric chemistry.

UNIT IV  ATMOSPHERIC DYNAMICS 9
Kinematics of the large-scale horizontal flow – Dynamics of horizontal flow – primitive equations – atmospheric general circulation – numerical weather prediction.

UNIT V  CLIMATE 9
The present day climate – Climate variability – Climate equilibrium, sensitivity – Green house warming – Climate changes – Climate monitoring and prediction – weather systems – tropical cyclones – case studies: tsunami and sea level rising, Acid rain – The concept of El Nino.

TOTAL : 45 PERIODS

REFERENCES

CL8073  BIO ENERGY CONSERVATION TECHNIQUES  L T P C
3 0 0 3

UNIT I  INTRODUCTION 8

UNIT II  BIOMETHANATION 8
UNIT III COMBUSTION

UNIT IV GASIFICATION

UNIT V PYROLYSIS AND CARBONIZATION

TOTAL : 45 PERIODS

TEXT BOOKS
1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis HoknoodChichester, 1984.

REFERENCES
2. Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981
5. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S

CL8074 BIOCHEMICAL ENGINEERING L T P C
3 0 0 3

UNIT I

UNIT II
The kinetics of enzyme catalysed reactions – the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, determination of elementary step rate constants. Isolation and utilization of Enzymes – production of crude enzyme extracts, enzyme purification, applications of hydrolytic enzymes, other enzyme applications, enzyme production – intercellular and extra cellular enzymes.

UNIT III
Metabolic pathways and energetics of the cell, concept of energy coupling, ATP and NAD, Photosynthesis, Carbon metabolism, EMP pathway, Tricarboxylic cycle and electron transport chain, aerobic and anaerobic metabolic pathways, transport across cell membranes, Synthesis and regulation of biomolecules.
UNIT IV
Typical growth characteristics of microbial cells, Factors affecting growth, Batch and continuous cell growth, nutrient media, enrichment culture, culture production and preservation. Immobilization technology – Techniques of immobilization, Characterization and applications, Reactors for immobilized enzyme systems.

UNIT V
Introduction to biological reactors, Continuously stirred aerated tank bioreactors, mixing power correlation, Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption, Multiphase bioreactors and their applications. Downstream processing and product recovery in bio processes.

TOTAL : 45 PERIODS

REFERENCES

CL8075 CLIMATE CHANGE AND ADAPTATION L T P C 3 0 0 3

UNIT I EARTH’S CLIMATE SYSTEM

UNIT II OBSERVED CHANGES AND ITS CAUSES

UNIT III IMPACTS OF CLIMATE CHANGE

UNIT IV CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES
UNIT V  
CLEAN TECHNOLOGY AND ENERGY  
9

TOTAL : 45 PERIODS

REFERENCES

2. Al core ‘inconvenient truth” – video form
3. IPCC Fourth Assessment Report – The AR4 Synthesis Report,

CL8076  
COMPUTATIONAL FLUID DYNAMICS  
L T P C
3 0 0 3

UNIT I  
CONSERVATION LAWS AND TURBULENCE MODELS  
9
Governing equations of fluid flow and heat transfer – mass conservation, momentum and energy equation, differential and integral forms, conservation and non-conservation form. Characteristics of turbulent flows, time averaged Navier Strokes equations, turbulence models-one and two equation, Reynolds stress, LES and DNS

UNIT II  
FINITE DIFFERENCE APPROXIMATION  
9
Mathematical behaviour of PDE, finite difference operators, basic aspects of discretization by FDM, explicit and implicit methods, error and stability analysis

UNIT III  
FINITE VOLUME METHOD  
15
Diffusion problems – explicit and implicit time integration; Convection-diffusion problems – properties of discretisation schemes, central, upwind, hybrid, QUICK schemes; Solution of discretised equations.

UNIT IV  
FLOW FIELD COMPUTATION  
6
Pressure velocity coupling, staggered grid, SIMPLE algorithm, PISO algorithm for steady and unsteady flows

UNIT V  
GRID GENERATION  
6
Physical aspects, simple and multiple connected regions, grid generation by PDE solution, grid generation by algebraic mapping.

TOTAL : 45 PERIODS

REFERENCES


CL8077 DESIGN OF EXPERIMENTS

UNIT I CONCEPTS AND TERMINOLOGY
Review of hypothesis testing – P Value, “t” Vs paired “t” test, simple comparative experiment, planning of experiment – steps. Terminology - factors, levels, variables, Design principles – replication, randomization, blocking, confounding, Analysis of variance, sum of squares, degrees of freedom.

UNIT II SINGLE FACTOR EXPERIMENTS
Completely randomized design, Randomized block design, effect of coding the observations, Latin Square design, orthogonal contrasts, comparison of treatment means – Duncan’s multiple range test, Newman-Keuel’s test, Fisher’s LSD test, Tukey’s test.

UNIT III FACTORIAL EXPERIMENTS
Main and interaction effects, Rules for sum of squares and expected mean square, two and three factor full factorial design, 2k designs with two and three factors, Yate’s algorithm, practical applications.

UNIT IV SPECIAL EXPERIMENTAL DESIGNS
Blocking and confounding in 2k design, nested design, split plot design, two level fractional factorial design, fitting regression models, introduction to response surface methods- Central composite design.

UNIT V TAGUCHI TECHNIQUES
Introduction, Orthogonal designs, data analysis using ANOVA and response graph, parameter design – noise factors, objective functions (S/N ratios), multi-level factor OA designs, applications.

TOTAL : 45 PERIODS

TEXT BOOK
1. Douglas C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, 2005

REFERENCES
UNIT I INTRODUCTION
Development of drugs and pharmaceutical industry; organic therapeutic agents uses and economics

UNIT II DRUG METABOLISM AND PHARMACOKINETICS & MICROBIOLOGICAL AND ANIMAL PRODUCTS
Drug metabolism; physico chemical principles; pharma kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones

UNIT III IMPORTANT UNIT PROCESSES AND THEIR APPLICATIONS
Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.

UNIT IV MANUFACTURING PRINCIPLES & PACKING AND QUALITY CONTROL
Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parential solutions, oral liquids; injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control.

UNIT V PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS
Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others. Analytical methods and tests for various drugs and pharmaceuticals – spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pHmetry

TOTAL : 45 PERIODS

TEXT BOOK

REFERENCES

UNIT I
Aim - scope and applications of Ecology, Ecological Engineering and Ecotechnology and their relevance to human civilization - Development and evolution of ecosystems. Principles and concepts pertaining to communities in ecosystem - Energy flow and material cycling in ecosystems - Productivity in ecosystems.
UNIT II
Classification of ecotechnology - Principles and components of Systems and Modeling - Structural and functional interactions in environmental systems - Human modifications of environmental systems.

UNIT III
Self organizing processes - Multiple seeded microcosms- Interface coupling in ecological systems - Concept of energy - Adapting ecological engineering systems to potentially catastrophic events - Agro ecosystems - Determination of sustainable loading of ecosystems.

UNIT IV
Principles and operation of soil infiltration systems - wetlands and ponds - source separation systems - aqua cultural systems - detritus based treatment for solid wastes - Applications of ecological engineering marine systems.

UNIT V
Case studies of integrated ecological engineering systems

TOTAL : 45 PERIODS

REFERENCES

CL8080 ELECTROCHEMICAL ENGINEERING L T P C
3 0 0 3

UNIT I

UNIT II
Mass transfer in electrochemical systems: diffusion controlled electrochemical reaction – the importance of convention and the concept of limiting current. over potential, primarysecondary current distribution – rotating disc electrode.

UNIT III

UNIT IV
UNIT V
Electrodes used in different electrochemical industries: Metals-Graphite –Lead dioxide –Titanium substrate insoluble electrodes –Iron oxide –semi conducting type etc. Metal finishing- cell design. types of electrochemical reactors, batch cell, fluidized bed electrochemical reactor, filter press cell, Swiss roll cell, plug flow cell, design equation, figures of merits of different type of electrochemical reactors.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
REFERENCES

CL8082 ELECTROCHEMICAL PROCESS ENGINEERING FOR CHEMICAL ENGINEERS

UNIT I INTRODUCTION OF ELECTROCHEMICAL ENGINEERING 9
Industrial importance of electrolytic processes, Basic concepts and definitions, Criteria for reactor performance, Electrochemical and catalytic reactions and reactors. Fundamentals of reaction kinetics, rate of electrochemical reaction, electrochemical thermodynamics, practical cell voltage requirements and polarization, single electrochemical reactions, potentiostatic operations of first order reaction and galvanostatic operation of first order reactions.

UNIT II ASPECTS OF MASS AND HEAT TRANSFER IN ELECTROLYTIC CELL SYSTEMS 9
Basic aspects of fluid dynamics, mass transfer-mass flux in a fully developed turbulent regime, entrance and exit effects, obtaining numerical values of mass transfer coefficient by calculation and experiment, mass transfer in two phase flow, energetic and energy balances, CSTR with general order reactions, effect of mass transport and side reaction.

UNIT III RATE PROCESSES AND REACTION MODELS 9
Rate processes, kinetics of elementary reactions, reaction mechanism and rate laws, transition state theory, derivation of kinetic relationships, reaction models.

UNIT IV REACTOR MODELS 9
General considerations, batch reactor and continuous reactor, Fed batch, continuous, cell recycle, plug flow reactor, two stage reactors, Reactor dynamics and stability. Reactors with non ideal mixing. Other types of reactors- fluidized bed reactors, packed bed reactors, bubble column reactors, trickle bed reactors.

UNIT V ELECTROLYTIC REACTOR DESIGN, SELECTION AND SCALE UP 9
Electrolytic reactor designs, Electrolytic reactor selection, scale up of electrolytic reactors, effect of scale up on mass transfer, effect of scale up on current distribution, Multiple electrode models and time factors.

TOTAL : 45 PERIODS

TEXT BOOKS

CL8083 ELECTROCHEMICAL PROCESSES FOR CLEAN TECHNOLOGY

UNIT I THE ELECTROCHEMICAL CELL AND REACTOR

UNIT II ELECTROCHEMICAL CELL DESIGN AND ENGINEERING

UNIT III ELECTROCHEMICAL MEMBRANE PROCESS

UNIT IV THE TREATMENT OF INDUSTRIAL PROCESS STREAMS AND EFFLUENTS

UNIT V ORGANIC AND INORGANIC ELECTROCHEMICAL SYNTHESIS

TOTAL : 45 PERIODS
TEXT BOOKS

CL8084 ELECTROCHEMICAL TECHNOLOGY FOR CHEMICAL ENGINEERS

UNIT I FUNDAMENTAL CONCEPTS
Electron transfer, mass transport, interplay of electron transfer and mass transport, control adsorption, electro catalysis, phase formation in electrode reactions, chemical reactions, the properties of electrolytic solutions, assessment of cell voltage, electrochemistry at surfaces on open circuit.

UNIT II THE CHLOR-ALKALI INDUSTRY

UNIT III THE EXTRACTION, REFINING AND PRODUCTION OF METALS
Electro winning, cementation, electroe fining, electrode position of metal powders. Principles of mineral processing: comminution, physical separation techniques, flotation, dewatering. Selection of extraction processes. Hydrometallurgy and electrometallurgy including leaching, solution purification, solvent extraction, metal winning and refining. Pyrometallurgical operations including roasting, smelting, converting and refining and refractory issues.

UNIT IV INORGANIC ELECTROLYTIC PROCESS
Fluorine, water electrolysis, sodium chlorate, sodium bromate, per acids and their salts, permanganate, potassium dichromate and chromic acid, hydrogen peroxide, ozone, manganese dioxide, synthesis of metal salts via anodic dissolutions.

UNIT V WATER PURIFICATION, EFFLUENT TREATMENT AND RECYCLING OF INDUSTRIAL PROCESS STREAMS
Metal ion removal and metal recovery, hypochlorite, and low tonnage chlorine electrolysis, electrodialysis. The treatment of liquors containing dissolved chromium, electrolytic methods of phase separation, flue gas desulphurisation, other electrochemical process.

TOTAL : 45 PERIODS
TEXT BOOKS

CL8085
ENERGY MANAGEMENT
L T P C
3 0 0 3

UNIT I
Energy sources; coal oil, natural gas; nuclear energy; hydro electricity, other fossil fuels; geothermal; supply and demand; depletion of resources; need for conservation; uncertainties; national and international issues.

UNIT II
Forecasting techniques, energy demand, magnitude and pattern, input and output analysis, energy modeling and optimal mix of energy sources. Energy - various forms, energy storage, structural properties of environment.

UNIT III
Bio-geo-chemical cycles; society and environment population and technology. Energy and evolution, growth and change, patterns of consumption in developing and advances countries, commercial generation of power requirements and benefit.

UNIT IV
Chemical industries, classification, conservation in unit operation such as separation, cooling tower, drying, conservation applied to refineries, petrochemical, fertilizers, cement, pulp and paper, food industries, chloro alkali industries, conservation using optimization techniques.

UNIT V
Sources of continuous power, wind and water, geothermal, tidal and solar power, MHD, fuel cells, hydrogen as fuel. Cost analysis, capacity; production rate, system rate, system cost analysis, corporate models, production analysis and production using fuel inventories, input-output analysis, economics, tariffs.

TOTAL : 45 PERIODS

REFERENCES
UNIT I  FUNDAMENTALS OF ENHANCED OIL RECOVERY  9

UNIT II  WATER FLOODING  9
Properties, sampling and analysis of oil field water; Injection waters; Water flooding - Sweep efficiency, Predictive techniques, Improved water flood processes, Performance of some important water floods.

UNIT III  ENHANCED OIL RECOVERY OPERATIONS-1  10
Flooding – miscible, CO₂, polymer, alkaline, surfactants, steam;

UNIT IV  ENHANCED OIL RECOVERY OPERATIONS-2  10
Gas injection, in-situ combustion technology, microbial method.

UNIT V  PROBLEMS IN ENHANCED OIL RECOVERY  7
Precipitation and deposition of Asphaltenes and Paraffins, Scaling problems, Formation of damage due to migration of fines, Environmental factors.

REFERENCES

UNIT I  INTRODUCTION  9

UNIT II  OCCUPATIONAL HEALTH AND HYGIENE  9

UNIT III  WORKPLACE SAFETY AND SAFETY SYSTEMS  9
Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision. Significance of human factors in the establishment and effectiveness of safe systems. Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising.
from the use of work equipment. Requirements for the safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Contingency arrangements for events of serious and imminent danger.

UNIT IV  TECHNIQUES OF ENVIRONMENTAL SAFETY  9

UNIT V  EDUCATION AND TRAINING  9
Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.

TOTAL : 45 PERIODS

REFERENCES
1. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
TOTAL : 45 PERIODS

REFERENCES

CL8089 ENVIRONMENTAL ENGINEERING L T P C
3 0 0 3

UNIT I ENVIRONMENT AWARENESS
Environment – friendly chemical Process; Hazard and risk analysis; Environmental Audit.

UNIT II CHEMICAL ENGINEERING PROCESSES
Unit Operations – application of - Abatement of water pollution; Current strategies to control air pollution; Disposal of solid wastes

UNIT III RECYCLING METHODOLOGY
Economic recovery and recycling of waste; Transport fuel- Bio-diesel for a cleaner environment.

UNIT IV CLEAN TECHNOLOGY
Towards Eco- friendly products of chemical industry; Pesticides –Their transfer and Transformation in the environment, Biological and electrochemical technology for effluent treatments

UNIT V POLLUTION PREVENTION
Mass exchange network synthesis for pollution control and minimization Implications of environmental constraints for process design, policies for regulation of environmental impacts, Concept of common effluent treatment; Environmental legislations, Role of Government and Industries

TOTAL : 45 PERIODS

REFERENCES
UNIT I
Environmental Legislations in India, Europe, USA and Canada – Development of Legislations, Standards and Guidelines

UNIT II

UNIT III
Factory Act 1987 of India, Occupational health and safety requirements and standards of ILO, Compliance of rules and guidelines of Factory Act applicable to industries.

UNIT IV
Principles of Environmental impact assessment and audit guidelines and legislature requirements for siting of industrial units in estates/complex. Preparatory procedures for EIA study, Evaluation of impact on air, water and land environment.

UNIT V
Principles of Environmental Auditing, Cleaner Technologies in Industrial Processes and evaluation of processes Auditing techniques in Preparing EA. Monitoring of ambient environment, including air, water and land, noise, liquid and solid waste management.

REFERENCES

UNIT I
Background of nanotechnology, particle size and surface area, quantum dot. Converging science and technology, nanotechnology as a tool for sustainability, health, safety and environmental issues.

UNIT II
SYNTHESIS AND FABRICATION OF NANOMATERIALS
Preparation of nano scale metal oxides, metals, CNT, functionalized nano porous adsorbents, nano composite- Chemical vapour deposition, sol gel, sonochemical, microwave, solvothermal, plasma, pulsed laser ablation, magnetron sputtering, electrospinning, Molecular imoring.
UNIT III CHARACTERISATION OF NANOMATERIALS
AFM, STM, SEM, TEM, XRD, ESCA, IR & Raman, UV-DRS, of nanomaterials for structural & chemical nature.

UNIT IV OTHER FEATURES OF NANO PARTICLES
Nanoparticle transport, aggregation & deposition. Energy applications- H₂ storage.

UNIT V ENVIRONMENTAL APPLICATIONS
Gas sensors, microfluidics and lab on chip, catalytic and photocatalytic applications, Nonmaterials for ground water remediation, nanomaterials as adsorbents, membrane process.

TOTAL : 45 PERIODS

REFERENCES
1. Environmental applications of nanomaterials-Synthesis, Sorbents and Sensors, edited by Glen E Fryxell and Guozhong Cao, worldscibooks, UK

CL8092 ENVIRONMENTAL POLICIES AND LEGISLATION L T P C
3 0 0 3

UNIT I INTRODUCTION

UNIT II WATER (P&CP) ACT, 1974
Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT III AIR (P&CP) ACT, 1981
Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT IV ENVIRONMENT (PROTECTION) ACT 1986
Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorisation – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards
UNIT V OTHER TOPICS
Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC - Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

TOTAL : 45 PERIODS

REFERENCES
1. CPCB, “Pollution Control acts, Rules and Notifications issued there under “Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.

CL8093 ENVIRONMENTAL REACTION ENGINEERING L T P C 3 0 0 3

UNIT I
Reaction engineering principles with applications to environmental systems, general reaction mechanisms, Rate Relationships: Concepts and Applications to Homogeneous Systems and Heterogeneous Systems with respect to chemical and biological reactions.

UNIT II
Ideal systems modeling and design, reactor concepts, ideal reactors, reaction rate measurements, Hybrid system modeling and design, Sequencing batch reactor, Reactors in series and reactors with recycle.

UNIT III
Non ideal system modeling and design, non ideal reactor behavior, RTD analysis, PFDR model.

UNIT IV

UNIT V
Biological reaction engineering; biological kinetics; enzyme kinetics; Michaelis-Menten equation; simple microbial kinetics; structured kinetic models biological reaction engineering; basic bioreactor concepts; bioreactor modeling; bioreactor operation; batch operation; semicontinuous operation; fed batch operation; continuous operation, and its environmental applications.

TOTAL : 45 PERIODS

REFERENCES
UNIT I
Risk analysis introduction, quantitative risk assessment, rapid risk analysis – comprehensive risk analysis – identification, evaluation and control of risk

UNIT II
Risk assessment – introduction and available methodologies, Risk assessment steps, Hazard identification, Hazard assessment (consequence analysis), probabilistic hazard assessment (Fault tree analysis)

UNIT III
Overall risk contours for different failure scenarios – disaster management plan – emergency planning – onsite and offsite emergency planning, risk management ISO 14000, EMS models – case studies – marketing terminal, gas processing complex.

UNIT IV
Safety measures design in process operations. Accidents modeling – release modeling, toxic release and dispersion modeling, fire and explosion modeling.

UNIT V
Past accident analysis: Flux borough – Mexico – Bhopal analysis. Government policies to manage environmental risk

TOTAL : 45 PERIODS

REFERENCES

UNIT I
Significance of Environmental Chemistry for Wastewater Engineering- Basic concepts of cell biology, metabolism, energetic of bio chemical reactions, enzymes and their importance in aerobic and anaerobic microbiological reactions, specific importance of co-factors, transport of materials in the organisms

UNIT II
Chemical equilibrium in gaseous and solutions, free energy change, entropy change of reactions in solutions,

UNIT III
Basic concepts of electro chemistry, Debye-Huckel Theory, solubility of strong electrolytes, acids and bases, buffers, pH, interpretation of pH data. Colloids, osmosis, viscosity of colloidal suspension, Brownian movement and diffusion sedimentation, surface forces, electrical properties of surfaces
UNIT IV
Colloids, osmosis, viscosity of colloidal suspension, Brownian movement and diffusion sedimentation, surface forces, electrical properties of surfaces

UNIT V
Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods - Sampling and analysis of ambient air for SPM, SO2, and Oxides of nitrogen - Good laboratory practice - Analytical quality control.

TOTAL : 45 PERIODS

REFERENCES
UNIT I  INTRODUCTION
The Fluidized state, Nature of hydrodynamic suspension, particle forces, species of Fluidization, Regimization of the fluidized state, operating models for fluidization systems, Applications of fluidization systems.

UNIT II  HYDRODYNAMICS OF FLUIDIZATION SYSTEMS

UNIT III  SOLID MIXING AND SEGREGATION
Phase juxtapositions operation shifts, Reversal points, Degree of segregation, Mixing Segregation equilibrium, Generalised fluidization of poly disperse systems, liquid phase Mixing and gas phase mixing.

UNIT IV  HEAT AND MASS TRANSFER IN FLUIDIZATION SYSTEMS
Mass transfer – Gas Liquid mass transfer, Liquid Solid mass transfer and wall to bed mass transfer, Heat transfer – column wall – to – bed heat transfer, Immersed vertical cylinder to bed heat transfer, Immersed horizontal cylinder to bed heat transfer.

UNIT V  MISCELLANEOUS SYSTEMS
Conical Fluidized bed, Moving bed, Slurry bubble columns, Turbulent bed contactor, Two phase and Three phase inverse fluidized bed, Draft tube systems, Semifluidized bed systems, Annular systems, Typical applications, Geldart’s classification for power assessment, Powder characterization and modeling by bed collapsing.

TOTAL : 45 PERIODS

REFERENCES

UNIT I  INTRODUCTION
Overview of fuel cells: Low and high temperature fuel cells; Fuel cell thermodynamics - heat, work potentials, prediction of reversible voltage, fuel cell efficiency.

UNIT II  FUEL CELL TECHNOLOGY
Fuel cell reaction kinetics - electrode kinetics, overvoltage, Tafel equation, charge transfer reaction, exchange currents, electro catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte.
UNIT III
Fuel cell characterization - in-situ and ex-situ characterization techniques, i-V curve, frequency response analysis; Fuel cell modelling and system integration: 1D model – analytical solution and CFD models.

UNIT IV
Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.

UNIT V
Fuel cell power plants: fuel processor, fuel cell power section (fuel cell stack), power conditioner; automotive applications, portable applications

TOTAL : 45 PERIODS

REFERENCES

CL8099  FUNDAMENTALS OF NANOSCIENCE  L T P C 3 0 0 3

UNIT I  INTRODUCTION
Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nano structured materials- nano particles quantum dots, nanowires-ultra-thin films-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II  PREPARATION METHODS
Bottom-up Synthesis-Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III  PATTERNING AND LITHOGRAPHY FOR NANOSCALE DEVICES
Introduction to optical/UV electron beam and X-ray Lithography systems and processes, Wet etching, dry (Plasma /reactive ion) etching, Etch resists-dip pen lithography.

UNIT IV  PREPARATION ENVIRONMENTS
Clean rooms: specifications and design, air and water purity, requirements for particular processes, Vibration free environments: Services and facilities required. Working practices, sample cleaning, Chemical purification, chemical and biological contamination, Safety issues, flammable and toxic hazards, biohazards.

UNIT V  CHARACTERISATION TECHNIQUES
X-ray diffraction technique, Scanning Electron Microscopy – environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS Nano indentation

TOTAL : 45 PERIODS
TEXT BOOKS

REFERENCES

CL8100 GAS TRANSPORTATION L T P C 3 0 0 3

UNIT I 9
Introduction, widespread use, the various types, the advantages and the special features of pipelines.

UNIT II 9
The fluid mechanics of various types of pipe flow including incompressible and compressible flows of Newtonian fluids, non-Newtonian fluids, flow of solid/liquid mixture (slurry), flow of solid/air mixture (pneumatic transport), and flow of capsules (capsule pipelines).

UNIT III 9
Various types of pipes (steel, concrete, PE, PVC, etc.), valves (gate, globe, ball, butterfly, etc.) and pressure regulators in pipelines. Blowers and compressors (for gases). Various kinds of flowmeters, sensors, pigs (scrapers) and automatic control systems used in pipelines.

UNIT IV 9
Various means to protect pipelines against freezing, abrasion and corrosion, such as cathodic protection, Planning, construction and operation of pipelines, including modern use of advanced technologies such as global positioning systems (GPS), directional drillings, automatic control using computers, and pipeline integrity monitoring such as leak detection.

UNIT V 9
Structural design of pipelines — load considerations and pipe deformation and failure. Economics of pipelines including life-cycle, Cost analysis and comparison of the cost-effectiveness of pipelines with alternative modes of transport such as truck or railroad. Legal, safety and environmental issues about pipelines.

TOTAL : 45 PERIODS

REFERENCES
UNIT I

UNIT II
IP – Patents – Copyrights and related rights – Trade Marks and rights arising from Trademark registration – Definitions – Industrial Designs and Integrated circuits – Protection of Geographical Indications at national and International levels – Application Procedures..

UNIT III

UNIT IV

UNIT V
Case Studies on – Patents (Basumati rice, turmeric, Neem, etc.) – Copyright and related rights – Trade Marks – Industrial design and Integrated circuits – Geographic indications – Protection against unfair competition.

TOTAL : 45 PERIODS

TEXT BOOK

REFERENCES

CL8105 MEMBRANE TECHNOLOGIES FOR WATER AND WASTEWATER TREATMENT

UNIT I INTRODUCTION
Solid Liquid separation systems-Filtration systems- Theory of Membrane separation – mass Transport Characteristics Cross Flow filtration-Membrane Filtration- Types and choice of membranes, porous, non porous, symmetric and assymmetric – Plate and Frame, spiral wound and hollow fibre membranes – Liquid Membranes

UNIT II MEMBRANE PROCESSES AND SYSTEMS
UNIT III  MEMBRANE BIOREACTORS  9
Introduction and Historical Perspective of MBRs, Biotreatment Fundamentals, Biomass Separation MBR Principles, Fouling and Fouling Control, MBR Design Principles, Design Assignment, Alternative MBR Configurations, Commercial Technologies, Case Studies

UNIT IV  PRETREATMENT SYSTEMS  8
Membrane Fouling – Pretreatment methods and strategies – monitoring of Pretreatment – Langier Index, Silt Density Index, Chemical cleaning, Biofoulant control

UNIT V  CASE STUDIES  8
Case studies on the design of membrane based water and wastewater treatment systems – zero Liquid effluent discharge Plants

TOTAL : 45 PERIODS

REFERENCES
1. Water Environment Federation (WEF), Membrane Systems for Wastewater Treatment, McGraw-Hill, USA, 2005

CL8106  MULTICOMPONENT DISTILLATION  L T P C
3 0 0 3

UNIT I  THERMODYNAMIC PRINCIPLES  9

UNIT II  THERMODYNAMIC PROPERTY EVALUATION  9
Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.

UNIT III  MINIMUM REFLUX RATIO FOR MCD SYSTEM  9

UNIT IV  VARIOUS METHODS OF MCD COLUMN DESIGN  9
Theta method of convergence – Kb method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method – Stage and reflux requirements – Short cut methods and Simplified graphical procedures.
UNIT V  VARIOUS TYPES OF MCD COLUMNS  9
Design of sieve, bubble cap, valve trays and structured packing columns for multi
component distillation – computation of plate efficiencies.

TOTAL : 45 PERIODS

TEXT BOOKS
Company, 1981

CL8107  MULTIPHASE FLOW  L T P C
3 0 0 3

UNIT I  CHARACTERISTICS OF MULTIPHASE FLOWS  9
Significance of multiphase flows, important non-dimensional numbers, parameters of
characterization, particle size measurement, size distribution and moments, size
distribution models

UNIT II  PARTICLE FLUID INTERACTION  9
Equation of motion for a single particle, calculation of drag, motion of a particle in two-
dimensions, effects of unsteady and non-uniform flow fields, effect of acceleration, effect
of coupling; Interaction between particles, mechanism of interaction, interparticle forces,
hard sphere model, soft sphere model, discrete element modeling, semi-empirical
methods, kinetic theory, force chains.

UNIT III  MODELING OF MULTIPHASE FLOWS  9
Flow patterns - identification and classification - flow pattern maps and transition
momentum and energy balance - homogeneous and separated flow models -
correlations for use with homogeneous and separated flow models - void fraction and
slip ratio correlations - influence of pressure gradient - empirical treatment of two phase
flow - drift flux model - correlations for bubble, slug and annular flows

UNIT IV  CONSERVATION EQUATIONS  9
Averaging procedures - time, volume, and ensemble averaging, quasi-one-dimensional
flow, two-fluid volume-averaged equations of motion, turbulence and two-way coupling.

UNIT V  MULTIPHASE SYSTEMS  9
Flow regime and hydrodynamic characteristics of packed bed, fluidized bed, pneumatic
conveying, bubble column, trickle beds; Conventional and novel measurement
techniques for multiphase systems including CARPT, Laser Doppler anemometry,
Particle Image Velocimetry.

TOTAL : 45 PERIODS

REFERENCES
2. Crowe, C. T., Sommerfeld, M. and Tsuji, Y., Multiphase Flows with Droplets and
Particles, CRC Press, 2011
2005
6. Rhode, M., Introduction to Particle Technology, John Wiley & Sons, New York,
2008.
1969.
UNIT I
Introduction to upstream economics analysis, energy overview of India – Time value of money, cash flow analysis, capital budgeting techniques, general probability, elements of oil and gas project cash flows.

UNIT II
Reserves classification methods, quantification, assessment of geoscience and reservoir engineering uncertainties – Assessment of reserves, production and demand in international market.

UNIT III
Inflation and cost escalation, oil market and OPEC, share of non OPEC countries in oil production – International oil and gas pricing mechanism – Geopolitics.

UNIT IV
Petroleum Fiscal system, classification and analysis – Reserves Auditing – Accounting systems for oil and gas.

UNIT V
Project Economic Evaluation and petroleum economic models – Decision analysis – Valuation of petroleum properties.

TOTAL : 45 PERIODS

REFERENCES
2. Cronquist, C., Estimation and classification of Reserves of Crude oil, Natural Gas, and Condensate, SPE (2001)
UNIT III  PLOT PLAN
Development of plot plan for different types of fluid storage, equipment layout, process piping layout, utility piping layout. Stress analysis - Different types of stresses and its impact on piping, methods of calculation, dynamic analysis, flexibility analysis.

UNIT IV  PIPING SUPPORT
Different types of support based on requirement and its calculation.

UNIT V  INSTRUMENTATION
Final Control Elements; measuring devices, instrumentation symbols introduction to process flow diagram (PFD) and piping & instrumentation diagram (P&ID)

TOTAL : 45 PERIODS

TEXT BOOKS

CL8110  POLLUTION ABATEMENT  L T P C
3 0 0 3

UNIT I
Man and environment, types of pollution, pollution controls aspects, industrial pollution, pollution monitoring and analysis of pollutants, Indian pollution regulations.

UNIT II
Water pollution- source of water pollution- measurement of quality- BOD- COD- colour and odor-PH- heavy metals-treatments etc (qualitatively). Industrial waste water treatment (qualitatively) and recycle.

UNIT III
Solid wastes- quantities and characterizations – industrial –hazardous waste- radioactive waste- simple treatments and disposal techniques (qualitatively treatment).

UNIT IV
Air pollution-types and sources of gaseous pollutants-particulate matter-hazardous air pollutants-global and atmospheric climatic change (Green house effect)-acid rain. Industrial exhaust –characterization and Methods of decreasing the pollutants content in exhaust gasses (qualitatively).

UNIT V

TOTAL : 45 PERIODS

REFERENCES
UNIT I  GENERAL ASPECTS OF POLYMERS  9
Classification, mechanisms and methods of polymerization, properties-molecular weight, glass transition temperature, crystallinity, thermal, electrical and mechanical properties.

UNIT II  APPLICATION ORIENTED POLYMERS  9
Resins-PVC-Silicon oil and resin, fibrous polymers-nylon 66, polyacrylonitrile, adhesives-epoxides, phenol formaldehyde, urea formaldehyde.

UNIT III  ELASTOMERS  9
Natural rubber, styrene-butadiene, poly isopropene-neoprene, silicon rubber, thermoplastic elastomer.

UNIT IV  PROCESSING OF POLYMERS  9
Processing additives, plasticzer, antiaging additives, surface and optical properties, modifiers, fire retardants, additives for rubber and elastomer, various molding techniques.

UNIT V  PHYSICAL AND CHEMICAL TESTING OF PLASTICS  9
Mechanical properties, tensile strength and hardness, electrical properties, volume resistivity, dielectric strength, optical properties glass, light transmission and refractive index, chemical analysis-elemental and functional analysis.

TOTAL : 45 PERIODS

REFERENCES

UNIT I  INTRODUCTION  5
Problem formulation, degree of freedom analysis, objective functions, constraints and feasible region, Types of optimization problem.

UNIT II  LINEAR PROGRAMMING  10
Simplex method, Barrier method, sensitivity analysis, Examples.

UNIT III  NONLINEAR UNCONSTRAINED OPTIMIZATION  10
Convex and concave functions unconstrained NLP, Newton’s method Quasi-Newton’s method, Examples.

UNIT IV  CONSTRAINED OPTIMIZATION  10
Direct substitution, Quadratic programming, Penalty Barrier Augmented Lagrangian Methods.
UNIT V    MULTI OBJECTIVE OPTIMIZATION

Weighted Sum of Squares method, Epsilon constrain method, Goal attainment, Examples. Introduction to optimal control and dynamic optimization.

REFERENCES


TOTAL : 45 PERIODS

CL8113            PROJECT ENGINEERING OF PROCESS PLANTS   L T P C
                                                   3 0 0 3

UNIT I
Project definition, Project Profile and standards, Feed back information (MIS), Evaluation and Modification, Selection, Criteria.

UNIT II

UNIT III
Plant Engineering Management, Objectives, Programme, Control, Plant Location and Site Selection, Layout diagrams, Selection and procurement of equipment and machineries, Installation, Recommission, Commissioning and performance appraisal, Strategies choice and Influence, Product planning and development, Provision and maintenance of service facilities.

UNIT IV
Process safety, Materials safety and Handling regulations, Safety in equipment and machinery operations, Design considerations of safety organization and control, Pollution, Pollution control and Abatement, Industrial Safety Standard Analysis.

UNIT V

TOTAL : 45 PERIODS

REFERENCES


CL8114 REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL MANAGEMENT

UNIT I OVERVIEW OF REMOTE SENSING 5

UNIT II REMOTE SENSING TECHNOLOGY 11
Classification of Remote Sensing Systems, Energy recording technology, Aerial photographs, Photographic systems – Across track and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing – Active and passive sensors, RADAR, LIDAR, Satellites and their sensors, Indian space programme - Research and development

UNIT III DATA PROCESSING 11

UNIT IV GEOGRAPHICAL INFORMATION SYSTEM 6
GIS Concepts – Spatial and non spatial data, Vector and raster data structures, Data analysis, Database management – GIS software

UNIT V REMOTE SENSING AND GIS APPLICATIONS 12
Monitoring and management of environment, Conservation of resources, Sustainable land use, Coastal zone management – Limitations

TOTAL : 45 PERIODS

REFERENCES
UNIT I
General: Risk types, Completion, Permitting, Resource, Operating, Environmental, Manageable, Insurable, Risk Causes, Risk Analysis types and causes.

UNIT II

UNIT III
Risk Management: Emergency relief Systems, Diers program, Bench scale experiments, Design of emergency relief systems, Internal emergency planning, Risk management plan, mandatory technology option analysis, Risk management alternatives, risk management tools, risk management plans, Risk index method, Dowfire and explosion method, Mond index Method.

UNIT IV

UNIT V

REFERENCES

TOTAL : 45 PERIODS
UNIT II
Past Accident Analysis, Consequence Analysis of fire, gas/vapour, Dispersions and explosion, Vulnerability models, Fault and Event Tree Analysis.

UNIT III
Safety in plant design and layout. Risk Assessment.

UNIT IV
Safety measures in handling and storage of chemicals, Process plant, personnel Protection, First Aid.

UNIT V
Disaster mitigation, Emergency Preparedness plans.

TOTAL : 45 PERIODS

REFERENCES

CL8117 SOIL POLLUTION ENGINEERING

UNIT I PHYSICS AND CHEMISTRY OF SOIL

UNIT II INORGANIC AND ORGANIC GEOCHEMISTRY

UNIT III CONTAMINANT FATE AND TRANSPORT IN SOIL
UNIT IV  GROUND IMPROVEMENT TECHNIQUES IN WASTE MANAGEMENT


UNIT V  SOIL REMEDIATION TECHNOLOGIES


TOTAL : 45 PERIODS

REFERENCES

CL8118  SOLVENT EXTRACTION  L T P C
3 0 0 3

UNIT I  EQUILIBRIUM IN LIQUID-LIQUID SYSTEM


UNIT II  DIFFERENTIAL / STAGE-WISE EQUILIBRIUM CONTACT OPERATIONS

Equilibrium stage-wise contact, Single and multiple contacts with co-current and counter current flow of phases for immiscible and partially miscible solvent phases , Calculation methods, Fractional extraction with reflux of raffinate and extract. Differential contact, HETS, NETS, HTU, NTU concepts and Estimation of these parameters, Mass transfer efficiency, Axial mixing and Residence time distribution in extractors and their estimation.

UNIT III  DISPERSION AND COALESCENCE IN EXTRACTORS

Characteristics of dispersion involving single and multiple nozzle distributors, Drop size and formation and coalescence, Mean drop size at dispersion and their settling velocities/relative characteristics velocities. Effect of drop oscillation ,wobbling and Internal circulation, Effect of surface active agents, Prediction of drop size and characteristics velocity in spray , packed and mechanically agitated contactors as in RDC, pulsed columns, solute transfer effects on drop dynamics.
UNIT IV  DESIGN OF LIQUID EXTRACTION COLUMNS  12
Design of extractor height and diameter, Prediction of flow capacities in terms of flooding rates, Regime of operating envelops. Hydrodynamic design variables such as hold up, characteristic velocities, pressure drop, Effect of direction of solute transfer on these variables and their prediction methods, Correction of mass transfer data, Axial mixing correction for column height, Interfacial area estimations, using slow, fast and instantaneous reactions and their application with models for mass transfer coefficients.

REFERENCES

TOTAL : 45 PERIODS
CL8120  TOTAL QUALITY MANAGEMENT  L T P C  3 0 0 3

UNIT I  CONCEPTS OF TQM  5
Philosophy of TQM, Customer focus, organization, top management commitment, team work, quality philosophies of Deming, Crosby and Muller.

UNIT II  TQM PROCESS  12
QC Tools, Problem solving methodologies, new management tools, work habits, quality circles, bench marking, strategic quality planning.

UNIT III  TQM SYSTEMS  8
Quality policy deployment, quality function deployment, Standardization, designing for quality, manufacturing for quality.

UNIT IV  QUALITY SYSTEM  10
Need for ISO 9000 system, Advantages, clauses of ISO 9000, Implementation of ISO 9000, quality costs, quality, auditing, case studies.

UNIT V  IMPLEMENTATION OF TQM  10
Steps, KAIZEN, 5s, JIT, POKAYOKE, Taguchi methods, case studies.

TOTAL : 45 PERIODS

REFERENCES

CL8121  WASTE MANAGEMENT AND ENERGY RECOVERY  L T P C  3 0 0 3

UNIT I  SOLID WASTE – CHARACTERISTICS AND PERSPECTIVES  6
Definition - types – sources – generation and estimation. Properties: physical, chemical and biological – regulation

UNIT II  COLLECTION, TRANSPORTATION AND PROCESSING TECHNIQUES  8
Onsite handling, storage and processing – types of waste collection mechanisms - transfer Stations : types and location – manual component separation - volume reduction : mechanical, thermal – separation : mechanical, magnetic electro mechanical

UNIT III  ENERGY GENERATION TECHNIQUES  16

UNIT IV  HAZARDOUS WASTE MANAGEMENT  8
UNIT V  ULTIMATE DISPOSAL

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

CL8122  WASTE WATER ENGINEERING  L T P C
3 0 0 3

UNIT I  INTRODUCTION
10

UNIT II  INDUSTRIAL WASTEWATER TREATMENT
10
Equalisation - Neutralisation - Oil separation - Flotation - Precipitation - Heavy metal Removal – Refractory organics separation by adsorption - Aerobic and anaerobic biological treatment - Sequencing batch reactors – High Rate reactors

UNIT III  ADVANCED WASTEWATER TREATMENT AND REUSE
8

UNIT IV  RESIDUALS MANAGEMENT
5
Residuals of industrial wastewater treatment - Quantification and characteristics of Sludge - Thickening, digestion, conditioning, dewatering and disposal of sludge - Management of RO rejects.

UNIT V  CASE STUDIES
12

TOTAL : 45 PERIODS
REFERENCES

EY8077 HYDROGEN AND FUEL CELLS L T P C 3 0 0 3

UNIT I HYDROGEN – BASICS AND PRODUCTION TECHNIQUES 9

UNIT II HYDROGEN STORAGE AND APPLICATIONS 9

UNIT III FUEL CELLS 9
History – principle – working – thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell

UNIT IV FUEL CELL – TYPES 9
Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits

UNIT V APPLICATION OF FUEL CELL AND ECONOMICS 9
Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
UNIT I  MATHEMATICAL PROGRAMMING  12

UNIT II  DYNAMIC PROGRAMMING  10
Elements of DP models, Bellman’s optimality criteria, Recursion formula, Solution of multistage decision problem by DP method. Application is Heat Exchange Extraction systems.

UNIT III  PERT, CPM and GERT  9
Network representation of projects, Critical path calculation, construction of the time-chart and resource leveling, Probability and cost consideration in project scheduling, Project control. Graphical Evaluation and Review Techniques.

UNIT IV  ELEMENTS OF QUEUING THEORY  7
Basic elements of the Queuing model, M/M/1 and M/M/C Queues.

UNIT V  ELEMENTS OF RELIABILITY THEORY  7
General failure distribution, for components, Exponential failure distributions, General model, Maintained and Non-maintained systems, Safety Analysis.

TOTAL : 45 PERIODS

REFERENCES