B.Tech (Chemical Engineering)

Four Year/Eight Semester Course

Semester 3 to 8

Operative from 2007-2008 onwards

Department of Chemical Engineering
The total number of credits for the B.Tech. Program in Chemical Engineering is 176

### III SEMESTER

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*Chemical Engineering – B.Tech. Effective from 2007-2008 onwards*
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MA201 MATHEMATICS III

MA201 TRANSFORMS, SPECIAL FUNCTIONS AND PARTIAL DIFFERENTIAL EQUATIONS

Laplace Transform of Standard functions, derivatives and integrals – Inverse Laplace transform – Convolution theorem-Periodic functions – Application to ordinary differential equation and simultaneous equations with constant coefficients and integral equations.


Bessel’s Equation – Bessel Functions - Recurrence relations-Generating function for Bessel functions - Legendre’s equation - Legendre polynomials-Rodrique's formula-generating function and recurrence relations for Legendre polynomials - orthogonality property of Legendre polynomials.

Formation of partial differential equations by eliminating arbitrary constants and functions - solution of first order equations - four standard types - Lagrange’s equation - homogeneous and non-homogeneous type of second order linear differential equation with constant coefficients.

Applications of Partial Differential Equations - Solution of one-dimensional heat flow equation and two dimensional heat flow equation (Cartesian and Polar form) in steady state by the method of separation of variables using Fourier series.

References.


CL201 ORGANIC CHEMISTRY

Organometallic compounds - Grignard reagent - synthesis of different types of compounds like alcohol, aldehyde, acid, amine and organometallic. Acetoacetic ester - tautomerism - base hydrolysis - acid hydrolysis - malonic ester - cyano acetic ester - synthesis of dicarboxylic acids and unsaturated acids.

R, S, configuration, mutarotation, conversions - glucose to fructose and vice versa, sucrose - structural elucidation, extraction, reactions, starch and cellulose - structural details, applications.

Alicyclic compounds - nomenclature - synthesis of alicyclic compounds using carbon - acroyloin condensation - Diels Alder reaction, Freunds’s synthesis - bayer's strain theory postulates, drawbacks - theory of strainless rings - conformations of cyclohexane. Coal tar distillation, separation of benzene, toluene, phenol and naphthalene - Aromaticity exhibited by these compounds. Fats and oils – Saponification - hydrogenation of oils


TEXTBOOKS:
EE27 DIGITAL ELECTRONICS


Digital Arithmetic & Data Converters: Addition, Subtraction ALU, Binary Multiplication and Division, Fixed point and Flouting point numbers. DAC and ADC.


Microprocessor Programming: Instruction set of INTEL 8085, Writing programs in HEX code, Assembler and Assembler directives.

TEXT BOOK:

REFERENCE:
CL203 INORGANIC CHEMICAL TECHNOLOGY

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

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


Gases, Water and Paints: Industrial Gases: Carbon dioxide, Nitrogen, Hydrogen, Oxygen and Acetylene - Water Treatment: Industrial and municipal water treatment - Manufacture of paints - Pigments:

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

TEXT BOOK:

REFERENCES:
CL205 MOMENTUM TRANSFER


Text books / Reference books:

CL207 PROCESS CALCULATION

Stoichiometry: Introduction - Units and Dimensions - Stoichiometric principles - composition relations, density and specific gravity.


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

TEXT BOOKS:

REFERENCES:
2. V. Venkataramani and N. Anantharaman, 'Process Calculations' Prentice Hall of India Ltd, N. Delhi. 2003
CE297 MECHANICAL ENGINEERING LAB

1. Load test on Diesel alternator set
2. Heat Balance of Diesel engine
3. Mechanical load test on petrol engine
4. Merse test on multi cylinder petrol engine
5. Volumetric efficiency on Diesel engine
6. Volumetric efficiency on two stage reciprocating compressor
7. COP in compression refrigerator cycle
8. Test on Air conditioning system
9. Viscosity index of lubricant
10. Study of steam power plant
11. Tension test on M.S. Bar
12. Hardness test - Brinell and Rockwell
13. Bending test of M.S. flat
15. Spring test
16. Torsion test

EE221 ELECTRICAL ENGINEERING LAB

1. Open circuit characteristics of DC shunt generators
2. No Load speed characteristics of Dc shunt motor
3. Load test on DC shunt generator
4. Equivalent circuit of single phase transformer
5. Load test on single phase transformer
6. Power measurement in Three phase circuit using two wattmeter method
7. Starting of three phase induction motor
8. Swinburne’s test
9. Calibration of watt meter
10. Calibration of Ammeter and Voltmeter
MA202 NUMERICAL TECHNIQUES

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence - Power method to find the dominant eigenvalue and eigenvector.

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton- Raphson method for \( f(x) = 0 \) and for \( f(x,y) = 0 \) - Order of convergence - Horner's method - Graeffe's method - Bairstow's method.


Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one dimensional heat flow equation - Bender - Schmidt recurrence relation - Crank - Nicolson method - Solution of one dimensional wave equation.

References.

1. GERALD, C.F., and WHEATLEY, P.O., Applied Numerical Analysis, Addison Wesley.


CL305 MATERIAL SCIENCE AND TECHNOLOGY


TEXT BOOKS:


REFERENCE:

1. V. Raghavan, Materials Science and Engineering, Prentice Hall
CL204 PHYSICAL CHEMISTRY


Electrical Conductance: Debye - Huckell Onsager theory; Ostwald's dilution law - solubility of electrolytes and solubility product – Applications, common ion action - acids, bases - definitions a) based on proton transference, dissociation constant, amphoteric electrolyte - pH - Buffer solutions. Hydrolysis of salts. Decomposition potential, over voltage, definitions of current density, current efficiency, energy consumption; oxidation - reduction redox couple; e.m.f. and energy relations. Conductometry, Potentiometry, Voltammetry, their applications. Fuel cells.


TEXTBOOKS:

REFERENCES:
CL206 CHEMICAL ENGINEERING THERMODYNAMICS

Fundamentals of Thermodynamics: Laws of thermodynamics as applied to open and closed system - reversible and irreversible processes - state and point function - Absolute entropy - Thermodynamic property changes for ideal gas.


Thermodynamic Relations: Thermodynamic relations - Maxwell’s relations - Jacobian algebra - estimation of thermodynamic properties.


Chemical equilibria - heat effects, industrial reactions - Free energy calculations - Homogeneous and heterogeneous reactions - Industrial reactions like NH₃ synthesis, SO₃ production etc.

TEXT BOOKS:

REFERENCE:
CL208 PARTICULATE SCIENCE AND TECHNOLOGY

This course is designed to give conceptual understanding on characterization of particulates, and processes associated with particulate material and synthesis methods to produce particulates of different quality in addition with a brief introduction on handling methods.

Characteristics of Particulate Material: Properties and characterisation of particulate solids, analysis and technical methods for size and surface area distribution of powder; Flow properties of particulates.

Synthesis Methods: Introduction to synthesis of composite material by spray technique, aerosol generation, Introduction to size reduction equipment, energy and power requirement in milling operations, computer simulation techniques for mill performance.

Particulate Processes: Gas-liquid separation methods, Classification by size, agitation of liquids and mixing of solids, Fluidization, encapsulation etc.

Handling of Particulate Material: Conveying methods, Storage methods and design of silo, selection of feeders and elevators.

TEXT BOOKS:

REFERENCES:
CL210 ENVIRONMENTAL ENGINEERING

Environment, Environmental quality and degradation, description of environment setting and procedure for environment impact assessment policies and acts.

Sources of air pollution - effects of air pollution on the environment, on materials, on human health, on animals. Analytical methods. Equipments for control of air pollution. Measurements of air pollution.

Sources of water pollution – Effects of water pollution - control of water pollution and treatment methods for effluent water. Measurements of COD & COD.


Sources and classification public health aspects, methods of collection, disposal methods.

Text Books/References


CL212 FLUID MECHANICS LABORATORY

1. Pipe friction
2. Rotameter
3. Floated orifice meter
4. Orifice meter/Venturi meter
5. Efflux time
6. Centrifugal pump
7. Open orifice/weirs and Notches
8. Non-Newtonian flow
9. Helical coil
10. Annular flow
11. Flow through fittings/valves
12. Reciprocating pump
13. Flow through non-circular conduits
14. Flow through packed bed
15. Fluidised bed
16. Semi Fluidised beds
CL214 PHYSICAL CHEMISTRY LABORATORY

1 and 2 Molecular weight Determination
   a  Rast's method.
   b  B.Pt Depression.
   c  B.Pt elevation and
   d  Transition temperature methods.

3 and 4 partition experiments.
   (a) Partition coefficient of iodine between two immiscible Solvents.
   (b) Eq. constant of KI + I = KI
   (c) Association factor of an organic acid
   (d) Curramorium couples.

5. and 6. Phase rules
   (a) Two component system
   (b) Three component system
   (c) Phenol - water system.

7  Optical experiments.
   a  polarimetry
   b  Refractometry.

8  and 9. Conductivity experiments.
   a  Cell constant.
   b  Ostwald Dilution law.
   c  Basicity of an organic acid.
   d  Conductometric titration.

10 Kinetics.
   a  First order reaction.
   b  Second order reaction

11 EMF
   a  single electro potentials.
   b  concentration cells.
   c  Titrations
   d  pH determination.

12 Miscellaneous.
   a  Surface tension.
   b  Viscosity
   c  Adsorption.
CL301 CHEMICAL REACTION ENGINEERING - I


Heat Effects: Temperature and pressure effects on single and multiple reactions.


TEXT BOOK:

REFERENCE:
CL303  ADVANCED PROGRAMMING LANGUAGE C++

Objects And Classes: Concepts in object-oriented programming, classes and objects, C++ programming basics, object-oriented analysis, object-oriented design methods.


Class Inheritance: Derived classes, The protected access specifier, Derived class constructors, overriding member functions, Class hierarchies, Public and Private inheritance, Multiple inheritance.

Polymorphism: Virtual functions, Abstract base classes and pure virtual functions.

Files And Streams: Introduction to object-oriented database - case studies.

TEXT BOOK:

REFERENCES:
CL202 ORGANIC CHEMICAL TECHNOLOGY

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

Industrial Microbial Processes And Edible Oils: Fermentation processes for the production of ethyl alcohol, citric acid and antibiotics, Refining of edible oils and fats, fatty acids, Soaps and detergents.

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

Polymer Based Industries And Their Characteristics: Plastics: Production of thermoplastic and thermosetting resins such as polyethylene, polypropylene, phenolic resins and epoxy resins; Polymers and their applications in engineering practice.


TEXT BOOKS:

REFERENCE:
CL307 MASS TRANSFER


Equilibria, Mass transfer coefficients - Individual and overall with relations, Theories of mass transfer, Analogies between momentum, heat and mass transfer to predict mass transfer coefficients.

Absorption – Solubility, theory of gas absorption, Design of absorption towers, Concept of Equilibrium and operating lines. Mass Transfer Equipments- Batch and continuous Stage wise contactors and Differential contactors, Concept of HTU and NTU, Tower packings and packing characteristics, Non-isothermal absorbers, Absorption with chemical reactions.

Humidification Theory, Psychometric Chart, Adiabatic Saturator, Wet Bulb Theory, Methods of Humidification and dehumidification, Cooling tower theory, Design of cooling towers, Industrial cooling towers, Air conditioning process, Recirculating water gas humidification system.

Drying Theory and Mechanism, Drying Characteristics, Estimation of Drying time, Drying rate curve, Classification of Driers, Through circulation driers design, Design of driers, Description and Application of Driers, Analysis of continuous driers.


TEXT BOOKS:


REFERENCE:

3. **CL309 HEAT TRANSFER**

Basic modes of heat transfer and the laws governing them. Steady state conduction through plane and composite walls general heat conduction equation, concepts of thermal diffusivity and equivalent thermal conductivity. Radial Heat conduction through thick cylindrical and spherical vessels.

Convection – Dimensional analysis and empirical correlations, critical insulation thickness for cylindrical and spherical surfaces, Hydrodynamic and thermal Boundary layers, physical significance of the dimensionless groups.

Thermal Radiation laws, spectrum of electromagnetic radiation, Black and Gray bodies, and configuration factor – typical examples.

Heat Exchangers – classification and design, overall and individual film coefficients, mean temperature difference, LMTD correction factor for multiple pass exchanger, NTU and efficiency of Heat exchangers, use of efficiency charts.

Evaporation, single and multiple effect operation, material and Energy balance in evaporators, boiling point elevation, Duhrin'gs rule, effect of liquid head, illustrative examples.

**TEXT BOOKS:**

**REFERENCES:**
CL311 PETROLEUM AND PETROCHEMICAL ENGINEERING

Primary Processing Of Crude Oil: Classification of crude oil, Atmospheric distillation, Vacuum distillation of residue-Products and distillation practice.

Secondary Processing Of Crude Oil: FCCU, Hydro cracking, Visbreaking, Thermal cracking, Coking, Reforming, Alkylation, Polymerisation and Isomerisation process.

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


Environmental And Safety Aspects In Refinery And Petrochemicals: Waste water and effluent gases treatment from alkylation units and petrochemical units, safety aspects in the above industries.

TEXT BOOKS:

REFERENCES:
CL313 MECHANICAL OPERATIONS LABORATORY

1. Sphericity factor on friction losses.
2. Agitated vessel
3. Settling studies
4. Drag studies
5. Filtration (constant rate)
6. Filtration (constant pressure)
7. Screening
8. Elutriation
9. Jaw crusher
10. Ball mill
11. Particle size distribution
12. Storage of Solids

CL315 TECHNICAL ANALYSIS LABORATORY

1-6 Analysis of water, oil, soap, cement, sugar, bleaching powder, fertilizer, drugs and vegetables, tannins, ores, alloys, cellulose
7-12 Analysis of products by colorimeter, polarimetry, potentiometric titration, Conductometric titrations, pH meter, gas chromatograph, flame photometer Turbidity meter, conductivity meter, refractometer, etc.
HM 302 HUMAN PSYCHOLOGY & ORGANISATIONAL BEHAVIOUR

Introduction: a. Principles of management, functions of organisations, organisational system - technology, process, design, structure and culture and their impact on the people at work. b. Definition - development of psychology as scientific discipline - methods and applications of psychology in human at work in industry.


Motivation, Leadership, Teamwork, Communication: Concept of. Motivation; why to people work; theories on motivation, (Maslow, Herzberg, achievement orientation, expectancy theory, theory x, y, z); techniques of motivating employees, Leadership - role of leader, qualities of a leader; styles of leadership (blake and mouton managerial grid, Frid Fiedler’s contingency approach, Rensis Likert’s four styles), determinants of leadership style to be adopted, Power, authority and accountability; delegation, Dynamics of groups; work groups, teamwork, Communication - Channels of communication, feedback, Barrier to communication; Non-verbal communication, grapevine, Transactional analysis

Human Engineering: Human and Engineering Factors influencing each other - Ergonomics, Effect of Physical environment - illumination, temperature, noise etc; Social economic and political responsibilities of an engineer.

Psychological Aspects Expounded By Thirukural: Realisation of truth, power of speech (utterances of pleasant words) and Action, Mutual desire, human effort, inconsistent conduct, possession of Decorum manly effort, energy

TEXT BOOKS:

REFERENCES:
CL302 PROCESS EQUIPMENT DESIGN AND DRAWING


Design Of Reaction Vessel And Storage Tank: Design and schematic of storage tank, (vertical and horizontal) supports, agitated vessel.

Design Of High Pressure Systems: Design of high pressure vessels and reactors

Design Of Phase Separation Equipment: Design of physical separation equipments such as cyclones, centrifuges, thickeners, filtration equipment, KO drum.

Drawing of Phase Separation Equipment: Drawing of physical separation equipments such as hydro-cyclones, packed towers, plate columns, electrostatic precipitators

TEXT BOOKS:

REFERENCES:
CL304 BIOCHEMICAL ENGINEERING


Functioning Of Cells And Fundamental Molecular Biology: Metabolism and bioenergetics, Photosynthesis, carbon metabolism, EMP pathway, tricarbocyclic cycle and electron transport chain, aerobic and anaerobic metabolic pathways. Synthesis and regulation of biomolecules, fundamentals of microbial genetics, role of RNA and DNA.


TEXT BOOKS:

REFERENCE:
CL306 EQUILIBRIUM STAGED OPERATIONS

Principle, theory, Vapour Liquid Equilibria calculations, Effect of Pressure and temperature on VLE, Methods of distillations, batch, continuous, flash, steam, vacuum, molecular distillations. Design of single stage flash and simple distillation columns.

Stage-wise and continuous Differential contact operations, Design calculations using Ponchon-Savarit and Mc-Cabe Thiele Methods, Efficiency interrelations. Reboilers and condensers. Open steam Distillation, Multicomponent Distillation- Azeotropic distillation and Extractive distillation, Multi component Flash and differential distillation.

Liquid - Liquid Equilibria for Different systems, Effect of Pressure and Temperature on LLE, Solubility criteria, Design of Batch and continuous extraction towers for miscible and immiscible systems. Industrial Applications, Design of Extractors with reflux.

Theory, Mechanism, Types of leaching, Solid - Liquid equilibria, Design of Batch and continuous extractors. Equipments and industrial applications.

Types of adsorption, nature of adsorbents, Adsorption isotherms, Operation of adsorption columns. Batch and continuous operations, Design of adsorbers.

TEXT BOOKS:


REFERENCES:


Dynamic behaviour of systems - derivation of transfer functions for first and second order systems, liquid level, temperature, pressure, flow and concentration control processes, linearisation of nonlinear systems, interacting and non-interacting systems. Transient response of first and second order systems, natural frequency, damping factor, overshoot, decay ratio, rise time and settling time.

Transient analysis of control systems - block diagram algebra, overall transfer function of closed loop control systems, regulator and servo problems, transient response of first and second order systems with P, PI and PID controller. Definition of stability of control systems, Routh test, limitations of Routh test, Padé’s approximation of time delay systems.


Introduction to advanced control techniques - feed forward control, cascade control, ratio control, adaptive control, inferential control, selective control.

Text books / Reference books:

ELECTIVE I

CL310 HEAT TRANSFER LABORATORY

1. Shell and Tube Heat exchanger
2. Condenser (Vertical)
3. Condenser (Horizontal)
4. Convective heat transfer - Forced & free convection
5. Transient heat conduction
6. Agitated vessel heat transfer
7. Heat Transfer in Jacketed Kettle
8. Thermal Conductivity of metal rod
9. Plate Heat Exchanger

CL312 CHEMICAL REACTION ENGINEERING LABORATORY

1. Reversible reaction in a batch reactor
2. Irreversible reaction in a batch reactor
3. Plug flow reactor
4. Mixed flow reactor
5. Adiabatic reactor
6. Combined reactor: Mixed flow-plug flow
7. Combined reactor: Plug flow-mixed flow
8. Heterogeneous catalytic reactor
9. Biochemical reactor
10. RTD studies
11. Photochemical reactor
12. Segregated flow reactor
13. Semibatch reactor
14. Gas-solid reaction
CL401  SAFETY IN CHEMICAL INDUSTRIES

Introduction: Industrial safety principles. Site selection and plant layout. Legal Aspects. Design for ventilation, Emergency response systems for hazardous goods basic rules and requirements which governs the chemical industries.

Hazards: Chemical hazards classification. Hazards due to fire, explosion and radiation. Reduction of process hazards by plant condition monitoring, Materials Safety Data sheets and National Fire protection agency’s classifications.

Diseases: Dangerous occupational diseases, poisoning, dust effect. The biomedical and engineering response to health hazards.

Control Of Hazards: Engineering control of plants instrumentation. Colour codes for pipe lines. Safety aspects of reactive chemicals.


TEXT BOOKS:

REFERENCES:
Design Of Heat Transfer Equipments: Design and Drawing of Heat Transfer Equipments such as heat exchangers with and without phase change, evaporators, crystallizers.

Design Of Mass Transfer Equipments: Design and Drawing of mass transfer equipments such as distillation columns, absorption columns, extraction columns, dryers and cooling towers.

Targetting: Heat exchanger networks, targeting, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting. Problem representation, temperature enthalpy diagram, simple match matrix Heat content diagram.


TEXT BOOKS:


REFERENCES:

HM 401 INDUSTRIAL ECONOMICS & MANAGEMENT


TEXT BOOKS:


REFERENCE:

CL405 PROJECT ENGINEERING

Plant location and site selection, plat layout, factors affecting plant location, project planning and scheduling of projects, procurement operations, office procedures, project financing.

Process utilities, process water, boiler feed water, water treatment & disposal, steam, steam distribution including appropriate mechanical valves and instrumentation, Furnaces, process pumps, compressors, vacuum pumps, pressurized air distribution systems, Refrigeration plant.

Process auxiliaries, piping design, layout, Support for piping insulation, plant constructions, start up and commissioning.

TEXT BOOKS:

REFERENCES:
1. Rase and Barrow, Project Engineering of Process Plants, John Wiley, 1964
ELECTIVE 2

ELECTIVE 3

CL407 COMPREHENSIVE VIVA-VOCE

CL409 MASS TRANSFER LABORATORY

1. Simple Distillation
2. Steam Distillation
3. Surface evaporation
4. Leaching
5. Batch adsorption
6. Diffusion
7. Air drying
8. Wetted wall column
9. Vacuum drying
10. H.E.T.P
11. Continuous adsorption
12. Extraction

CL411 PROCESS DYNAMICS AND CONTROL LABORATORY

1. Analog Simulator.
2. Process trainer
3. Interacting & non interacting Systems
4. Control of a thermal system
5. Flapper - Nozzle system
6. Control valve characteristics
7. Level control system
8. Transducer characteristics
9. I & II Order System Dynamics
10. Pressure control system
11. Frequency Response
CL402 PROCESS ENGINEERING ECONOMICS


Capital requirements for process plants: Project implementation steps, Feasibility studies, Capital requirements for process plants, Cost indices, Equipment cost, Service facilities. Capital requirements for complete plants, Balance sheet.

Cost, earnings, profits and returns: variable cost, fixed cost, income statement, Economic production charts. Capacity factors, Taxes and insurance.

Economics of selecting alternates: Annual cost method, Present worth method, Equivalent alternates, Rate of return and payment time. Cash flow analysis.


TEXT BOOKS:

REFERENCES:
CL404 TRANSPORT PHENOMENA


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


Heat Transfer analysis: Temperature distribution in solids and fluids in laminar flow - Equations of change for multi component systems.

Mass Transfer analysis: Concentration distribution in solids and in fluids laminar flow - Equations of change for multi component systems.

TEXT BOOKS:

REFERENCE:

ELECTIVE 4

ELECTIVE 5

CL406 PROJECT WORK
LIST OF ELECTIVES

CL314 CHEMICAL REACTION ENGINEERING - II

Modes of contacting different phases: Self mixing of single fluids, mixing of two miscible fluids, Introduction. Design for heterogeneous reacting systems.

Design of reactor for non catalytic reactions: Fluid-particle systems: Models for non-catalytic heterogeneous reactions, their limitations, selection and their applications to design.


TEXT BOOKS:
CL316 NUCLEAR ENGINEERING

Principles of nuclear power generation, nuclear fission and fusion, energy from fission and fuel burn up.

Radioactivity, neutron energies, thermal neutrons, nuclear cross sections, Fission reactor types, reactor control, fuel arrangements in a thermal reactor.

Pressurized water reactor, PWR power plant, Boiling water reactor, BWR power plant, Gas cooled reactor, high temperature gas cooled reactor.

Concept of breeding, fast breeder reactors, Liquid metal fast breeder reactor and accessories.

Thermal pollution by nuclear power plants, Radio-active pollution of environment by nuclear power plants, radio-active waste disposal.

TEXTS/REFERENCES:

1. Glasstone, "Nuclear Reactor Engineering".
2. M.N. El Vakil, "Nuclear Power Engineering".
3. Arora and S. Domkundwar, "Power Plant Engineering", Dhanpat Rai & Sons
CL413 BIO-TECHNOLOGY


Sensors, Monitoring and control systems in Bioprocesses: Instrumentation and process control in Bioprocesses.


Fermentation Technology and R-DNA Technology: Bio-process Technology and Genetic Engineering.

TEXT BOOKS:


REFERENCE:

CL415 POLYMER TECHNOLOGY


Polymer material structure and Properties: Deformation, flow and melt characteristics. Morphology and order in crystalline polymers. Rheology and the mechanical properties of polymers. Polymer structure and physical properties.


TEXT BOOK:

REFERENCES:
CL417 MICRO ELECTRONICS PROCESSING

Crystal growth and wafer preparation: silicon crystal growth from the melt, silicon float zone process, material characterization, Gas crystal growth technique. Silicon oxidation: Thermal oxidation, silicon oxidation model, impurity redistribution during oxidation, oxide thickness characteristics.

Photolithography: optical lithography, next generation lithographic methods - electron beam, extreme ultraviolet, X-ray, Ion beam lithographic methods, comparison of various methods.

Etching: wet chemical etching - silicon etching, silicon dioxide etching, silicon nitride and poly silicon etching, Aluminium etching, Gallium Arsenite etching. Dry etching plasma etching, reactive plasma etching.


Ion Implantation: Range of implantation ions, Implant damage and annealing, Implantation related processes.

Film deposition: Epitaxial growth techniques, structure and defects in epitaxial layers, Dielectric deposition, Polysilicon deposition, metallization Process integration: Passive components, Bipolar technology, MOSFET Technology, MESFET technology, MEMS technology.

TEXT BOOKS:

REFERENCES:
CL408 NANO TECHNOLOGY

Supramolecular Chemistry. Definition and examples of the main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supramolecular structures.

Physical Chemistry of Nanomaterials. Students will be exposed to the very basics of nanomaterials; A series of nanomaterials that exhibit unique properties will be introduced.

Methods of Synthesis of Nanomaterials. Equipment and processes needed to fabricate nanodevices and structures such as bio-chips, power devices, and opto-electronic structures. Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches.

Biologically-Inspired Nanotechnology Basic biological concepts and principles that may lead to the development of technologies for nanoengineering systems. Coverage will be given to how life has evolved sophisticatedly; molecular nanoscale engineered devices, and discuss how these nanoscale biotechnologies are far more elaborate in their functions than most products made by humans.

Instrumentation for Nanoscale Characterization. Instrumentation required for characterization of properties on the nanometer scale. The measurable properties and resolution limits of each technique, with an emphasis on measurements in the nanometer range.

TEXT BOOKS:
1. Supramolecular Chemistry by Jean-Marie Lehn,
2. Supramolecular Chemistry by Jonathan Steed & Jerry Atwood
3. Intermolecular and Surface Forces by Jacob Israelachvili.
CL410 ENERGY ENGINEERING

Coal: Coal and Coal derived fuels; Characteristics, production methods and uses. Coal combustion technology, waste heat recovery.

Oil And Gases: Fuels from oil and gases: Characteristics, production methods and uses. Technology for combustion of fuels derived from oil and gas.

Solar Energy: Solar energy utilization, Thermal application and photovoltaic applications; wind, geothermal and hydro energy utilization.

Bio Energy: Biomass conversion for fuels; production methods based on thermochemical and bioconversion. Characteristics and uses; Design of digestors.

Nuclear Energy: Nuclear Energy; Nuclear fission fuels processing, Nuclear reactions and nuclear reactors, Nuclear Engineering.

TEXT BOOKS:

REFERENCE:
CL412 PHARMACEUTICAL TECHNOLOGY

Introduction to Physical Pharmaceutics: Metrology and Calculations, Molecular structure, properties and States of Matter, Solutions, Phase Equilibria, Micromeritic and Powder Rheology, Surface and Interfacial Phenomena, Dispersion Systems,

Diffusion & Dissolution, Kinetics and drug stability, Viscosity & Rheology, and Polymer Science and Applications.

Formulations and Development, Packaging, Introduction to Industrial Processing, Transport Phenomena (Fluid Flow, Heat Transfer and Mass Transfer),

Particulate Technology (Particle Size, Size reduction, Size Separation, Powder Flow and Compaction), Unit Operations (Mixing, Evaporation, Filtration, Centrifugation, Extraction, Distillation, and Drying),

Materials of Pharmaceutical Plant Construction, Good Manufacturing Practice (GMP’s) Guidelines

TEXT BOOKS:
1. Physical Pharmacy by Alfred Martin.
2. Remington's Pharmaceutical Sciences

REFERENCES:
1. Bentley's Pharmaceutics by E A Rawlins
2. Cooper and Gunn's Tutorial Pharmacy
RESERVED ELECTIVES

CL01 ADVANCES IN HEAT TRANSFER

Transient Heat conduction, Extended surfaces and generalized expressions for fins or spines. Effectiveness of fins and spines, Temperature - time response of thermocouples and use of transient heat conduction charts.

Convection - Theory and practice. Energy equation for thermal boundary layer over a flat plate. Data analysis for forced and free convection problems, Analogy between heat, mass and momentum transfer.

Heat Transfer with phase change, Boiling and condensation, Boiling Regimes and types of condensation processes, effect of pressure, turbulence and other factors on boiling and condensation heat transfer.


TEXT BOOKS:

REFERENCES:
CL02 FLUIDIZATION ENGINEERING


Heat transfer between Fluidised beds and surfaces - Entrainment & Elutriation: Heat transfer between fluidised beds and surfaces: Experiment finding theories of bed heat transfer comparison of theories. Entrainment of or above TDH, model for Entrainment and application of the entrainment model to elutriation.

TEXT BOOK:

CL03 ENZYME ENGINEERING


Enzyme production on large scale technology: Isolation and purification of enzymes, protein fractionation methods.

Immobilization technology and developments: Immobilization techniques for enzymes. Characteristics and uses for immobilized enzyme systems.

Industrial bioreactors utilizing isolated enzymes and Biosensors development and applications: Reactor design and analysis for immobilized enzyme reactors. Applications in biosensors. Some modern developments for enzymes in organic synthesis.

TEXT BOOKS:

REFERENCE:
CL04 PROCESS DYNAMICS AND CONTROL- II

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

Design of controllers for difficult & complex dynamics: Inverse response systems - controller design - design of inverse response compensator. Time delay systems - controller design - Smith predictor method. Dynamics and control of complex processes - Theoretical analysis of complex processes like jacketed kettle, absorber and heat exchanger.

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

Controller Design and art of process control degrees of freedom analysis - Introduction to distillation system - Controller design for multiloop systems. Interaction and pairing of control loops - Decoupling and controller design. The art of process control.


TEXT BOOK:

REFERENCES:
CL05 FOOD TECHNOLOGY AND ENGINEERING

Food process engineering - Fundamentals: Fundamentals of food process engineering, application of quantitative methods of material and energy balances in food engineering practices.

Unit Operations in food industries: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.


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

Food biotechnology: Food biotechnology, Dairy and cereal products, Beverages and food ingredients, High fructose corn syrup, Single cell protein.

TEXT BOOK:


REFERENCES:

CL06 NEW SEPERATION PROCESSES


Sorption Techniques: Types and choice of adsorbents, Normal Adsorption techniques, chromatographic techniques, types and Retention theory mechanism Equipment and commercial processes, Recent advances and economics, Molecular Sieves.

Membrane Separation Processes: Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators, Dialysis, Reverse Osmosis, Ultra filtration, Concentration Polarization in Membrane and Economics of Membrane operations.

Ionic Separation: Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion - Exchange, Commercial processes.


TEXT BOOKS:

REFERENCES:
CL07 FERTILIZER TECHNOLOGY

Introduction to Chemical Fertilizers: Chemical inorganic Fertilizers and Organic manures. Types of fertilizers: Mixed, complex and Granulated, plant nutrients.

Processes for Raw Materials: Processes for manufacture of ammonia, nitric acid, phosphoric acid and sulphuric acid.


Complex Fertilizers: Processes for nitro - phosphates and complex NPK fertilizers liquid fertilizers

Phosphatic Fertilizers and Indian Fertilizer Industry: Single and Triple Superphosphate, biofertilizer. Fertilizer Industry in India.

TEXT BOOKS:

REFERENCES:
CL08 COMPUTER AIDED PROCESS PLANT DESIGN


Basic model development for preliminary systems: Methods of calculating vapour liquid equilibrium data for ideal and non-ideal mixtures - Bubble point and Dew point - Flash and distillation calculations - Equipment design - Development of software programmes for the following systems - Piping system, single phase & two phase.

Cad model for fluid moving machinery & storage design: Separator system - Two phase and three phase - Storage system - Atmospheric, pressurised & cryogenic.

Cad model for heat transfer equipment design: Double pipe - Shell and tube heat exchanger - PHE - Air cooler - Heat integration of evaporators.

Cad model for mass transfer equipment and safety devices design: Binary mixtures - Pseudo binary - Multistage distillation system - Heat integration of distillation columns - Absorber and strippers - Liquid-liquid extractors - Safety devices-pressure safety valve & flare system

TEXT BOOKS:

REFERENCES:
CL09 APPLIED MATHEMATICS IN CHEMICAL ENGINEERING


Formulation of physical problems: Mathematical modelling of chemical engineering processes based on first principles.

Analytical solutions of equations: Separable forms, homogeneous equations, exact solutions, singular solutions.


Optimization: Types of optimization problems, optimization of a function of single variable, unconstrained minimization, constrained minimization.

TEXT BOOKS:


REFERENCES:


CL10 INTRODUCTION TO CFD


Introduction to Multigrid Methods – Boundary conditions.

Introduction to CAD systems and Structured and unstructured mesh.

Simple Governing Equation for Turbulent and Multiphase flow.
Internal Flows: T-Junction – Manifold, Valves
External Flows: Flow over formed body

TEXT BOOKS


REFERENCES