#### **B.Tech (Chemical Engineering)**

Engineers, from times immemorial, have played a crucial role in contributing to the betterment of humanity and in shaping the world by creating, developing, organizing and managing complex technologies. The growing influence of technology on all functions of society has created a good demand of Engineering graduates. The primary objectives of the course is to educate men and women for leadership in the industry and educational institutions, advance the knowledge base of the engineering professionals, and to influence the future direction of engineering practices.

Eligibility Criteria: 10+2 with Maths or equivalent in any stream

To earn a B.Tech (Chemical engineering), a student has to earn a minimum of 180 credits. Minimum 100 credits are to be earned from science subjects, minimum 40 credits from Chemical Engineering subjects and remaining can be taken from any stream.

Every student has to attain a minimum of D grade in all courses; a student may however, and repeat or change any course being offered. Notwithstanding, every student must acquire the desired number of credits. The detailed course structure under different categories is given in succeeding pages. Brief description of the course content follows thereafter.

Codes	Subject Name	Credit
8A.101	Mathematics – I	4
8A.102	Physics	4
8A.103	Chemistry	4
8A.104	Basic Electrical and Electronics Engg.	4
8A.105	Engineering Thermodynamics	4
8A.106	Computer Programming	4
8A.107	Engineering Graphics	4
8A.108	Mathematics – II	4
8A.109	Material Science	4
8A.110	Environmental Science	4
8A.111	Basic Civil and Mechanical Engg.	4
8A.112	Engineering Mechanics	4
8A.113	Communicative English	4
8A.114	Mathematics III	4
8A.201	Humanities and Communication skills	4
8A.202	Chemical Process Principles	4
8A.203	Organic Chemistry	4
8A.204	Chemical Engineering Thermodynamics 1	4
8A.205	Material Science & Engineering	4
8A.206	Mathematics IV	4
8A.207	Fluid and Particle Mechanics	4
8A.208	Physical and Analytical Chemistry	4
8A.209	Chemical Engineering Thermodynamics II	4
8A.210	Particle Technology	4
8A.211	Chemical Reaction Engineering	4
	Petroleum Refinery Engineering &	
8A.212	Petrochemicals	4
8A.213	Process Heat Transfer	4
8A.214	Mass Transfer Operations I	4
8A.301	Environmental Engineering	4
8A.302	Process Instrumentation	4
8A.303	Chemical Process Industries	4
8A.304	Process Dynamics & Control	4
8A.305	Mass Transfer Operations II	4
	Economics and Management of Chemical	
8A.306	Industries	4
8A.307	Energy Engineering	4
8A.308	High Polymer Engineering	4
8A.309	Water Treatment Technology	4

Chemical Engineering Design & Drawing I	4
Transport Phenomena	4
Safety Engineering in Process Plants	4
Biochemical Engineering	4
Numerical Analysis	4
Computational Fluid Dynamics	4
Advances in Bioprocess Engineering	4
Computer Aided Design	4
Unconventional Separation Techniques	4
Chemical Engineering Design & Drawing II	4
Optimization of Chemical Processes	4
Micro Electronics Processing	4
Food Technology	4
Process Modeling and Simulation	4
Petroleum Exploration and Storage	4
Composite Materials	4
Project I	4
Project II	4
	Chemical Engineering Design & Drawing I Transport Phenomena Safety Engineering in Process Plants Biochemical Engineering Numerical Analysis Computational Fluid Dynamics Advances in Bioprocess Engineering Computer Aided Design Unconventional Separation Techniques Chemical Engineering Design & Drawing II Optimization of Chemical Processes Micro Electronics Processing Food Technology Process Modeling and Simulation Petroleum Exploration and Storage Composite Materials Project I Project II

## 8A.101 MATHEMATICS – 1

#### Credit: 4

**Content:** Curvature, radius of curvature, evolutes and involutes, Directional cosines and ratios – angle between two lines – the equation of plane - equations to a straight line and shortest distance between two skew lines, Differential Equations, D - Euler's linear equation of higher order with variable coefficients - simultaneous linear differential equations – solution by variation of parameters method – simple applications to electric circuits.

#### 8A.102 PHYSICS

Credit 4

**Content:** Ultrasonic Waves Productions (Piezoelectric & Magnetostriction method) – Detections, Factors affecting Acoustic of Buildings (Reverberation, Loudness, Focusing, Echo, Echelon Effect and Resonance) and their Remedies - Sabine's formula for Reverberation Time, Interference, Diffraction, Polarization, Lasers - Principles of Laser – Spontaneous and Stimulated Emissions - Einstein's Coefficients – Population Inversion and Laser Action – Optical resonators – Types of Lasers - NdYAG, CO2 laser, GaAs Laser, Nuclear energy source

## 8A.103 CHEMISTRY

Credit 4

**Content:** Hardness of water – units and calcium carbonate equivalent. Determination of hardness of water- EDTA method. Disadvantages of hard water-boiler scale and sludge, caustic embitterment, priming & foaming and boiler corrosion, Classification, types of polymerization reactions - mechanism of radical, ionic and Ziegler-Natta polymerizations, Galvanic cells, single electrode potential, standard electrode potential, electromotive series. EMF of a cell and its measurement. Nernst equation, Corrosion And Its Control

## **8A.104 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING** Credit 4

**Content:** Review of Kirchoff's laws – series and parallel circuits, equivalent resistance, star/delta conversion. Concepts of AC circuits – rms value, average value, form and peak factors – real and reactive power – power factor, voltmeter and ammeter method, two and three wattmeter methods, Principle of DC generator and motor, Half-wave rectifier and Full-wave rectifier- filters - Amplifiers-common emitter and common collector amplifiers- Hartley oscillator and RC phase shift oscillator, Boolean algebra, Model of communication system

## 8A.105 ENGINEERING THERMODYNAMICS

Credit 4

**Content:** Energy conversion and efficiencies - System, property and state - Thermal equilibrium - Temperature - Zeroth law of Thermodynamics, First Law of Thermodynamics, Second Law of Thermodynamics, Third Law of Thermodynamics, Air standard cycles: The air standard Carnot cycle - Air standard Otto cycle, diesel cycle, dual cycle and Bryton cycles and their efficiencies, Refrigeration Cycles and Systems

#### 8A.106 COMPUTER PROGRAMMING

Credit 4

**Content:** History of Computers – Block diagram of a Computer – Components of a Computer system – Classification of computers - Hardware – Software – categories of Software – Operating System, Problem solving techniques, Introduction to C, Structures, Introduction to preprocessor

## **8A.107 ENGINEERING GRAPHICS**

Credit 4

**Content:** Introduction to Standards for Engineering Drawing practice, Lettering, Line work and Dimensioning, Projection of Solids and Sections of Solids, Isometric projections and Orthographic projections, Computer Aided Drafting: Introduction to Computer Aided Drafting hardware

## 8A.108 MATHEMATICS – II

Credit 4

**Content:** Binomial, exponential and logarithmic series (without proof) – problems on summation, approximation and coefficients. Inverse of matrix by row transformation, Exponential, circular, hyperbolic, inverse hyperbolic and logarithmic functions of a complex variable, Moments, kurtosis and skewness based on moments only. Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions. Correlation and regression rank correlation.

## 8A.109 MATERIAL SCIENCE

Credit 4

**Content:** Crystal Systems – Bravais Lattices – Coordination Number, Atomic Radius, Packing Factor for FCC & HCP structures – Miller Indices for a cubic crystal– Powder X Ray Diffraction Method, Qualitative ideas of point, line, surface and volume defects Dielectric Polarization and Mechanism – Internal or local Field - Clausius-Mossotti relation, Elementary ideas of Piezoelectric, Ferroelectrics and Pyroelectric material Qualitative ideas of Anti ferromagnetic Ordering, Semiconductors and superconductor, Liquid Crystals

## 8A.110 ENVIRONMENTAL SCIENCE

Credit 4

**Content:** Environmental segments-lithosphere, hydrosphere, biosphere and atmospherelayers of atmosphere. Pollution-definition and classification. Pollutants-classification. Forest resources-use and overexploitation, deforestation, forest management, Concept of an ecosystem, Air Pollution, Water Pollution And Solid Waste Management, Social Issues And The Environment

# 8A.111 BASIC CIVIL AND MECHANICAL ENGINEERING

## Credit 4

**Content:** Buildings-Definition-Classification according to NBC-plinth area, Floor area, carpet area, floor space index, Buildings- Various Components and their functions,

Surveying-classification, general principles of surveying – Basic terms and definitions of chain, compass and leveling surveying, Internal and external combustion systems, Solar thermal systems – Solar photovoltaic – Solar pond – wind, wave, tidal, geothermal and ocean thermal energy conversion systems, Elements of arc and gas welding, brazing and soldering.

## **8A.112 ENGINEERING MECHANICS**

#### Credit 4

**Content:** Basic Concepts Force System and Equilibrium, Definition of Force, Moment and Couple, Principle of Transmissibility, Varignon's theorem, Resultant of force system Condition of static equilibrium for coplanar force system, stability of equilibrium, concept of free body diagrams, Static dry friction, simple contact friction problems, ladders, wedges, screws and belt friction, moment of inertia first moment of inertia, second moment of inertia and product moment of inertia, polar moment of inertia, radius of gyration, mass moment of inertia, Kinematics and Kinetics of Particles, work- Energy equation, Impulse – momentum, Impact – Direct central impact and oblique central impact, Kinematics and Kinetics of Rigid bodies, Plane motion,

## 8A.113 COMMUNICATIVE ENGLISH

Credit 4

**Content:** Importance of Communication, modes of communication, barriers to communication, strategies for effective communication, Listening: Importance, types, barriers, Developing effective listening skills, Comprehension of technical and non-technical material, Effective sentences, Report writing, Basics of phonetics

# 8A.114 MATHEMATICS III

Credit 4

**Content:** Functions of a Complex Variable – Limit – Continuity – Derivative of a Complex function ,Analytic functions – Cauchy-Riemann Equations – Laplace equation – Harmonic Functions ,Conformal Mapping – Examples: Zn, sinz, cosz, sinhz, coshz, (z+1/Z), Vector spaces, Fourier Sine and Cosine integral representations – Fourier Transforms

## 8A.201 HUMANITIES AND COMMUNICATION SKILLS

Credit 4

**Content:** Humanities, Science and Technology: Importance of humanities to technology, education and society- Impact of science and technology on the development of modern civilization. Contributions of ancient civilization, Concept of communication, Writing a rough draft, editing, proof reading, final draft and styling text. Technical report writing: Synopsis writing, formats for reports. Introductory report, Progress report, Incident report, Feasibility report, Marketing report.

## 8A.202 CHEMICAL PROCESS PRINCIPLES

## Credit 4

**Content:** Introduction to chemical engineering, chemical process industries and role of chemical engineer, unit operations and unit processes, fundamental concepts, units and

dimensions, conversion of units, dimensional analysis, conversion of empirical equations, mole concept and mole fraction, Material balances: typical flow sheet, batch, stage wise and continuous operation, Material balance without chemical reactions, Basic material balance principles- Material balance in unit operations such as Evaporation, Energy balances: Heat capacity, specific heat and enthalpy, Heat capacities of gases and gaseous mixtures, Effect of temperature on heat capacity of gas, Mean heat capacity of gas, Kopp's rule, Latent heats, Heat of fusion, Heat of vaporization, Trouton's rule, Kistyakowsky equation for non-polar liquids,

#### 8A.203 ORGANIC CHEMISTRY

Credit 4

**Content:** Electron displacements in organic molecules – inductive, electromeric, mesomeric and hyper conjugative effects – types of reagents, nucleophilic, electrophilic and free radicals – types of reactions, substitution, addition and rearrangements – Mechanism, Kinetic and stereochemistry of SN1, SN2, E1 and E2 reactions, Proteins, nucleic acids – Aminoacids – Classification and biological importance – Synthesis of glycine and alanine by Gabriels method and Sorensen's method – Synthesis of Leucine (Strecker's method) and tryptophan by Azlactone method, Heterocyclic compounds

## 8A.204 CHEMICAL ENGINEERING THERMODYNAMICS I

Credit 4

**Content:** Fundamental concepts and definitions - closed, open and isolated system - intensive and extensive properties, Heat effects in chemical reactions, Thermodynamic properties of pure fluids, Flow processes - total energy balance - mechanical energy balance - Bernoulli equation - flow in pipes and maximum velocity - flow through nozzles and ejectors - critical pressure ratio in nozzles

## 8A.205 MATERIAL SCIENCE & ENGINEERING

Credit 4

**Content:** Structure of atom-present concept of atom-Rutherford's and Bhor's model-Bonding in solids, Types of solids-crystalline and amorphous solids-crystal systems-Bravais lattices-miller, indices-coordination number-crystal defects-determination of crystal structure-X-ray, diffraction-electron diffraction methods, Solid solutions-types of solid solutions, Non-ferrous metals and alloys-aluminum and its alloys-copper and its alloys-Non ferrous metals and alloys used for high temperature services and nuclear application-organic polymers and its properties

## 8A.206 MATHEMATICS IV

Credit 4

**Content:** Random variables – Mean and Variance of probability distributions, Binomial Distribution, Poisson Distribution, Poisson approximation to Binomial distribution, Hyper Geometric Distribution, Geometric Distribution, Probability densities, Normal Distribution, Uniform Distribution – Gamma Distribution. Theory of Inference, Series Solutions of Differential Equations, Partial Differential Equations

## 8A.207 FLUID AND PARTICLE MECHANICS

Credit 4

**Content:** Introduction to fluid mechanics-Definition of fluid-Physical properties of fluid-Variation of viscosity and density with temperature and pressure. Rheology of fluids-classification of fluids, Basic equations of fluid flow, Flow past immersed bodies, Flow rate equation for Venturi, Orifice, Mouth piece, Pitot tube, Rectangular, Triangular, Trapezoidal weir, Rotameter.

# 8A.208 PHYSICAL AND ANALYTICAL CHEMISTRY

Credit 4

**Content:** Adsorption , Physisorphtion and Chemisorption , Adsorption isotherms Langmuir Isothermonly) catalysis , criteria of catalysis , Homogeneous catalysis (gases, liquids) , Mechanism of acid, base catalysis , Negative catalysis in gas reactions, Colloids, Classification and preparation , Stability , electrical double layer , micelle formation , purification of colloids, Electro analytical methods, Photochemistry

# 8A.209 CHEMICAL ENGINEERING THERMODYNAMICS II

Credit 4

**Content:** Properties of solutions, partial molar properties, definition, physical significance, determination, tangent-intercept method, chemical potential, effect of temperature and pressure, Phase equilibrium, phase diagram for binary solutions, Applied phase equilibrium, Chemical reaction equilibria, effect of temperature on equilibrium constant, simultaneous reactions, phase-rule for reacting systems

# 8A.210 PARTICLE TECHNOLOGY

Credit 4

**Content:** Particle diameter and shape factor, particle size analysis, sieve analysis, particle size distribution, ICI sedimentation, Principles of free and hindered settling, theory of constant pressure and constant rate filtration, Laws of combination, types and selection of equipment for all ranges, different types of conveyors

# **8A.211 CHEMICAL REACTION ENGINEERING**

Credit 4

**Content:** Overview of chemical reaction engineering, Definition of reaction rate. Kinetics of homogeneous reaction, Concentration dependent term of rate equation, Introduction to reactor design, Steady state mixed flow reactor, Heat effects in reactor. Non isothermal reactor design. General graphical design procedure. Optimum temperature progression. Adiabatic and non adiabatic operations. Multiple steady states. Non ideality in reactors. Basics of non ideal flow, Heterogeneous processes.

## **8A.212 PETROLEUM REFINERY ENGINEERING & PETROCHEMICALS** Credit 4

**Content:** History and development of refining-Origin and formation of petroleum. Exploration, Drilling and Secondary recovery methods of crude. Storage and transportation of crude and products, Petroleum processing, Thermal Conversion process, Production of Acetylene, Ethylene and Propylene by steam cracking of Naphtha, Production of Aromatics in Refinery, Manufacture of Poly ethylene, P.V.C, Poly propylene, Poly styrene, Mono ethylene glycol, Methanol and Formaldehyde

## 8A.213 PROCESS HEAT TRANSFER

Credit 4

**Content:** Modes of heat transfer, convection and film concept of heat transfer coefficient, Forced convection heat transfer, heat transfer to fluids in laminar and turbulent flow, Radiation heat transfer, radiation errors in pyrometer, overall heat transfer coefficient fouling factors, heat exchanger effectiveness, Evaporation, performance criteria and factors affecting evaporator performance

## 8A.214 MASS TRANSFER OPERATIONS I

Credit 4

**Content:** Molecular diffusion, steady state diffusion of A through stagnant B and equimolar counter diffusion in binary gases, Gas absorption, absorption equipment, multistage absorption, tray towers, tray types and general features of tray designs (qualitative treatment), continuous contact equipment, venture scrubbers, packed columns, packing materials and characteristics, general constructional details of packed columns, flooding and loading, choice between plate and packed columns, Humidification and dehumidification, theory of wet-bulb temperature and adiabatic saturation temperature, Lewis relation, water cooling with air, types of cooling towers, enthalpy transfer unit, general design procedure, application of simplified methods of cooling tower design, spray chambers for air humidification.

# 8A.301 ENVIROMENTAL ENGINEERING

Credit 4

**Content:** Introduction to environmental engineering, environmental legislation and regulation, Water treatment, physical, chemical and biological characteristics of Wastewater, Wastewater treatment methods, screening, grit removal, oil removal and equalization, Sludge treatment and disposal, hazardous waste -types of hazardous waste - health effects, treatment methods, Air pollution

## 8A.302 PROCESS INSTRUMENTATION

Credit 4

**Content:** Instrumentation, Temperature measurement, Pressure measurement, Barometer method for atmospheric pressure measurement. Low pressure measurement by enetometer, McLeod gage, thermal conductivity gauge, Pressure measurement using bourdon tube, flat and corrugated diaphragms, and capsules, Flow measurement using head type flowmeters based on differential pressure measure mentorifice meter, venturimeter, flow nozzle and pivot tube. Open channel meters like weirs, flumes. Electromagnetic flowmeters, Composition analysis using spectroscopic methods like absorption ,emission and mass spectrometers. Analysis of solids by X-ray diffraction. Gas analysis by thermal conductivity, polarography & chromatography.

#### **8A.303 CHEMICAL PROCESS INDUSTRIES**

#### Credit 4

**Content:** Fuel gases: natural gas, coke oven gas, producer gas, water gas, LPG. Industrial gases: carbon dioxide, hydrogen, nitrogen, oxygen. Sulphur and sulphuric acid: manufacturing of sulphur and sulphuric acid, Nitrogen industries: ammonia, nitric acid, urea, fertilizer industries, ammonium sulphate, ammonium nitrate, nitrolime, MAP, DAP and nitrophosphates, mixed and complex fertilizers, carbon chemicals, carbon black, activated carbon, synthetic graphite, calcium carbide, classes of glass, raw materials, methods of manufacture. Ceramics and refractories (general study), General study of food processing, food byproduts, leather, gelatin, adhesives, vegetable oils, animal fats and oils, waxes, sugar, starches and related products, industrial alcohol by fermentation, absolute alcohol, beers, wines and liquors.

## 8A.304 PROCESS DYNAMICS & CONTROL

Credit 4

**Content:** Introduction to process dynamics and control, Linear open loop systems, second order systems, mercury thermometer in a well and manometer, impulse and step response of under damped, critically damped and over damped system, their derivation, Transient response of simple control systems, step response and offset, introduction to stability of linear systems, Introduction to frequency response, substitution rule, bode diagram for first order systems, first order systems in series, second order systems, bode stability criterion, gain margin and phase margin

## 8A.305 MASS TRANSFER OPERATIONS II

Credit 4

**Content:** Distillation, differential distillation, minimum reflux conditions, Design of fractionation columns by McCabe, Extraction, applications, ternary equilibria on triangular coordinate system, mixer rule, distribution curve, selectivity, choice of solvent, Leaching, factors affecting rate of leaching, stage efficiency, practical equilibrium, Constant underflow, variable underflow, ultra filtration

# **8A.306 ECONOMICS AND MANAGEMENT OF CHEMICAL INDUSTRIES**

Credit 4

**Content:** Equivalence and cost comparison - time value of money and equivalence, equations used in economic analysis, compound interest and continuous interest as a cost, Hoskold's formula, capitalized cost, cost comparison with equal and unequal duration of service life, depreciation and taxes, Cost estimation, Profitability analysis, Inflation, financial ratios related to balance sheet and profit and loss account

## 8A.307 ENERGY ENGINEERING

Credit 4

**Content:** Energy, units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooing, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, Biomass

energy resources, thermo chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell

## **8A.308 HIGH POLYMER ENGINEERING**

Credit 4

Content: Kinetics of Polymerization, different types of copolymers, Thermoplastics , ABS – acetal , acrylic , cellulose acetate , cellulose propionate, fluoropolymers CTFE,PTFE,PVF,FEP), Molecular weight of polymers, Experimental methods for molecular weight determination, Processing methods, compression moulding, vulcanization of rubber

## 8A.309 WATER TREATMENT TECHNOLOGY

Credit 4

**Content:** Water resources, Rainfall and runoff, ground water and surface waters. Quantity of water, water needs Industrial demand, Institutional demand and Fire fighting demand. Quality of water, Treatment technologies-Coagulation, flocculation and sedimentation. Usual coagulants, the jar test, flash mixers, flocculators, clarifiers and clariflocculators, Carbon adsorption, Desalination, Ion exchange and membrane processes. Turbidity removal, taste and odour control, Water quality standards for drinking water, mineral water, boiler feed water and swimming pools. Water recycling and reuse, rain water harvesting. Water pollution control and water management.

## 8A.310 CHEMICAL ENGINEERING DESIGN& DRAWING I

#### Credit 4

**Content:** Introduction to chemical engineering drawing, P&ID symbols and drawings, I&C drawing of heat exchangers, Mechanical design of process equipment, Process design and detailed drawing of shell & tube heat exchangers and double pipe heat exchanger for single phase streams. Process design of condensers: Tubular horizontal & Tubular vertical for condensation of single vapors.

## 8A.311 TRANSPORT PHENOMENA

Credit 4

**Content:** Prediction of transport coefficients , viscosity, thermal conductivity, diffusivity, effect of temperature, pressure and composition on transport coefficients, Shell momentum balance, general transport equations for momentum, application of transport equations to steady flow problems, Shell energy balance, equation of continuity in curvilinear coordinates and multi component equations of change (no derivation)

#### 8A.312 SAFETY ENGINEERING IN PROCESS PLANTS

Credit 4

**Content:** Introduction to safety: Concept and importance of industrial safety. Fundamental safety tenets. Safety in the site selection and lay out. Location and design parameters for chimney, flares, rupture discs, System Safety Analysis: Systems approach to safety utilizing techniques such as plant Inspections, safety Audits, Emergency Preparedness: Fire and Explosion. Fire hazards. Fire pyramid. Types of fires. Types of fire extinguishers and its handling. Types of built in extinguishing systems. Fixed fire protection systems.

#### 8A.313 BIOCHEMICAL ENGINEERING

Credit 4

**Content:** Introduction to biochemical engineering – Comparison of chemical and biochemical processes, industrially important microbial strains used for different bio products, Chemicals of life, Sterilization - Media and air, methods. Stoichiometry of Growth and Product Formation, Fermentation Energy, Introduction to enzymes – Classification, kinetics of enzyme catalyzed reactions, factors, affecting E.S complex, derivation of Michaelis Menten equation for single substrate, determination of M.M parameters, enzyme inhibition

## 8A.314 NUMERICAL ANALYSIS

Credit 4

**Content:** Sources of errors, significant digits and numerical instability, numerical solution of polynomial and transcendental equations - bisection method , method of false position , Newton-Raphson method, Solutions of system of linear algebraic equations, Lagrange's interpolation polynomial, divided differences Newton's divided difference interpolation polynomial, The Taylor series method - Euler and modified Euler methods - Runge–Kutta methods (2nd order and 4th order only), finite difference method of solving heat equation and wave equation with given initial and boundary conditions

## **8A.401 COMPUTATIONAL FLUID DYNAMICS**

Credit 4

**Content:** Introduction of the governing equations of fluid mechanics, Conservation equations for mass, momentum, energy and chemical species, Introduction of finite difference method, The numerical procedure for solving Navier-Stokes equation, Mixed variational form, Galerkin and FE approximations, the algebraic problem, stability, the LBB condition, mass conservation.

## 8A.402 ADVANCES IN BIOCHEMICAL ENGINEERING

Credit 4

**Content:** Definition and introduction of biochemical engineering. Microbiology – general idea on structure of cells(prokaryotes and eukaryotes) and cell theory. Classification of microorganisms(protist kingdom)and their morphological characteristics, Enzyme classification.Comparison of enzymes with synthetic catalysts. Kinetics of enzymecatalysed reactions-Michealis-Menten equation for single substrate reaction-concept of substrate and substrate-enzyme complex. Cell growth stoichiometry . Batch cultivation of cells –growth cycle phases like lag, exponential growth, maximum stationary phase, and death phase. Medium formulation, yield factors, Monod growth kinetics

## 8A.403 COMPUTER AIDED DESIGN

Credit 4

**Content:** Introduction to computer aided design - use of computers for physical property evaluation, thermodynamic properties of gases and binary mixtures, Design of pressure vessels, Computer aided design of heat exchanger systems, Computer aided design of packed bed absorbers and strippers - computer aided mechanical design of bubble

## **8A.404 UNCONVENTIONAL SEPARATION TECHNIQUES**

Credit 4

**Content:** Membrane separation processes - fundamentals, mechanism and equilibrium relationships ,types and structure of membranes, Diffusional separation processes - gaseous diffusion , mechanism , process description , design considerations, Chromatographic and allied fixed bed separation processes , Separation by action in a field

## 8A.405 CHEMICAL ENGINEERING DESIGN & DRAWING II

Credit 4

**Content:** Process design and detailed drawing of: Evaporators- Standard short tube, Standard long tube and forced circulation evaporators, Process design of steady state isothermal binary component distillation columns. Detailed drawing of distillation column and its accessories, Process design

## 8A.406 OPTIMISATION OF CHEMICAL PROCESSES

Credit 4

**Content:** Nature and organisation of optimisation problems, scope and hierarchy of optimisation ,typical applications of optimization, Numerical methods for unconstrained functions - one dimensional search , gradient, free search with fixed step size, Linear programming , basic concepts in linear programming , graphical interpretation, simplex method,

## 8A.407 MICRO ELECTRONICS PROCESSING

Credit 4

**Content:** Integrated circuits ,Semiconductors and charge carriers ,basic relationships and conductivity , basic units of integrated circuits, Chemical vapour deposition reactors , regimes of fluid flow , intrinsic kinetics and transport Effects, Lithography , illumination and pattern transfer, resists and resist development ,yield and ultimate limits

# 8A.408 FOOD TECHNOLOGY

Credit 4

**Content:** General aspects of food industry - world food needs and Indian situation - constituents of food, Preservation by heat and cold, Soft and alcoholic beverages - dairy products, meat, poultry and fish products - treatment and disposal of food processing wastes

# 8A.409 PROCESS MODELING AND SIMULATION

Credit 4

**Content:** Basic modelling principles - uses of mathematical modelling - classification of modeling techniques, Mathematical models for chemical engineering systems - continuous flow tanks – enclosed vessel, Gas flow system - hydraulic transients between two reservoirs - reaction kinetics – general modelling scheme, Digital simulation - numerical integration - Euler and fourth order Runge Kutta methods , simulation of gravity flow tank - CSTR in series - non isothermal CSTR - binary distillation column - batch reactor

## 8A.410 PETROLEUM EXPLORATION AND STORAGE

Credit 4

**Content:** Petroleum geology and its scope, Origin of petroleum (emphasis on both techniques and geochemistry), oil and gas traps. Physical and chemical characteristics of crude oil, source rock and maturation, Instruments used, principles and working, magnetometers, Seismograms, Radiation counters and gravimeters. Effective strategies for integrated geophysical exploration from a system view point, Methods of petroleum prospecting and exploration such as geophysical, seismic, etc. drilling equipments such as rigs, platforms etc and techniques for offshore and onshore operation. Surface operation for separation of oil and gas, well head operation including separation of oil from associated gas.

## 8A.411 COMPOSITE MATERIALS

Credit 4

**Content:** Introduction to composite materials-definitions and basic concepts-natural and man made composites, classification based on structure, phase composition and layered composition types of composite materials, Manufacturing of advanced composites, Theory of reinforcement, Testing of composites materials and products for quality control- Brief outlines of testing of glass fibre, testing of resins-testing of products.

**8A.445 PROJECT I** Credit 4

**8A.446 PROJECT II** Credit 4