Fourth Year

Semester I

Sr. No.	Subjects	Examination Hrs	Examination Marks	Marks for Class work	Total
Che 401	Process Equipment Design	3	60	40	100
Che 402	Chemical Engineering Mathematics	3	60	40	100
Che 403	Transport Phenomena	3	60	40	100
Che 404	Numerical Analysis Modelling & Simulation	3	60	40	100
Che 405	: Elective - II	2	30	20	50
		14	270	180	450
	Practical and Orals				
Che 406	Modelling & Simulation	6	60	40	100
Che 407	Process Equipment Design & Drawing(Oral)	--	60	40	100
Che 408	Seminar	-	--	--	50
		6	120	80	250
	Total				700

Reference Book

1. Transport Phenomena : Bird
2. Momentum, Heat and Mass Transfer : Bennet - Myers

CHE-404- NUMERICAL ANALYSIS MODELLING & SIMULATION

Numerical Analysis:

Root finding Methods:

Bisection method, successive approximation, Newton-Raphson method, Mullers's method.

Numerical Integration:

Trapezoidal rule, Simpson's rule, Weddle's rule, Gregory-Newton formula, interpretation by Sterling's formula.

Solution of Simultaneous Linear Equations:

Gauss elimination, Gauss-Siedel method

Solution of Ordinary Differential Equations:

Taylor's series method, Euler's method, Runga-Kutta method, Milcara's method.

Process Modeling and Simulation:

Introduction:

Applications of mathematical modeling Fundamental Laws:

Continuity equations, energy equation, equations of motion, transport equations, equations of state, phase and chemical equilibrium, chemical Kinetics

Examples of Mathematical models:

Mathematical models of chemical engineering systems such as CSTRs, PFRs, baten reactors, distillation columns,

Computer Simulation:

Digital simulation of chemical engineering system models considered above.

CHE - 405 : ELECTIVE - II

a) Environmental Engineering

Nature of pollutants, their sources and sinks. Meteorology and problems associated with dispersion. Sampling methods. Control techniques for gaseous and particulate pollutants.

Water Pollutin : Characterisation of industrial waste waters. Permissible limits of pollutants. Primary, secondary and tertiary treatment methods. Recovery methods for pollutants. Solid waste treatment.

b) Electrochemical Engineering

Introduction to electrochemical engineering. Theoretical aspects and special features of electrochemical process. Role of mass transfer in a veriety of electrochemical processes. Some aspects of electrochemical reactor design. Scale up and optimisation of reactors.

Illustrative examples, particularly production of caustic soda, aluminium, adiponitrile and speciality organic materials; recovery of metal values from waste streams.

c) Biochemical Engineering

Scope of biochemical engineering in modern industry. Characteristics of biological materials. Enzyme kinetics. Isolation and application of enzymes. Immobilised enzymes. Cell structure and metabolism. Kinetics of microbial growth. Sterilization of liquids and gases. Design and control of industrial bio-reactor. Product recovery and purification. Elementary aspects of genetics and biomedical engineering. Applications in the manufacture of foods and beverages, pharmaceuticals, chemicals and agro chemicals.

d. Multiphase reactions

Mass transfer with chemical reaction in gas-liquid and liquid liquid systems. Three-phase reactors, Fixed bed and slurry reactors.

Biochemicals reactors including treatment of aqueous waste streams.

e) Petroleum engineering

Characteristics of Indian and Foreign crudes. Basic features of on shore and off shore oil and gas fields. Characteristics of associated gas. Exploration and development. Secondary and tertiary recovery of oils. Piping from the oil wells. Oil field chemicals.

Transportation of oil products.

CHE 406- Modelling & Simulation

Digital Simulation of Chemical Engineering Systems.

CHE 407 Process Equipment Design & Drawing(Oral)

Process design and drawing of at least five equipments.

CHE 408 - Seminar

Students will be required to prepare a critical reviews of selected topics in Chemical Engineering and allied subjects and submit in the form of a standard typed report. The student will also be required to make an oral presentation of the review.

Semester II

No.	Subjects	Examination Hrs	Marks	Marks for Class work	Total
[illegible]	Process Dynamics & [illegible]	3	60	40	100
[illegible]	Chemical Reaction Engineering II	3	60	40	100
[illegible]	Plant Design & Project Engineering	3	60	40	100
[illegible]	Process Engineering & Economics & Costing	3	60	40	100
[illegible]	Elective III	2	30	20	50
		14	270	180	450

Practical and Orals

No.	Subjects	Examination Hrs	Marks	Marks for Class work	Total
CHE 414	Process Control Laboratory	3	60	40	100
[illegible]	Plant Design & Drawing (Oral)		60	40	100
[illegible]	Project work		100	50	150
		3	220	130	350
	Total				800

CHE 409- Process Dynamics & Control

Introduction : Characteristics of chemcial proces control
Mathematical modelling of a chemical process:
State variables and state equations

Input-output model

Linearization of nonlinear systems

Solution of linear differential equations using laplace - Transform. Transfer functions and input-output models Dynamic behaviour of first order, second order and higher order systems.

Feedback control : Dynamic behaviour of feedback controlled processes, effect of proportional, intergal and derivative action.

Stability analysis: notion of stability, Routh-Hurwitz criterion for stability

Root locus analysis

Feedback controller design: performance criteria, selection type of feedback controller.

Tuning of controllers (Selection of K_C, τ_I, τ_D, etc.) criteria.

Frequency response analysis of linear processes: Bode plots, Nyquists plots.

Design of feedback control systems using frequency response techniques.

Feedback control of systems with large dead time/inverse response

Feedforward control, ratio control, feedforward - feed-back control, cascade control, selective control, split-range control.

Digital computer control: sampling continuous time singal, reconstruction of continuous time signal from discrete values, conversion of continuous time to discrete time models.

Z transfer, discrete time response of dynamic systms, design of digital feedback controllers.

(Introduction to Digital Control Principles)

CHE 410- Chemical Reaction Engineering II

A. Heterogeneous Reacting Syetems:-

Rate equations for heterogeneous reaction, contacting patterns for two phase systems.

B. Fluid Particle Reactions:-

Selection of model, Unreacted core model for spherical particles of unchanging size, Rate of reaction for shrinking spherical particles, Determination of the rate controlling steps, Application to design - particles of single size, plug flow solids, uniforms gas composition, Mixed flow of particles of single unchanging size, Mixed flow of size mixture of particles of unchanging size, Applications to fluidized bed with entrainment of solid fines, instantaneous reaction.

.. Fluid - Fluid Reaction:-

Rate equations, for instantaneous, fast, intermediates and for slow reaction, Slurry reaction kinetics, Rate equation for infinitely slow reaction, film conversion parameter, Aerobic fermentations, Application to design - Towers for fast and slow reactions, Mixer settlers, Semi-batch contacting patterns, Reactive distillation and extractive reactions.

d. Catalysis:-

Concept of catalyst Selection, classification and characteristics of catalyst, Preparation of a catalyst and its deactivation, Poisioning of catalyst and regeneration.

Adsorption and its classificatio, different types of isotherms, Determination of catalyst Surface area by BET method.

.. Solid Catalyzed Reaction:-

Rate equations, diffusion within Porous catalyst, Experimental methods for finding rates, Product distribution in multiple reactions.

Application to Design - Staged adiabatic packed bed reactors and fludized bed reactors, Fluid - solid catalytic fixed bed reactors.

Design of Heterogeneous Catalytic Reactors.-

Fixed bed Reactors, Isotermal and adiabtic fixed bed reactors, Nonisothermal, Non adiabatic fixed bed reactors, Fluidized bed reactors, Slurry reactors, Trickle - bed reactors.

ChE 411- Plant Design & Project Engineering

Introduction: Basic considerations in Chemical Engg. Plant design, Project identification, Preliminary techno-economic feasibility.

Process design aspects, Selection of proces, factors affecting proces selection, importance of laboratory development pilot plant, scale up methods, Types flow sheets, Selection of Process Equipmnet: Development of process flow sheet from process information.

Process auxiliaries, piping design layout, supports, fittings, insulation, pipe fittings, types of valves, selection of valves, process control and instrumentation, control system design.

Transportation of fluids Pump, Compreners, Fans blowers, Selection.

Process utilities, process water, boiler feed water, water treatment, waste treatment of disposal, Coil heating system, Chilling plant, Compressed air and vacuum.

Plant location and layout-factors affecting both planning and layouts, Drawings of Plant layout, Use of scale up methods, Plant elevtion drawings and complete engineering flow sheet drawings.

Safety measures in Plant Equipment, Problems in Standardisation and Commissioning.

Project Scheduling, Use of PERT/CPM techniques.
Project evaluation and assesment of project profitability.

CHE 412- Process Engineering Economics & Costing

Cash flow statement, project evaluation, discount cash flow, pay back period, break-even point, introduction to market survey, preliminary analysis of balance sheet, minimum economic plant capacity, technological obsolence, need for expansion and diversification, concept of marginal additional investment, role of research and development, Indian Chemical Industry, current state and trends.

Estimation of investment, 6/10 factor rule cost of infrastructure, estimate of investment for the same, estimating cost of productioin, principle of costing, Estimating working capital requairments, estimating financial cost by way of interest charges and depriciation, Methods for detrmination of depriciation, profitability of project.

CHE-413- Elective III

a) Industrial Thermodynamics

Basic concepts and definitions, simple and composite system, thermodynamic process, Energy concepts and consequences, work and heat interactions, Application of laws of tyermodynamics to open and closed systems, Heat energies and heat pumps, reversibility and entropy and their applications to indusrial problem, Heat exchange network design for distillation and power systems.

Phase equilibria and its appliction in industrial systems, Chemical reaction equilibria analysis.

b) Newer Separation Process

Need for newer separation processes, Characterization of separation processes, Discussion of new separation methods, such as, adsorption on molecular sives; gas-liquid chromatography; extractive and addative crystallization, extraction with reaction, Extraction with supercritical fluids, Separation of racemic mixtures, Separation by membrances such as, reverse osmosis, pervaporation, etc, Separation of gases by membranes, Liquid membrane permeation, Separations via sublimation/desubilimation.

c) Polymer Engineering

Characteristics of polymerization reactions. Polymerisation reactor design and control. Heat transfer to solid and molten polymers. Mixing of polymers. Processing of polymers by compression, injection and extrusion techniques. Lamination, casting, foaming, blow moulding, vacuum forming, calendering etc.

d. Optimisation, Computer Aided Design & Project Engineering

i. Optimising: Statistical methods in data colection and correlation. Analytical methods for locating optimal conditions for univariable and multivariable unconstrained and constrained systems. Direct search techniques. Linear Programming.

ii. Computer Aided Design : Use of digital computers in flowsheet calculations. Modular approach to design. Computer graphics.

iii. Project Engineering : Concept of a project as conglomeration of multiple technical and non-technical disciplines. Stages in a project such as process licence, process engineering, detailed engineering, procurement, construction, commissioning, project planning and cost control. Brief introduction to individual engineering disciplines and their scope of work in the project. CPM/PERT network methods: identification of critical path and critical activities. Contractual or reimbursement for contractors. Legal aspects such as guarantees, liabilities, insurance, patent indemity, etc.

e. Applied Catalysis

i. Catalytic aspects of industrially important processes. Process in petroleum refining. Catalytic cracking, hydrocracking, reforming hydro desulphurization.

ii. Partial oxidation of hydrocarbons, autoxidation of propylene.

iii. Processes : fertiliser industry. Steam reforming of naphtha, low temperature water gas shift reaction, methanation.

iv. Catalytic hydrogenation.

CHE 414 Process Control Laboratory

Practicals based on theory subject process Dynamics and Control.

CHE 415 Plant Design & Drawing (Oral)

Term work: four drawings of 2 process flow sheets, plant layout and piping system. Problems of project scheduling.

CHE-416- Project work

Every student will be required to submit a project report in a typed form, on a topic from the field of chemical engineering which may be either selected by the studnet but specifically approved by the faculty member who will guide the student, or on a topic to be assiged by one or more faculty members.

The project work on the topic will consist of either some investigational work, or design problem or experimental setup of some development work or prototype equipment or dissertation related to the field of chemical engineering.

Every student will be orally examined in the topic incormorated in the project and in the related area of specialisation.

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