CHEMICAL ENGINEERING

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Deo G	goutam	7363	7881
Gupta JP	jpg	7175	
Gupta SK	skgupta	7031	7127
Khanna A	akhanna	7117	
Kumar A	anilk	7195	
Kunzru D	dkunzru	7193	7811
Sharma A	ashutos	7026	7406
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ASSOCIATE PROFESSOR

Kaistha N	nkaistha	7513	7136
Panda S	spanda	6146	6065
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Joshi YM	joshi	7993	6065
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The Department of Chemical Engineering offers academic programmes leading to B.Tech., M.Tech. and Ph. D. degrees in Chemical Engineering.

The Department imparts graduate education with emphasis on chemical engineering fundamentals and prepares students for a high level of competence in the use of modern engineering methods, CAD and microprocessors based instrumentation, etc. Most of the graduate courses have a strong engineering science and modern orientation. They are primarily intended to prepare students for teaching and R&D careers in computer aided process design, simulation and controls, interfacial phenomena, process safety; complex fluid flow modeling etc. Our students find employment in renowned industrial and academic organisations in India and abroad.

The department has a young and dynamic faculty who are recognised both nationally and internationally, who have received numerous awards and honours for excellence in fundamental research for process development (e.g., Shanti Swarup Bhatnagar; Herdillia, Amar Dye-Chem and NOCIL awards of IIChE; Fellowships of Academy of Sciences and Engineering, etc.) Their research in diverse areas of Chemical Engineering is published in prestigious international journals with high impact factors.

The departmental faculty has also authored nearly 30 textbooks and research monographs through reputed publishers in India and abroad which reflects the faculty's commitment to teaching. There are a number of completed and ongoing projects sponsored by various national funding agencies including the Department of Science and Technology, Ministry of Human Resource Development, CSIR, ARDB, DBT, etc. The department enjoys an excellent rapport and professional interaction with various industrial organizations. Faculty members engage in high level consultancy work in industry during summers, whereas some others have sponsored projects funded by industry (e.g., IPCL Baroda, GSFC Baroda, Duncan Industries Ltd., UP State Agro Industries, Engineers India Ltd., GAIL, BPCL, CHT, Hindustan Lever, etc.).

CURRENT COURSE STRUCTURE FOR B.TECH. STUDENTS
CHEMICAL ENGINEERING

	SEMESTER							
	FIRST	**SECOND**	**THIRD**	**FOURTH**	**FIFTH**	**SIXTH**	**SEVENTH**	**EIGHTH**
C	CHM101	TA101	MTH203	HSS-I-2	SE-1	HSS-II-1	HSS-II-2	SE-2
O	PHY101	PHY103	CHM201	TA201	CHE312	CHE313	CHE452	CHE453
U	PHY102	MTH102	ESO202	ESO218	CHE331	CHE362	CHE492	CHE463
R	MTH101	ESC102	ESO212	CHE211	CHE361	CHE381	CHE494	DEL-2
S	HSS-I-1/	CHE100	CHE251	CHE221	OE-1	CHE391	CHE495	DEL-3
E	ENG112N	PE102				OE-2	DEL-1	
	ESC101						OE-3	
	PE101							

ChE 100 Intro. to Chemical Engineering
ChE 211 Fluid Mechanics
ChE 221 Chem. Engg. Thermodynamics
ChE 251 Chemical Process Calculations
HSS-I
ChE 312 Heat and MassTransfer
ChE 313 Separation Processes
ChE 331 Chemical Reaction Engineering
ChE 361 Chemical Process Industries
OE-I Open Elective-I
SE-I Sc Elective-I
ChE 362 Biochemical Engineering
ChE 381 Process Dynamics and Control
ChE 391 Unit Opn. Lab I
OE-II Open Elective-II
HSS-II
ChE 452 Computer Applications in Chemical Engineering
ChE 492 Unit Opn. Lab II
ChE 494 Summer In-Plant Training
ChE 495 Project
DE-I Departmental Elective - I
OE-II Open Elective - III
HSS-II
ChE 453 Chem. Engg. Design
ChE 463 Electronic, Polymeric & Ceramic Materials & Processing
DE-II, DE-III Departmental Elective - II, III
SE-II Sc Elective -II

COURSE DESCRIPTION

ChE 100 **INTRODUCTION TO CHEMICAL ENGINEERING**

L-T-P-D-[C]

2-0-0-0-[0]

What is engineering vis-à-vis basic Science? What is Chemical Engineering? What do Chemical Engineers do? Diversity of employment opportunities; Intimate connections with other physico-chemical sciences, biological and biomedical sciences, and other engineerings: case studies and examples; Historical perspectives and needs, e.g., petrochemical industries, pulp and paper, textiles; Concerns of chemical engineering: traditional areas, environment, energy, new materials, bioengineering and biotechnology, food, health; Safety, IPR, Professional ethics; Frontiers: role and future of Chemical Engineering in the computer/information revolution; biomolecular revolution (e.g., nanodevices); Basic tools of Chemical Engineering: physico-chemical, mathematical and biological sciences, transport phenomena, thermodynamics, kinetics and reactors, design; Concept of unit operations and descriptions of important unit operations; Concepts of scale-up, modeling and simulation: from molecular to terrestrial (e.g., ecology) scales; Visit to research laboratories of the department and other specially chosen laboratories in the Institute to introduce chemical engineering concerns; Simple laboratory demonstrations; Screening of educational videos from AIChE and I Chem E, as well as from Indian industries; Plant visits.

ChE 211 **FLUID MECHANICS** **Prereq. ESO 212**

L-T-P-D-[C]

3-0-0-1-[4]

Review of Navier-Stokes' (NS) equations; non-dimensionalization of NS equations; introduction to turbulence; analogies; correlations for fluid flow Short introduction to non-Newtonian flows, Engineering Bernoulli Equation; f vs. N_{Re} charts; K factors and equivalent lengths for various fittings; hydraulic diameter; Head vs. Q plots of centrifugal pumps; NPSH, cavitation and priming; pipeline system design including pseudo-steady state approximation; flow measurements; compressors and blowers. Compressible flows in conduits, *Mixing and Agitation:* Power consumption; mixing times; scale-up, Characterization of solids; fundamentals of two-phase flow; flow through packed beds and in fluidized beds (pressure drops, loading and flooding); pneumatic and hydraulic transportation. Filtration, Centrifuges and cyclones (including some recent models).

ChE 221 **CHEMICAL ENGINEERING THERMODYNAMICS** **Prereq. ESO 202**

L-T-P-D-[C]

3-0-0-1-[4]

Review of I and II Laws of Thermodynamics, P–V–T Relations of Pure Fluids Graphical,Tabular and Mathematical representaion; Generalized compressibility chart; Generalized EOS; Thermodynamic Potentials; Maxwell Relations, Thermodynamic Property Relations, Thermodynamic properties of real gases, Multicomponent mixtures, Properties of solutions, Phase Equilibrium (VLE, LLE, VLLE), Review of Thermochemistry; Chemical reaction equilibria.

ChE 251 **CHEMICAL PROCESS CALCULATIONS** **Prereq. None**

L-T-P-D-[C]
3-0-0-1-[4]

Guidelines for Problem Solving; Review of Basic concepts – Process variables & properties, Degree of Freedom, Steady State Material Balances – in non-reacting systems and reacting system, Recycle & purge, elemental vs. species balance, combustion of fossil fuels, Steady State Material balances in Multiphase systems, Steady State Energy Balances – in non-reacting & reacting systems, De-Coupled & coupled mass & energy balances, Calculations for network of units with recycle & bypass, Process Flow sheeting with sequential modular calculations, Unsteady State Balances.

ChE 312 **HEAT AND MASS TRANSFER** **Prereq. ESO 212, ChE 221**

L-T-P-D-[C]
3-0-0-1-[4]

Heat conduction, Molecular diffusion, Convective heat transfer (laminar & turbulent), convective mass transfer (laminar & Turbulent), simultaneous heat and mass transfer, wet-bulb and adiabatic saturation, Interface mass transfer; Boiling: pool and convective boiling, correlations, Condensation: film-wise and drop-wise condensation, correlations, Radiation: thermal radiation, radiation properties, view factors, heat exchange between surfaces, Heat exchanger design: Shell-and-tube, compact exchangers, reboiler, and condenser, Evaporators: type of equipment, single and multiple effect evaporators, Crystallization: phase equilibria, crystal growth, types of equipment, design, Aspen/Matlab should be used wherever possible.

ChE 313 **SEPARATION PROCESSES** **Prereq. ChE 221, ChE 312**

L-T-P-D-[C]
3-0-0-1-[4]

Mass transfer equipment: continuous contact and staged contact units for absorption, extraction, distillation, adsorption, humidification, drying, Phase equilibria: phase diagrams, V-L-E, G-L-E, S-L-E; estimation of binary and multicomponent phase equilibria, Single stage (steady state): binary and multicomponent, Single stage unsteady state: (distillation, drying, adsorption [blow down]), Separations without reflux: isothermal cases: stage contactor: McCabe -Thiele method, stage efficiency, matrix method, Thomas method for solution, continuous contact (HTU, NTU), Separations without reflux: non-isothermal cases (absorption, adsorption, drying, humidification): McCabe-Thiele method, numerical solutions, Separations with reflux: distillation, extraction and adsorption, McCabe-Thiele and matrix method; continuous contact, Membrane separation processes: fundamentals, introduction, different types of processes, Design of gas-liquid, liquid-liquid contactor; staged and continuous contact, Estimation of stage efficiencies, Short-cut methods for distillation. Aspen should be used as much as possible.

ChE 331 **CHEMICAL REACTION ENGINEERING** **Prereq. ChE 221**

L-T-P-D-[C]

3-0-0-1-[4]

Introduction, Basic Concepts in Chemical Kinetics, Collection and Analysis of Rate Data, Nonelementary Homogeneous Reactions, Isothermal Reactor Design, Design for Multiple Reactions in Isothermal Reactors, Nonisothermal Reactors, Nonideal flow, Catalysis, Kinetics of Catalytic Reactions , Diffusion and Reaction in Porous Catalysts.

ChE 361 **CHEMICAL PROCESS INDUSTRIES** **Prereq. ChE 251**

L-T-P-D-[C]

3-0-0-1-[4]

Role of Chemical Engineer, Elementary Process Flowsheeting P & I diagrams, Inorganic Industry–Fertilizers, Chlor alkalies, Natural Products –Pulp & Paper, Oils, Soaps, Herbs, Petroleum & Petrochemicals: Refining/Crude Distillation; FCC, Catalytic Reforming; Alkylation, Amination, Hydrocracking, Aromatic Extraction, Plastics, Intermediates, dyes & paints, Pharmaceuticals, Environmental Pollution & Waste Treatment.

ChE 362 **BIOCHEMICAL ENGINEERING** **Prereq. ESO 212, ChE 331**

L-T-P-D-[C]

3-0-0-1-[4]

Cell Structure and Cell Types, Chemicals of Life (RNA, DNA, enzymes etc.), Kinetics of Enzyme Reactions, Applied Enzyme Catalysis, Metabolic Stoichiometric and Energetics, Molecular Genetics and Control, Biomass Production, Transport Phenomena in Biosystems, Design and Analysis of Biological Reactors, Fermentors, Downstream Product Recovery and Purification, Interaction of Mixed Microbial Populations, Biological Wastewater Treatment.

ChE 381 **PROCESS DYNAMICS AND CONTROL** **Prereq. MTH 203**

L-T-P-D-[C]

3-0-0-1-[4]

Introduction, Process models, Linearization, Laplace transforms. Process dynamics, Time delay, Feedback control, Instrumentation, Stability (Routh array & root locus), Frequency response analysis (Bode and Nyquist plots), Design of feedback controllers, High level control (Cascade, Smith predictor, feedforward, adaptive, inferential, ratio, override etc.), MIMO systems, Digital control.

ChE 391 **UNIT OPERATION LAB. I** **Prereq. ChE 251, 211, 312, 331**

L-T-P-D-[C]

0-0-6-1-[4]

Fluid flow, Fluid particle systems, Thermodynamics, Heat transfer, Mass transfer.

ChE 452 **COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING**

L-T-P-D-[C]

3-0-0-1-[4]

Artificial Intelligence and Networks in Chemical Engineering, Expert Systems (CONPHYDE, KBS) and Tools (KEE, ART), Artificial Neural Network, Learning and Training, Process Plant Diagnosis, Safety Analysis, Process Modelling, Interfacial properties, Fault Diagnosis and Trouble Shooting, Data Base Management and

Qualitative Interpretation of Process Data, Simulation Packages, ASPEN PLUS, Batch Processing Packages (SUPERPRO), FLUENT

ChE 453 **CHEMICAL ENGINEERING DESIGN** **Prereq. ChE 251, 452**

L-T-P-D-[C]
3-0-0-1-[4]

Introduction to Design – Process Development, process alternatives, Process Flowsheeting and simulation using ASPEN PLUS, Conceptual Process Synthesis, Conceptual design of reactors, pressure vessels, distillation/adsorption columns, storage vessels, Synthesis of Separation Trains, Cost Estimation & profitability analysis, Heat Exchange Network Analysis, Scale-up & pilot plant studies, HAZOP and Safety in design, Batch process Design for sequential processing using SUPERPRO, Continuous plant design (group term projects).

ChE 463 **ELECTRONIC, POLYMERIC & CERAMIC MATERIALS & PROCESSING**

L-T-P-D-[C] **Prereq. ChE 312**
3-0-0-1-[4]

Atomic structure, semiconductor materials, solar cells, Transistors and Process Sequence of Fabrication, Control of Microcontamination, Microlithography, Doping, Etching, Oxidation, Chemical Vapour Deposition and Reactor Design, Classification and Electrical, Mechanical Properties of Polymer, Polymer Catalysis and Molecular Chemistry, Flow Behaviour and Polymer Processing, Polymer Blends and Composites, Applications of Polymers (Exchange Resin etc.), Ceramic Raw Materials and Characterization, Ceramic Processing Additives, Ceramic Beneficiation Process, Ceramic Forming Processes (Sol-gel, Casting etc.), Zeolites, Ceramic Drying, Surface Processing and Shaping.

ChE 492 **UNIT OPERATION LAB II** **Prereq. ChE 312, 313, 331, 381**

L-T-P-D-[C]
0-0-6-1-[4]

Mass Transfer, Heat transfer, chemical reactors, Computer aided data acquisition and on-line analysis, Process dynamics and control.

ChE 494 **SUMMER IN-PLANT TRAINING**

L-T-P-D-[C]
0-0-4-0-[2]

A written report and an oral presentation/interview after successful completion of an 8-week industrial in-plant training with a chemical industry.

DEPARTMENT ELECTIVES

ChE 495 **PROJECT** **Prereq. #**

L-T-P-D-[C]
0-0-8-0-[0]

Student will work on design/research projects to carry out theoretical/experimental work on problems in chemical engineering as assigned by the project advisor.

DEPARTMENT ELECTIVES

ChE 600 **RESEARCH METHODS AND SKILLS** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Definition and nature of research, Motivation for research, different types and styles of research in sciences, role of serendipity, scientific temperament, Is science necessary? Working of some of the great minds from all walks of life- scientists, artists, writers,etc.Tools for thinking, critical and positive thinking, creativity and innovation, mind mapping; Development of problem solving skills, scaling and orders of magnitude analysis, role of simple models in thinking and in developing an understanding. Scientific and critical reasoning skills, art of reading and understanding scientific papers and critical evaluation of the underlying premises and assumptions, literature reviews. Professional attitudes and goals, concept of excellence, ethics in science and engineering, some famous frauds in science. Scientific communication, Organisation of ideas, writing scientific papers, reports and thesis; Making scientific presentations at conferences; Presenting popular lectures to semi-technical and or/non-technical audience/ participating in public debates on scientific issues.

ChE 611 **TRANSPORT PHENOMENA**

L-T-P-D-[C] **Prereq. #**

3-0-0-0-[4]

Kinematics, Transport theorem, constitutive relations, Equations of motion and their solutions, Boundary layer theory, Turbulence; Energy equation and its exact solutions, Continuity equation for multicomponent systems, constitutive relations, Interphase transport of momentum, energy and mass and macroscopic balances.

ChE 616 **MODELLING AND SIMULATION OF SEPARATION PROCESSES** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Advanced topics in multicomponent staged separation processes such as distillation, absorption, extraction. General design methods flash separation short-cut and rigorous methods.

ChE 618 **NEW SEPARATION PROCESSES** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Separation Factors for Rate Governed Separation Processes, Membrane Characterization; Reverse Osmosis: Models of Solvent and Solute Transport, Concentration Polarization; Ultrafiltration: Types of Transport through UF Membranes, Fouling and Concentration Polarization in UF, Osmaotic Pressure Model utization; Diafiltration: Process Design; Dialysis: Solute Transport analysis of dialyzer operation, Mode of Dialysis; Electro-dialysis: Types of Electro- dialysis - Ion Transport Fundamentals, Concept of Limiting Current Density, Concentration Polarization; Liquid Membrane; Permeation of Gases through Membranes and Pervaporation.

ChE 621 **THERMODYNAMICS I** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Postulational Thermodynamics: Postulates; Equilibrium criteria; Gibbs Duhem relation; Energy minimum principle; Thermodynamic potentials; Stability and phase Transition. Statistical Thermodynamics: Statistical mechanics of ensembles;

Estimation of Thermodynamic properties in Ideal gases, Estimation of equilibrium constant in reacting systems.

ChE 622 **INTRODUCTION TO MOLECULAR SIMULATION** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Theory methods, and application of molecular simulation. Elementary satistical mechanics. Molecular modeling. Basic Monte Carlo and molecular dynamics techniques and ensemble averaging. Evaluation of free energies, phase equilibria, interfacial properties, and transport and rate coefficients. Applications to simple and complex fluids and solids. Commercial simulation software.

ChE 623 **THERMODYNAMICS OF FLUIDS AND FLUID MIXTURES** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Classical thermodynamics of phase equilibria: Thermodynamic properties from volumetric data: Nature of intermolecular forces, Theory of corresponding states; Fugacities in gas mixtures and liquid solutions; gas solubilities; High pressure equilibria.

ChE 631 **CHEMICAL REACTION ENGINEERING** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Behaviour of chemical reactions; Behaviour of chemical reactors: ideal and non-ideal flow, non-isothermal reactor performance, reactor stability; Heterogeneous reactions: interphase and intraphase heat and mass transfer effects; Fluid-Solid non-catalytic reactions; Heterogeneous catalytic reactions.

ChE 633 **PRINCIPLES OF HETEROGENEOUS CATALYSIS** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Adsorption; Energetics; Isotherms and Rates: Experimental aspects of adsorption and allied phenomena on catalyst surfaces; Pore structure and surface area estimation and their significance; Important catalysts, Promoters and Carriers; Mechanisms of some typical heterogeneous catalytic reactions, e.g., Oxidation.

ChE 641 **MATHEMATICAL METHODS IN CHEMICAL ENGINEERING** **Prereq.** #

L-T-P-D-[C]

3-0-0-0-[4]

Modelling, Vector Spaces, Matrices, Linear Operators, Initial Value Problem, Partial Differential Equation, Sturm Louiville Theory, Separation of Variables, Greens Functions, Transform Techniques, Nonlinear Equations, Continuation Methods, Bifurcation and Chaos.

ChE 642 **NUMERICAL METHODS IN CHEMICAL ENGINEERING** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Systems of Linear and Non-Linear Algebraic Equations: Successive Substitution, Newton-Raphson, Eigenvalues and Eigenvectors of Matrices, Interpolation, Solutions of ODEs (IVP): Runge Kutta, Multistep Methods, Gear's algorithm,

Stiffness and Stability of algorithms, ODE (BVPs) and PDEs: Finite Difference, Finite Elements, Shooting Methods.

ChE 645 **MODELING AND SIMULATION IN CHEMICAL ENGINEERING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Mathematical Model and its Necessity: Model Development principles: Synthesis of sub-models, Experimental facts, Hypothesis, Dimensional Analysis, Scaling, Reduction of equations.

Classification of Models: Deterministic and stochastic - Example from thermal diffusion, Lumped and Distributed parameter - Example from stirred tank and plug flow, Additional examples from transport processes and chemical kinetics.

Modelling and Simulation Techniques: Length and time scale analysis in multiscale systems, Population balance models - Fundamentals, Examples from Crystallization, coagulation, Microbial population, Monte Carlo methods - Basics of Random No. and Probabbility distribution, Time and event driven methods, Stochastic models - Poisson Process, Markov process, Birth-death process, Non-linear dynamics and Chaos- Principles, Application in mixing, reaction, stirred tank, fludized bed, Fractal models - Diffusion and reaction limited growth, Aggregate structure.

Solution and analysis of results: Parameter estimation, Asymptotes, Moments, Phase plane, Time series.

ChE 647 **APPLIED STATISTICS FOR CHEMICAL ENGINEERS** **Prereq.** #

L-T-P-D-[C]
3-0-0-0-[4]

Elementary concepts of statistics; Significance tests: linear regression; Hypothesis testing; Analysis of variance; Design of experiments; Non-linear parameter estimation: Model building and model discrimination.

ChE 652 **OPTIMIZATION** **Prereq.** #

L-T-P-D-[C]
3-0-0-0-[4]

Mathematical formulation of optimization problems; single variable problems: search techniques; Multivariable problems without constraints: direct methods, first and second order methods; Multivariable problems with constraints: Calculus of variations; Pontryagin's maximum principle; Dynamic Programming.

ChE 654 **PROCESS ENGINEERING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Introduction to the elements of process design, process development, process evaluation ; flow sheeting; Pilot plant; Optimization and economic considerations, process design engineering, project engineering, practical considerations; safety considerations and successful plant operations, case studies.

ChE 658 **CHEMICAL PLANT SAFETY AND HAZARD ASSESSMENT** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Hazardous properties of chemicals; Site selection; Risk assessment method; Vapour release models; Fire and explosions; Boiling Liquid Expanding Vapour Explosions (BLEVE); Safety audit; Emergency planning and disaster management; Inherently safer design; Process intensification; Plant Security.

ChE 659 **PROCESS ENGINEERING PRINCIPLES IN MICROELECTRONIC FABRICATION**

L-T-P-D-[C] **Prereq. #**

3-0-0-0-[4]

Micro-electronic material processing techniques covering aspects through transport mechanism, reaction kinetics and design : silicon crystal growth, oxidation, ion implantation, chemical and physical vapor deposition, rapid thermal processing, epitaxy, lithography, plasma processing (deposition and etch), electrochemical deposition, chemical mechanical planarization. Clean room technology: particulate deposition and filtration aspect.

ChE 662 **PETROLEUM REFINERY ENGINEERING** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Petroleum refining in India; refinery tests and crude oil evaluation ; crude distillation column design; Delayed Coking; Catalytic cracking; Catalytic reforming; Catalytic isomerization; Alkylation; Polymerization; Hydrocracking; Hydrotreating.

ChE 666 **PARTICULATE SCIENCE & TECHNOLOGY** **Prereq.** #

L-T-P-D-[C]

3-0-0-0-[4]

Particle characterization; particle mechanics; discharge of particulate bulk solids; particles in fluids; process in applications.

ChE 670 **INTRODUCTION TO POLYMER SCIENCE & TECHNOLOGY** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Polymer Fundamentals: Chemistry of Polymer synthesis, Polymer Reaction Kinetics: Step-growth polymerization, free-radical chain growth polymerization, Emulsion Polymerization, Ionic and cationic polymerization. Chain statistics and rubber elasticity. Physical properties and characterization of polymers.

ChE 671 **REACTION ENGINEERING OF POLYMERS** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Kinetics and mechanisms of polymerization: condensation, free radical, ionic, stereo-regular, copolymerization. Techniques of polymerization: bulk, suspension, emulsion, dispersion, interfacial in both semi-batch and multiphase reactors. Molecular weight distribution and control: simulation of some industrial reactors.

ChE 672 **PRINCIPLES OF POLYMER, PROCESSING** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4]

Review of equations of motion, constitutive equations; Calendaring, extrusion; molding; mixing; fibre spinning.

ChE 673 **ENVIRONMENTAL POLLUTION: CONTROL, DESIGN AND MODELLING**

L-T-P-D-[C] **Prereq. #**

3-0-0-0-[4]

Air Pollution - Atmospheric Pollutants: Photochemical smog in troposphere; O_3 depletion in stratosphere; Acid Rain, Chemical equibiliria, *Aerosols*: Atmospheric deposition, nucleation, *Troposphere Energy Balance*: Pressure & Temperature relationship; Stability criteria: Stack plume rise, Puff and Plume dispersion, *Control of Pollutents*: Absorption; Adsorption: Break through Analysis, *Particles:* Mechanism of Particles capture; Water Pollution - Organic/Inorganic/Biological; Waste Water Treatment; Aerobic and Anerobic digesters, Dissolved O_2 model, Activated sludge process reactor design, Bio-tower reactor design.

ChE 676 **ENGINEERING APPLICATIONS OF RHEOLOGY** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4] Classification of fluid behaviour: Constitutive relations; Rheometry: Flow of non-Newtonian fluids in closed conduits: Flow in complex geometries: Fixed and fluidized beds; two phase flows, Mixing and agitation: requirements; Dimensional analysis; heat and mass transfer processes in non-Newtonian systems.

ChE 677 **INTRODUCTION TO POLYMER PHYSICS AND RHEOLOGY**

L-T-P-D-[C]

3-0-0-0-[4] Introduction; Mathematical Preliminaries; Review of thermodynamics and statistical mechanics; Description and statistical properties of a single polymer chain (ideal and real chains); Excluded-volume effects; Thermodynamics of polymer solutions and blends; Flory-Huggins theory; Continuum aspects of rheology; Experimental measures of rheological response; Polymer dynamics: General theory of Brownian motion; Molecular theories for polymer dynamics and rheology; Rouse & Zimm theories; Tube model and Reptation theory.

ChE 678 **MECHANICS OF SOFT MATTER** **Prereq. #**

L-T-P-D-[C]

3-0-0-0-[4] Fundamental Equations: The strain tensor; The stress tensor; Thermodynamics of deformation; Hooke's law; Homogeneous deformations; Stress equilibrium relations in Cartesian, cylindrical and polar coordinates. Equilibrium of an elastic medium bounded by a plane; Solid bodies in contact with and without interactions. Saint Venant's principle.

Equilibrium of rods and plates: Equations of equilibrium of rods; Bending and torsion of rods. Euler's buckling instability. Twisting instability of rods. Equation of equilibrium for a bent plate; The energy of a bent plate; Application of bending plate geometry for solving problems related to Adhesion.

Nonlinear elasticity: Molecular approach to rubber; strain energy theory; specific forms of strain energy; Neo-Hookean elasticity. Shearing of an compressible elastic material. Cavitation in crosslinked networks.

Mechanics of cell wall: Elasticity of cellular filaments; soft networks in cell; biomembranes, membrane undulations.

ChE 679 **SPECIAL TOPICS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Course contents vary from time to time.

ChE 681 **ADVANCED PROCESS DYNAMICS AND CONTROL** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Process Identification Techniques for SISO & MIMO systems - off line & on line; Generalized Predictive Control (GPC); Model Predictive Control (MPC): Dynamic Matrix Control (DMC), Internal Model Control for SISO & MIMO systems; Optimal Control; Multivariable Control; Control Design for Complete Plants; Case Studies using MATLAB & SIMULINK software.

ChE 683 **COMPUTER-AIDED PROCESS CONTROL** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Hardware: Analog and digital interfacing, sensors and transducers. System software: realtime programming, Application software: data logging, filtering, Digital Control: Z-transforms, discrete time dynamic systems, adaptive control, introduction to MIMO control systems. Laboratory exercises.

ChE 688 **FUNDAMENTALS OF COLLOID AND INTERFACE SCIENCE & TECHNOLOGY**

L-T-P-D-[C]
3-0-0-0-[4]

Prereq. #

Capillarity, interfacial thermodynamics, surflactants, stability of muliphase systems, foam, emulsion, multiphase reactors, wetting and adhesion, catalyst sintering/redispersion; Stability and coagulation of colloids, nucleation and growth: Colloids in chemical engineering, in separation processes, bio-science.

ChE 699 **M. TECH. THESIS**

ChE 701/ 702 **GRADUATE SEMINAR (M.TECH.)**

ChE 799 **PH. D. THESIS**

ChE 801/ 802 **GRADUATE SEMINAR (PH. D.)**