## COURSE STRUCTURE FOR M.E. CHEMICAL (For 2008 Course)
### (w.e.f. June – 2008)
### SEMESTER I

<table>
<thead>
<tr>
<th>CODE</th>
<th>SUBJECT</th>
<th>TEACHING SCHEME</th>
<th>EXAMINATION SCHEME</th>
<th>CREDITS</th>
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<tr>
<td></td>
<td></td>
<td>Lect.</td>
<td>Pr</td>
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<tr>
<td>509101</td>
<td>Applied Statistics for Chemical Engineers</td>
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<tr>
<td>509102</td>
<td>Management of R&amp;D in Chemical Industries</td>
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<tr>
<td>509103</td>
<td>Advanced Separation Processes</td>
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<tr>
<td>509104</td>
<td>Elective I</td>
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<td>509105</td>
<td>Elective II</td>
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<tr>
<td>509106</td>
<td>Lab Practice I</td>
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<td>509107</td>
<td>Seminar I</td>
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### SEMESTER II

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<td>Process Modeling and Simulation</td>
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<td>509109</td>
<td>Advanced Transport Phenomena</td>
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<td>509110</td>
<td>Advanced Process Control</td>
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<td>509111</td>
<td>Elective III</td>
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<td>509112</td>
<td>Elective IV (Open)</td>
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### SEMESTER III

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<tr>
<td>609101</td>
<td>Seminar III (Based on Project)</td>
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### SEMESTER IV

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* The Term Work of Project stage II of semester IV should be assessed jointly by the pair of internal and external examiners, along with the oral examination of the same.

**Note:** The Contact Hours for the calculation of load of teacher Seminar- 1 Hr / week / student Project - 2 Hr / week / student

### LIST OF ELECTIVES

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<th>Elective I</th>
<th>Elective II</th>
<th>Elective III</th>
<th>Elective IV</th>
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<tbody>
<tr>
<td>1. Computational Fluid Dynamics</td>
<td>1. Industrial Pollution</td>
<td>1. Catalysis And Surface Phenomenon</td>
<td>Open Elective</td>
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</table>
EMPIRICAL STATISTICS: Measures of Central tendency, dispersion, skew ness and kurtosis Principle of least squares - Correlation and regression - rank correlation.

SAMPLING DISTRIBUTIONS AND ESTIMATION: Sampling distributions - Point and interval estimates for population proportions, mean and variance – Maximum likelihood estimate method - Method of moments.

TESTING OF HYPOTHESIS: Sampling distributions - Tests based on Normal, t, Chi-square and F distributions - Analysis of variance – oneway and two-way classifications.

DESIGN OF EXPERIMENTS: Completely randomized design - Randomized block design - Latin square design - 2 power 2 factorial design.

LINEAR PROGRAMMING: Basic concepts - Graphical and Simplex methods – Transportation problem - Assignment Problem.

Reference Books:

509102  Management of R&D in Chemical Industries

Teaching scheme  Examination Scheme
Lecture: - 3h/week  Theory: - 100 Marks


References:

1. NUTS AND BOLTS OF CHEMICAL EDUCATION RESEARCH, edited by Diane M. Bunce and Renée S. Cole, ACS Symposium Series 976, American Chemical Society, Washington, D.C.,
2. Design of experiments (DOE) in chemical engineering, LAZIC Zivorad, Wiley-VCH, Weinheim
4. Getting It Right: R&D Methods for Science and Engineering, Peter Bock
509103 Advanced Separation Processes

Teaching scheme
Lecture: - 3h/week

Examination Scheme
Theory: - 100 Marks

GENERAL
Review of conventional processes, Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and equipment used in cross flow filtration, cross flow electro filtration, dual functional filter, Surface based solid-liquid separations involving a second liquid, Sirofloc filter.

MEMBRANCE SEPARATIONS
Types and choice of membranes, Plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, Commercial, pilot plant and laboratory membranes permeators involving dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis, Economics of membrane operations, Ceramic membranes.

SEPARATION BY ADSORPTION TECHNIQUES
Mechanism, Types and choice of adsorbents, Normal adsorption techniques, Affinity chromatography and immuno chromatography. Types of equipment and commercial processes, Recent advances and process economics.

IONIC SEPARATIONS
Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, Ion exchange chromatography and electro dialysis, Commercial Processes.

OTHER TECHNIQUES
Separations involving lyophilisation, Prevaporation and permeation techniques for solids, liquids and gases. Industrial viability and examples, Zone melting, Addluctive crystallization, Other separation process, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques.

References:
Introduction to Fluid Dynamics

Conjugate Heat Transfer (CHT)
Introduction to CHT, Fluid boundary conditions, CHT solid boundary conditions, CHT interface conditions, many to one CHT interface conditions, linear solver.

Geometric Modeling and CAD Repairing
Geometric transformations, Parametric representation of curves and surfaces, Concept of topology, Surface modeling, Faceted models, Solid modeling. Creation of water tight geometry, Faceted Boolean operations, Dependent and independent CAD errors.

Structured and Unstructured Grid Generation
Basic theory of structured grid generation, Surface grid generation, Mono block, multi block, hierarchical multi block, Moving and sliding multiblock, Grid clustering and grid enhancement. Basic theory of unstructured grid generation, advancing front, Delaunay triangulation and various point insertion methods, Unstructured quad and hex generation, grid based methods, various elements in unstructured grids, Surface mesh generation, Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms, grid clustering and quality checks for volume mesh. Adaptive, Moving and Hybrid Grids, Need for adaptive and, moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination

Introduction to CFD
Philosophy of CFD, Governing equations of fluid dynamics and there physical meaning, Mathematical behavior of governing equations and the impact on CFD simulations, Simple CFD techniques and CFL condition.

Numerical Methods in CFD
Finite Difference, Finite Volume, and Finite Element, Upwind and downwind schemes, Simple and Simpler schemes, Higher order methods, Implicit and explicit methods, Study and transient solutions

Introduction to Turbulence Modeling
Introduction and background, Algebraic models, One equation models, Two equation models, Near wall treatment, Reynolds stress models, Eddy viscosity models (EVM),
Nonlinear eddy viscosity models, LES, RANS, and, hybrids, Direct numerical simulation (DNS)

Introduction to Multiphase Modeling
Fundamentals of multiphase flows, Eulerian-Lagrangian (ELAG) approach, Eulerian-Eulerian (E2P) approach, Volume Of Fraction (VOF) approach, Solving example problems

Chemical Fluid Mixing Simulation
Stirred tank modeling using the actual impeller geometry, Rotating frame model, The MRF Model Sliding mesh model, Snapshot model, Evaluating Mixing from Flow Field Results, Industrial Examples

Post-Processing of CFD results
contour plots, vector plots, and scatter plots, Shaded and transparent surfaces, Particle trajectories and path line trajectories, Animations and movies, Exploration and analysis of data.

References:

4. Turbulence Modelling for CFD, D.C. Wilcox 1993
5. An Introduction to Multigrid Methods, Pieter Wesseling, John Wiley & Sons, 1992
Introduction to fundamental concepts and principles of process synthesis and design and use of flow sheet simulators to assist in process design.


Life Cycle Assessments of process: From design to product development, Project costing and performance analysis, Environmental concerns, green engineering, engineering ethics, and health and safety.

Introduction to commercial process design and costing software such as HYSYS, Aspen plus etc., Chemical Process (reactor, heat exchanger, distillation etc) analysis using commercial software

Heat Exchanger Network Synthesis:
Introduction & problem highlights ,HENS basics & graphics, The pinch point approach, Performance targets, trade-off & utilities, Heat & power integration, HENS as mathematical programming

Ideal Distillation: Column and sequence fundamentals, Sharp splits & sequencing Phase diagrams for 2, 3 and 4 components, Feasibility and vapor ow rates for single columns, Residue curve basics


Reactor Networks: Geometry of mixing and basic reactor types, The Attainable Region (AR) approach, AR in higher dimensions & for other processes, Reactive Separation processes, Fundamental behavior and problems, Separation through reactions. Reactive Residue Curve Maps

References


Quantum Considerations
Introduction, Internal energy levels, Microstates, Macrostates and Probability, Case or repeated trials, Phase space, combinatorial problems with respects to particles and energy states.

Entropy and Probability
Thermodynamic probability, State of maximum Thermodynamic probability, Microscopic meaning of entropy, Use of Lagrangion multipliers, Stirling's approximation.

Statistical Mechanics

Statistical Evaluation Of Thermodynamic Properties
Ideal Monatomic gas, Partition function, Calculation of the translational properties of an ideal monatomic gas, Sector - Tetrode equation, Potential energy function for a diatomic molecule, Rigid rotor harmonic – oscillator approximation, Rotational and vibrational partition functions of ideal polyatomic gases.

Thermodynamic Of Irreversible Processes
Irrevesible processes, Phenomenological laws, Application of onsager - reciprocal relations, Seebeek effect, Peltier effect, Thompson effect.

References:
Elective I
509104 Computer Aided Design

Teaching scheme
Lecture: - 3h/week

Examination Scheme
Theory: - 100 Marks

ELEMENTS OF COMPUTER SYSTEM
Central Processors, Data storage, Alphanumeric input and output, Graphical I/O Basic software, Operating system, Models of operation, Time sharing, Real time operation, Data and file management systems.

PROPERTIES ESTIMATION

EQUIPMENT DESIGN
Computer aided design of reactors evaporators adsorption columns. Distillation columns (specific attention to multi component systems. Heat exchangers.

MASS AND ENERGY BALANCE COMPUTATIONS

DYNAMIC SIMULATION
Review on ordinary and partial differential equation, Boundary value problems, Stiff differential equation system, Dynamic simulation of stirred tanks system with heating Multi component system, Reactors, Absorption and distillation columns, Application of orthogonal collocation and weighted residuals techniques in heat and mass transfer systems, Introduction to special software for steady and dynamic simulation of Chemical engineering systems.

References:
Elective II  
509105. Industrial Pollution Control

Teaching scheme
Lecture: - 3h/week

Examination Scheme
Theory: - 100 Marks

Air pollutants, dynamics, plume behavior, dispersion of air pollutants, dynamics, plume behavior, dispersion of air pollutants, atmospheric dispersion equation and its solutions, Gaussian plume models.

Design concepts for pollution abatement systems for particulates and gases. These include gravity chambers, cyclone separators, filters, electrostatic precipitators, condensation, adsorption and absorption, thermal oxidation and biological processes.

**Waster water treatment processes**: Design concepts for primary treatment, grid chambers and primary sedimentation basins, biological treatment

Bacterial population dynamics, kinetics of biological growth and its applications to biological treatment, process design relationships and analysis, determination of kinetic coefficients, activated sludge process.

Design, trickling filter design considerations, advanced treatment processes.

Study of environment pollution from process industries and their abatement. Fertilizer, paper and pulp, inorganic acids, petroleum and petrochemicals, recovery of materials from process effluents.

**Solid waste and Hazardous waster management**: Sanitary land fill design, Hazardous waste classification and rules, management strategies. Treatment methods – component separation, chemical and biological treatment, incineration, solidification and stabilization, and disposal methods.

**References:**

1. C. S. Rao Environmental pollution control engineering, 2nd edition
2. S.P. Mahajan Pollution control in process industries.
## Elective II
### 509105. Process Optimization

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<thead>
<tr>
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</table>

Introduction to process optimization; formulation of various process optimization problems and their classification.

Basic concepts of optimization-convex and concave functions, necessary and sufficient conditions for stationary points.


Successive linear and quadratic programming, optimization of staged and discrete processes.


### Reference
1. Kalyanmoy Deb, Optimization for engineering design, Prentice Hall of India
2. T.F.Edgar and D.M.Himmelblau, Optimization of chemical processes, Mc Graw Hill,
6. SS Rao, Optimization Theory and Applications
Elective II

509105. Drugs and Pharmaceutical Engineering

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<thead>
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<td>Lecture: - 3h/week</td>
<td>Theory: - 100 Marks</td>
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INTRODUCTION
Development of pharmaceutical Industry, Organic therapeutic agents, uses and economics, Drug metabolism, Physic Chemical principles, Pharma Kinetics, Action of drugs on human bodies.

MANUFACTURING PRINCIPLES
Compressed tablets, Wet granulation, Dry granulation or slugging, Direct compression, Tablet formulation, coating pills, capsules oral liquids, injections and ointments.

PHARMACEUTICAL PRODUCTS
Vitamins, cold remedies, Laxatives, Analgesics, Nonsterodial conceptives, External antiseptics, Antacids and others.

MICROBIOLOGICAL AND ANIMAL PRODUCTS: Antibiotics, Biological, Harmanes, Vitamins, preservation.

PHARMACEUTICAL ANALYSIS: Analytical methods and tests for various drugs and pharmaceuticals.

PACKING AND QUALITY CONTROL: Packing, Packing techniques, Quality control.

References:
Elective II
509105. Fluidization Engineering

Teaching scheme        Examination Scheme
Lecture: - 3h/week      Theory: - 100 Marks

INTRODUCTION
The fluidized state, Nature of hydro dynamic suspension particle-particle forces, species of fluidization, Regimization of the fluidized state, operating models for fluidizations systems, Application of fluidization systems.

HYDRODYNAMICS OF FLUIDIZATION SYSTEMS
General bed behavior pressure drop, Flow regimes, Incipient fluidization, pressure fluctuations, phase holdups, Measurement techniques, Empircial correlations for soilds holdup, liquid holdup and gas holdup, Flow models - generalized wake model, structural wake model and other importatnt models.

SOLIDS MIXING AND SEGREGATION
Phase juxtaposition operation shifts, Reversal points, Degree of segregation, Mixing - segregation equilibrium, Generalized fluidization of poly disperse systems, liquid phase mixing and gas phase mixing.

HEAT AND MASS TRANSFER FLUIDIZATION SYSTEMS
Mass transfer - gas-liquid mass transfer, Liquid solid mass transfer and wall to bed mass transfer. Heat transfer - column wall - to - bed heat transfer, Immersed vertical cylinder-to-bed heat transfer, Immersed horizontal cylinder to-bed heat transfer.

MISCELLANEOUS SYSTEMS
Conical fluidized bed, Moving bed, Slurry bubble columns, Turbulent bed contactor, Two phase and three phase inverse fluidized bed, Draft tube systems, Semi fluidized bed systems, Annular systems, typical applications, Geldart's classification for power assessment, Powder characterization and modeling by bed collapsing.

References:
Each student should perform at least 8 experiments/ assignments from the list given below and submit the journal which will form the term-work for the subject.

1. To study the performance of an ion exchange resin in a packed bed.
2. To study the effect of operating variable in Reverse Osmosis.
3. To study the effect of operating variables in Ultra filtration
5. To determine the effect of specific parameters on the adsorption i.e. temperature and concentration.
6. To Study the Supercritical Extraction
7. Computer Aided Design of Reactive Distillation Column
9. Computer Aided Design of Absorption Column
509107 Seminar I

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<th>Teaching Scheme</th>
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<td>Practical : 4 Hr/Week</td>
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Each student is required to deliver a seminar in first semester on the state of the art of the topic of his/her choice, preferably the topic of his/her dissertation and submit it in form of a short report.
SEMESTER II

509108 Process Modeling and Simulation

Teaching scheme
Lecture: - 3h/week

Examination Scheme
Theory: - 100 Marks

BASIC MODELLING
Introduction to modeling, Application and scope of coverage, Formulation, Review of algebraic equators, Ordinary and partial differential equation. Analytical and numerical techniques, Smoothing techniques, Spline function approximations.

MODELLING OF HEAT, MASS AND MOMENTUM TRANSFER OPERATIONS
Review of heat, mass and momentum transfer operations, Modeling ar exchangers, Evaporators, Absorption columns, Extractors, Distillation columns, Membrane processes.

MODEL DISCRIMINATION AND PARAMETER ESTIMATION
Rate equations, Linear and non-linear regression analysis, Design of experiments, Factorial, Central, fractional design, Evolutionary operation techniques, Case studies.

OPTIMIZATION TECHNIQUES
Function, Analysis and numerical methods for single variable and multivariable system, constrained optimization problems.

APPLICATION OF OPTIMIZATION
Heat transfer and energy conservation, Separation techniques, Fluid flow systems, Chemical Reactor design.

References:
Basic concept and review of classical flow problems using shell balances.

**Review of mathematics:** Scalar, Vectors, Tensors, divergence, relation between rectangular coordinates and cylindrical coordinates, relation between rectangular coordinates and spherical coordinates, partial derivative, substantial derivative, total derivative, line integral, surface integral, integral theorems, frame of reference (Eularian and Lagrangian).

**The equations of change for isothermal flow:** Equations of continuity, equation of motion, the equation of mechanical energy, application of Navier-Stokes equation to solve problems, the equations of change for incompressible non-Newtonian fluids.

**The equations of change for non-isothermal flow:** Equations of energy, the energy equation in curvilinear coordinates, use of equations of change to set up steady state heat transfer for problems.

**The equations of change for multi component systems:** The equations of continuity for a binary mixture, the equation of continuity of A in curvilinear coordinates, the multicomponent equations of change in terms of the flows, the multi component fluxes in terms of the transport properties, use of equations of change to setup diffusion problems.

Velocity, temperature and concentration distributions with more than one independent variables, unsteady flow, stream function, potential flow, boundary layer theory, steady state two dimensional flow for momentum, heat and mass.

**Turbulent flow:** Introduction, fluctuations and time smoothened equations for velocity, temperature and concentration, time smoothing of equation of change, equation of energy, equation of continuity of A, Reynolds stresses.

**Dimensional Analysis:** Introduction, momentum, heat and mass transfer.

**References**
Brief review of – dynamic behavior of processes, single-loop feedback control systems, stability analysis and design of feedback control systems, Process identification

Multiloop control systems (cascade, selective, split- range), PID enhancements (feed-forward, ratio, adaptive, inferential, anti-reset windup, auto-tuning, gain scheduling)

**Multivariable Control Systems:**
MIMO control systems, input-output pairing, loop interaction, controllability and observability, transfer function model, open-loop dynamic analysis in state-space, transient response, stability analysis, synthesis of alternative control configurations, RGA analysis and loop pairing, design of non-interacting control loops, centralized MVC systems.

**Advanced Process Control Systems:**
Introduction to model-based control (MBC), real-time optimization, MPC, IMC base PID, statistical process control, batch process control, state estimation, robust controller design, distributed parameter controllers.

**Plant wide Control Systems:**
Issues, internal feedback of material and energy, interaction of plant design and control system design, design of plant wide control systems, effect of control structure on closed-loop performance, use of APC soft wares for plant wide control..

ANN and Fuzzy logic Control Systems (FLC), need, classification, design, development, estimator, multilevel control systems, , fuzzy logic tuned set-point weight PID controller, FLC of semi batch reactors and bioreactors.

**References:**
Elective III
509111 Catalysis And Surface Phenomenon

Teaching scheme
Lecture: - 3h/week

Examination Scheme
Theory: - 100 Marks

Introduction of Catalysis
Classification of Catalysis - Homogeneous, Heterogeneous, Biocatalysts, Preparation of catalysis
- Laboratory Techniques, Industrial methods, Transition models, Dual functional catalysts,
Zeolites, Enzymes, Solid Catalysts, Powder Catalysts, Pellets, Composition, Active ingredients,
Supportive materials, Catalysts activation.

Catalysts Characterization
Surface area measurements, BET Theory, Pore size distribution, Porosimetry Chemisorption
techniques, Static and dynamic methods, Crystallography and surface analysis techniques, XRD,
XPS, ESCA, ESR, NMR, Raman and Masbauar spectroscopies, Surface acidity and toxicity,
Activity, Life time, Bulk density, Thermal stability etc.

Theories of Catalysts
Crystal structure and its defects, Geometric and electronic factors, Analysis of transition model
catalysis, Chemistry and thermodynamics of adsorption, Adsorption isotherms - Langmuir
model, Tempkin model, Freundich model, Elovich equation, Langmiur Hinshelwood model,
Rideal - Eely mechanism, Reversible - irreversible mono and bimolecular reactions with and
without inerts, Determination of rate controlling steps, Inhibition, parameter estimation.

Mass and Heat Transport in Porous Catalysts
Internal and external transport, fixed bed, Fluidized bed reactors, Effect of internal transport on
selectivity. Effectiveness factor and Thiele modulus.

Catalyst Deactivation
Poisons, sintering of catalysts, Pore mouth plugging and uniform poisoning models, Kinetics of
deactivation, Catalyst regeneration.

Industrial Catalysis
Industrial catalysts preparation methods, Typical industrial catalytic processes, Case studies,
Catalytic deactivation prevention methods, New techniques for catalyst characterization, Overall
study.

References:
1967.
Elective III
509111  Advanced Reaction Engineering

Teaching scheme            Examination Scheme
Lecture: - 3h/week                       Theory: - 100 Marks

Kinetics Of Heterogeneous Reactions

Population Balance Models

External Diffusion Effects In Heterogeneous Reactions
Mass and heat Transfer coefficients in packed beds, Quantitative treatment of external transport effects, Modelling diffusion with and without reaction.

Internal Transport Processes In Porous Catalysts
Intrapellet mass and heat transfer, Evaluation of effectiveness factor, mass and heat transfer with reaction.

Design Of Heterogeneous Catalytic Reactors
Isothermal and adiabatic fixed bed reactors, Non-isothermal and non-adiabatic fixed bed reactors.

Introduction to multiphase reactor design, Two phase fluidized bed model, slurry reactor model, Trickle bed reactor model.

References:
Elective III

509111 Mathematical Methods In Chemical Engineering

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**Tensors, Matrices** and Their Applications, Tensor Algebra and Elements of Tensor Calculus, Numerical Linear Algebra: Solution of Systems of Linear and Nonlinear Algebraic Equations and the Algebraic Eigenvalue Problem

**Advanced Topics in ODEs:** General Results for Systems of Linear First Order ODEs, Phase Portraits of multi-dimensional Linear Systems, Nonlinear Systems, Elementary Stability and Bifurcation Analysis, Green’s Function, Series Solutions and Special Functions, Orthogonal Polynomials, Differential Eigenvalue Problems, Sturm-Liouville Problems

**PDEs:** Classification and General Results including the Maximum Principle, Detailed discussion of Laplace’s, Wave and Diffusion Equations (class notes and handouts); Boundary Conditions; External vs. Internal Problems; Finite, Semi-Infinite and Infinite Spatial Domains; Solution in Different Coordinate Systems

**Analytical Methods for Partial Differential Equations:** PDEs arising from models for Reaction-Diffusion-Convection Phenomena, Instability and Pattern Formation in Systems Governed by PDEs.

**Numerical Solution to ODEs and PDEs:** Finite Difference Method, Method of Weighted Residuals, Pseudo-Spectral Methods, Introduction to Finite Element Method and Femlab

**Perturbation Methods:** Regular and Singular Perturbation, Method of Multiple Scales, Homogenization
Introduction to Lattice Methods, Stochastic Simulation Techniques

References:

3.
Advance Enzyme Kinetics: Models for complex enzyme kinetics, modeling of effect of pH and temperature, models for insoluble substrate, models for immobilized enzyme systems, diffusion limitations in immobilized enzyme system, electrostatic and steric effects.

How cell work- the central dogma, DNA replications, sending the messages, genetic code, translation, posttranslational processing, sensing of extra cellular environment, role of cell receptors.

Major metabolic pathways, bioenergetics, Glucose metabolism, metabolism of nitrogenous compounds, respiration, metabolism of hydrocarbons, anaerobic metabolism, autotrophic metabolism.

Bioreactors: modifications of batch and continuous reactors, chemostat with recycle, multistage chemostat, fed-batch operation, perfusion system, active and passive immobilization of cells, diffusional limitations in the immobilized system, solid state fomenters.


Biological waste water treatment: microbial participation in natural cycle of matter, activated sludge process, design and modeling of activated sludge process, Nitrification, anaerobic digestion, mathematical modeling of anaerobic digester, anaerobic denitrification, phosphate removal.

References
2) Bioprocess Engineering Principles – P. M. Doran – Academic Press
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<tr>
<td>Lecture: - 3h/week</td>
<td>Theory: - 100 Marks</td>
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509113 Lab Practice II

Teaching Scheme
Practical: 6 Hrs/Week

Examination Scheme
T.W. : 50 marks

Each student should perform at least 8 experiments/ assignments from the list given below and submit the journal which will form the term-work for the subject

1. Stability analysis using Bode diagrams for control systems.
2. Simulation of Non Isothermal CSTR.
3. Simulation of Batch Reactor.
8. Computer Aided Process design of simple reactors (CSTR, Tubular) with or without heat transfer.
12. Steady state flow sheeting of Processes with recycles /Purge/Bypass etc.
13. Study of dynamic behavior of simple systems such as tank in series, double effect evaporators, etc.
14. Study of coupling of manipulated and controlled variables using relative gain analysis (RTA).
15. Dynamic simulation of Simple process systems with controllers.
17. Controller Tuning of Multiple Input-Multiple output system.
18. To determine Close Loop Time Constant for Distillation Column Control.
509114 Seminar II

Teaching Scheme  Examination Scheme
Practical : 4 Hr/Week  T.W. : 50 marks

Each student is required to deliver a seminar in first semester on the state of the art of the topic of his/her choice, preferably the topic of his/her dissertation and submit it in form of a short report.

609101 Seminar III (Based on Project)

Teaching Scheme  Examination Scheme
Practical : 4 Hr/Week  T.W. : 50 marks

Each student is required to deliver a seminar in third semester on the state of the art of the topic of his/her choice, preferably the topic of his/her dissertation and submit it in form of a short report.

609102 Project Stage I

Teaching Scheme  Examination Scheme
Practicals: 18 Hrs/Week  

Students are required to prepare a report based on project of their choice.

609103 : Project Stage II

Teaching Scheme  Examination Scheme
Practical : 18 Hrs/Week  T.W.:50marks / Project 200 Marks

Students are required to prepare report on project of their choice. They are required to submit project report and appear for the oral examination.