B.Tech. Programs:
- Chemical Engineering
- Civil Engineering
- Computer Science and Engineering
- Electrical and Electronics Engineering
- Electronics and Communication Engineering
- Information Technology
- Mechanical Engineering

Pharmacy Programs:
- B.Pharmacy
- Pharma-D
- Pharma-D (Post Baccalaureate)
- M.Pharm (Pharmaceutics)
- M.Pharm (Pharmacology)
- M.Pharm (Pharmaceutical Analysis & Quality Assurance)
- M.Pharm (Industrial Pharmacy)

M.Tech. Programs:
- M.Tech (Computer Science and Engineering)
- M.Tech (Software Engineering)
- M.Tech (Computer Science)
- M.Tech (Computer Networks & Information Security)
- M.Tech (Power Electronics & Electrical Drives)
- M.Tech (Electrical Power Systems)
- M.Tech (CAD/CAM)
- M.Tech (Machine Design)
- M.Tech (VLSI System Design)
- M.Tech (Embedded Systems)
- M.Tech (Electronics & Communications Engineering)
- M.Tech (Wireless & Mobile Communication)
- M.Tech (Structural Engineering)
- M.Tech (Construction Management)

For B.Tech Four Year Degree Course
(Applicable for the batches admitted from 2012-2013)
COURSE STRUCTURE AND DETAILED SYLLABUS

CHEMICAL ENGINEERING

FOR

B.TECH FOUR YEAR DEGREE COURSE
(Applicable for the batches admitted from 2012-2013)

ANURAG GROUP OF INSTITUTIONS
(AUTONOMOUS)
(Formerly CVSR College of Engineering)
Venkatapur, Ghatkesar, Hyderabad – 500 088.
www.cvsr.ac.in
# IV YEAR I SEMESTER

<table>
<thead>
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## IV YEAR II SEMESTER

### COURSE STRUCTURE

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Note: All End Examinations (Theory and Practical) are of three hours duration.

**T – Tutorial**   **P – Practical**   **D – Drawing**
IV Year B.Tech. CHEM – I Sem

Transport Phenomena

Course Objective:
- Provides fundamentals for momentum, heat & and to study analogy between momentum, heat and mass transfer & design of heat, mass and momentum transfer equipments
- With deeper knowledge in mathematics and numerical methods, solve the equations analytically or numerically
- To be able to analyze various transport processes with understanding of solution approximation methods and their limitations

UNIT I:

Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity (Molecular momentum transport), generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density, molecular theory of viscosity of liquids.

Thermal conductivity and the mechanisms of energy transport: Fourier's law of heat conduction (molecular energy transport), pressure and temperature dependence of thermal conductivity, and theory of thermal conductivity of gases at low density.

UNIT II:

Diffusivity and mechanisms of mass transport: Fick's law of binary diffusion (molecular mass transport), temperature and pressure dependence of diffusivities, theory of diffusion in gases at low density.

Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.
UNIT III:
Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection and free convection.
Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction.

UNIT IV:
Diffusion with homogeneous chemical reaction, diffusion into falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution), diffusion and chemical reaction inside a porous catalyst.
The equation of change for isothermal systems: the equation of continuity, the equation of motion, the equation of mechanical energy, the equation of angular momentum. The equation of change in terms of the substantial derivative, use of equation of change to solve flow problems.

UNIT V:
Velocity distributions in turbulent flow: comparison of laminar and turbulent flows, time-smoothed equations of change for compressible fluids, time-smoothed velocity profile near a wall and Reynolds stresses.
The equations of change for non-isothermal systems: the energy equation, special forms of energy equation, the Boussinesq's equation of motion for forced and free convection, use of the equations of change to solve steady state problems.
Course Outcome: student will

- Have the ability to understand the chemical and physical transport processes and their mechanism.
- Have the ability to do heat, mass and momentum transfer analysis.
- Have the ability to analyze industrial problems along with appropriate approximations and boundary Conditions.
- Demonstrate the ability to engineer cost effective solution to control or monitor the chemical process
TEXT BOOK:

REFERENCES:
ANURAG GROUP OF INSTITUTIONS
(Autonomous)

IV Year B.Tech. CHEM – I Sem

L T/P C
4 1/– 4

Process Dynamics and Control

Course Objectives

• To represent dynamic systems by equations and by transfer functions in block diagrams and to obtain transient response to disturbances like step, impulse, ramp and sinusoidal forcing function.
• To estimate the stability limits for a system, with or without control and to calculate and use the frequency response of a system
• To analyze, design and tune feedback / feedforward, cascade and model based controllers in the context of various control strategies used to control chemical processes.
• Develop the ability to use computer software to help describe and design control systems and apply this knowledge in the laboratory.

UNIT 1:

UNIT 2:
Higher order systems: Second order system- Transient response of under damped, critically damped, over damped systems to step, impulse and sinusoidal forcing functions. Transporation lag. The Control System: Components of a control system, Negative and Positive feed back control systems, Servo and Regulatory control problems, Development of Block diagram, Controllers and final control elements. Reduction of physical control systems to block diagrams: Block diagram of a chemical reactor control system. Closed loop Transfer function. Overall Transfer functions for single loop control systems. Overall Transfer functions for multi loop control systems. Transient response of simple control systems.
UNIT 3:
Locus: concept of root locus, plotting of the root locus diagram for feedback
control systems. Transient response from root locus. Application of root locus
to control systems.

UNIT 4:
Introduction to frequency response: Bode diagrams for first order, first order
system in series, second order systems and for controllers and transportation
lag. Bode stability criterion. Gain margin and phase margin. Control system
design by frequency response. Nyquist Plots. Nyquist stability criteria.

UNIT 5:
Advanced control strategies: Cascade Control. Feed Forward Control. Ratio
Control. Smith Predictor. Dead time compensation. Internal Model Control.
Controller tuning and Process Identification: ISE, ITAE, IAE, Ziegler –
Nicholas and Cohen-Coon tuning methods, process identification by step,
frequency and pulse testing. Control Valves: Construction sizing,
Characteristics and valve Positioner.

Course Outcomes
A student will:
• Understand and discuss the importance of process control in process
operation and the role of process control engineers.
• Understand the operation of modern microprocessor-based controllers.
• Use process simulators for studying process dynamics and design basic
control strategies.
• Understand the impact of process control on society.

Text Book:
1. Process System Analysis and Control, 3rd Ed., D.R. Coughanowr and

References:
1. Chemical Process Control, G.Stephanopoulos, PHI learning Pvt Ltd., New
   Delhi, 2010.
2. Outlines of Chemical Instrumentation and Process Control, 3rd Ed., A.
3. Process Control, B.Wayne Bequette, PHI learning Pvt Ltd., New Delhi,
   2003.
Chemical Process Equipment Design

Course Objective:
The objective of this course is to acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. internal and external pressure vessels, tall vessels, high pressure vessels, supports etc.), and different types of equipment testing methods.

UNIT I:
Introduction to design
Introduction; development of flow and block diagrams from process description, Piping and instrumentation diagram, material and energy balance, sizing of equipment, design preliminaries, design codes, Material of construction selection procedure, fabrication methods and testing methods, selection for gas, liquid and solid processes.

UNIT II:
Mechanical design of process equipment
Fundamentals principles and equations, General Design considerations of pressure vessels, Design of thin walled vessels under internal and external pressure, compensation for opening and braches, Design vessels subjected to combined loading, theories of failure, design of flange joints and supports, design of high pressure vessels, design of storage vessels for volatile and non volatile liquids.

UNIT III:
Design of shell and tube heat exchangers
Basic procedure and theory, Overall heat transfer coefficient, fouling factors, Shell and tube exchanger construction details, mean temperature difference, General design considerations of shell and tube exchanger, tube side heat transfer coefficient and pressure drop, shell side heat transfer and pressure drop.
UNIT IV:
Design of separation columns (Distillation, Absorption & extraction)
Continuous distillation basic principles and process description, Design variables in distillation column, Design methods for binary systems, plate efficiency, plate contractors, plate hydraulic design, packed columns.

UNIT V:
Design of reactor, evaporator
Introduction, material of construction, Agitation, classification of reactor vessels, reactor selection, Design considerations, Types of evaporators, Design considerations of evaporator, Optimum pipe diameter.

Course outcomes:
• Knowledge of basics of process equipment design and important parameters of equipment design
• Ability to design internal pressure vessels and external pressure vessels, special vessels (e.g. tall vessels) and various parts of vessels (e.g. heads) including various unit operation equipments
• Ability to draw process flow diagrams using symbols
• Knowledge of equipment fabrication and testing methods

TEXT BOOK:

REFERENCES:
ANURAG GROUP OF INSTITUTIONS  
(Autonomous)

IV Year B.Tech. CHEM – I Sem  
L T/P C  
3 1/- 3

Biochemical Engineering

Course objective:  
To enhance skills in the areas of biochemical processes, to provide the fundamental background of biological systems, bio-chemical engineering, Immobilized Enzyme Technology, and down stream processing.

UNIT 1:  
Introduction to microbiology: Biophysics and the cell doctrine, the structure of the cells, important cell types, from nucleotides to RNA and DNA, amino acids into proteins. Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action. Simple enzyme kinetics with one and two substrates, other patterns of substrate concentration dependence, modulation and regulation of enzyme activity. Other influences on enzyme activity.

UNIT 2:  

UNIT 3:  

UNIT 4:  
Design and analysis of biological reactors: Batch reactors, fed batch reactors, enzyme catalyzed reactions in CSTR, CSTR reactors with recycle and wall growth, Ideal plug Flow reactors, Sterilization reactors, sterilization of gases, packed bed reactors using immobilized catalyst. Fermentation technology: Media formulation, design and operation of typical aseptic, aerobic
fermentation process. Transport phenomena in bioprocess system: gas liquid mass transfer in cellular systems, determination of oxygen transfer rates, Overall KL a estimates and power requirements for sparged and agitated vessels, Scaling of mass Transfer equipments, Heat Transfer.

UNIT 5:
Down stream Processing: Strategies to recover and purify products; Separation of insoluble product-Filtration and centrifugation; Cell Disrution-Mechanical and Non-Mechanical methods; Separation of Soluble products: Liquid-liquid Extractions, Membrane separation (Dialysis, Ultrafiltration and reverse osmosis); Chromatographic separation-Gelpermeation Chromatography, Electrophoresis, final steps in purification-Crystallization and drying.

COURSE OUTCOMES:
• Student can apply the application of chemical engineering principles in biochemical systems.
• Student will Understand the difference between bioprocesses and chemical processes
• Student will be able to understand the biological systems and kinetics of enzymatic reactions.
• Student will be able to design equipments for handing biological processes.
• Student will Understand Operations utilized in the purification of biological products enable them to recommend, install and easily learn to operate the equipment
• Student learn about Heat & mass transfer considerations and scale up of bioprocesses

Text books:

References:
ANURAG GROUP OF INSTITUTIONS
(Autonomous)

IV Year B.Tech. CHEM – I Sem

L T/P C
3 1/- 3

Industrial Safety and Hazard Management

Course Objective:
This course will provide effective use of chemical industries utilities. This course also emphasis on the knowledge of loss prevention, personal safety, industrial safety, hazard analysis, toxicology and personal proactive equipments

Unit I:
Introduction:
Safety program, Engineering ethics, Accident and loss statistics, Acceptable risk, Public perception, Toxicology: How toxicants enter biological organisms, How toxicants are eliminated from biological organisms.

Unit II
Industrial Hygiene:

Unit III
Fires and Explosions:
The fire triangle, Distinction between fire and explosions: Definitions, Flammability characteristics of liquids and vapors, MOC and inerting, ignition energy, Auto ignition, Auto oxidation, Adiabatic compression, Explosions.

Designs to Prevent fires and Explosions:
Inerting, Explosion proof equipment and instruments, Ventilations, Sprinkler systems.
Hazards Identification: Process hazards checklists, Hazard surveys, Hazop safety reviews.

Unit IV
Introduction to Reliefs: Relief concepts: Definitions, Location of reliefs, Relief types, Data for sizing reliefs, Relief systems
**Relief Sizing:** Conventional spring operated relief's in liquids, Conventional spring operated relief's in vapor or gas service, Rupture disc relief's in liquid, vapor or gas service.

**Unit V**

**Chemical Process Safety:** Introduction, Chemical process in Hazardous operations, chemical reactors, Reaction Hazards, Operational Deviations and Technical Report.


**Course Outcomes:**
- Understanding of Safety principles.
- Ability to do Hazard analysis.
- Identify and take preventive measure of industrial hazards and accidents.
- Know and acquire knowledge of accident investigation and statistical analysis of accidents

**TEXT BOOK:**

**REFERENCES:**
ANURAG GROUP OF INSTITUTIONS
(Autonomous)

IV Year B.Tech. CHEM – I Sem

L T/P C
3 1/- 3

Design and Analysis of Experiments
Elective - 3

COURSE OBJECTIVES
1. To learn the DAE in chemical engineering.
2. To identify different factors or levels for the laboratory experiments.
3. To analyze the factors.
4. To fit regression line models for the chemical experiment.

UNIT I:
Introduction to Testing of Hypothesis [Definitions and Concepts/Theory only of Null Hypothesis & Alternative Hypothesis, tail test no problems].
Introduction to Design of Experiment: Principles of an Experimental Design [Randomness, Replication and Local Control].
Design Terminology [Block, Degree of freedom, Confounding, Design, Effect, factor space, factor, Main effect, Interaction, Level].
Review of ANOVA [Basic assumptions, Concepts of ANOVA tables for one-way and two-way with problems]

UNIT II:
Factorial Experiment: [Definition and Concepts/Theory of Factor Effect, Fixed, Random Mixed Factor Effect].
Only Concepts/Theory of [Completely Randomized Design, RBD and LSD Recollection, Graeco-Latin Squares no problems].

UNIT III:
Factorial design; Concept/Theory of analysis of 2k factorial designs.
Analysis of 22, 23 and 24factorial design [Concept of ANOVA table Problems].
Confounding in Factorial Designs, confounding in 23 and 24 factorial design.

UNIT IV:
Concept/Theory of Analysis of 3k factorial design.
Analysis of 32 and 33 factorial design [Concept of ANOVA table Problems].
Confounding in 33 factorial design.
Introduction to Balanced Incomplete Block Design. Analysis of Balanced
Incomplete Block design BIBD [Concept of ANOVA table Problems].

UNIT V:
Regression analysis-[Simple Linear Regression, Interval Estimation in Simple Linear Regression, Analysis of Variance of Simple Linear Regression, Lack of Fit of the Simple Linear Regression. Multiple Regression, Polynomial Regression, Nonlinear Regression with Problems].

Correlation [Definitions and Correlation in Linear and Multiple Regression].

COURSE OUTCOMES:
• Able to relate statistics concepts for analyzing data from experiments.
• Student will be able to identify advantages of factorial methods over BGA, OFAT.
• Student will be able to apply Factorial experiments to chemical engineering experiments.
• Student will be able to apply linear regression models for real time experiments.

TEXT BOOK:
Design of Experiments for Engineers and Scientists, Jiju Antony, Elsevier.

REFERENCES:
4. Experimental Design and Data Analysis for Biologists, Gerry P. Quinn and Michael J. Keough, Cambridge University Press.
ANURAG GROUP OF INSTITUTIONS
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IV Year B.Tech. CHEM – I Sem

Petroleum and Petro Chemical Technology
Elective – 3

L T/P C
3 1/- 3

Course Objectives:
Studying this subject the students will learn about the extraction and production of oil and gas to meet energy needs, as well as refining of crude oil for a wide spectrum of useful products such as petrochemicals, Chemicals, Plastics.

UNIT I:
Origin formation and composition of petroleum: Origin and formation petroleum, Reserves and deposits of world, Indian petroleum Industry. Petrochemical industry- feedstock.

UNIT-II:
Petroleum Processing data: Evaluation of petroleum, Thermal properties of petroleum Fractions, important products properties and test methods. Fractionation of Petroleum: Dehydration and desalting of crudes, heating of crude pipes still heaters, distillation of petroleum, blending of gasoline.

UNIT III:

UNIT IV:

UNIT V:
Chemicals from Ethane-Ethylene –Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, Vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene Manufacture, Acetaldehyde from Acetylene.
Course Outcomes:
- Introduction with the petroleum refinery worldwide.
- Develop knowledge of different refining processes.
- Treatment techniques of chemical from petroleum.
- To get acquainted with technologies used for manufacturing petroleum products at commercial scale.

TEXT BOOKS:

REFERENCES:
Environmental Biotechnology
Elective – 3

COURSE OBJECTIVE:
This course focuses on fundamentals of molecular biology and biotechnology for environmental applications. The major topics include activated sludge processes, stoichiometry, bioenergetics, anaerobic digestion, biological nitrogen and phosphorus removal, molecular microbiology tools, biofouling, antibiotic resistance, and biofuels.

UNIT I
Environmental Monitoring: Sampling: physical chemical and biological analysis, recombinant DNA technology, determination of biodegradable organic material, monitoring pollution, bio indicators, biomarkers, toxicity testing using biological material, biosensors.
Natural resources recovery: oil recovery, recovery of metals.

UNIT II
Biological Sewage Treatment: pollution caused by biodegradable material, function of waste water treatment system, sewage treatment methods, modifications to existing processes, removal of nitrogen and phosphorous, sludge treatment and disposal, anaerobic digestion agricultural waste and industrial waste.

UNIT III
Bioremediation: synthetic compounds, petrochemical compounds, Inorganic wastes, bioremediation strategies, bioremediations techniques in situ and ex situ, Phytoremediation, metals and gaseous bioremediation, biochemical pathways of biodegradation.
Agricultural biotechnology: detection and diagnostics, micro propagation, somatic cell genetics, production and transgenic plants, safety and transgenic crops, transgenic plants and animals, disease control, germplasm and biodiversity.
UNIT IV
Biotechnology and sustainable technology:
Provision of bulk and fine chemicals, microbial polymers and plastics, Industrial processes and clean technology.
Biotechnology of the marine environment: pharmaceuticals, molecular biology products, polymers, enzymes and transgenic organisms, micro-algae and marine population.

UNIT V

COURSE OUTCOMES:
1. Describe the role of microorganisms in processes such as biofilm formation, biocorrosion, mineral leaching, composting, clean drinking water
2. Explain how environmental conditions can be manipulated to enhance or retard the above processes
3. Summarize the significance of the biorefinery concept and explain how plant biomass can be converted to fermentable substrates and subsequently microbially transformed into biochemicals, biopolymers and biofuels
4. Critically analyze relevant journal articles and investigate industrial application of the above concepts

TEXT BOOK:
Environmental Biotechnology, A. Scraag, Oxford university press, New Delhi, 2005
Process Dynamics and Control Lab

COURSE OBJECTIVE:

- To obtain transient response to disturbances like step, impulse, ramp and sinusoidal forcing function.
- To analyze stability and performance of feedback loops using Laplace and frequency domain techniques.
- To determine experimentally the methods of controlling the processes including measurement using process simulation techniques.
- Students perform computer-simulation-based design projects as well as laboratory experiments to relate the learned mathematical concepts to real world processes and also to learn team-based problem solving.

(At least ten experiments from the following syllabus should be performed)

1. Calibration and determination of the time lag of various first order instruments. 
   Major equipment: First order equipment like Mercury-in-Glass thermometer.

2. Calibration and determination of the time lag of various second order instruments. 
   Major equipment: Second order equipment like Mercury-in-Glass thermometer with Thermal well.

3. Experiments with single and two capacity systems without interaction. 
   Major equipment: Single tank system, two tank systems

4. Experiments with single and two capacity systems with interaction. 
   Major equipment: Single tank system, two tank systems

5. Estimation of damping coefficient for U-tube manometer. 
   Major equipment: U-tube manometer.

   Major equipment: Level control trainer setup with computer.
7. Temperature Control Trainer.
   Major equipment: Temperature control trainer setup with computer

8. Pressure Control Trainer.
   Major equipment: Pressure control trainer setup with computer.

   Major equipment: Cascade control apparatus with computer

10. Experiments on proportional, reset, rate mode of control etc.
    Major equipment: PID control Apparatus.

11. Control valve Characteristics
    Major equipment: Control valve setup.

**COURSE OUTCOMES: students will**
- Understand and be able to describe quantitatively the dynamic behavior of process systems
- Develop the ability to use computer software to help describe and design control systems.
- Design and tune feedback controllers on real systems as well as simulated systems
- Have knowledge on the development and use of right type of control dynamics for process control under different operative conditions.
Simulation Lab

COURSE OBJECTIVES

- Understanding Basic Simulation techniques using Common Mathematical Principles.
- Implementation of Force balance equations for transportation of fluids in closed pipes using C/C++ simulink with MATLAB.
- Implementation of Total continuity, Component continuity, Energy balance equations for common unit operations like Heat transfer equipment, Reactors, Tanks in series using C/C++ simulink with MATLAB.
- Understanding P, V, T behavior of Binary system using thermodynamic principles.

(At least Ten experiments from the following syllabus should be performed)

1. Simulate the non-interaction system response for a step change

2. Simulate the interaction system response for a step change

3. Simulate velocity and height of the tank at various intervals for Gravity Flow Tank.

4. Simulate the Shell and tube exchanger for various case studies.

5. Simulate Batch Reactor for Concentration at various time intervals.

6. Simulate Plug Flow Reactor for Concentration at various time intervals.

7. Simulate Distillation Column for Binary Mixtures.

8. Write a program to evaluate bubble point temperature and vapor composition
9. Write a program to evaluate liquid composition and dew point temperature

10. Simulate three CSTR’S connected in series for concentration at various time intervals - Open loop.

11. Simulate three CSTR’S connected in series for concentration at various time intervals – Closed loop.

12. Simulate non-isothermal CSTR to find concentration, temperature, of reactor contents along with cooling jacket temperature and flow rate at various time intervals.

**COURSE OUTCOMES**

- Student will be able perform Basic Simulation techniques using Common Mathematical Principles.
- Student will be able to apply of Force balance equations for transportation of fluids in closed pipes using C/C++ simulink.
- Student will be able to apply Total continuity, Component continuity, Energy balance equations for common unit operations like Heat transfer equipment, Reactors, Tanks in series using C/C++.
- Student will perform analysis of P, V, T behavior of Binary system using thermodynamic principles.
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IV Year B.Tech. CHEM – II Sem

L T/P C
3 1/- 3

Industrial Pollution Control Engineering

Course Objective:
The aim of this course is that the students will learn the essential principles used in industrial pollution in chemical industries and understand important issues in industrial pollution and pertinent environmental legislations.

UNIT I:

UNIT II:
General methods of control and removal of S02, Oxides of nitrogen and organic vapors from gaseous effluent.
Air pollution sampling and measurement: Types of pollutant and sampling and measurement, ambient air sampling, collection of gaseous air pollutants. Collection of particulate air pollutants. Stack sampling: sampling system, particulate sampling and gaseous sampling. Analysis of air pollutants: sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and Ozones, hydrocarbons, particulate matter.

UNIT III:
Air pollution control methods and equipments: Source collection methods, raw material changes, equipment modification. Cleaning of gaseous equipments particulate emission control: collection efficiency, control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their construtional details and design. Scrubbers: wet scrubbers, Spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects. Control of gaseous emissions: Absorption by liquids and solids, absorption equipment and their design aspects.
UNIT IV:

UNIT V:
Hazardous Waste Management: Nuclear Wastes: health and environment effects, Sources and disposal methods. Chemical waste: health and environment effects. Treatment and disposal: Treatment and disposal by industry, off site treatment and disposal, treatment practices in various countries. Biomedical Wastes: Types of wastes and their control.

COURSE OUTCOMES:
1. Student will know about the different types of wastes generated in an industry, their effects on living and non-living things.
2. Student will learn about environmental regulatory legislations and standards and climate changes.
3. Student will able to understand the different unit operations and unit processes involved in conversion of highly polluted water to potable standards.
4. Student can analyze and quantify hazardous and nonhazardous solid waste wastes, treatment and disposal.

TEXT BOOKS:

REFERENCES:
ANURAG GROUP OF INSTITUTIONS
(Autonomous)

IV Year B.Tech. CHEM – II Sem

Plant Design and Economics

COURSE OBJECTIVE:
The objective of this course is to teach principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.

UNIT I:
Introduction, Process design development, General design considerations, cost and asset accounting. In detail case study for nitric acid and sodium dodecylbenzene sulfonate. Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment.

UNIT II:
Organization for presenting capital investments, estimates by compartmentalization, estimation of total product cost direction, Production costs, fixed charges, plant over head costs, financing.

UNIT III:
Interest and investment cost, types of interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due to interest on investment, source of capital, Taxes and insurances, type of taxes: Federal income taxes, insurance-types of insurances, Self insurance. Depreciation: types of Depreciation, service life, salvage value, Present value, Methods for determining depreciation, single unit and group depreciation.

UNIT– IV:
Profitability: Alternative investments and Replacements, profitability standards, Discounted cash flow, Capitalized cost, payout period, Alternative investments, analysis with small investments, increments and replacements.
UNIT V:
Optimum design and Design strategy, incremental cost, general procedure for determining optimum condition, comparison of graphical and analytical methods, optimum production rates, semi continuous cyclic operation, fluid dynamics, mass transfer strategy of linearization.

COURSE OUTCOMES:
1. Learn basics of Cost estimation, Working Capital and Capital Investment \ and understand the \ time value of money
2. Study depreciation methods and learn tax calculation methods
3. Learn the methods of estimation of profitability of an industry
4. Study the procedures adopted for Replacement and Selection from Alternatives.
5. Learn the importance of Cash flow diagrams and Break-even analysis.
6. Study the types of reports and inculcate Report writing skills along with its organization.

TEXT BOOKS:

REFERENCES:
ANURAG GROUP OF INSTITUTIONS  
(Autonomous)

IV Year B.Tech. CHEM – II Sem  
L T/P C
3 1/- 3

Optimization of Chemical Processes (Theory)  
Elective – 4

COURSE OBJECTIVE:
• To provide students to understanding of different optimization techniques  
  like linear programming, genetic algorithm and different search techniques  
  and apply it in the design of process.
• To apply the optimization techniques to design heat transfer equipment,  
  mass transfer equipment, reactor, bio reactor and fluid mechanics.

Unit-I:
Nature and organization of optimization problems: what optimization is all  
about, why optimize, scope and hierarchy of optimization, examples and  
applications of optimization, the essential features of optimization problems,  
general procedure for solving optimization problems, obstacles of  
optimization, classification of models, how to build a model, fitting functions  
to empirical data, the method of least squares, factorial experimental design,  
fitting a model to data subject to constraints.

Unit-II:
Basic concepts of optimization: Continuity of functions, unimodal versus  
multimodal functions, convex and concave functions, convex region,  
necessary and sufficient conditions for an extremum of an unconstrained  
function, interpretation of the objective function in terms of its quadratic  
approximation.

Optimization of unconstrained functions: one-dimensional search:  
Numerical methods for optimizing a function of one variable, scanning and  
bracketing procedures, Newton's, Quasi-Newton's and Secant methods of uni- 
dimensional search, region elimination methods, polynomial approximation  
methods, how the one-dimensional search is applied in multi-dimensional  
problem, evaluation of uni-dimensional search methods.

Unit-III:
Unconstrained Multivariable Optimization: direct methods, random  
search, grid search, univariate search, simplex method, conjugate search  
directions, Powell's method, indirect methods-first order, gradient method,  
conjugate method, indirect method-second order-Newton's method forcing the
Hessain matrix to be positive definite, Movement in the search directions, termination, summary of Newton's method, relation between conjugate gradient and Quasi-Newton method.

Unit-IV:

Linear Programming And Applications: Basic concepts in linear programming, Degenerate LP's-graphical solution, natural occurrence of linear constraints, the simplex method of solving linear programming problems, standard LP form, obtaining a first feasible solution, the revised simplex method, sensitivity analysis, duality in linear programming, the Karmarkar algorithm, LP applications.

Genetic Algorithms: (Qualitative treatment) Working principles, differences between GAs and traditional methods, similarities between GAs and traditional methods, GAs for constrained optimization, other GA operators, real coded GAs, Advanced GAs.

Unit-V:

Optimization of unit operations-1: recovery of waste heat, shell and tube heat exchanger, evaporator design, liquid-liquid extraction process, optimal design of staged distillation column.

Optimization of unit operations-2: Optimal pipe diameter, optimal residence time for maximum yield in an isothermal batch reactor, chemostat, optimization of thermal cracker using linear programming.

COURSE OUTCOMES:

• Translate a verbal description of the chemical engineering problem into mathematical description
• Formulate unconstrained or constrained objective functions of chemical engineering problems
• To gain exposure to application of optimization techniques in case of various petrochemical processes.
• Understand how the problem formulation influences its solvability, Solve the optimization problem, Interpret the results of optimization and present the insights.

TEXT BOOKS:

ANURAG GROUP OF INSTITUTIONS
(Autonomous)

IV Year B.Tech. CHEM – II Sem  L T/P  C
3  1/-  3

Polymer Technology
Elective – 4

COURSE OBJECTIVE:
To enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers.

UNIT-I
Introduction: definitions: Polymer & macro molecule, monomer, functionally, average functionally, co-polymer, polymer blend, plastic and resin's classification of polymers: based on resource, structure, applications thermal behavior, mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index, determination of average molecular weights: End group analysis, Osmometry, light scattering techniques, viscometer, Gel permeation chromatography

UNIT-II
Natural polymers: brief study of
• Natural rubber
• Shellac
• Rosin
• Cellulose
• Proteins
Degradation of polymers, Role of the following additives in the polymers:
i)Fillers and reinforcing fillers ii) Plasticizers iii)Lubricants iv) Antioxidants and UV stabilizers v) Blowing agents vi) Coupling agents vii) Flame retardants viii) Inhibitors

UNIT-III
Mechanism and kinetics of: Addition or chain polymerization
• Free radical addition polymerization
• Ionic addition polymerization
• Coordination polymerization
• Coordination or step growth or condensation polymerization.
Compounding of polymer resins. **Brief description of:** I Compression and transfer moulding ii) Injection moulding iii) Extrusion IV) Blow moulding v) calendaring vi) Laminating and pultrusion.

**UNIT-IV**

**Methods of polymerization:** mass or bulk polymerization process, solution polymerization process, suspension polymerization process and emulsion polymerization method comparison of merits and emerits of these methods. Properties of polymers: crystalline and amorphous status, melting and glass transition temperature and their determination, effect of polymer structure on mechanical, physical chemical and thermal properties.

**UNIT-V**

**Degradation of polymers, Role of the following additives in the polymers:**
- i) Fillers and reinforcing fillers
- ii) Plasticizers
- iii) Lubricants
- iv) Antioxidants and UV stabilizers
- v) Blowing agents
- vi) Coupling agents
- vii) Flame retardants
- viii) Inhibitors

**Brief description of manufacture, properties and uses of:**
- i) Polyethylene (HDRP & LDPE)
- ii) Poly propylene
- iii) polyvinylchloride
- iv) polystyrene
- v) polytetra fluoroethylene
- vi) poly methyl methacrylate
- vii) polyvinyl acetate & polyvinyl alcohol

**Course Outcome:**
- Understand mechanism and mathematical modeling of different types of polymerizations
- Quantitative determination of degree of polymerization and molecular weight distribution
- Design of batch and continuous reactors for these polymerizations

**TEXTBOOKS:**

**REFERENCES:**
ANURAG GROUP OF INSTITUTIONS
(Autonomous)

IV Year B.Tech. CHEM – II Sem  L  T/P  C
3  1/-  3

Bioprocess Engineering
Elective – 4

COURSE OBJECTIVES:
The course will cover engineering principles, processes and techniques for using biological agents such as cells, enzymes or antibodies for the production of chemicals, food, biofuels and pharmaceuticals, and waste treatment. The course will include stoichiometry and kinetics of reactions that employ biological agents; design, analysis and operation of reactors (fermentors); and product recovery and purification (downstream processing).

Unit I:
Introduction: Biotechnology and bio processing, An overview of biological basics, Basics of enzyme and microbial kinetics: Enzyme kinetics, Mechanistic models for simple enzyme kinetics, effects of PH and temperature, Immobilized enzyme systems.
Operating considerations for bioreactors:
Cultivation method, modifying batch and continuous reactors, immobilized cell systems: Active immobilization of cells, Passive immobilization. Solid state fermentations.

Unit II:
Selection, Scale-up, Operation & Control of bioreactors:
Scale-up and its difficulties, bioreactor instrumentation and control, Sterilization of process fluids: Sterilization of liquids, Sterilization of gases.

Unit III:

Unit IV:
Bio process considerations in using animal cell culture: Structure and biochemistry of animal cells, Methods used for the cultivation of animal cells,
Bioreactor considerations for animal cell culture, Products of animal cell culture.

**Bio process considerations in using plant cell cultures:** Plant cells in culture compared to microbes, bio reactors for plant cell cultures.

**Unit V:**

**Mixed Cultures:** Simple models describing mixed culture interactions, mixed cultures in nature, Industrial utilization of mixed cultures, Biological wastewater treatment, an example of industrial utilization of mixed cultures.

**Genetically Engineered Organisms:** Influence of product on process decisions, guidelines for choosing host-vector systems, Metabolic engineering, Protein engineering.

**COURSE OUTCOMES:**

- Processes involved in production of chemicals, food, bio fuels and pharmaceuticals using biological agents.
- Design and operation of reactors using biological agents
- Unit operations and processes for product recovery
- Economics of bioprocesses

**TEXT BOOK:**


**REFERENCES:**