5CH220PC / 5CT220PC: **Heat Transfer (**PCC-I**)**

Subject Code	Title	Credits-03		
5CH220PC / 5CT220PC	**Heat Transfer**	L	T	P
Semester: V	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand fundamental heat transfer mechanisms.
- Apply concepts to industrial equipment like heat exchangers, boilers, condensers.
- Develop problem-solving skills for real-world heat transfer applications.
- Introduce energy-efficient and sustainable heat transfer practices.
- Enhance employability through exposure to industrial case studies and software tools.

Course Outcomes (COs)

After completion, students will be able to:

- CO1: Explain conduction, convection, and radiation principles.
- CO2: Solve steady and transient heat transfer problems.
- CO3: Design and analyze heat exchangers used in industries.
- CO4: Evaluate heat transfer performance in industrial processes.
- CO5: Apply energy-saving and optimization techniques.

SECTION A

UNITI: Importance of heat transfer in chemical process industries. Modes of heat transfer, steady state conduction in one dimension. Fourier's law. Heat transfer through plane, cylindrical and spherical walls, compound resistance in series, thermal insulation, critical and economic thickness. Extended surface equipment's, types, their design and operation.(**7)**

UNITII: Heattransferbyconvection,filmconcept,individualandoverall coefficients and factors affecting them. Natural and forced convection. Dimensional analysis applied to heat transfer. Dittus-Boelter equation, Limitations and application. Theories of heat& Mass transfer & analogy between momentum & heat transfer. (**7)**

UNIT III: Heat transfer by parallel and counter current flow, concept of log mean temperature difference, rate of heat transfer. Heat transfer by film wise and drop wise condensation in horizontal & vertical tube. Process design of condenser **(7)**

SECTION-B

UNIT IV: Heat exchange equipment's and their design, double pipe, parallel, counter current, shell and tube heat exchangers, fouling factors, concepts of transfer units in heat exchangers, NTU concept for heat exchangers. Compact Exchangers, plate, plate fin, Spirals etc construction, features advantages, limitation & their process design aspects. **(7)**

UNIT V: Boiling and Evaporators: Theory of boiling. Classification, types and field applications of evaporators. Single & multiple effect evaporators. Heat transfer in agitated vessels, jackets, coils etc. **(7)**

UNIT VI: Heat transfer by radiation, concept of black body, Kirchhoff's law, Stefan's law, Black and gray body radiation, view factors luminous and non-luminous gases. Heat transfer in packed and fluidized beds. Recent developments and technological forecasting in heat transfer. **(7)**

Text Books :

1) Heat Transfer by Sukhatme.
2) Heat Transfer by McAdams
3) Process Heat Transfer By Kern D. Q.
4) Process Heat transfer By G He.

Reference Books:

1) Unit Operations of Chemical Engineering by McCab and Smith
2) Chemical Engineering by Coulson & Richardson, Vol. I
3) Heat Transfer by R.C. Sachdeva

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

5CH221PC / 5CT221PC : **Industrial Waste Treatment (**PCC-II**)**

Subject Code	Title	Credits-03		
5CH221PC / 5CT221PC	**Industrial Waste Treatment**	L	T	P
Semester: V	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand sources and characteristics of industrial wastes
- Learn treatment methods for liquid, solid, and gaseous wastes
- Apply cost-effective and sustainable solutions
- Develop skills for pollution control and regulatory compliance
- Promote environmental responsibility and circular economy concepts

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Identify industrial waste sources and characteristics
- **CO2:** Analyze wastewater using standard parameters
- **CO3:** Select and design suitable treatment methods
- **CO4:** Understand air and solid waste management techniques
- **CO5:** Apply environmental regulations and sustainability practices

SECTION - A

UNIT I: Disposal Effects on Environment:

Effects of industrial wastes on environment (streams, land, and air); water quality criteria and effluent standards; waste minimization strategies including good housekeeping, volume and strength reduction, material and process modification, recycle, reuse and by-product recovery; environmental audit; environmental legislation. (7)

UNIT II: Effluent Treatment:

Conventional methods of industrial wastewater treatment and disposal; equalization and neutralization; solid–liquid separation (sedimentation and filtration); coagulation and flocculation; chemical precipitation and oxidation; Physio-chemical treatment methods; removal of dissolved impurities; residue/sludge management; combined treatment of industrial and municipal wastes. (7)

UNIT III: Biological Treatment Methods:

Biological Treatment Methods: Principles and methods for the removal of suspended impurities and biodegradable organic matter; aerobic and anaerobic decomposition processes; treatment systems including stabilization ponds, activated sludge process, and oxidation ditch. (7)

SECTION - B

UNIT IV: Advanced Waste Water Treatment:

Nitrogen removal, Phosphorous removal, Removal of refractory Organics, Removal of dissolved inorganic substances, Chemical precipitation, ion exchange, Reverse Osmosis, Electrodialysis. (7)

UNIT V: Industrial Waste Water Treatment – I:

Sources and classification of industrial effluents; wastewater treatment for the following industries: Textiles, Tanneries, Pulp and Paper, Pharmaceuticals, Sugar, Distilleries. (7)

UNIT VI: Industrial Waste Water Treatment – II:

Wastewater treatment for the following industries: Food Processing, Fertilizers, Steel, Thermal Power Plants, Petrochemical and Refineries, Dairy, Pesticide and Agrochemical, Cement, Paint and Dye Manufacturing (7)

Text Books:

1. Rao.M.N. and Dutta, Waste Water Treatment, Oxford and IBH Publishing Ltd., Calcutta,2008.
2. Ecken Felder, W, Industrial Waste Pollution Control, McGraw Hill Book Co., New Delhi, 2003.
3. S C Bhatia, Managing Industrial Pollution.

Reference BookS:

1. Nemerow, N.L., Theory & Principles of Industrial Waste Treatment, Addison Wesley, Reading Mass, 1993.
2. Wastewater Engineering Treatment & Reuse, Metcalf & Eddy Inc.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

5CH222PC / 5CT223PE: **Computer Programming & Application (**PCC-III**)**

Subject Code	Title	Credits-03		
5CH222PC / 5CT223PE	**Computer Programming & Application**	L	T	P
Semester: V	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Develop basic programming skills for engineering problems
- Apply programming in chemical engineering calculations
- Use tools for data analysis and visualization
- Introduce simulation and automation basics
- Improve industry readiness

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Write simple programs for engineering calculations
- **CO2:** Solve numerical problems using programming
- **CO3:** Analyze and visualize data
- **CO4:** Use programming tools for process applications
- **CO5:** Apply basic automation and simulation concepts

SECTION-A

UNIT I: Numerical solution of first order differential equations with initial condition, Euler's method, Runge-Kutta method. **(7)**

UNIT II: Systems of linear equations, solution by the method of determinants, matrix inversion for the solution of linear equations, Gausses limitation method. **(7)**

UNIT III: Roots of algebraic and transcendental equation, iteration methods, Regula-Falsi method, Newton-Raphson method, roots of simultaneous and solution set of transcendentals & algebraic equations. Development of equations for heat transfer, fluid mechanics & reaction engineering problems. **(7)**

SECTION-B

UNITIV: Regression analysis - Least Square, error approach, approximation by Chebyshev orthogonal polynomial. **(6)**

UNIT V: Elements of optimization techniques, single variable function, optimization-direct search, with and without acceleration, method of regular intervals and Fibonacci search method, gradient methods.**(7**

UNIT VI: Computer programming in modular form, use of subroutine libraries, Block diagrams of preliminary aids in programming, capacity optimization. **(7)**

Text Book: Digital Computation for Chemical Engineering by Leon Lapidus, McGraw Hill.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**

✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks

✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks

✓ Teaching Evaluation Components : 10Marks
(Viva Voce / Assignments / Report Writing etc.)

✓ Class Attendance : 10Marks

- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

5CH223PE: **Inorganic Chemical Technology (**PEC-I**)**

Subject Code	Title	Credits-03		
5CH223PE	**Inorganic Chemical Technology**	L	T	P
Semester: V	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand the manufacturing processes of major inorganic chemicals used in industry.
- Study raw materials, reaction mechanisms, and process conditions involved in production.
- Analyze process flow diagrams (PFDs) and industrial equipment used.
- Understand safety, environmental, and economic aspects of inorganic chemical industries.
- Develop awareness of industrial practices and applications relevant to fertilizers, cement, glass, and alkali industries.

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Describe the manufacturing processes of important inorganic chemicals such as acids, alkalis, fertilizers, cement, and glass.
- **CO2:** Explain process chemistry, reaction conditions, and raw material requirements for industrial production.
- **CO3:** Interpret and analyze process flow diagrams and unit operations involved in inorganic industries.
- **CO4:** Evaluate environmental impacts, waste management, and safety measures in chemical plants.
- **CO5:** Apply knowledge to select appropriate processes and suggest improvements for industrial applications.

SECTION-A

UNIT-I : Sugar, Starch, and Soap Industries:

Sugar and starch industries: sugar, starches, and related products Soap and detergent industries: manufacture of detergents, soap, and glycerine (7)

Unit II: Pulp, Paper, Cement, and Lime Industries

Pulp and paper industries: types, raw materials, and manufacture of pulp and paper Cement and lime industries: Portland cement—types, raw materials, setting and hardening, manufacturing processes; manufacture and uses of lime and gypsum. (7)

Unit III: Industrial and Fuel Gases

Industrial gases: manufacture and applications of carbon dioxide, hydrogen, oxygen, and nitrogen Fuel gases: manufacture and uses of producer gas, water gas, natural gas, and synthesis gas. (7)

SECTION-B

Unit IV: Acids and Fertilizer Industry

Acids: sulfuric acid, nitric acid, and hydrochloric acid Fertilizer industry: manufacture of ammonia, urea, diammonium phosphate (DAP), and superphosphates (SSP and TSP).(6)

Unit V: Electrochemical Processes

Principles of electrochemical technological processes Electrolytic processes in aqueous and molten (fused) systems Manufacture of caustic soda and chlorine. (6)

Unit VI: Electrothermal and Energy Storage Industries

Electrothermal industries: production of aluminum, lithium, and titanium Electrochemical sources of energy and storage. (7)

Note: The students are expected to visit the various industries to have a thorough understanding of the subject.

Text Books:

1. Austin, G.T., "Shreve's Chemical Process Industries", Fifth Edition, McGraw- Hill International Book Co, Singapore,1984.

2. Dryden, C.E., "Outlines of Chemical Technology ", Edited and Revised by Gopala Rao M.and M. Sittig, Third edition, Affiliated East-West press, 1997.

Reference Books:

1. Kent, J.A.,"Riggel's Hand Book of Industrial Chemistry",7th Edition, Van Nostrant Reinhold, 1974.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

5CH224PE: **Biochemical Engineering (**PEC-I**)**

Subject Code	Title	Credits-03		
5CH224PE	**Biochemical Engineering**	L	T	P
Semester: V	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand fundamentals of biochemical processes
- Learn microbial growth and kinetics
- Study fermentation and bioreactor design
- Apply biochemical engineering in industries
- Promote sustainable and bio-based technologies

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Explain basic biochemical and microbial concepts
- **CO2:** Analyze microbial growth kinetics
- **CO3:** Understand fermentation processes and reactors
- **CO4:** Apply downstream processing techniques
- **CO5:** Identify industrial applications of biochemical engineering

SECTION A

UNIT I: Introduction to Biochemical Engineering

Scope and importance of biochemical engineering, Basics of cell biology (Prokaryotic and eukaryotic cells), Introduction to biomolecules: (Proteins, carbohydrates, lipids), **Enzymes:** Structure and function, Enzyme classification **(7)**

UNIT II: Microbiology for Engineers

Types of microorganisms: Bacteria, fungi, yeast, Growth phases of microorganisms, Sterilization techniques: Heat, filtration, chemical, Culture media and preparation **(7)**

UNIT III: Enzyme Kinetics & Biochemical Reactions

Enzyme kinetics basics, Michaelis–Menten kinetics, Factors affecting enzyme activity, Immobilized enzymes (concept and applications) **(7)**

SECTION B

UNIT IV: Fermentation Technology

Types of fermentation: Batch, fed-batch, continuous, Fermentation processes: Alcohol production, Antibiotics, Organic acids, Media formulation, Scale-up basics (7)

UNIT V: Bioreactors & Mass Transfer

Types of bioreactors: Stirred tank, airlift, Design features: Agitation, aeration, Oxygen transfer: Concept of kLa, Mixing and scale-up considerations (7)

UNIT VI: Downstream Processing & Industrial Applications

Product recovery techniques: Filtration, centrifugation, Extraction, drying, Purification methods (basic idea), Waste management in biochemical industries, Introduction to modern trends: Biofuels, bioplastics, Overview of industrial tools: Aspen HYSYS (basic awareness) (6)

Text books:

1) Biochemical Engineering – M. Doble, S. Satyanarayana – Tata McGraw-Hill Education (India) Pvt. Ltd.
2) Biochemical Engineering Fundamentals – James E. Bailey, David F. Ollis – McGraw-Hill International Edition
3) Bioprocess Engineering: Basic Concepts – Michael L. Shuler, Fikret Kargi – Prentice Hall (Pearson Education)

Reference books:

1) Bioprocess Engineering Principles – Pauline M. Doran – Academic Press (Elsevier)
2) Biochemical Engineering – James M. Lee – Prentice Hall (Pearson Education)

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments /Group activities/ Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

5CH225PE: **Material Science & Engineering (**PEC-I**)**

Subject Code	Title	Credits-03		
5CH225PE	**Material Science & Engineering**	L	T	P
Semester: V	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

The course aims to:

1. Understand the **structure–property relationship of materials** (metals, ceramics, polymers, composites).
2. Study **crystal structure, defects, and phase behavior** of materials.
3. Learn **mechanical, thermal, and chemical properties** relevant to engineering applications.
4. Analyze **material selection criteria** for chemical process industries.
5. Develop awareness of **corrosion, degradation, and material protection techniques**.

Course Outcomes (COs)

After completion of the course, students will be able to:

- **CO1:** Explain **structure, classification, and properties** of engineering materials.
- **CO2:** Analyze the effect of **crystal structure, defects, and phase diagrams** on material behavior.
- **CO3:** Evaluate **mechanical, thermal, and chemical properties** for engineering applications.
- **CO4:** Select suitable **materials for chemical process equipment** based on operating conditions.
- **CO5:** Identify and suggest methods for **corrosion prevention and material protection**.

SECTION A

UNIT I: Introduction to materials and their principle properties, Simple stresses and strains, Concept of stress, strain, shear stress, shear strain, Hooks law, Elastic limit, stress-strain curve for mild steel and elastomeric materials, factor of safety, Poisson's ratio, Strain energy due to axial load and impact. Introduction to determination of mechanical properties of materials ASTM methods. (7)

UNITII: Basic principles in their selection for fabrication and erection of chemical plant. Testing of materials, destructive and non-destructive tests, structure of atom and chemical bonds, crystal structures and their influence on material properties, Deformation and slip processes. (7)

UNIT III: Metals and their alloys: Iron – carbon diagram, Ferrous and nonferrous alloys, mild steel, special steels, stainless steels, brasses, brasses, aluminium alloys and titanium alloys, high and low temperature material, insulation, refractories. Methods for fabrication, rolling, bending, central punching, riveting, welding. Nickel and its alloys: aluminium and its alloys. (7)

SECTION B

UNITIV: Corrosion and its control: Corrosion attack methods, Different types of corrosion : chemical, biochemical, and electrochemical; Internal and external factors affecting corrosion of chemical equipments, Methods to minimize corrosion, corrosion charts for process equipments.

Polyaniline and anti-corrosive surface coatings electrochemical corrosion prevention corrosion case studies from the chemical industry. (7)

UNIT V: Polymers, natural and synthetic: Selection of polymetric materials for equipment linings, fibre reinforced plastic, application of special polymers like Nylon 66, Teflon in engineering. Polymer Composites. (7)

UNIT VI: Ceramic and glasses: Definition of ceramics and glasses; interaction between structure, processing, properties; Applications of ceramic and glass materials; Crystalline and noncrystalline ceramics, silicates, refractories, clays, cements, glass vitreous silica & borosilicate. (7)

Text Books:

1. James F. Shacketford, Introduction to Material Science, McMillan publishing company, New York ISBN1990
2. D.Z. Jestrazebaski, Properties of Engineering Materials, 3rd Ed. Toppers. Co. Ltd.

Reference Books:

1. J.L. Lee and Evans, Selecting Engineering materials for chemical and process plants, Business Works1978
2. Design of machine elements, Spott M .M. Prentice Hall
3. A text book of machine design, Khurmi R.S. and GuptaJ.K.
4. Material Science &Metallurgy for Engineers, Dr.V.D.Kodgire, Everest Publishing House.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments /Group activities/ Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

5CH226PC / 5CT224PC: Heat Transfer Lab. (PCC-I Lab.)

Subject Code	Title	Credits- 01		
5CH226PC / 5CT224PC	Heat Transfer Lab	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	0	0	2

List of experiments:

1. Heat Conduction
2. Natural convection
3. Thermal radiation-determination of emissivity
4. Double pipe heat exchanger
5. Shell and tube heat exchanger
6. Plate Heat exchanger
7. Heat transfer in agitated vessels
8. Double effecte vaporator
9. Open pane vaporator
10. Heat pipe demonstrator
11. Fluidized bed heat transfer

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks
- **External University Practical Examination** : **25 Marks**

5CH227PC / 5CT225PC : Industrial Waste Treatment Lab. (PCC-II Lab.)

Subject Code	Title	Credits- 01		
5CH227PC / 5CT225PC	Industrial Waste Treatment Lab	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	0	0	2

1. Study of sampling and preservation methods.
2. To determine pH, TDS & Conductivity of the given sample.
3. To illustrate the various operations involved in gravimetric analysis and to determine the various categories of solids that are commonly defined in water and wastewater.
4. To Measure mineral and phenolphthalein acidity
5. Measurement of phenolphthalein alkalinity and total alkalinity using dye indicators
6. To determine the DO content of given sample of water.
7. To Determine chloride ion concentration in a water sample by Mohr's method.
8. To determine COD value for determining organic strength of solution.
9. To determine Optimum Coagulant Dosage by Jar Test & its relation with pH.
10. To determine the efficiency of cyclone separator.
11. To study the reverse osmosis system.
12. To study standard curve with UV spectrophotometer.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks
- **External University Practical Examination** : **25 Marks**

5CH228PC: Computer Programming & Application Lab. (PCC-III Lab.)

Subject Code	Title	Credits- 01		
5CH228PC	**Computer Programming & Application Lab**	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	0	0	2

List of Experiments:

1. Design analgorithm, draw a flow chart and write program to perform addition, subtraction, multiplication and division of two numbers by taking two values from users.
2. Algorithm quadratic equation (for root of).
3. Program for solving ordinary differential equation with initial value of Euler'smethod.
4. To find value of unknown of simultaneous by Gauss elimination method.
5. To find roots of equation using Bisection method.
6. Algorithm for Regula-Falsi method.
7. Find the roots of equation by Newton-Raphsons method.
8. Program for modified Newton – Raphson method.
9. Design algorithm for regression.
10. Algorithm for print the grades of students using if-else-if statement.
11. Design algorithm and flow-chart for Runga-Kutta method.
12. Design algorithm and flow-chart to find greatest and smallest element.

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the mainlist.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks
- **External University Practical Examination** : **25 Marks**

5CH229M: Chemical Engineering in Liquid Waste Management. (MDM-III)

Subject Code	Title	Credits- 01		
5CH229M	**Chemical Engineering in Liquid Waste Management**	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	2	0	0

Course Objectives (COs)

- Understand sources and characteristics of liquid wastes
- Learn treatment techniques using chemical engineering principles
- Apply cost-effective and sustainable wastewater treatment methods
- Develop problem-solving skills for real industrial scenarios
- Promote environmental responsibility and regulatory awareness

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Identify and characterize industrial wastewater
- **CO2:** Apply physical, chemical, and biological treatment methods
- **CO3:** Design/select suitable treatment systems for small-scale industries
- **CO4:** Analyze wastewater data and suggest improvements
- **CO5:** Understand regulations and sustainable practices

UNIT I: Wastewater Characteristics & Preliminary Treatment

Sources of liquid waste (Chemical, textile, dairy, agro-based industries), Wastewater characteristics (Physical, chemical, biological parameters (pH, BOD, COD, TSS, TDS)), Basics of Sampling and analysis methods, Preliminary & primary treatment (Screening, grit removal, sedimentation, Equalization and neutralization) **(7)**

UNIT II: Chemical & Biological Treatment Processes

Basic Chemical treatment (Coagulation–flocculation, Precipitation, Adsorption (activated carbon)) Basics of Biological treatment (Aerobic processes (activated sludge – concept), Anaerobic processes), Introduction to Sludge handling and disposal. **(7)**

UNIT III: Advanced Treatment, Reuse & Sustainability

Introduction to Tertiary treatment (Filtration, disinfection, Membrane processes (RO)) Water reuse and recycling, Waste minimization techniques, Introduction to Zero Liquid Discharge (ZLD), Environmental regulations (Central Pollution Control Board guidelines), Case studies (Dairy wastewater treatment, Textile effluent treatment) **(7)**

Recommended Books

1. Metcalf & Eddy, Wastewater Engineering: Treatment and Resource Recovery, ata McGraw-Hill Education (India), 2003
2. S. K. Garg, Environmental Engineering (Vol. II: Sewage Disposal and Air Pollution Engineering), Khanna Publishers, New Delh, 2017

3. Peavy, Row & Tchobanoglous, Environmental Engineering, Tata McGraw-Hill (India), 1985
4. W. Wesley Eckenfelder Jr., Industrial Water Pollution Control, Tata McGraw-Hill (India), 2000
5. Rajaram, Vasudevan, Siddiqui, Agrawal, Khan, Solid and Liquid Waste Management: Waste to Wealth, PHI Learning Pvt. Ltd., New Delhi, 2016

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **20 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Teaching Evaluation Components : 05Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 05Marks
- **End-Semester Examination** : **30 Marks**

5CH230M: Chemical Engineering in Liquid Waste Management. (MDM-IV)

Subject Code	Title	Credits- 01		
5CH230M	**Chemical Engineering in Solid Waste Management**	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	2	0	0

Course Objectives (COs)

- Understand sources and characteristics of solid waste
- Learn handling, treatment, and disposal techniques
- Apply chemical engineering principles in waste management
- Promote sustainable and resource recovery practices
- Develop awareness of environmental regulations

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Identify and classify solid waste from various sources
- **CO2:** Analyze physical and chemical properties of solid waste
- **CO3:** Select suitable treatment and disposal methods
- **CO4:** Apply waste minimization and resource recovery techniques
- **CO5:** Understand regulations and sustainable practices

UNIT I: Solid Waste Characteristics & Collection Systems

Types of solid waste (Municipal, industrial, agricultural, hazardous), Composition and characteristics (Moisture content, density, calorific value), Waste generation sources (Households, industries, agro-based units), Collection, segregation, and transportation systems, Storage and handling practices **(7)**

UNIT II: Treatment & Processing Techniques

Physical processing (Size reduction, screening), Biological treatment (Composting (aerobic)), Vermicomposting, Basics of Thermal treatment (Incineration, pyrolysis), Introduction of Chemical treatment (Stabilization/solidification), Recycling and reuse techniques **(7)**

UNIT III: Disposal, Resource Recovery & Sustainability

Landfilling (Sanitary landfill concept, Basics of Leachate and gas management, Resource recovery (Biogas production, Recycling of plastics, metals), Waste minimization strategies, Introduction to circular economy, Environmental regulations (Central Pollution Control Board guidelines), Case studies (Municipal solid waste management, Industrial solid waste reuse) **(7)**

Recommended Books

1. K. Sasikumar, Sanoop Gopi Krishna, Solid Waste Management, PHI Learning Pvt. Ltd., New Delhi, 2009
2. P. Jayarama Reddy, Municipal Solid Waste Management, CRC Press / Taylor & Francis (Indian usage), 2011
3. M. N. Rao & H. V. N. Rao, Solid and Hazardous Waste Management, CBS Publishers & Distributors, New Delhi, 2011

4. S. K.Garg, Environmental Engineering (Solid Waste Management Section), Khanna Publishers

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **20 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Teaching Evaluation Components : 05Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 05Marks
- **End-Semester Examination** : **30 Marks**

5CH231M: Chemical Engineering in Liquid Waste Management Lab. (MDM-III)

Subject Code	Title	Credits- 01		
5CH231M	**Chemical Engineering in Liquid Waste Management**	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	0	0	1

LIST OF EXPERIMENTS

1. Determination of pH of wastewater sample
2. Determination of Total Dissolved Solids (TDS)
3. Determination of Total Suspended Solids (TSS)
4. Determination of Biochemical Oxygen Demand (BOD)
5. Determination of Chemical Oxygen Demand (COD)
6. Sedimentation study (settling characteristics of suspended solids)
7. Filtration experiment (sand/charcoal filter model)
8. Equalization and mixing study (demonstration/basic analysis)
9. Coagulation–Flocculation (Jar Test)
10. Neutralization of acidic/alkaline wastewater
11. Adsorption using activated carbon
12. Study of Activated Sludge Process (lab model/demo)
13. Anaerobic treatment (biogas generation – demonstration)

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks
- **External University Practical Examination** : **25 Marks**

5CH232OE1 Risk & Safety Management (Open Elective- III)

Subject Code	Title	Credits-02		
5CH232OE1	Open Elective- III Risk & Safety Management	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	2	0	0

Course Objectives

1. To introduce fundamental concepts of industrial safety, hazards, and risk.
2. To understand the causes, types, and impacts of industrial accidents.
3. To develop knowledge of chemical hazards and principles of industrial toxicology.
4. To study fire and explosion phenomena along with their prevention and control.
5. To familiarize students with hazard identification and analysis techniques such as HAZOP.
6. To understand risk assessment methods and safe work practices in industries.

Course Outcomes

After completion of course Students will be able to

1. Identify and classify different types of industrial hazards and risks.
2. Analyze causes and consequences of industrial accidents.
3. Evaluate chemical hazards and toxicological effects in industrial environments.
4. Explain fire and explosion mechanisms and recommend safety measures.
5. Apply hazard analysis techniques such as HAZOP for process safety evaluation.
6. Assess risks and implement safe work practices in industrial operations.

Unit I: Introduction to Industrial Safety and Hazards

Introduction to industrial safety and its importance Basic terminology: hazard, risk, safety, accident, incident, near miss Types of hazards: physical, chemical, biological, mechanical, electrical, and ergonomic .Accidents: definition, classification, and causes of industrial accidents Impact of accidents on human life, environment, equipment, and economy .Major accident case studies (brief overview) .Statistical data on industrial accidents and losses (national and global perspective) (7)

Unit II: Chemical Hazards, Toxicology, and Fire Safety

Introduction to chemical hazards and associated risks .Basic principles of industrial toxicology (exposure routes, dose-response, toxicity classification) .Health effects of toxic substances (acute and chronic effects) .Fire and explosion fundamentals: fire triangle, fire tetrahedron .Classification of fires and fire hazards in industries .Causes and prevention of fires and explosions .Fire protection and control systems: extinguishers, detection systems, and safety measures (7)

Unit III: Hazard and Risk Analysis Techniques

Hazard identification and classification methods .Hazard analysis techniques with emphasis on HAZOP (Hazard and Operability Study) .Risk analysis: qualitative and quantitative approaches

.Risk assessment and risk management strategies .Safe work practices and safety procedures in industries. Safety audits and safety management systems (basic concepts) (7)

Text Books :

1. Fundamentals of Industrial Safety and Health Dr. K. U. Mistry **,**Siddharth Prakashan, Ahmedabad

2. Industrial Safety Management (Hazard Identification and Risk Control), L. M. Deshmukh McGraw Hill Education (India) Pvt. Ltd., Chennai / Tata McGraw Hill (earlier editions)

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **20 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Teaching Evaluation Components : 05Marks
  (Viva Voce / Assignments / Report Writing/group activities etc.)
- ✓ Class Attendance : 05Marks
- **End-Semester Examination** : **30 Marks**

5CH232OE2 Renewable Biomass Energy Technology (Open Elective- III)

Subject Code	Title	Credits-02		
5CH232OE2	Open Elective- III Renewable Biomass Energy Technology	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	2	0	0

Course Objectives (COs)

- Understand biomass as a renewable energy source
- Learn conversion technologies for energy production
- Apply chemical engineering principles in biomass processing
- Promote sustainable and decentralized energy solutions
- Develop awareness of rural and industrial applications

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Identify types and properties of biomass resources
- **CO2:** Explain biomass conversion technologies
- **CO3:** Analyze energy generation processes from biomass
- **CO4:** Design basic biomass-based energy systems
- **CO5:** Evaluate sustainability and environmental impacts

UNIT I: Biomass Resources & Characterization

Introduction to renewable energy and role of biomass, Types of biomass (Agricultural residues (cotton stalk, bagasse, husk), Animal waste, forest waste, municipal organic waste, Properties of biomass (Moisture content, calorific value, composition), Biomass availability in India (focus on rural regions), Collection, storage, and preprocessing. **(7)**

UNIT II: Biomass Conversion Technologies

Basics of Thermochemical conversion (Combustion, Gasification, Pyrolysis), Biochemical conversion (Anaerobic digestion (biogas production), Fermentation (bioethanol)), Chemical conversion (Basics of Transesterification (biodiesel)) **(7)**

UNIT III: Applications, Energy Systems & Sustainability

Biomass energy systems (Biogas plants (fixed dome, floating dome), Biomass boilers), Waste-to-energy concepts, Energy efficiency and process optimization, Environmental impacts and carbon neutrality, Government policies and initiatives (Ministry of New and Renewable Energy schemes), Case studies (Rural biogas plants, Biomass power generation) **(7)**

Recommended Textbooks (India-Relevant)

- Biomass Energy by S. P. Sukhatme
- Non-Conventional Energy Sources by G. D. Rai
- Renewable Energy Engineering and Technology by V. V. N. Kishore

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **20 Marks**

✓ Class Test-I (MCQ/ Subjective/ Objective) : 05Marks
✓ Class Test–II (MCQ/ Subjective/ Objective) : 05Marks
✓ Teaching Evaluation Components : 05Marks
(Viva Voce / Assignments / Report Writing/Group activities etc.)
✓ Class Attendance : 05Marks

- **End-Semester Examination** : **30 Marks**

6CH233PC: **Mass Transfer-I (**PCC-I**)**

Subject Code	Title	Credits-03		
6CH233PC	**Mass Transfer-I**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- To understand the fundamentals of mass transfer and diffusion.
- To analyze interphase mass transfer and apply mass transfer theories.
- To design and evaluate absorption equipment.
- To study drying and humidification operations used in industry.
- To understand crystallization principles and modern mass transfer techniques.

Course Outcomes (COs)

After completion, students will be able to:

CO1: Explain fundamental concepts of diffusion and mass transfer operations

CO2: Apply Fick's law and mass transfer coefficients to solve numerical problems

CO3: Analyze interphase mass transfer using different theories

CO3: Design absorption columns using stagewise and HTU-NTU methods

CO4: Evaluate drying and humidification processes using psychrometric charts

CO5: Calculate yield and performance of crystallization processes

SECTION A

UNIT I: Fundamentals of Mass Transfer & Diffusion

• Importance & industrial applications, Classification of mass transfer operations, Molecular diffusion & convective mass transfer, Concepts of flux, resistance, driving force, equilibrium, direction of mass transfer, Mass flux, driving force, equilibrium, Fick's First & Second Law, Dependence of diffusivity on physical properties, Diffusion in gases and liquids, Dimensionless numbers: Reynolds, Schmidt, Sherwood (7)

UNIT II: Interphase Mass Transfer & Theories

• Two-film theory, Penetration theory, Surface renewal theory (conceptual), Individual & overall mass transfer coefficients, Controlling resistance concept, Mass transfer in turbulent flow, Empirical correlations & analogies, Analogies of mass transfer. (7)

UNIT III: Gas Absorption & Adsorption

• Physical & chemical absorption, Henry's law, Operating & equilibrium lines, Stagewise calculations, Absorption & stripping factor, Kremser equation, HTU–NTU method, Tray & packed towers, Adsorption equilibria, types of adsorption, properties of adsorbents, single and multi-stage adsorption, adsorption isotherms, principles of adsorption, adsorption of liquids, basic equations, adsorber design, adsorption equipment's (7)

SECTION-B

UNIT IV: Drying

- Principles of drying, phase equilibrium, cross circulation drying, through circulation drying, drying of suspended particles, Moisture content definitions, Equilibrium moisture, Rate of drying curve, Constant & falling rate periods, Drying time calculation, Types of dryers & industrial applications **(7)**

UNIT V: Humidification

- Humidity definitions, Wet bulb & dry bulb temperature, Psychrometric chart, Enthalpy-humidity relationships, Cooling towers & humidifiers, Dehumidification processes, and measurement of humidity, adiabatic saturation temperature, concept of dehumidification, equipments for humidification operations **(7)**

UNIT VI: Crystallization & Modern Developments

- Principles of crystallization, equilibria, Solubility & supersaturation, Yield calculation, Nucleation & crystal growth, Heat effects, Types of crystallizers, fractional crystallization, caking of crystals, Various types of crystallizers and their applications. **(7)**

Text Books:

Unit Operation in Chemical Engineering : W .L. McCabe & J. C. Smith, Mc-Graw Hill.
Mass Transfer Operation: R. E. Treybal.

Reference Books:

Mass Transfer : T. K. Sherwood, R.I. Pigford, McGraw Hill.
Chemical Engineering : Coulson & Richardson

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

6CH234PC: **Petrochemical Technology (**PCC-II**)**

Subject Code	Title	Credits-03		
6CH234PC	**Petrochemical Technology**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand petrochemical feedstocks and processing routes
- Identify major petrochemical products and their applications
- Interpret basic process flow diagrams
- Recognize industrial practices and safety concerns
- Develop awareness of downstream and MSME opportunities

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** understand industry structure and feedstock base
- **CO2:** understand how raw materials are converted into basic building blocks
- **CO3:** learn key primary petrochemical products and their importance
- **CO4:** understand value addition and product chain
- **CO5:** gain exposure to widely used petrochemical products, understand safe, sustainable, and responsible industrial practices

SECTION-A

UNIT- I: General Introduction - History, economics and future of petrochemicals, energy crisis and petrochemical industry, sources and classification of petrochemicals, different feedstock, Types of cracking Process **(7)**

UNIT- II: First generation petrochemicals - alkanes - C1, C2, C3, C4 petrochemicals, alkenes - C2, C3, C4, petrochemicals, alkynes - C2, C3, C4 petrochemicals, B-T-X aromatics, diene based petrochemicals. **(7)**

UNIT- III: Second generation petrochemicals - synthesis gas, methanol, formaldehyde chloromethanes, ethanol, acetaldehyde, acetic acid, acetic anhydride, isopropyl alcohol, ethylene oxide, propylene oxide, acetone, vinyl chloride, phenol, aniline and styrene.**(7)**

SECTION - B

UNIT- IV: Third generation petrochemicals - plastics, rubbers and fibres, olefinic polymers, polyethylene, polypropylene, polyisobutylene, diene polymers - polybutadiene, neoprene, polyisoprene, SBR, synthetic fibres.**(7)**

UNIT- V: Miscellaneous petrochemicals - petroleum proteins, synthetic detergents, resin and rubber chemicals, explosives - TNT and RDX. **(7)**

UNIT- VI: Various technological forecasting of the petroleum and petrochemicals.**(7)**

Text Books:

1. S.Maiti, "Introduction to petrochemicals", Oxford and IBH publishing Co.,1992.
2. H.Steines, "Introduction to petrochemical Industry", Pergamon,1961.

3. I D Mall Petrochemical Process Technology.

Refernce Books:

1. G.D.Hobson and W.Pohl, "Modern Petroleum Technology", Applied Science Publishers, IV Edition, 1975
2. Richard frank Goldsten and A.Lawrence Waddams, "The Petroleum Chemical Industry", E&FN Spon Ltd., 1967
3. G.T.Austin, "Shreves Chemical Process Industries", McGraw Hill, V Edition, 1986

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

6CH235PC / 6CT235PE : **Chemical Reaction Engineering-I (**PCC-III**)**

Subject Code	Title	Credits-03		
6CH235PC / 6CT235PE	**Chemical Reaction Engineering-I**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand chemical reaction kinetics and rate laws
- Design and analyze basic reactors
- Apply material balances to reacting systems
- Interpret industrial reactor operations
- Develop problem-solving skills for real processes

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Understand fundamental reaction concepts and terminology
- **CO2:** Derive and apply rate equations
- **CO3:** Understand how temperature impacts industrial reactions
- **CO4:** Solve basic reactor design problems
- **CO5:** Connect theory with real industrial practices

SECTION-A

UNIT 1: Basics of Chemical Reaction Engineering

Definition and scope of CRE, Types of reactions: homogeneous, heterogeneous, Rate of reaction and rate equations, Factors affecting reaction rates (temperature, concentration, catalyst), Elementary and non-elementary reactions. **(7)**

UNIT 2: Reaction Kinetics and Rate Laws

Order and molecularity of reactions, Rate laws and rate constants, Integrated rate equations for: Zero-order, First-order, Second-order reactions, Half-life method, Determination of reaction order (experimental methods – basic idea) **(7)**

UNIT 3: Temperature Effects on Reaction Rates

Temperature dependence of rate constant, Arrhenius equation, $k=Ae^{-Ea/RT}$, Activation energy and frequency factor, Effect of temperature in industrial reactors, Introduction to catalysts and catalytic reactions **(7)**

SECTION-B

UNIT 4: Ideal Reactor Types

Batch reactor (BR), Continuous Stirred Tank Reactor (CSTR), Plug Flow Reactor (PFR), Comparison of reactor types, Conversion, yield, and selectivity **(7)**

UNIT 5: Design of Ideal Reactors

Material balance for: Batch reactor, CSTR, PFR, Design equations (simple derivations), $F_{A0}-FA+rAV=0$, Space time and space velocity, Performance comparison of reactors**(7)**

UNIT 6: Industrial Reactors, Safety & Sustainability

Overview of industrial reactors (fixed bed, fluidized bed – basic idea), Reactor safety: temperature control, runaway reactions, Introduction to reactor scale-up, Environmental considerations in reaction engineering, Green chemistry and sustainable processes**(7)**

Text Books:

1) Chemical Reaction Engineering: Octane Levenspiel, Wiley Eastern Ltd.
2) Chemical Engineering Kinetics: Smith J.M. McGraw Hill.

Reference Books:

1) Reaction Kinetics for Chemical Engineers, Walas McGraw Hill
2) Elements of Chemical Reaction Engineering, H. Scott Fogler, Prentice Hall.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

6CH236PE: **Organic Chemical Technology (**PEC-II**)**

Subject Code	Title	Credits-03		
6CH236PE	**Organic Chemical Technology**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand major organic chemical industries and processes
- Apply basic chemical engineering concepts to organic manufacturing
- Analyze process flow diagrams and industrial operations
- Recognize safety, environmental, and sustainability aspects
- Develop awareness of MSME-scale chemical industries

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** understand industry structure and raw material base.
- **CO2:** learn key petrochemical processes and products.
- **CO3:** gain process-level understanding of essential chemicals
- **CO4:** understand widely used polymer industries and sustainability issues
- **CO5:** Exposure to high-value industries and local employment potential and understand safe and eco-friendly industrial practices.

SECTION-A

UNIT 1: Introduction to Organic Chemical Industry

Overview of organic chemical technology, Classification of organic chemicals (bulk, fine, specialty chemicals), Raw materials: petroleum, natural gas, coal, biomass, Basic unit operations in organic industries, Introduction to process flow diagrams (PFDs) (7)

UNIT 2: Petroleum-Based Organic Chemicals

Petrochemical feedstocks: naphtha, LPG, natural gas, Production of:Olefins (ethylene, propylene), Aromatics (benzene, toluene, xylene), Downstream products and applications, Industrial importance in India (7)

UNIT 3: Industrial Production of Basic Organic Chemicals

Manufacture of: Methanol, Ethanol (fermentation and synthetic), Acetone, Acetic acid, Reaction mechanisms (basic understanding only), Process conditions and catalysts (7)

SECTION-B

UNIT 4: Polymer and Plastic Technology

Introduction to polymers, Types: thermoplastics, thermosets, Manufacturing of: Polyethylene (PE), Polyvinyl chloride (PVC), Polystyrene, Processing techniques: molding, extrusion, Plastic waste management and recycling.(7)

UNIT 5: Dyes, Pharmaceuticals & Agrochemicals

Basics of dye industry (types and applications), Introduction to pharmaceutical manufacturing, Agrochemicals: pesticides, fertilizers (organic perspective), Role of small-scale industries in rural regions, Quality control and regulatory basics (7)

UNIT 6: Safety, Environment & Green Technology

Industrial hazards in organic chemical plants, Handling of toxic and flammable chemicals, Effluent treatment and waste management, Basics of green chemistry, Sustainable and bio-based chemical processes (7)

Note: The students are expected to visit the various industries to have a thorough understanding of the subject.

Text Books:

1. P.H. Groggins, "Unit Processes in Organic Synthesis", McGraw Hill Book Co., Kogakusha (1984)
2. J.A.Kent, "Riegel's Hand book of Industrial Chemistry",7th Edition, Van Nostrand Reinhold Co., New York (1974)

Reference Books:

1. Peter Wiseman, "An Introduction to Industrial Organic Chemistry", 2nd Edition, Applied Science Publishers Ltd., London (1979)
2. CHEMTECH 1-4, "Chemical Engineering Education Development Centre", I.I.T., Madras 1975-78

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

6CH237PE: **Fuel Cells and Hydrogen Energy (**PEC-II**)**

Subject Code	Title	Credits-03		
6CH237PE	**Fuel Cells and Hydrogen Energy**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand hydrogen as a clean energy carrier
- Learn principles and types of fuel cells
- Study hydrogen production, storage, and utilization
- Apply chemical engineering concepts to energy systems
- Promote sustainable and low-carbon technologies

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Explain fundamentals of hydrogen energy and fuel cells
- **CO2:** Describe hydrogen production and storage methods
- **CO3:** Analyze working and performance of different fuel cells
- **CO4:** Evaluate fuel cell systems for practical applications
- **CO5:** Understand safety, sustainability, and future energy scenarios

SECTION A

UNIT I: Introduction to Hydrogen Energy

Energy scenario (Conventional vs renewable energy), Hydrogen as energy carrier (Properties, advantages, limitations), Hydrogen economy concept, Applications of hydrogen energy (07)

UNIT II: Hydrogen Production Technologies

Conventional methods(Concept of Steam methane reforming, Coal gasification), Renewable methods (Water electrolysis, Biomass-based hydrogen production), Comparison of production methods, Introduction to green hydrogen (07)

UNIT III: Hydrogen Storage & Transportation

Storage methods (Compressed gas, Liquid hydrogen, Introduction to Metal hydrides), Transportation challenges, Safety considerations, Storage material basics (07)

SECTION B

UNIT IV: Fuel Cells – Principles & Types

Basic working of fuel cells, Electrochemical principles, Types of fuel cells (PEMFC, SOFC, MCFC), Advantages and limitations (07)

UNIT V: Fuel Cell Design & Applications

Components (Electrodes, electrolyte, catalyst), Performance parameters (Efficiency, polarization), Applications (Transportation, Stationary power generation, Portable devices (07)

UNIT VI: Safety, Sustainability & Future Trends

Hydrogen safety (Handling, storage risks), Environmental impact, Integration with renewable energy systems, Economic and policy aspects, Government initiatives (Ministry of New and Renewable Energy (Hydrogen Mission)) (07)

Textbooks

- Hydrogen and Fuel Cells by Bent Sørensen, Elsevier Academic Press, 2005
- Fuel Cell Fundamentals by Ryan O'Hayre, John Wiley & Sons, 2016 (3rd Edition)
- Non-Conventional Energy Sources by G. D. Rai, Khanna Publishers, New Delhi, 1998
- Fuel Cell Systems Explained by James Larminie, Andrew Dicks, John Wiley & Sons,2003

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**

✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks

✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks

✓ Teaching Evaluation Components : 10Marks
(Viva Voce / Assignments /Group activities/ Report Writing etc.)

✓ Class Attendance : 10Marks

- **End-Semester Examination** : **60 Marks**

6CH238PE: **Food Science & Engineering (**PEC-II**)**

Subject Code	Title	Credits-03		
6CH238PE	**Food Science & Engineering**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

The course aims to:

- Understand fundamentals of food science and processing
- Apply chemical engineering principles in food industries
- Learn preservation and storage techniques
- Analyze food processing operations and equipment
- Promote food safety and sustainability

Course Outcomes (COs)

After completion of the course, students will be able to:

- **CO1:** Explain composition and properties of food materials
- **CO2:** Apply heat and mass transfer in food processing
- **CO3:** Understand food preservation and storage techniques
- **CO4:** Analyze food processing equipment and operations
- **CO5:** Ensure food safety and quality standards.

SECTION A

UNIT I: Fundamentals of Food Science

Composition of foods (Carbohydrates, proteins, fats, water), Physical and chemical properties of food , Food spoilage and deterioration, Introduction to food microbiology (7)

UNIT II: Food Preservation Techniques

Thermal processing (Pasteurization, sterilization), Refrigeration and freezing, Drying and dehydration, Use of preservatives (6)

UNIT III: Heat and Mass Transfer in Food Processing

Heat transfer in food systems, Evaporation and concentration, Drying mechanisms, Freezing and thawing (6)

SECTION B

UNIT IV: Food Processing Operations & Equipment

Size reduction, mixing, separation, Filtration, centrifugation, Extrusion and homogenization, Equipment used in food industries (7)

UNIT V: Food Safety, Quality & Packaging Food safety standards (Food Safety and Standards Authority of India guidelines), Basics of Quality control and testing, Food packaging (Materials and methods, Shelf-life analysis) (8)

UNIT VI: Industrial Applications & Emerging Trends

Processing of (Dairy products, Fruits and vegetables, Oils and fats), Waste utilization in food industries, Introduction to functional foods and nutraceuticals, Sustainability and energy efficiency in food processing, Case studies (Dairy plant, Agro-processing unit) (8)

Text Books:

1. Food Processing Technology: Principles and Practice, P. J. Fellows, Woodhead Publishing (Elsevier), 2017 (4th Edition)

2. Food Engineering and Technology, Zeki Berk, Academic Press (Elsevier), 2018 (2nd Edition)

3.Introduction to Food Engineering, R. Paul Singh, Dennis R. Heldman, Academic Press, 2013 (5th Edition)

4. Fundamentals of Food Engineering, D. G. Rao, PHI Learning Pvt. Ltd., New Delhi, 2010

5. Food Science and Technology, S. Srilakshmi, New Age International Publishers, 2015

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments /Group activities/ Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

6CH239PE / 6CT234PE :Process Equipment Design & Drawing (PEC-III**)**

Subject Code	Title	Credits-03		
6CH239PE / 6CT234PE	**Process Equipment Design & Drawing**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

The course aims to:

- Understand fundamentals of process equipment design
- Apply design principles to chemical engineering equipment
- Develop skills in engineering drawing and interpretation
- Learn selection of materials and design codes
- Build capability for industrial equipment design and documentation

Course Outcomes (COs)

After completion of the course, students will be able to:

- **CO1:** Apply design principles for process equipment
- **CO2:** Perform basic design calculations for chemical equipment
- **CO3:** Prepare and interpret engineering drawings
- **CO4:** Select suitable materials and fabrication methods
- **CO5:** Understand industrial standards and safety aspects

SECTION A

UNIT I: Introduction to Process Equipment Design

Role of design in chemical engineering, Design procedure and steps, Design considerations (Mechanical, thermal, and safety aspects), Introduction to Codes and standards (ASME (conceptual understanding)), Material selection for process equipment (7)

UNIT II: Design of Pressure Vessels

Types of pressure vessels, Design of thin cylinders and spheres, Design under internal pressure, Basic Heads and closures, Introduction to thickness calculation (7)

UNIT III: Design of Heat Transfer Equipment

Design basics of heat exchangers, Introductory Shell and tube heat exchanger design, Selection of materials, Fouling considerations, Thermal and mechanical design aspects (7)

SECTION B

UNIT IV: Design of Mass Transfer Equipment

Introduction to Design of packed columns, Basics of Tray columns, Basics of Absorption and distillation equipment, Column internals and selection (7)

UNIT V: Engineering Drawing & Drafting Basics of engineering drawing

Drawing of (Pressure vessels, Heat exchangers, Storage tanks), Basic Piping and Instrumentation Diagram (P&ID), Basic Introduction to CAD tools) (7)

UNIT VI: Industrial Practices, Fabrication & Safety

Fabrication techniques (Welding, forming), Basics of Inspection and testing methods, Maintenance of equipment, Safety in design and operation, Case studies (Chemical plant equipment), Introduction to simulation/design tools (Basics of AutoCAD etc.) **(7)**

Text Books:

1. Process Equipment Design, M. V. Joshi, Macmillan India Ltd, 1985
2. Chemical Engineering Design (Volume 6), R. K. Sinnott, Elsevier Butterworth-Heinemann, 2005 (4th Edition)
3. Process Equipment Design**,** B. C. Bhattacharya , CBS Publishers & Distributors, New Delhi , 2011
4. Plant Design and Economics for Chemical Engineers, Max S. Peters, Klaus D. , McGraw-Hill, 2003 (5th Edition)

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments /Group activities/ Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

6CH240PE: **Thermodynamics of Phase & Chemical Equilibrium (**PEC-III**)**

Subject Code	Title	Credits-03		
6CH240PE	**Thermodynamics of Phase & Chemical Equilibrium**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

The course aims to:

- Understand thermodynamic principles of phase and chemical equilibrium
- Apply concepts to real chemical engineering systems
- Develop problem-solving skills using thermodynamic models
- Analyze equilibrium in multiphase and reacting systems
- Prepare students for design and simulation applications

Course Outcomes (COs)

After completion of the course, students will be able to:

- **CO1:** Explain phase equilibrium behavior of pure and multicomponent systems
- **CO2:** Apply VLE, LLE concepts in separation processes
- **CO3:** Analyze chemical equilibrium in reacting systems
- **CO4:** Use thermodynamic relations for equilibrium calculations
- **CO5:** Solve practical problems relevant to chemical industries.

SECTION A

UNIT I: Fundamentals of Thermodynamics & Phase Behavior

Review of thermodynamic laws, Phase rule and phase diagrams, Properties of pure substances, Ideal and real systems, Introduction to fugacity and activity (7)

UNIT II: Vapor–Liquid Equilibrium (VLE)

Raoult's law and deviations, Ideal and non-ideal solutions, VLE diagrams (T–x–y, P–x–y), Azeotropes, Basic flash calculations (6)

UNIT III: Liquid–Liquid & Solid–Liquid Equilibrium

Liquid–liquid equilibrium (LLE), Extraction systems, Solid–liquid equilibrium (SLE), Basic concept Crystallization.(7)

SECTION B

UNIT IV: Chemical Reaction Equilibrium

Concept of chemical equilibrium, Equilibrium constant and its temperature dependence, Gibbs free energy and equilibrium, Homogeneous reactions (6)

UNIT V: Equilibrium in Multiphase Systems

Simultaneous phase and chemical equilibrium, Heterogeneous reactions, Reaction equilibrium with phase equilibrium, Basic numerical methods for equilibrium problems (6)

UNIT VI: Industrial Applications & Computational Tools

Application in (Distillation, Absorption, Crystallization), Introduction to thermodynamic models (basic) (Concept of Activity coefficient models), Use of computational tools (Introduction to Aspen HYSYS), Case studies (Separation processes in industries, Sustainability and energy efficiency) (8)

Text Books:

1. Introduction to Chemical Engineering Thermodynamics, J. M. Smith, H. C. Van Ness, M. M. Abbott, McGraw-Hill Education, 2005

2. Chemical Engineering Thermodynamics, Y. V. C. Rao, Universities Press (India), 1997

3.Thermodynamics for Chemical Engineers, K. V. Narayanan, PHI Learning Pvt. Ltd., New Delhi, 2007

4. Chemical Engineering Thermodynamics, P. Ahuja, PHI Learning Pvt. Ltd., 2009

5. Phase Equilibria in Chemical Engineering, Stanley I. Sandler, Wiley, 2006

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments /Group activities/ Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

6CH241PE: **Renewable Energy Sources (**PEC-III**)**

Subject Code	**Title**	**Credits-03**		
6CH241PE	**Renewable Energy Sources**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

The course aims to:

- Understand different renewable energy sources and technologies
- Apply chemical engineering principles in energy systems
- Analyze energy conversion and efficiency
- Promote sustainable and decentralized energy solutions
- Develop awareness of policies and future energy trends

Course Outcomes (COs)

After completion of the course, students will be able to:

- **CO1:** Identify and explain various renewable energy sources
- **CO2:** Analyze working principles of renewable energy systems
- **CO3:** Evaluate performance and efficiency of systems
- **CO4:** Design basic renewable energy solutions
- **CO5:** Understand sustainability and environmental impacts

SECTION A

UNIT I: Introduction to Renewable Energy

Energy scenario: (Conventional vs renewable energy), Need for renewable energy, Classification of renewable sources, Energy conversion basics, Environmental impact (7)

UNIT II: Solar Energy Systems

Solar radiation basics, Solar thermal systems (Solar water heater, Solar cooker), Basics of Solar photovoltaic (PV) systems, Basics of Energy storage (6)

UNIT III: Wind and Hydropower Energy

Wind energy (Principles and components, Basic of Wind turbines), Hydropower (Small and micro hydropower), Site selection and limitations (6)

SECTION B

UNIT IV: Biomass and Bioenergy

Biomass resources and properties, Biogas production (anaerobic digestion), Biofuels (Bioethanol, Biodiesel), Waste-to-energy concepts (6)

UNIT V: Emerging Renewable Technologies

Basics of Geothermal energy, Introduction to Ocean energy (tidal, wave), Introduction to Hydrogen energy, Basic concept of Fuel cells **(6)**

UNIT VI: Energy Management, Sustainability & Policies

Energy efficiency and conservation, Basic concept of Energy audit, Integration of renewable energy systems, Environmental and economic aspects, Government initiatives (Ministry of New and Renewable Energy schemes), Case studies (Solar and biomass projects) (8)

Text Books:

1. Non-Conventional Energy Sources, G. D. Rai ,Khanna Publishers, New Delhi, 1988

2. Renewable Energy Engineering and Technology, V. N. Kishore, TERI Press, New Delhi, 2008

3. Renewable Energy Resources, John Twidell, Tony Weir, Routledge, 2015 (3rd Edition)

4. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme, J. K. Nayak, Tata McGraw-Hill Education (India), 2008

5. Energy Technology (Non-Conventional, Renewable and Conventional), S. Rao, B. B. Parulekar, Khanna Publishers, 2010

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments /Group activities/ Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

6CH242PC: Mass Transfer –I Lab (PCC-I Lab.)

Subject Code	Title	Credits- 01		
6CH242PC	**Mass Transfer –I Lab**	L	T	P
Semester: VI	Total Contact Hours: 2 Hrs / Week	0	0	2

List of Experiments:

1. To calculate the diffusivity of vapors of volatile liquid into air by Stefan's tube. (Winkelmann's Experiment)
2. To find coefficient of mass transfer of naphthalene ball in stagnant air.
3. To find yield of crystallization with and without seeding.
4. To establish Freundlich and Langmuir isotherm.
5. To determine liquid diffusion coefficient of solute diffusing in water.
6. To determine the critical moisture content of given material.
7. To measure humidity of air from humidifier.
8. To study unsteady state adsorption.
9. To compare the mass transfer in stagnant infinite medium in laminar and turbulent flow.
10. To determine gas film mass transfer coefficient by wetted column for G/L system.
11. Use of humidity or psychometric chart.
12. To compare the mass transfer coefficient for different liquids from free surface by evaporation.
13. Separation of $NaNO_3$ by fractional crystallization.
14. To study the efficiency of tray drier.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks

External University Practical Examination : **25 Marks**

6CH243PC: Petrochemical Technology Lab (PCC-II Lab.)

Subject Code	Title	Credits- 01		
6CH243PC	**Petrochemical Technology Lab**	L	T	P
Semester: VI	Total Contact Hours: 2 Hrs / Week	0	0	2

List of Experiments:

1. To determine the aniline & mixed aniline point of petroleum products & hydrocarbon solvents.
2. To determine the diesel index of liquid petroleum product and hydrocarbons.
3. To study the distillation characteristics of light petroleum product by Distillation.
4. To determine flash & fire point of liquid petroleum products by Abels or Pensky martin apparatus by closed cup method.
5. Determination of cloud and pour point of heavy liquid petroleum products.
6. Determination of % carbon residue of liquid petroleum products by Conradson carbon residue apparatus
7. Determination of smoke point of light petroleum products.
8. To determine the kinematic viscosity of given petroleum product by redwood viscometer.
9. To determine the kinematic viscosity of oil sample using Saybolt's viscometer.
10. To determine the %age of moisture present in the given sample of liquid petroleum by Dean and Stark's method.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks
- **External University Practical Examination** : **25 Marks**

6CH244PC / 6CT238PE: Chemical Reaction Engineering-I Lab. (PCC-III Lab.)

Subject Code	Title	Credits- 01		
6CH244PC / 6CT238PE	**Chemical Reaction Engineering-I Lab.**	L	T	P
Semester: VI	Total Contact Hours: 2 Hrs / Week	0	0	2

List of Experiments:

1. To determine the rate constant of saponification of ethyl acetate characterized byan acid like HCL.
2. To determine the activation energy of hydrolysis of an ester such as ethyl acetate.
3. To determine the kinetic of reaction between ethyl acetate and sodium hydroxide at room temperature using differential method of analysis.
4. To determine the kinetics of reaction between ethyl acetate and sodium hydroxide at room temperature by integral method.
5. Show that the decomposition of H2O2 in aqueous solution as first order reaction and determine value of rate constant.
6. To determine void volume porosity of catalyst particle.
7. To determine the RTD curve for packed bed reactor.
8. To determine the RTD curve for PFR.
9. To determine the RTD curve for mixed flow reactor.
10. Verification of performance equation of batch reactor.

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the main list. All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks
- **External University Practical Examination** : **25 Marks**

6CH245M: Environmental Impact & Risk Assessment. (MDM-V)

Subject Code	Title	Credits- 01		
6CH245M	**Environmental Impact & Risk Assessment**	L	T	P
Semester: VI	Total Contact Hours: 2 Hrs / Week	0	0	2

Course Objectives (COs)

The course aims to:

- Understand environmental impacts of industrial activities
- Learn methods of Environmental Impact Assessment (EIA)
- Analyze risks associated with chemical industries
- Apply safety and risk mitigation strategies
- Promote sustainable and responsible engineering practices

Course Outcomes (COs)

After completion of the course, students will be able to:

- **CO1:** Identify environmental impacts of industrial projects
- **CO2:** Apply EIA methodologies for project assessment
- **CO3:** Analyze industrial risks and hazards
- **CO4:** Suggest mitigation and safety measures
- **CO5:** Understand environmental regulations and compliance

UNIT I: Environmental Impact Assessment (EIA)

Introduction to environment and sustainability, Concept and importance of EIA, Steps in EIA process (Screening, scoping, impact analysis), Environmental parameters (Air, water, soil, noise). Basics of Impact identification methods. **(7)**

UNIT II: Risk Assessment in Chemical Industries

Introduction to industrial hazards, Types of risks (Fire, explosion, toxic release), Basic concepts of Risk assessment methods (Qualitative and quantitative), Introduction to Hazard identification techniques (HAZOP), Basics of Consequence analysis. (7)

UNIT III: Environmental Management, Safety & Regulations

Risk mitigation and control measures, Disaster management and emergency planning, Environmental management systems (EMS), Environmental laws and regulations (Central Pollution Control Board guidelines), Case studies (Industrial accidents, Environmental impact of projects) **(7)**

Text Books:

1. Environmental Impact Assessment, L. W. Canter, McGraw-Hill, New York, 1996
2. Environmental Engineering, Peavy and Row, Tata McGraw-Hill, New Delhi, 1985
3. Environmental Science and Engineering, J. G. Henry and G. W. Heinke, Prentice Hall of India, New Delhi, 2000
4. Environmental Management, N. K. Uberoi, Excel Books, New Delhi, 2004
5. Risk Assessment in Chemical Engineering, Mark Tweeddale, Butterworth-Heinemann, Oxford, 2003

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**

✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks

- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments /Group activities/ Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

VSEC -IV (Technical Dept. Specific): Minor Project on Recent Developments

Subject Code	Title	Credits- 02		
6CH401VS	**Minor Project on Recent Developments**	L	T	P
Semester: VI	Total Contact Hours: 2 Hrs / Week	1	0	2

Course Objectives

- To provide students with an opportunity to apply fundamental chemical engineering principles to solve real-world problems.
- To develop skills in literature survey, problem identification, and formulation of engineering solutions.
- To enhance practical exposure through experimentation, simulation, or design-based projects.
- To improve communication, teamwork, and technical report writing abilities.

Course Outcomes

After completion of the course, students will be able to:

- Identify and define a chemical engineering problem and propose appropriate methodologies for its solution.
- Apply theoretical knowledge and tools (e.g., modeling, simulation, or experimental techniques) to execute the project.
- Analyze and interpret results, and draw meaningful engineering conclusions.
- Present the project work effectively through written reports and oral presentations with professional ethics.

The project work must include:

- A comprehensive dissertation/Experimentation.
- Periodic progress evaluations, and
- A final viva-voce examination conducted by an internal panel.

The topic selected should align with the current academic and research priorities in the field of Chemical Engineering, and must comply with the academic and ethical standards set by the institute.

Evaluation Scheme:

Component	**Marks**
Experimental Work / Design	15
Progress & Regularity (Periodic Reviews)	15
Final Viva Voce/Presentation (Internal panel)	20
Total	**50**