Dr. Babasaheb Ambedkar Technological University, Lonere

(Established as a University of Technology in the State of Maharashtra)

(Under Maharashtra Act No. XXIX of 2014)

P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra

Telephone and Fax. : 02140 - 275142

www.dbatu.ac.in

Curriculum for Final year

B. Tech. in Chemical Engineering

With effect from AY 2026-27

Final Year

SEMESTER VII

Category	Course Code	Course Title	Teaching and Evaluation Scheme							
			L	T	P	CA	MSE	ESE	Total	**Credits**
PCC	26UD1507PC701	Transport Phenomena	3	-	-	20	20	60	100	**3**
PCC	26UD1507PC702	Process Equipment Design and Drawing	3	-	-	20	20	60	100	**3**
PCC	26UD1507PC703	Heat Transfer Equipment Design	3	-	-	20		60	100	**3**
PCC	26UD1507PCL 704	Process Equipment Design Drawing and Simulation Laboratory	-	-	4	60	-	40	100	**2**
PEC	26UD1507PE705	Program Elective - IV A. Optimization Techniques. B. Modeling and Simulation in Chemical Engineering. C. Membrane Technology.	3	-	-	20	20	60	100	**3**
MDM	26UD1507MD706	Multidisciplinary Minor V (Chemical Recation Engineering)	2	-	-	20	20	60	100	**2**
PEC	26UD1507PE707	Program Elective- V A. Pollution Control in Process Industries. B. Materials for Engineering Applications. C. Introduction to Polymer Science And Engineering.	3	-	-	20	20	60	100	**3**
ELC	26UD1507MP708	Mini Project 2	-	-	2	60	-	40	100	**1**
ELC	26UD1507FT709	Field Training/Internship Evaluation	-	-		60	-	40	100	**1**
		Total	**17**	**-**	**6**	**200**	**140**	**460**	**800**	**21**
Semester VIII										
PCC	26UD1507PC801	Environmental quality monitoring and Analysis.	3	-	-	20	20	60	100	3
PEC	26UD1507PE802	Program Elective- VI A. Chemical Process Utilities. B.Computational Fluid dynamics. C. Research Methodology.	3	-	-	20	20	60	100	3
MDM	26UD1507MD803	Multidisciplinary Minor VI (Chemical Technology and Plant Safety)	2	-	-	20	20	60	100	2
ELC	26UD1507PR804/ 26UD1507IN804	Project/Internship/OJT	-	-	24	60	-	40	100	12
		Total	**8**	**-**	**24**	**120**	**60**	**220**	**400**	**20**

Semester VII

Transport Phenomena	**3 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	**26UD1507PC701**	**Transport Phenomena**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**3**

Course Objective:

After completion of course, students will have adequate background, conceptual clarity and knowledge of appropriate techniques related to:

1. Transport of momentum, transport of energy, mass transfer.
2. The transport of mass of various chemical species.
3. Create chemical engineering knowledge using the transport phenomena approach with special focus on combined transport problems.

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the analogy among momentum, heat and mass transport.
2. Formulate a mathematical representation of a flow/heat/mass transfer phenomena.
3. Solve flow/heat/mass transfer problems either individually or coupled for simple geometries analytically.
4. Identify the similarities among the correlations for flow, heat and mass transfer interfaces.
5. Create original solutions to fluid flow, heat transfer and mass transfer problems, and solve problems combining these transport phenomena.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	✓	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	-	✓	-	-	-	-	-	-
CO3	✓	-	✓	✓	-	✓	-	-	-	-	-	-
CO4	✓	-	✓	✓	-	✓	-	-	-	-	-	-

Detailed syllabus

UNIT I

1. **Viscocity and Mechanism of Momentum Transport:** Newton's Law of Viscosity; Non-Newtonian fluids ; The Bingham model; The power law model; The Elli's model and the Reiner Philipp off model; Temperature and pressure dependents of viscosity.

2. **Velocity Distribution in Laminar Flow:** Shell momentum balances; Boundary conditions ; Flow of a falling film; flow through a circular tube; flow through annulus.

UNIT II

1. **Equation of Change For Isothermal Systems:**Equations of continuity and motion in Cartesian and curvilinear co-ordinates; Use of the equations of change to set-up steady flow problems. Tangential annular flow of Newtonian fluid; Shape of surface of a rotating liquid.

2. **Velocity Distribution with more than one Independent Variable:** Unsteady viscous flow ; Flow near a wall suddenly set in motion.

UNIT III

1. **Interphase Transport in Isothermal Systems:** Definition of fraction factors; Friction factors for flow in tubes; for around spheres.

2. **Thermal Conductivity and Mechanism of Energy Transport:** Fourier's law of heat conduction; temperature and pressure dependence of thermal conductivity in gases and liquids

3. **Temperature Distribution in Solids and in Laminar Flow:** Shell energy balances; Boundary conditions; Heat conduction with an electrical heat source; with a viscous heat source.

UNIT IV

1. **Equations of Change for Non-Isothermal Sytems:** Use of equations of energy and equations of motion (for forced and free convection) in non-isothermal flow; Tangential flow in an annulus with viscous heat generation; steady flow of a non-isothermal film; Transpiration cooling.

2. **Temperature Distributions with more than one Independent Variable:** Unsteady heat conduction in solids; Heating of a semi-infinite slab.

3. **Interphase Transport in Non-Isothermal Systems:** Definition of heat transfer coefficient; Heat transfer coefficients for forced convection in tubes; for forced convection around submerged objects.

4. **Diffusivity and the Mecahnism of Mass Transport:** definition of concentrations; Velocity and mass fluxes; Fick's law of diffusion; Temperature and pressure dependence of mass diffusivity.

UNIT V

1. **Concentration Distribution in Solid and in Laminar Flow:** Shell mass balances; Boundary conditions; Diffusion through a stagnant gas film; Diffusion with heterogeneous chemical reaction.
2. **Equation of Change for Multicomponent Systems:** Equations of continuity for a binary mixture.
3. **Interphase Transport in Multicomponent Systems:**Definition of binary mass transfer coefficients in one phase. Correlations of binary mass transfer coefficient in one phase at low mass transfer rates.

TEXT BOOK:

Bird R.B., Stewart W.E. and Light Foot E.N. Transport Phenomena – John Wiley International – 2ndEdition, New York, (2002).

REFERENCE BOOKS:

Christie J. Geankoplis – Transport Processes and Unit Operations – Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

Process Equipment Design and Drawing 3

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	26UD1507PC702	Process Equipment Design and Drawin	3	-	-	20	20	60	100	3

Course Objectives:

1. To learn the design procedure of various process equipment.
2. To understand the mechanical aspect of equipment design.
3. To understand the different types of code used in mechanical design of process equipment in chemical process industries.
4. To learn the design aspects of other component of process equipment.
5. To understand the relation between design, safety and environmental aspects.

Course Outcomes: At the end of the course, the student will be able to:

1. Identify equipment and instruments based on symbols
2. Draw process flow diagrams using symbols
3. Apply mechanical design aspects to process equipment
4. Design heat exchangers, evaporators, absorbers, distillation columns, reactors and filters.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	✓	-	-	✓	-	-	-	-	-	-	✓
CO2	-	✓	-	-	✓	-	-	-	-	-	-	-
CO3	✓	-	✓	✓	✓	✓	-	-	-	-	-	-
CO4	✓	-	✓	✓	✓	✓	-	-	-	-	-	-

Detailed syllabus

UNIT I:

Mechanical Design of Process Equipment: Introduction to mechanical aspects of chemical equipment design,

UNIT II:

Design Preliminaries, Design of cylindrical and spherical vessels under internal pressure, Design of heads and closers, Design of tall vessels.

UNIT III:

Drawing: Drawing of process equipment symbols for fluid handling, heat transfer, mass transfer, drawing of process equipment symbols for vessels, conveyers and feeders etc. Drawing of process equipment symbols for separators, mixing & comminution etc. Drawing of process equipment symbols for distillation, driers, evaporators, scrubbers etc.

UNIT IV:

Drawing of process equipment symbols for crystallizer, grinding, jigging, elutriation, magnetic separation, compressor etc. Drawing of basic instrumentation symbols for flow, temperature, level, pressure and combined instruments, Drawing of miscellaneous instrumentation symbols, detailed drawing of equipment, drawing of flow sheet.

UNIT V:

Process Equipment Design: Design of a heat exchanger, Design of an absorber, Design of a distillation column, Design of evaporator, Design of condenser, Design of a chemical reactor.

Text / References:

1. Brownell L.E, Process Equipment Design - Vessel Design, Wiley Eastern Ltd., 1986.
2. Bhattacharya B.C., Introduction to Chemical Equipment Design - Mechanical Aspects, CBS Publishers and Distributors, 2003.
3. Towler, G. P. and R. K. Sinnott, Chemical Engineering Design, Principles, Practice and Economics of Plant and Process Design, 2nd Edition, Butterworth Heinemann, 2012.
4. Donald Kern, Process Heat Transfer, 1st Edition, Tata McGraw-Hill Education, 1950
5. Robert E. Treybal, Mass-Transfer Operations, 3rd Edition, McGraw-Hill Book Company, 1981.

Heat Transfer Equipment Design — 3 Credit

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	26UD1507PC703	Heat Transfer Equipment Design	3	-	-	20	20	60	100	3

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. process design of double pipe heat exchanger
2. process design of Shell and Tube heat Exchanger
3. process design of condenser and reboiler
4. process design of evaporator
5. process design of agitator

Course Outcomes: At the end of the course, the student will be able to:

1. Do process design of double pipe heat exchanger
2. Do process design of Shell and Tube heat Exchanger
3. Do process design of condenser and reboiler
4. Do process design of evaporator
5. Do process design of agitator

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	✓	-	✓	-	-	-	-	-
CO2	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO3	✓	✓	-	-	✓	-	✓	-	-	-	-	-
CO4	✓	✓	-	-	✓	-	✓	-	-	-	-	-
CO6	✓	✓			✓		✓					

Detailed Syllabus

Unit I:
Detailed Process Design of Double Pipe Heat Exchangers

Unit II:
Detailed Process Design of Shell and Tube heat exchanger

Unit III:
Detailed Process design of condenser and reboiler

Unit IV:
Detailed Process Design of Evaporator

Unit V:
Detailed process design of Agitator

Text/Reference books:

1. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergamon press, 1970
2. D. Q. Kern, "Process Heat Transfer", McGraw Hill, 1950.

Process Equipment Design, Drawing and Simulation Laboratory 2 Credit

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	26UD1507PCL704	Process Equipment Design and Drawing Laboratory	-	-	4	60	-	40	100	2

Course Objective:

1. To learn how to use and draw basic Standard equipment symbols and Standard instrumentation symbols used in the chemical process industry.

2. To study how to design and draw Heads and closures, Keys and couplings, Supports for vessels- like Bracket Support, Leg Support, Skirt Support and packed absorption tower.
3. Learn to draw the process flow diagram using symbols.
4. Learn to design heat exchangers, evaporators, absorbers, distillation columns, reactors, filters etc.

Course Outcomes: At the end of the course, the student will be able to:

1. Identify equipment and instruments based on symbols.
2. Draw process flow diagrams using symbols.
3. Apply mechanical design aspects to process equipment.
4. Design heat exchangers, evaporators, absorbers, distillation columns, reactors , filters etc.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-

List of Experiments :

- Based on the theory course students should design and draw the sheets of chemical process vessels.
- General Concepts of Simulation for Process Design: Introduction; Process simulation models; Methods for solving non-linera equations; Recycle partitioning and tearing; Simulation examples.
  Design of following equipment using ASPENPLUS or any good software

  a. Heat Exchanger

  b. Absorption column

  c. Distillation column

  d. Reactor

  e. Evaporator

  f. Flow sheeting of a chemical plant

  g. Simulation of a small size chemical plant.

Professional Elective-IV **3 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	26UD1507PE705.A	A. Optimization Techniques	3	-	-	20	20	60	100	3

Course Objectives

1. To understand the fundamentals and importance of optimization techniques in engineering applications.
2. To learn the formulation of optimization problems with objective functions and constraints.
3. To study analytical and numerical methods for solving unconstrained and constrained optimization problems.
4. To develop the ability to solve single-variable and multivariable optimization problems using appropriate techniques.
5. To understand the application of software tools for solving real-world optimization problems in chemical engineering.

Course Outcomes:

At the end of the course, the student will be able to:

1. Formulate engineering optimization problems by identifying objective functions, design variables, and constraints.
2. Understand the fundamental concepts and mathematical techniques used in optimization.
3. Apply appropriate methods to solve unconstrained single-variable optimization problems.
4. Solve unconstrained and constrained multivariable optimization problems using analytical and numerical methods.
5. Utilize optimization software tools to solve engineering design and process optimization problems.

Mapping of Course outcomes with Program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	-		-	-	-	✓	-	-	-
CO2	✓	✓	✓	-	✓	-	-	-	-	-	-	-
CO3	✓	✓	✓	-	✓	-	-	-	-	-	-	-
CO4	✓	✓	✓	-	✓	-	-	-	-	-	-	-
CO5	✓	✓	-	-		-	-	-	-	-	-	-

Detailed Syllabus

Unit 1 : Introduction to optimization, optimization problem formulation

Unit 2 : basic concepts of optimization

Unit 3: Unconstrained single variable optimization : methods and applications, Unconstrained multivariable optimization: methods and applications

Unit 4 : Unconstrained multivariable optimization : gradient based methods, introduction to linear programming

Unit 5 : Linear programming : simplex method, constrained non-linear programming, Applications of Optimization, Software tools for optimization

References:

1. Optimization of Chemical Processes, by T. F. Edgar and D. M. Himmelblau
2. Engineering Optimization : Methods and optimization by A. Ravindran and K. M. Ragsdell

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1507PEE705.B**	**B. Modeling and Simulation Chemical Engineering**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**3**

Course Objectives

1. To understand the principles of mathematical modeling for chemical engineering processes using fundamental conservation laws.
2. To develop mathematical models for heat transfer, mass transfer, and chemical reaction systems.
3. To study lumped and distributed parameter models for process equipment and reactors.
4. To learn the fundamentals and applications of process simulation techniques.
5. To develop the ability to use modern simulation software for analyzing and solving chemical engineering problems.

Course Outcomes

At the end of the course, the student will be able to:

1. Apply mass, component, energy, and momentum balance equations to develop mathematical models of chemical engineering systems.
2. Develop lumped parameter models for heat transfer equipment, mass transfer equipment, and reactors with heat transfer.
3. Formulate distributed parameter models for mass transfer equipment, heat exchangers, and plug flow reactors.
4. Analyze and simulate chemical engineering processes using appropriate mathematical techniques.

5. Utilize modern process simulation software to model, analyze, and optimize chemical engineering operations.

Mapping of Course outcomes with Program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO 1	✓	-	-	-	-	-	-	-	-	-	✓	✓
CO 2	✓	✓	-	-	-	-	-	-	-	-	✓	✓
CO 3	✓	✓	✓	-	✓	-	-	-	-	-	✓	✓
CO 4	-	-	✓	-	✓	-	-	-	-	-	✓	✓

Detalied Syllabus:-

Unit 1: Basic Modeling Introduction to modeling – Types of Models, Dependent & Independent Variables, Application and scope coverage, Modeling fundamentals, Chemical engineering modeling, Several aspects of the modeling approach, General modeling procedure

Unit 2: Formulation of dynamic models Mass balance equation - Balancing procedure, Case studies: CSTR, Tubular reactor , Coffee percolator, Total mass balance, Case Studies: Tank drainage, Component balances Case Studies: Waste holding tank, Continuous heating in an agitated tank, Heating in a filling tank, Parallel reaction in a semi continuous reactor with large temperature difference, Momentum balances – Dimensionless model equations, CSTR, Gas liquid mass transfer in a continuous reactor, Multistage Evaporator

Unit 3: Modeling of stage wise processes Introduction, Stirred tank reactor, Reactor Configurations, Generalized model description, Heat transfer to and from reactors, Steam heating in jacket, Dynamics of the metal jacket walls, Batch reactor – Constant volume, Semi - Batch reactor, CSTR - Constant volume CSTR, CSTR cascade, Reactor stability, Reactor Control, Bioreactors, Trickle bed reactor

Unit 4: Mass transfer process models Liquid-liquid extraction, Binary batch distillation, Continuous binary distillation, Multi-component separation, Multi-component steam distillation, Absorber- stage wise absorption, steady state gas absorption with heat effects.

Unit 5: Modeling of distributed system Plug flow tubular reactor, Liquid phase tubular flow reactor, Gas phase tubular flow reactor contactors, Dynamic simulation of the Plug-Flow tubular reactor , Dynamic modeling of plug-flow contactors: liquid–liquid extraction column dynamics, Steady-state

tubular flow with heat loss, Steady state counter-current heat exchanger, Heat exchanger dynamics Scope of process simulation, Formulation of problem, Step for steady state simulation, Process simulation approaches for steady state simulation, Strategies, Process simulator, Structure of process simulator, Integral process simulation, Demonstration of process simulator.

Text / References:

1. W. L. Luyben, —Process Modeling, Simulation and Control for Chemical Engineering, McGraw Hill Book co., 1973.

2. John Ingham, Irving, J. Dunn, Elmar, Heinzle Jiri, E. Prenosil, —Chemical Engineering Dynamics, VCH Publishers Inc., New York, 1974.
3. Amiya K. Jana, Chemical Process Modelling and Computer Simulation, Prentice Hall India, 2nd Edition, 2011.

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1507PEE705.C**	**C. Membrane Technology**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**3**

Course Objective:

1. To gain the knowledge and understanding of all the membrane technology
2. To understand the need of various technologies related to membrane processess in chemical engineering.

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the technologies of membrane synthesis.
2. Classify the membranes.
3. Select membrane according to the application.
4. Understand and able to formulate and solve the mathematical models of membrane processes.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓	-	-	-	-	-
CO2	-	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	-	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-

Detailed Syllabus

UNIT I:

Introduction: Membrane separation process, Definition of Membrane, Membrane types, Advantages and limitations of membrane technology compared to other separation processes, Membrane materials.

UNIT II:

Preparation of synthetic membranes: Phase inversion membranes, Preparation techniques for immersion precipitation, Synthesis of asymmetric and composite membranes, and Synthesis of inorganic membranes.

UNIT III:

Transport in membranes: Introduction, Driving forces, Transport through porous membranes, transport through non-porous membranes, Transport through ion-exchange membranes.

UNIT IV:

Membrane processes: Pressure driven membrane processes, Concentration as driving force, Electrically driven membrane processes.

UNIT V:

Polarization phenomena and fouling: Concentration polarization, Membrane fouling Modules: Introduction, membrane modules, Comparison of the module configuration

Reference Books:

1. Mulder M, Basic Principles of Membrane Technology, Kluwer Academic Publishers, London, 1996.
2. Richard W. Baker, Membrane Technology and Research, Inc. (MTR), Newark, California, USA, 2004.
3. KaushikNath, Membrane Separation Processes, Prentice-Hall Publications, New Delhi, 20

Multidisciplinary Minor V **2 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
MDM	26UD15707MD706	MDM V (Chemical Reaction Engineering)	2	-	-	20	20	60	100	2

Detailed Syllabus

Unit I: Introduction, Mole Balances and Reactor Types

Introduction to Chemical Reaction Engineering; Industrial applications of chemical reactors; Rate of reaction and basic terminology; General mole balance equation; Mole balances for: Batch Reactor, Continuous Stirred Tank Reactor (CSTR), Plug Flow Reactor (PFR); Classification and comparison of ideal reactors.

Unit II: Conversion, Stoichiometry and Rate Laws

Conversion and its significance; Design equations based on conversion; Stoichiometry of reacting systems; Concentration relationships for batch and flow reactors; Reaction rate law; Reaction order and molecularity; Rate constant; Temperature dependence of reaction rates: Arrhenius equation, Collision theory, Transition State (Activated Complex) theory; Elementary and non-elementary reactions

Unit III: Isothermal Reactor Design

Design of Batch Reactor; Design of Continuous Stirred Tank Reactor (CSTR); Design of Plug Flow Reactor (PFR); Reactor sizing; Reactors in series; Reactors in parallel; Performance comparison of ideal reactors; Selection of reactors for industrial applications

Unit IV: Determination of Reaction Rates and Catalysis

Experimental methods for determining reaction rates: Batch reactor (Integral) method; Differential method; Method of initial rates; Method of half-life; Introduction to catalysis: Homogeneous and heterogeneous catalysis; Catalytic reactors; Industrial applications of catalytic reactors

Unit V: Multiple Reactions and Reactor Performance

Types of multiple reactions: Series reactions, Parallel reactions; Selectivity and yield; Introduction to residence time distribution; Ideal and non-ideal reactor behaviour; Scale-up considerations; Industrial applications of chemical reaction engineering

Text Books

H. Scott Fogler, Elements of Chemical Reaction Engineering, 5th Edition, Pearson Education.

Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, John Wiley & Sons.

Reference Books

Lanny D. Schmidt, The Engineering of Chemical Reactions, 2nd Edition, Oxford University Press.

J. M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw-Hill.

Professional Elective-V **3 Credits**

Category	Code	Subject Nam	L	T	P	CA	MSE	ESE	Total	Credit
PEC	26UD1507PE707.A	A.Pollution Control in Process Industries	3	-	-	20	20	60	100	3

Course Objectives

1. To understand the sources, characteristics, and environmental impacts of pollutants generated in process industries.
2. To study the meteorological factors influencing the dispersion and control of air pollutants.
3. To learn the principles and methods of air pollution prevention and control.
4. To understand the treatment technologies for industrial wastewater, solid waste, and hazardous waste.
5. To develop the ability to select and design suitable pollution control equipment and treatment processes for industrial applications.

Course Outcomes

At the end of the course, the student will be able to:

1. Analyze the sources, characteristics, and environmental effects of pollutants generated from process industries.
2. Explain the influence of meteorological factors on air pollution dispersion and control.

3. Apply appropriate air pollution control methods and technologies for industrial emissions.
4. Select suitable treatment technologies for industrial water, wastewater, and solid waste management.
5. Design and evaluate unit operations and equipment used for pollution control in process industries.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO2	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO3	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO4	✓	✓	-	✓	✓	-	✓	-	-	-	-	-
CO5	✓	✓	✓	✓	-	-	✓	-	-	-	-	-

Detailed Syllabus

Unit I: Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil. Air pollution sources & effects: Classification and properties of air pollutants, Emission sources, Behavior and fate of air pollutants, Effect of air pollution.

Unit II: Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants, Estimation of plume rise. Air pollution sampling and measurement: Types of pollutant sampling and measurement, Ambient air sampling, Stack sampling, Analysis of air pollutants.

Unit III: Air pollution control methods & equipment: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous emissions, Design methods for control equipment.

Unit IV: Control of specific gaseous pollutants: Control of sulphur dioxide emissions, Control of nitrogen oxides, Carbon monoxide control, Control of hydrocarbons and mobile sources. Water pollution: Water resources, Origin of wastewater, types of water pollutants and there effects.

Unit V: Waste water sampling, analysis and treatment: Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, Basic processes of water treatment, Primary treatment, Secondary treatment, Advanced wastewater treatment, Recovery of materials from process effluents.Solid waste management: Sources and classification, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal. Hazardous waste management: Definition and sources, Hazardous waste classification, Treatment methods, Disposal methods.

Text / References:

1. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern Limited, India, 1993.
2. Noel de Nevers, Air Pollution and Control Engineering, McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke, Environmental Science and Engineering, 2nd Edition, Prentice Hall of India, 2004.
4. Rao M.N. and Rao H.V.N - Air Pollution, Tata - McGraw Hill Publishing Ltd., 1993.

5. De A.K - Environmental Chemistry, Tata - McGraw Hill Publishing Ltd., 1999.

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1507PE707.B**	**B.Materials for Engineering applications**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**3**

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Processing, microstructure and properties of materials.
2. Behavior of materials under various conditions.
3. Modes of failure of engineering materials and design new materials with better properties and cost effective processes.
4. Suitable materials for engineering applications.

Course Outcomes: At the end of the course, the student will be able to:

1. Correlate processing, microstructure and properties of materials.
2. Understand behavior of materials under various conditions.
3. Characterize modes of failure of engineering materials and design new materials with better properties and cost effective processes.
4. Identify suitable materials for engineering applications.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	✓	-	-	✓	-	✓		✓	-	-	-
CO2	-	✓	-	-	✓	-	✓		✓	-	-	-
CO3	-	✓	-	-	✓	-	✓		✓	-	-	-
CO4	-	✓	-	-	✓	-	✓		✓	-	-	-

Detailed Syllabus:

Unit I: Materials Science and Engineering: Materials, Classification of Materials, and Properties: Mechanical, Dielectric, Magnetic, and Thermal.

Unit II: Metallurgical Aspects of Materials: Structure of Metals and Alloys, Nature of Metallic Bonding,Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals, Significance of micro structural features.

Unit III: Heat Treatment: effect of cooling and heating rates and ageing materials for mechanical load bearing applications; Corrosion Resistant Materials: Some important Metals, Alloys, Ceramics and Polymers.

Unit IV: Materials for Electrical Applications: Conductors, Dielectrics, insulators; Materials for Civil Engineering Applications.

Unit V: Materials for Biomedical applications: Steels, Ti and its alloys, Ni-Ti alloys, bioceramics, porous ceramics, bioactive glasses, calcium phosphates, collagen, thin films, grafts and coatings, biological functional materials Latex products.

Text / Reference:

1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, B H, 2005.
3. ASM Publication Vol. 20, Materials Selection and Design, ASM, 1997
4. Pat L. Mangonon: The Principles of Materials Selection and Design, PHI, 1999.

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1507PE707.C**	**C.Introduction to Polymer Science and Engineering**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**3**

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and

knowledge of appropriate solution techniques related to :

1. Thermodynamics of polymer structures
2. Polymerization reactor for a polymer product.
3. Characterization of polymers.
4. Polymer additives, blends and composites.
5. Polymer Rheology

Course Outcomes: At the end of the course, the student will be able to:

1. Understand thermodynamics of polymer structures
2. Select polymerization reactor for a polymer product.
3. Characterize polymers.
4. State polymer additives, blends and composites.
5. Understand Polymer Rheology

Mapping of course outcomes with program outcomes:-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	✓	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO5	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-

Detailed Syllabus:

Unit I: Introduction: Basic concepts of Polymer Science, Various molecular forces in polymer,

Various Molecular weights and their distribution.

Unit II: Polymerization: (i) Step growth: Mechanism, Kinetics, Polyfunctional Step growth

polymerization. (ii) Radical polymerization: Mechanism, Kinetics, Effects of temperature, pressure. (iii)

Ionic and Coordination Polymerization: Kinetics of Cationic and Anionic polymerization.

Unit III: Polymerization Conditions: Bulk, Solution, Suspension and Emulsion polymerization.

Unit IV: Measurement of Molecular Weight: End group analysis, Colligative property measurement, Gel Permeation Chromatography.

Unit V: Polymer Processing:Plastic technology: Molding, Extrusion, Additives and Compounding; Fiber Technology:Textile and Fabric properties, Spinning, Elastomer technology: Vulcanization, Reinforcement.

Text/References:

1. Text book of Polymer Science: Fred W. Billmeyer, Jr., Second Edition, 1994, John Wiley and Sons, Inc., Singapore.

2. Principals of Polymerization, George Odian, Third Edition, 2002, John Wiley and Sons, Inc., Singapore.

3. Fundamentals of Polymers, Anil Kumar and Gupta, R. K., McGraw Hill, 1998.

Mini-project 2 **1 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
ELC	26UD1507MP708	Mini-Project 2	-	-	2	60	-	40	100	1

The purpose behind the mini project is that the student should be exposed to more hands-on rather than merely theory. It is expected that the student (or a small group say, not more than two in a group, to be confirmed) will undertake to make a working model, a program, critics on technology evolution, experimental work, survey etc. which he will benefit from since he /she will be doing it first-hand. It should be related to chemical engineering field.

Field Training /Internship Evaluation	1 Credit

Field Training/Internship Evaluation

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
ELC	26UD1507FT709	Field Training/Internship Evaluation	-	-	-	60	-	40	100	1

Field Training/Evaluation is to be done in this semester for the training performed by the student at the end of fifth or sixth semester for a total period of upto 4 weeks which can be done in multiple phases and in different industries.

Semester VIII

Environmental quality monitoring and Analysis	3 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	26UD1507PC801	Environmental quality monitoring and Analysis	3	-	-	20	20	60	100	3

Course Objectives

1. To understand the fundamentals of environmental quality, environmental pollution, and their impacts on human health and ecosystems.
2. To study the physical, chemical, and biological parameters used for environmental quality assessment.
3. To learn the principles and methods of environmental sampling, sample processing, and analytical techniques.
4. To understand the application of dispersion models for predicting the transport and distribution of pollutants.
5. To study the chemical exchange processes occurring among air, water, soil, and sediment in the environment.

Course Outcomes

At the end of the course, the student will be able to:

1. Explain the concepts of environmental quality, pollution, and their effects on human health and the environment.
2. Analyze various physical, chemical, and biological parameters used for environmental quality monitoring.
3. Apply appropriate sampling, processing, and analytical methods for environmental constituents.
4. Solve environmental pollution problems using air and water dispersion models.
5. Evaluate the chemical exchange processes among air, water, soil, and sediment for environmental assessment and management.

Mapping of Course outcomes with Program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	✓	-	✓	-	-	-	-	✓
CO2	-	-	-	-	✓	-	✓	-	-	-	-	✓
CO3	-	-	-	-	✓	-	✓	-	-	-	-	✓
CO4	-	-	-	-	✓	-	✓	-	-	-	-	✓
CO5	-	-	-	-	✓	-	✓	-	-	-	-	✓

Unit1 : Introduction, definition of environment, link between source/environment/receptor, health effects, toxicology, Chemicals of concern, relevant properties for environmental fate and transport, definition of equilibrium, , equilibrium partitioning of chemicals between different phases of environment

Unit 2 : Parameters for environmental water/air/soil/sediment-screening parameters, primary air pollutants, monitoring of environmental parameters-screening parameters-BOD, COD, TOC, TDS, environmental sampling- definition and synthesis of a sampling/monitoring/analysis method, QA/QC

Unit 3 : Methods for sampling/processing/analysis of organic and inorganic constituents in air/water/soil/sediment, introduction to environmental transport-BOX Models and the application to multimedia transport of pollutants

Unit 4 : Atmospheric dispersion-Gaussian Dispersion model, fundamentals of mass transport-definition of intraphase and interphase chemical flux, interphase mass transport

Unit 5: Chemical exchange between air-water, Chemical exchange between sediment-water, Chemical exchange between soil-air, overall transport model and scenario.

Professional Elective VI **3 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1507PC801.A**	**A. Chemical Process Utilities**	**3**	**-**	**-**	**20**	**20**	**40**	**100**	**3**

Course Objectives

1. To understand the role, classification, and importance of primary and secondary utilities used in chemical process industries.
2. To study the properties, selection, treatment, recycling, and reuse of water for various industrial applications such as boiler feed and cooling.
3. To understand steam generation, handling, utilization, condensate recovery, steam traps, and safe and efficient steam systems.
4. To study the applications of air in process industries and understand the design of air receivers and piping networks for water, steam, condensate, and air.
5. To understand cooling towers, pressure and vacuum systems, refrigeration systems, refractories, and insulation used in chemical process industries.

Course Outcomes

At the end of the course, the student will be able to:

1. Explain the classification, importance, properties, and selection criteria of utilities and heat transfer media used in process industries.
2. Analyze raw water characteristics and apply appropriate water treatment, recycling, reuse, and resource management methods for industrial applications.
3. Explain steam generation and utilization systems, evaluate steam traps and condensate recovery systems, and apply principles of safe and efficient steam heating.
4. Apply engineering principles for the use of air in conveying, drying, and instrumentation, and analyze the design of air receivers and industrial piping networks.
5. Explain the principles and applications of cooling towers, pressure and vacuum systems, refrigeration systems, refractories, and insulation in process industries.

Mapping of Course outcomes with Program outcomes

CO-PO Mapping

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	-	-	-	-	-	-	-	-	✓
CO2	✓	✓	✓	✓	-	✓	✓	-	-	-	-	✓
CO3	✓	✓	✓	✓	✓	✓	-	✓	-	-	✓	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	-	-	✓	✓

Detailed Syllabus

Unit 1 : Utilities in process industries, primary & secondary and their importance, Heat Transfer Media : Classification, characteristic properties, selection criteria for their industrial applications.

Unit 2 : Water : Raw water and its characteristics treatment and conditions for use in process industries, e.g. for boiler feed, cooling etc., recyling and reuse of water, Water treatment and water resource management.

Unit 3 : Steam Generation & Utilization : Steam generation, modern boilers, steam handling, condensate removal, Steam traps-classification and characteristics, condensate utilization and flash steam, Efficient steam heating systems, Safety in boiler systems.

Unit 4 : Air : Use of air in process in industries for conveying, drying and instrumentation; design of air receivers, Piping Network : Design of pipelines and piping networks for water, steam, condensate and air.

Unit 5: Properties of air water vapors: Cooling towers, : Pressure and Vacuum systems, Refrigeration systems, : Refractories and insulation.

Professional Elective VI **3 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1507PC801.B**	**B. Computational Fluid Dynamics**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**3**

Course Objectives

1. To understand the governing equations of fluid flow and their formulation for computational analysis.
2. To study numerical discretization techniques and turbulence modeling used in Computational Fluid Dynamics (CFD).

3. To learn numerical methods for solving discretized linear algebraic equations arising in fluid flow problems.
4. To understand solution techniques for coupled governing equations in CFD simulations.
5. To develop the ability to generate structured and unstructured computational grids for engineering applications.

Course Outcomes

At the end of the course, the student will be able to:

1. Derive and formulate the governing equations of fluid flow for Computational Fluid Dynamics (CFD) analysis.
2. Apply turbulence models and discretization techniques for numerical simulation of fluid flow.
3. Solve discretized linear algebraic equations using appropriate numerical methods.
4. Solve coupled governing equations using suitable iterative and direct solution techniques.
5. Generate and evaluate structured and unstructured computational grids for CFD simulations.

Mapping of Course outcomes with Program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	-	✓	-	-	-	-
CO2	✓	✓	✓	✓	-	✓	-	✓	-	-	-	-
CO3	✓	✓	✓	✓	-	✓	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO5	✓	✓	✓	-	-	-	-	✓	-	-	-	-

Unit 1 : CFD as an engineering analysis tool, derivation of flow governing equations

Unit 2 : Initial and boundary conditions, wellposedness, turbulence modelling, discretization of the governing equations using finite difference/volume methods

Unit 3 : Concepts of consistency, stability and convergence, template for the discretization of a generic unsteady transport equation, spectral analysis of errors and TVD schemes

Unit 4 : Solution of discretized linear algebraic equations, direct methods, classical iterative methods, convergence analysis, advanced methods for solution of discretized equations

Unit 5 : Solution of coupled equations: methods for compressible flows, evaluation of pressure in incompressible flows, pressure-velocity coupling algorithms, Template for the solution of governing equations, structured and unstructured grid generation methods, benchmarking and calibration.

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1507PC801.C**	**C. Research methodology**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**3**

Course Objectives:

1. To Understand the concept of research, paper writing, similarities, etc
2. To familiarize the students about the statistical methods, data interpretation , error analysis
3. To carry out analysis on the a published paper

Course Outcomes:

At the end of the program the student will be able to:

CO1: Understand and Describe importance of research.
CO2: Classify and select appropriate resources for Research.
CO3: Analyse the contents of literature and identify further scope.
CO4: Formulate a Research Problem.
CO5: Develop effective written and oral Presentation skills.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		3				1		3			2

CO2	2		2	1			1		1			2
CO3	2		3	3			1		1	2		2
CO4	2	3	3	2					2	2		2
CO5	2		1	3			3					3

Detailed syllabus:

Unit I

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.

Unit II

Research process – Criteria for good research – Problems in Indian context. Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated

Unit III

Hypothetical proposals for future development and testing, selection of Research task.

Unit IV

Mathematical modelling and simulation – Concepts of modelling – Classification of Mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation, applications in Chemical and allied industries.

Unit V

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation- Significance of report writing – Different steps inreport writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

Applications of statistical methods in research

Texts/ References:

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.

3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Multidisciplinary Minor VI **2 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
MDM	**26UD1507MD803**	**Multidisciplinary Minor VII (Chemical Technology and Plant Safety)**	**2**	**-**	**-**	**20**	**20**	**40**	**100**	**2**

Course Objectives

1. To introduce the basic concepts of chemical industries, unit operations, unit processes, and the role of chemical engineers in chemical processing.
2. To study the manufacturing processes of major chemical industries such as chloro-alkali, phosphorus, nitrogen, sulfur, sulfuric acid, soap, detergent, sugar, starch, and fermentation industries.
3. To understand the principles of chemical process design and identify safety parameters associated with chemical processes and industrial operations.
4. To develop knowledge of chemical hazards, flammability, explosivity, toxicity, pressure hazards, electrical hazards, and safe handling and storage of hazardous chemicals.
5. To understand methods of fire prevention and control, emergency response, safety checklists, protective devices, and safe operation of chemical process plants.

Course Outcomes

At the end of the course, the student will be able to:

1. Explain the basic concepts of chemical industries, unit operations, unit processes, chemical processing, and the role of chemical engineers.

2. Describe and analyze the manufacturing processes of major chemical industries including chloro-alkali, phosphorus, nitrogen, sulfur, soap and detergent, sugar, starch, and fermentation industries.
3. Identify chemical process hazards and evaluate safety parameters associated with process design, equipment, chemicals, storage, and plant operations.
4. Apply appropriate safety practices for handling, storage, transportation, and emergency management of hazardous gases, liquids, and solids in chemical process plants.
5. Explain and apply principles of chemical fire prevention and control, including fire classification, extinguishing systems, fire-fighting equipment, safety checklists, and protective devices.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	-	-	-	-	-	-	✓	-	✓
CO2	✓	✓	✓	✓	✓	-	-	-	-	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	-	-	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Detailed Syllabus

Unit I: Introduction and Basic Chemical Industries: Chemical Industries: Facts and figures, unit operation and unit process concepts, chemical processing, and role of chemical engineers, Chloro-Alkali Industries: Soda ash, Solvay process, dual process, natural soda ash from deposits, electrolytic process, caustic soda, Phosphorus Industries: Phosphoric acid (wet process, electric furnace process), calcium phosphate, ammonium phosphates, nitro phosphates, sodium phosphate

Unit II: Nitrogen and Sulfur Industries: Nitrogen Industries: Ammonia, nitric acid, urea from ammonium carbonate, ammonium nitrate, Sulfur and Sulfuric Acid Industries: Elemental sulfur mining (Frasch process), Sulfur production by oxidation-reduction of H_2S, Sulfur and sulfur dioxide from pyrites, Sulfuric acid (contact process, chamber process)

Unit III: Soap and Detergents: Batch saponification production, Sugar and Starch Industries: Sucrose, Extraction of sugarcane to produce crystalline white sugar, Extraction of sugarcane to produce sugar, Starch production from maize, Production of dextrin by starch hydrolysis in a fluidized bed. Fermentation Industries: Ethyl alcohol by fermentation.

UNIT IV: Safety in Chemical Processes: Introduction, Chemical Process classification, Process design and safety parameters. Safety parameters in the process design of phenol from cumene, safety in polyvinyl chloride plant. Chemicals and their Hazards: Introduction, Acetonitrile, acetyl chloride, butyl amine, acrylamide, acrylonitrile, allyl alcohol, benzene, bromine, isopropyl alcohol, acetaldehyde, ethylene oxide, butane, n-hexane, anhydrous ammonia, acetone, toluene, p-xylene, acetic acid, monochloro benzene, oleum, carbon mon.

UNIT V: Hazards in Chemical Process plants: Introduction, Hazards, Hazard code and explosive limit, electrical safety in chemical process plants, static electricity hazards, pressure vessel hazards, LEL and UEL of various compounds, explosive hazard, flammable liquid hazards, protection to storage tanks, fire zone location, fireball, fireball hazard. Safety in handling gases, liquids and solids: Introduction, safety in handling of gases, chlorine hazards, chlorine leakage management, safety in handling of fluorine, important safety considerations in ammonia storage, flammable solids storage, flammable liquid storage, handling of LNG, requirements to be fulfilled for storing hydrocarbons or chemicals, fail safe concept, transportation of hazardous chemicals, Hazardous in plastics processing. **Combating Chemical Fires:** Classification of fires, control of high vaour pressure fire, fire fighting foams, foam for fire protection, Foam characteristics, gaseous agent extinguishing system, automatic sprinkler system, chemical extinguishing powders, natural gas fire control. Portable fire extinguishers: Soda-acid extinguishers, carbon dioxide extinguisher, dry chemical fire extinguisher, general safety precautions for maintenance of fire extinguishers. Safety Checklist: safety studies for chemical plants, safety checklist during startup, safety checklist during shutdown mode, safety checklist for installation, safety needs during construction. Protective devices.

Text / Reference:

1. Austin G.T., Shreve's Chemical Process Industries - International Student Edition, 5thEdition, Mc Graw HillInc.,1998.
2. Sittig M. and Gopala Rao M., Dryden's Outlines of Chemical Technology for the 21stCentury,3rd Edition, WEP EastWestPress,2010.
3. A.Wangham, Theory and practice of Heat engines, ELBS cambridge University press, 1970.
4. J. L. Threlkeld, Thermal Environmental Engineering, Prentic Hall 1970.
5. S.D.Dawande, Chemical Hazards and safety, Dennet& Co publishers, 2007.

Project/Internship/OJT **12 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
ELC	26UD1507PR804/ 26UD1507IN804	Project/Internship/ OJT	-	-	24	60	-	40	100	12

Project/Internship/OJT

Every student will have to do Project Work /Internship/On job training(OJT) for the whole semester. The student can choose area suitable to him/her and should devote full semester for the project work or internship assigned to him/her either in industry or research institution. The work will be continuously monitored by the Guide/s assigned to him/her. The student has to prepare/submit reports and do presentations as per the rules framed by the University/department from time to time.