K. K. Wagh Institute of Engineering Education and Research, Nashik
(Autonomous wef AY 2022-23)

Structure and Syllabus of Final Year B. Tech (Chemical Engineering)

Pattern: 2022
(wef AY 2022-23)

- **Summary of Credits and Total Marks for U.G.Programme :**

Semester	Group -C	
	Credits	**Marks**
I	20	650
II	22	800
III	22	750
IV	20	700
V	22	750
VI	22	750
VII	22	750
VIII	20	750
Total	**170**	**5900**

● **Definition of Credit :**

The Under Graduate (U.G.) and Post Graduate (P.G.) programmes will have credit system. The details of credit will be as follow

1 Credit = 1 hour/week for lecture
= 2 hours/week for practical
= 1 hour /week for tutorial

● **Abbreviations :**

TH : Theory
PR : Practical
TU : Tutorial
OR : Oral
CCE: Continuous Comprehensive Evaluation
TW: Termwork

● **Description of various Courses:**

Type of Course	Description	Type of Course	Description
ESC	Engineering Science Course - Workshop -Drawing-Fundamentals of different branches	DCC	Department Core Course
BSC	Basic Science Courses	DEC	Department Elective Course
LHSM	Liberal arts, Humanities, Social Sciences and Management courses	OEC	Open Elective Courses of other technical or emerging areas /Courses designed by Industry
PSI	Project work, Seminar, Internship, PBL	IMC	Induction and Mandatory Courses
NC /AC	Non Credit Courses /Audit Courses	ASM	Additional Specialized / MOOCs

Final Year B.Tech Chemical Engineering wef AY 2025-26

SEM-VII

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks								Credits			
			TH	**TU**	**PR**	**INSEM**	**ENDSEM**	**CCE**	**TU**	**TW**	**PR**	**OR**	**TOTAL**	**TH**	**TU**	**PR**	**TOTAL**
CHE224001	DCC	Process Modeling and Simulation	3	-	-	20	60	20	-	-	-	-	**100**	3	-	-	**3**
CHE224002	DCC	Process Dynamics and Control	3	-	-	20	60	20	-	-	-	-	**100**	3	-	-	**3**
CHE224003	DCC	Lab Work in Process Modeling and Simulation	-	-	2	-	-	-	-	25	-	25	**50**	-	-	1	**1**
CHE224004	DCC	Lab Work in Process Dynamics and Control	-	-	2	-	-	-	-	25	25	**-**	**50**	-	-	1	**1**
CHE224005	DEC	Elective IV	3	-	-	20	60	20	-	-	-		**100**	3	-	-	**3**
CHE224006	DEC	Elective V	2	-	-	20	30	-	-	-	-		**50**	2	-	-	**2**
CHE224007	ASM	Research Methodology	3	-	-	20	60	20	-	-	-		**100**	3	-	-	**3**
CHE224008	LHSM	Innovation and Start-ups	2	-	-	-	-	50	-	-	-		**50**	2	-	-	**2**
CHE224009	PSI	Project Phase II	-	-	8	-	-	-	-	100	-	50	**150**	-	-	4	**4**
Total hours/marks/credits			**16**	**00**	**12**	**100**	**270**	**130**	**00**	**150**	**25**	**75**	**750**	**16**	**-**	**6**	**22**

Elective IV		**Elective V**	
CHE224005A	Industrial Pollution and Control	CHE224006A	Advanced Separation Processes
CHE224005B	Green Technology	CHE224006B	Energy Audit
CHE224005C	Catalysis	CHE224006C	Chemical Process Safety

DCC	Department Core Course
DEC	Department Elective Course
ASM	Additional Specialized / MOOCs
LHSM	Liberal arts, Humanities, Social Sciences and Management courses
PROJ	Project
PSI	Project work, Seminar, Internship, PBL

Final Year B.Tech Chemical Engineering wef AY 2025-26

SEM-VIII

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks								Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TU	TW	PR	OR	TOTAL	TH	TU	PR	TOTAL
CHE224011	DCC*	Process Engineering and Plant Design	3	-	-	-	60	40**	-	-	-	-	**100**	3	-	-	**3**
CHE224012	DEC*	Elective VI	3	-	-	-	60	40**	-	-	-	-	**100**	3	-	-	**3**
CHE224013	LHSM*	Entrepreneurship	2	-	-	-	-	50	-	-	-	-	**50**	2	-	-	**2**
CHE224014	PSI	Internship	-	-	24	-	-	-	-	200	-	100	**300**	-	-	12	**12**
Total hours/marks/credits			**8**	**00**	**24**	**00**	**120**	**130**	**00**	**200**	**00**	**100**	**550**	**8**	**-**	**12**	**20**

* Considering Internship of 6 months, these courses to be offered in online mode

** Four Written Assignments/LMS Tests of 10 marks each will be conducted at the end of each month and one at the end of semester, when students will report for review/presentation of Internship work.

Elective VI	
CHE224012A	Chemical Project Economics
CHE224012B	Membrane Technology

Semester VII (B. Tech.) Chemical Engineering
CHE224001: Process Modeling & Simulation

Teaching Scheme:	**Credit Scheme: 3**	**Examination Scheme:**
Theory: 3 hrs/week		In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks

Prerequisite: Courses in Engineering Mathematics, Mass Transfer, Fluid Mechanics, Heat Transfer & Reaction Engineering.

Course Objectives:
1. To study basics of modeling & simulation in chemical engineering.
2. To apply fundamental laws of modeling in heat, mass and momentum transfer processes and in reaction engineering & Kinetics.
3. To apply numerical techniques for solving chemical engineering problems.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Describe basic modeling concepts, types, and governing principles.	2 – Understand
CO2	Develop mathematical models for heat, mass transfer, and reaction systems using systematic modeling approaches.	3 – Apply
CO3	Analyze chemical process models using appropriate numerical techniques for solving differential and algebraic equations.	4 – Analyze
CO4	Simulate chemical engineering operations using modern tools like Aspen Plus, MATLAB, or ANSYS Fluent and evaluate process performance.	5 – Evaluate

Course Contents:

Unit 1	**Fundamentals of Modeling (L07)**	**COs Mapped: CO1, CO2**
Physical and mathematical modeling, forms of modeling equations, systematic approach of model building, categories of models, governing laws of modeling.		
Unit 2	**Modeling of Heat Transfer Operations (L08)**	**COs Mapped: CO2**
Two heated tanks, concentric tube heat exchanger, shell and tube heat exchanger, evaporator, rotary dryer, cooling tower etc, mixing process, pressure change equipments.		
Unit 3	**Modeling of Stage wise and continuous processes (L07)**	**COs Mapped: CO2**
Mass transfer equipments such as distillation, extraction, absorption, drying etc.		
Unit 4	**Modeling Reaction Engineering (L07)**	**COs Mapped: CO2**
Reactors such as PFR, stirred tank reactors, bioreactor, two and three phase reactors.		
Unit 5	**Numerical Techniques and Process Simulation Tools (L07)**	**COs Mapped: CO3, CO4**
Numerical methods for differentiation and integration, Computer simulation, Simulation approach, Types of Simulators such as Aspen Plus, Aspen Hysys, UniSim Design, MATLAB, Ansys Fluent etc.		

REFERENCE BOOKS:

1. Chemical Engineering Dynamic Modeling with PC Simulation, John Ingham, Irving J. Dunn, VCH Publishers, 1st Edition.

2. Process Modeling, Simulation, and Control for Chemical Engineers, William L. Luyben, McGraw-Hill Education, 2nd Edition.
3. Modeling and Simulation in Chemical Engineering, R.E.G. Franks, Wiley-Interscience, New York, 1st Edition.
4. Process Analysis and Simulation, David M. Himmelblau, Kenneth B. Bischoff, John Wiley & Sons, 1st Edition.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Three Assignments on Unit-1, Unit-2, Unit-3 & 4	10
2	Group Presentation on Unit-5	05
3	LMS Test on Each Unit	05
	Total	**20**

Semester VII (B. Tech) Chemical Engineering
CHE2214002: Process Dynamics and Control

Teaching Scheme:	Credit Scheme: 3	Examination Scheme:
Theory: 3 hrs/week		In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks

Prerequisite: Fundamental Knowledge of Process Instrumentation, Fundamental Knowledge of Laplace transform.

Course Objectives:

1. To introduce to the dynamic behavior of chemical processes and develop mathematical models using transfer functions.
2. To enable students to design and analyze feedback control systems, evaluate their stability, and understand controller tuning techniques.
3. To acquaint students with frequency response analysis, advanced control strategies, and applications of modern control systems like PLC, DCS.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Explain the dynamic behaviour of chemical processes, concept of feedback control and stability criterion	2 – Understand
CO2	Apply balance equations to develop transfer function models for physical systems and predict their time and frequency response.	3 – Apply
CO3	Design appropriate controllers using tuning techniques and apply advanced control strategies for process automation.	4 – Analyze
CO4	Evaluate the stability and performance of control systems using analytical and tuning methods.	5 – Evaluate

Course Contents:

Unit 1	Dynamic Behavior of Simple Processes (7h)	COs Mapped: CO1, CO2

Importance of instruments in chemical process industries, need and scope of process instrumentation, objectives of chemical process control, input-output model, types of forcing functions, dead-time systems, transfer function of thermometer, liquid level tank, pure capacitive process, CSTR, dynamic response of first order system to forcing functions, linearization of nonlinear systems.

Unit 2	Design of Single-Loop Feedback Control Systems (7h)	COs Mapped: CO1, CO2, CO3

Second order systems/processes – damped vibrator, interacting and non-interacting systems, U-Tube manometer, step response of second order system, characteristics of under-damped system, ON- OFF and regulating controllers, concept of feed-back control system, servo & regulatory problem, block diagram reduction of complicated control systems, and dynamic behavior of feed-back control processes.

Unit 3	Stability Analysis of Feed-Back Systems (7h)	COs Mapped: CO1, CO3, CO4

Notion of stability, characteristic equation, stability analysis of feedback control system using Routh-Hurwitz criteria, root locus. simple performance criteria – controller tuning with one-quarter decay ratio criteria, time integral performance criteria, selection of feed-back controller, Ziegler Nicholes Tuning technique and Cohen-coon technique

Unit 4	Frequency Response Analysis of Linear Processes (7h)	COs Mapped: CO1, CO2, CO4

Response of first order system to sinusoidal input, Frequency response characteristics of general linear system, Bode diagrams - First order system, Second order system, Pure capacitive process, dead time system, P, PI, PD & PID controllers, Bode stability criteria, Gain margin, Phase Margin, Nyquist Stability criteria.

Unit 5	**Multiple Loop and Advanced Control Systems (7h)**	**COs Mapped: CO3**

Control systems with multiple loops- cascade, selective, split range control systems, feed forward, ratio, adaptive and inferential control systems, supervisory control systems, PLC and DCS, IoT-enabled process monitoring and control, Case studies of industrial and advanced control systems.

REFERENCE BOOKS:

1. Chemical Process Control: An Introduction to Theory and Practice, George Stephanopoulos, PHI Learning, 1st Edition.
2. Process Systems Analysis and Control, Donald R. Coughanowr, McGraw-Hill Education, 3rd Edition.
3. Process Control: Modeling, Design and Simulation, B. Wayne Bequette, PHI Learning, 1st Edition.
4. Process Dynamics and Control, Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, Francis J. Doyle III, Wiley, 4th Edition.
5. Process Dynamics, Modeling, and Control, Babatunde A. Ogunnaike, W. Harmon Ray, Oxford University Press, 1st Edition.
6. Computer Control of Processes, M. Chidambaram, Alpha Science International Ltd., 2nd Edition.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Three Assignments on Unit-1, Unit-2, Unit-3 & 4	10
2	Group Presentation on Unit-5	05
3	LMS Test on Each Unit	05
	Total	**20**

Semester VI (B. Tech.) Chemical Engineering
CHE224003: Lab work in Process Modeling & Simulation

Teaching Scheme:	Credit Scheme: 1	Examination Scheme:
Practical: 2 hrs/Week		TW: 25 marks Oral: 25 marks Total: 50 Marks

Prerequisite: Courses in Engineering Mathematics, Mass Transfer, Fluid Mechanics, Heat Transfer & Reaction Engineering.

Course Objectives:

1. To introduce students to modern process simulation tools for modeling chemical processes and unit operations.
2. To enable students to develop, simulate, and analyze steady-state process models of unit operations, reactors, and process flowsheets.
3. To train students in performing sensitivity analysis, energy integration, and optimization for improving chemical process performance using simulation software.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Describe basic modeling concepts, types, and governing principles.	2 – Understand
CO2	Develop mathematical models for heat, mass transfer, and reaction systems using systematic modeling approaches.	3 – Apply
CO3	Analyze chemical process models using appropriate numerical techniques for solving differential and algebraic equations.	4 – Analyze
CO4	Simulate chemical engineering operations using modern tools like Aspen Plus, MATLAB, or ANSYS Fluent and evaluate process performance.	5 – Evaluate

Suggested List of Laboratory Assignments:

Ten practical's will be conducted with the use of mathematical and chemical engineering software's such as UniSim Design, DWSIM, Aspen Plus, Aspen Hysys, MATLAB, Excel etc. development of programs for numerical methods and process simulation

Sr. No	Laboratory Experiments	COs Mapped
1.	Introduction to Process Simulation Tools (Aspen Plus / HYSYS / DWSIM / UniSim Design).	**CO1, CO4**
2.	Simulation of Basic Unit Operations: Flash and Distillation.	**CO1, CO4**
3.	Simulation of Absorption and Extraction Units.	**CO1, CO4**
4.	Simulation of Heat Transfer Equipment: Heat Exchangers and Evaporators.	**CO1, CO4**
5.	Simulation of Dryers and Crystallizers in Process Simulators.	**CO1, CO4**
6.	Simulation of Reactors: CSTR and PFR for Single Reactions.	**CO1, CO2**
7.	Modeling of Batch and Equilibrium Reactors.	**CO1, CO2**
8.	Simulation of Reaction Systems with Reversible and Parallel Reactions.	**CO1, CO2**
9.	Energy Integration and Heat Exchanger Network (HEN) Design.	**CO1, CO2**
10.	Simulation of Utility Systems: Compressors, Pumps, and Steam Systems.	**CO1, CO2**
11.	Sensitivity Analysis and Optimization in Process Simulation.	**CO3**

12.	Process Flowsheet Development for Industrial Chemical Processes.	**CO3**

Guidelines for Laboratory Conduction

- Faculty explains the objective, methodology, software, input data, and expected outcomes.
- Lab assistants ensure proper setup and guide students in using simulation tools.
- Students work individually or in small groups with faculty and lab assistant supervision.
- Students perform simulations and verify results with the teacher.
- Perform necessary calculations (mass/energy balance, efficiency) and compare with theory.
- Prepare reports with objectives, simulation steps, results, graphs, and conclusions.
- Reports are reviewed by faculty and submitted digitally or in hard copy.

Guidelines for Student's Lab Journal

Write-up should include title, aim, Stepwise simulation process, results, report creation conclusions, etc.

Guidelines for Termwork Assessment

1. Each experiment from lab journal is assessed for 30 marks based on three rubrics.
2. Rubric R-1 is for timely completion, R-2 for understanding and R-3 for presentation/journal. Each rubric carries 10 marks.

Semester VII (B. Tech) Chemical Engineering
CHE224004: Lab work in Process Dynamics and Control

Teaching Scheme:	Credit Scheme: 1	Examination Scheme:
Practical: 2 hrs/Week		TW: 25 marks Practical: 25 marks Total: 50 Marks

Prerequisite: Fundamental Knowledge of Process Instrumentation, Fundamental Knowledge of Laplace transform.

Course Objectives:

1. To acquire basic understanding of the First order and Second order system
2. To apply the knowledge Different types of controllers in Chemical Industries.
3. To analyze feedback control systems, evaluate their stability, and understand controller tuning techniques.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Explain the dynamic behaviour of chemical processes, concept of feedback control and stability criterion	2 – Understand
CO2	Apply balance equations to develop transfer function models for physical systems and predict their time and frequency response.	3 – Apply
CO3	Design appropriate controllers using tuning techniques and apply advanced control strategies for process automation.	4 – Analyze
CO4	Evaluate the stability and performance of control systems using analytical and tuning methods.	5 – Evaluate

Suggested List of Laboratory Assignments:

Any eight practical's to be performed out of the following:

Sr. No	Laboratory Experiments	COs Mapped
1.	First Order System–To determine time constant for mercury thermometer	**CO1, CO2**
2.	Single Tank system – To determine time constant and study the response of single capacity system for step change.	**CO1, CO2**
3.	U- Tube Manometer- To determine step response of second order under damped system (U-Tube manometer) and study the characteristics	**CO1, CO2**
4.	Interacting System – To evaluate the step response for Interacting system and determine time constants.	**CO1, CO2**
5.	Non- Interacting System – To evaluate the step response for Non-Interacting system and determine time constants.	**CO1, CO2**
6.	Root Locus Analysis – To Study Root locus analysis	**CO4**
7.	Root Locus Analysis using MATLAB– To Analyze the stability for the system by Root locus method using MATLAB	**CO4**
8.	Bode Plot using MATLAB– To Analyse the stability for the system by Bode Plot method using MATLAB	**CO4**
9.	On-Off controller – To Study characteristics of On-Off controller for temperature control system	**CO3**
10.	On-Off controller - To Study characteristics of On-Off controller for pressure control system	**CO3**
11.	P, PI, PID controller– Analyze the Behavior of P, PI, and PID controller.	**CO3**

Guidelines for Laboratory Conduction
• Teacher will brief the given experiment to students with its procedure, observations, calculation, and outcome of the experiment. • Apparatus and equipment's required for the allotted experiment will be provided by the lab assistants using SOP. • Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant. • After performing the experiment, students will perform calculations based on the obtained readings and get it verified from the teacher. • Students will then complete the experimental write up.
Guidelines for Student's Lab Journal
Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, results, conclusions, etc.
Guidelines for Termwork Assessment
1. Each experiment from lab journal is assessed for 30 marks based on three rubrics. 2. Rubric R-1 is for timely completion, R-2 for understanding and R-3 for presentation/journal. Each rubric carries 10 marks.

Semester VII (B. Tech.) Chemical Engineering
CHE224005A: Industrial Pollution and Control

Teaching Scheme:	Credit Scheme: 3	Examination Scheme:
Theory: 3 hrs/week		In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks

Prerequisite: Fundamental Knowledge of Environmental Science, General Chemistry, Engineering Mechanics, Calculus and Statistics and Engineering Principles.

Course Objectives:
1. To learn a variety of chemical, physical, and biological treatment processes related to industrial pollution control.
2. To make pollution profiles of the industries, categorization, control methodologies and technologies.
3. To develop system design, ethical concepts and solving of the engineering problems on industrial systems.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Discuss the types of pollution and emission sources, environmental effects, and legal standards relevant to the chemical process industries.	2 – Understand
CO2	Apply pollutant sampling and analysis techniques for air and liquid effluents, and recommend appropriate treatment for industrial emissions.	3 – Apply
CO3	Analyze the design and operational principles of air and wastewater treatment systems and assess their effectiveness.	4 – Analyze
CO4	Evaluate the impacts, disposal methods, and treatment technologies for chemical, and biomedical wastes across industries and global practices.	5 – Evaluate

Course Contents:

Unit 1	Introduction (L07)	COs Mapped: CO1

Types of pollution / emissions using material and energy balances via flow sheets and effects of environment, Environment legislation, Effluent guidelines and standards. Sources and characteristics of pollutants in paper and pulp industry, petroleum and petroleum industry.

Unit 2	Pollutant Sampling and Measurement (L08)	COs Mapped: CO2

Ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: Sampling system, particulate sampling, and gaseous sampling.
Analysis of air pollutants: Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants, CO_2, water, Ozone, hydrocarbons, and particulate matter. Treatment of liquid and gaseous effluent in the industry.

Unit 3	Air Pollution Control Methods and Equipment's (L07)	COs Mapped: CO3

Source collection methods: raw material changes, process changes, and equipment modification.
Cleaning of gaseous effluents particulate emission control: Collection Efficiency, particulate control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their constructional details and design aspects.
Scrubbers: Wet scrubbers, spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects.

Control of gaseous emissions: absorption by liquids, absorption equipment, adsorption by solids, equipment and the design aspects.

Unit 4	Characterization and Treatment of Effluents (L07)	COs Mapped: CO3

Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, controlling of BOD curve, self-purification of running streams, sources of wastewater. Introduction to wastewater treatment, Methods of primary treatments: Screening, sedimentation, flotation, neutralization. Biological treatment of wastewater, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds, Attached growth processes, trickling filters, rotary drum filters, anaerobic processes.
Methods of tertiary Treatment: A brief study of carbon absorption, ion exchange, reverse osmosis, ultrafiltration, chlorination, ozonation, treatment and disposal.

Unit 5	Waste Management (L07)	COs Mapped: CO4

Chemical waste: Health and environment effects, sources and disposal methods.
Chemical Waste: Health and environmental effects, treatment and disposal, treatment and disposal by industry, off site treatment and disposal, treatment practices in various countries.
Biomedical waste: Types of waste and their control.

REFERENCE BOOKS:

1. Environmental Pollution and Control Engineering, C.S. Rao, New Age International, 2nd Edition, Revised.
2. Pollution Control in Process Industries, S.P. Mahajan, Tata McGraw-Hill, New Delhi, 1st Edition.
3. Wastewater Treatment, M. Narayana Rao, A.K. Datta, Oxford and IBH Publications, New Delhi, 2nd Edition.
4. Industrial Pollution Control and Engineering, A.V.N. Swamy, Galgotia Publications, Hyderabad, 1st Edition.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Three Assignments on Unit-1, Unit-2, Unit-3 & 4	10
2	Group Presentation on Unit-5	05
3	LMS Test on Each Unit	05
	Total	**20**

Semester VII (B. Tech.) Chemical Engineering
CHE224005B: Green Technology

Teaching Scheme:	Credit Scheme: 3	Examination scheme:
Theory: 3 hrs/week		In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks

Prerequisite: Basic chemistry, environmental science, chemical engineering thermodynamics, mass transfer and reaction engineering, and process calculations.

Course Objectives:

1. To introduce students about green chemistry principles and their application in sustainable chemical engineering.
2. To equip students with strategies for waste minimisation circular economy, and renewable resource utilisation.
3. To enable students to analyze and apply green technologies, catalysis, and process intensification methods in real-world chemical industry scenarios.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Identify fundamental green chemistry principles, sustainable development, and environmental assessment tools for chemical process applications.	2- Understand
CO2	Apply sustainable synthesis methods using green solvents and renewable feedstocks for new chemical and polymer development.	3- Apply
CO3	Analyze waste minimization, circular economy, advanced catalysis, and process intensification methods, including their industrial applications and emerging sustainable solutions, for their impact on environmental, economic, and global sustainability.	4-Analyze

Course Contents:

Unit 1	Foundations of Green Chemistry and Sustainability (L08)	COs Mapped: CO1

Introduction to Green Chemistry and Sustainable Development, Principles of Green Chemistry, Atom Economy and Green Metrics (E-factor, PMI), Circular Economy, Life Cycle Assessment (LCA), Basics of Environmental Toxicology and Risk Assessment relevant to Chemical processes.

Unit 2	Waste Minimization and Circular Economy (L07)	COs Mapped: CO1, CO2

Waste generation in Chemical industries, Process integration and strategies for waste minimization, Design for degradation and safe disposal, Circular economy approaches: reuse, recycling, and upcycling in chemical manufacturing, Case studies on biodegradable polymers and plastic waste management.

Unit 3	Green Solvents and Renewable Feedstocks (L07)	COs Mapped: CO3

Green solvent selection: Ionic liquids, Deep eutectic solvents, Supercritical CO_2 and water, Replacement strategies for VOCs, Use of renewable feedstocks for chemical and polymer synthesis, Advances in bio-based surfactants and water-based systems.

Unit 4	Catalysis and Process Intensification (L07)	COs Mapped: CO1, CO2, CO3

Advanced catalysis: Heterogeneous, Homogeneous, Biocatalysis, Emerging synthesis techniques: Microwave, Sonochemistry, Photocatalysis, Electrochemical and Mechanochemical methods, Process intensification equipment and safety design.

Unit 5	**Industrial Applications and Emerging Green Technologies (L07)**	**COs Mapped: CO1, CO2, CO3**

Case studies in bio-refinery manufacturing: Green Ammonia, Green Polyethylene, and Green PVC. Energy-efficient technologies: Solar, Green Hydrogen, Fuel cells, Global sustainability goals (SDGs), Role of green technologies in achieving net-zero emissions, Carbon capture and utilization (CCU), Green Hydrogen Production and Storage, AI/ML applications in green process optimization

REFERENCE BOOKS:

1. Green Chemistry: An Introductory Text, Mike Lancaster, Royal Society of Chemistry, 2025, 4th Edition.
2. Green Chemistry: Theory and Practice, Paul T. Anastas, John C. Warner, Oxford University Press, 2000, 1st Edition.
3. Green Technology, Jay Warmke, Annie Warmke, Educational Technologies Group, 2009, 1st Edition.
4. An Introductory Text on Green Chemistry, Indu Tucker Sidhwani, Rakesh K. Sharma, Wiley, 2020, 1st Edition.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Three Assignments on Unit-1, Unit-2, Unit-3 & 4	10
2	Group Presentation on Unit-5	05
3	LMS Test on Each Unit	05
	Total	**20**

Semester VII (B. Tech.) Chemical Engineering
CHE224005C- Catalysis

Teaching Scheme:	Credit Scheme: 3	Examination Scheme:
Theory: 3 hrs/week		In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks

Prerequisite: Chemical Reaction Engineering, Physical Chemistry

Course Objectives:
1. To introduce the fundamentals of catalysis and its role in chemical industry.
2. To differentiate between homogeneous and heterogeneous catalysis.
3. To analyze catalyst properties, preparation methods, and characterization techniques.
4. To understand catalytic reaction mechanisms and kinetics.
5. To evaluate catalytic reactor design and industrial catalytic processes.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Describe fundamental concepts of catalysis, catalyst types, deactivation mechanisms, and methods of preparation and characterization.	2- Understand
CO2	Apply kinetics and rate laws to catalytic reactions and estimate kinetic parameters.	3-Apply
CO3	Analyze catalytic reactor types and industrial catalytic applications using design principles.	4-Analyze

Course Contents:

Unit 1	Fundamentals of Catalysis (L07)	COs Mapped: CO1

Definition and importance of catalysis; Classification: Homogeneous, Heterogeneous, Enzyme, and Biocatalysis; Physical and chemical properties of catalysts: activity, selectivity, and stability; Catalyst deactivation.

Unit 2	Catalytic Reaction Mechanisms and Kinetics (L07)	COs Mapped: CO1, CO2

Adsorption isotherms: Langmuir and Freundlich; Langmuir-Hinshelwood and Eley-Rideal mechanisms; Rate laws for catalytic reactions; Evaluation of kinetic parameters; Influence of temperature and pressure.

Unit 3	Catalyst Preparation and Characterization (L08)	COs Mapped: CO1, CO2

Preparation techniques: impregnation, co-precipitation, sol-gel, vapor phase methods; Catalyst supports and promoters; Characterization techniques: BET surface area, XRD, SEM, TEM, Temperature-Programmed Desorption/Reduction (TPD/TPR), FTIR, XPS, Acid-base property evaluation.

Unit 4	Catalytic Reactor Design (L07)	COs Mapped: CO1, CO3

Types of catalysis: Homogeneous, Heterogeneous, and Enzyme; Catalytic Reactor Types and Principles: Fixed-Bed Reactors (FBR), Fluidized-Bed Reactors (FBR), Trickle Bed Reactors (TBR), Membrane Reactors, Loop Reactors and Circulating Catalytic Reactors, Microreactors in Catalysis

Unit 5	Industrial and Application-Based Catalysis (L07)	COs Mapped: CO2, CO3

Case studies on catalytic process applications in industry: Reactor design for ammonia synthesis, Hydrocracking and hydroformylation, Catalytic hydrogenation in fine chemical and pharmaceutical industries, Environmental catalysis: automotive emission control, VOC oxidation; Process intensification and reactor selection; Role of catalysis in green chemistry and sustainable processes;

REFERENCE BOOKS:

1. Catalysis: From Principles to Applications, G.C. Bond, Oxford University Press, 1st Edition.
2. Principles and Practice of Heterogeneous Catalysis, J. M. Thomas and W. J. Thomas, Wiley-VCH, 2nd Edition.
3. Catalysis: Principles and Applications, B. Viswanathan and S. Sivasanker, Narosa Publishing House, 1st Edition.
4. Chemical Kinetics and Catalysis, R. A. van Santen and J. W. Niemantsverdriet, Springer, 2nd Edition.
5. Catalysis: From Principles to Applications, D. L. Trimm & Z. I. Onsan, Elsevier Scientific Publishing Co., 1st Edition.
6. Elements of Chemical Reaction Engineering, H. Scott Fogler, Prentice Hall, 5th Edition.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Three Assignments on Unit-1, Unit-2, Unit-3 & 4	10
2	Group Presentation on Unit-5	05
3	LMS Test on Each Unit	05
	Total	**20**

Semester VII (Final Year B. Tech.) Chemical Engineering
CHE224006A: Advanced Separation Processes

Teaching Scheme:	**Credit Scheme: 2**	**Examination Scheme:**
Theory: 2 hrs/week		In Semester Exam: 20 marks End Semesters Exam: 30 marks Total: 50 Marks

Prerequisite: Mass transfer, Thermodynamics, Reaction Engineering

Course Objectives:

1. To provide knowledge of advanced and emerging separation techniques used in the chemical industry.
2. To introduce modern materials and design strategies for efficient and sustainable separation.
3. To develop skills for analysing and optimizing separation systems in industrial applications.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Discuss the principles and applications of various advanced separation processes.	2- Understand
CO2	Apply advanced separation techniques to address industrial separation challenges.	3-Apply
CO3	Analyze the performance and integration of hybrid and emerging separation technologies.	4-Analyze

Course Contents:

Unit 1	Advanced Distillation Processes ((L05)	COs Mapped: CO1, CO2

Multicomponent Distillation: design principles, K-value concept, tray-to-tray calculations; Azeotropic Distillation, Extractive Distillation, Residue Curve Maps, Entrainer Selection; Pressure-swing Distillation.

Unit 2	Membrane-Based Separations (L06)	COs Mapped: CO1, CO2

Membrane transport processes such as microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), reverse osmosis (RO), pervaporation, and gas separation; Nanocomposite membranes and bio-based membranes, design parameters, fouling control, module configuration; Applications of membranes.

Unit 3	Adsorption and Chromatography (L06)	COs Mapped: CO1, CO2

Advanced adsorption methods like TSA and PSA with design and cycle details.; New adsorbent materials such as MOFs, zeolites, and carbon-based adsorbents; Liquid and Gas Chromatography techniques: process design and optimization.

Unit 4	Hybrid and Reactive Separation Processes (L05)	COs Mapped: CO1, CO2, CO3

Reactive separation: reactive distillation, reactive extraction, reactive crystallization with process design and applications; Hybrid processes: Membrane distillation, adsorption membrane systems; Industry applications.

Unit 5	Emerging and Non-Conventional Techniques (L05)	COs Mapped: CO1, CO2, CO3

Basic concepts of foam fractionation and froth flotation with applications; basic principles of centrifugal and magnetic separations with applications; introduction to electrophoresis and its role in biotechnology; basics of supercritical fluid extraction using CO_2.

REFERENCE BOOKS:

1. Mass Transfer Operations, Treybal R.E., McGraw-Hill Education, 3rd Edition.
2. Handbook of Separation Process Technology, Rousseau R.W., Wiley-Interscience, 1st Edition.
3. Separation Processes for Chemical Engineers, Schweitzer P.A., McGraw-Hill Publications, 1st Edition.
4. Separation Processes, King C.J., McGraw-Hill Education, 2nd Edition.
5. Basic Principles of Membrane Technology, Mulder M., Springer Science & Business Media, 2nd Edition.
6. Selected Topics in Chemical Engineering, M.M. Sharma, McGraw-Hill Education.

Semester VII(B.Tech.) Chemical Engineering
CHE224006B: Energy Audit

Teaching Scheme:	Credit Scheme:2	Examination scheme:
Theory: 2 hrs/week		In Semester Exam: 20 marks End Semesters Exam: 30 marks Continuous Comprehensive Evaluation: - Total: 50 Marks

Prerequisite: Knowledge of process calculations, mass transfer operations, and fluid mechanics aids in analyzing and optimizing energy usage.

Course Objectives:

1. To introduce the global and national energy scenario and provide foundational knowledge of energy policies, pricing, environmental impacts, and energy auditing practices.
2. To equip students with essential tools and techniques for conducting energy audits and managing industrial energy consumption effectively across thermal and electrical systems.
3. To develop analytical skills for evaluating energy performance, interpreting audit data, and preparing structured energy audit reports with practical recommendations

Course Outcomes: On completion of the course, students will be able to–

Sr. No.	Course Outcomes	Bloom's Level
CO1	Understand the global and national energy scenario, policies, and fundamental energy audit concepts.	2- Understand
CO2	Apply energy management and audit techniques to evaluate thermal systems and industrial utilities.	3-Apply
CO3	Analyze audit results, monitor energy performance, and develop comprehensive energy audit reports.	4-Analyze

Course Contents:

Unit 1	Energy Scenario, Policies & Audit Fundamentals (L08)	Cos Mapped: CO1

Overview of global and Indian energy scenario, Energy consumption patterns and energy security, Energy pricing, environmental concerns, and climate agreements, Energy Conservation Act 2001, ECBC, national energy policies, Types of energy audits: Preliminary, detailed, benchmarking, performance indicators, Energy audit methodology: Planning, data collection, instruments.

Unit 2	Energy Management and Audit Practices (L06)	Cos Mapped: CO2, CO3

Definition and need of energy audit, types of energy audits – preliminary, detailed and investment-grade. Energy management approach – understanding energy costs, benchmarking energy performance, matching energy use requirements, maximizing system efficiency and optimizing input. Concepts of fuel and energy substitution. Overview of energy audit instruments. Role, responsibilities and duties of energy managers and auditors in implementing energy conservation initiatives.

Unit 3	Electrical and Thermal Energy Audit (L06)	COs Mapped: CO1, CO3

Steam systems and condensate recovery, Boiler and furnace efficiency assessment, Heat exchanger performance evaluation, Insulation, refractories, and energy saving in thermal utilities, HVAC system audit: Coefficient of performance (COP) and improvement strategies.

Unit 4	Energy Performance Monitoring (L06)	COs Mapped: CO1, CO3

Instrumentation for energy audit: flow meters, lux meters, power analyzers, thermocouples, Sankey diagrams and energy balance calculations, Monitoring and targeting (M&T), CUSUM analysis, Process flow mapping, fuel substitution.		
Unit 5	**Energy Audit Reports and Case Studies (L10)**	**COs Mapped: CO1, CO3**
Guidelines for writing energy audit reports – structure, clarity and content. Preparation and presentation of audit findings. Post-monitoring of energy conservation projects, integration of Management Information Systems (MIS). Data analysis and representation in reports, developing findings and actionable recommendations. Impact of renewable energy integration on audit outcomes. Instruments used for audit and monitoring energy savings, their types and measurement accuracy. Case studies of implemented energy cost optimization projects in both electrical and thermal utilities.		

REFERENCE BOOKS

1. Energy Management Handbook, W.C. Turner and Steve Doty, The Fairmont Press, Inc., 8th Edition.
2. Handbook on Energy Audit and Environment Management, Y.P. Abbi and S. Jain, TERI Press, 1st Edition.
3. Energy Efficiency and Conservation Manuals, Petroleum Conservation Research Association (PCRA), 1st Edition.
4. ASHRAE Handbook: HVAC Systems and Equipment, ASHRAE, 1st Edition.

Semester VII (B. Tech.) Chemical Engineering
CHE224006C: Chemical Process Safety

Teaching Scheme:	Credit Scheme: 2	Examination Scheme:
Theory: 2 hrs/week		In Semester Exam: 20 marks End Semesters Exam: 30 marks Total: 50 Marks

Prerequisite: Fundamental knowledge in Chemical Engineering Thermodynamics, Chemical Technology, Chemical Reaction Engineering

Course Objectives:
1. To introduce basic concepts of Industrial Safety and their applications in Chemical Engineering.
2. To create manpower related to Industrial Safety.
3. To develop study, analyze and develop safety techniques to avoid accidents.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Describe the significance of process safety in high-risk industries	2- Understand
CO2	Interpret the exact causes behind different accidents in chemical history and apply the knowledge of Industrial hygiene for safety purpose.	3-Apply
CO3	Assess the causes and types of fire and explosions, and **select** appropriate prevention strategies.	4-Analyze
CO4	Evaluate hazard management strategies, including HAZOP, risk assessment, and emergency planning.	5-Evaluate

Course Contents:

Unit 1	Introduction (L05)	COs Mapped: CO1, CO2

Importance of process safety with examples of major accidents; which might cover chemical, petroleum & petroleum chemical Industrial. Safety culture, storage of dangerous materials, plant layout safety systems, OSHA incidence rate, FAR, FR.
The accident process: Initiation, propagation, and termination.
Toxicology: ingestion, inhalation, injection, dermal absorption, dose versus response curves, relative toxicity, threshold limit values.

Unit 2	Toxicology (L05)	COs Mapped: CO1, CO2, CO3

Toxicology: ingestion, inhalation, injection, dermal absorption, dose versus response curves, relative toxicity, threshold limit values.
Industrial hygiene: government regulations, identification, evaluation: evaluating exposures to volatile toxicants by monitoring, evaluating worker exposures to dusts, evaluating worker exposures to noise, estimating worker exposures to toxic vapors.

Unit 3	Fires, Explosions and their Preventions (L05)	COs Mapped: CO1, CO2, CO3, CO4

Technology and process selection, scale of disaster, fire triangle, distinction between fires and explosion, definitions of ignition, auto-ignition temperature, fire point, flammability limits, mechanical explosion deflagration and detonation, confined explosion, unconfined explosion, vapour cloud explosions, boiling liquid expanding vapour explosion (BLEVE), dust explosion, shock wave, flammability characteristics of liquids and vapours, minimum oxygen concentration (MOC).
Design to prevent Fires and Explosions: Inerting, static Electricity, Explosion proof equipment and Instrument, Ventilation, sprinkler systems and Miscellaneous Design for preventing Fires and Explosion.

Unit 4	Hazard Analysis (L05)	COs Mapped: CO1, CO2, CO3, CO4
Identification process, checklists, hazard surveys, HAZOP studies, safety reviews. Risk assessment: review of probability theory, interaction between process units, revealed and unrevealed failure and probability of coincidence, event trees and fault trees.		
Unit 5	**Emergency Preparedness and Planning (L05)**	**COs Mapped: CO1, CO4**
Typical emergency Plan, On-Site and Off Site Plans, Emergency Control Programme, Emergency shutdown systems, Individual responsibility during emergency. Role of computers in safety, Tackling of disasters, Technology and process selection for emergency. Prevention of hazard human element		
REFERENCE BOOKS:		
1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl and Joseph F. Louvar, Pearson Education Inc., publishing by Prentice Hall, 3rd Edition. 2. Loss Prevention in the Process Industries (Vol. 1 and 2), P. P. Lees, Butterworth, 1st Edition. 3. Industrial Hazards and Safety Handbook, R. W. King and J. Magid, Butterworth, 1st Edition. 4. Introduction to Safety Science, Khulman, TUV Rheinland, 1st Edition. 5. Explosion Hazards and Evaluation, W. E. Baker, Elsevier, Amsterdam, 1st Edition. 6. Management of Disasters and How to Prevent Them, O. P. Kharbanda and E. A. Stallworthy, Gower Publishing, 1st Edition.		

Semester VII (B. Tech.) Chemical Engineering
CHE224007: Research Methodology

Teaching Scheme:	Credit Scheme: 3	Examination Scheme:
Theory:03 hrs/week		Insem: 20 Marks Endsem: 60 Marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks

Prerequisite Courses, if any: - Mathematics & Statistics, Core Engineering & Science Fundamentals

Course Objectives:

4. To equip students with skills to define research problems, conduct systematic literature reviews, and manage references ethically.
5. To equip students with skills of appropriate data collection methods, sampling techniques, and tools for effective research in various disciplines.
6. To develop proficiency in statistical and analytical techniques for hypothesis testing, data interpretation, and validation.
7. To familiarize students with well-structured research reports with proper literature review, interpretation, and referencing.
8. To explore emerging trends, interdisciplinary opportunities, and industry collaborations in chemical engineering research.

Course Outcomes: On completion of the course, students will be able to–

Sr. No.	Course Outcomes	Bloom's Level
CO1	Differentiate between various research designs and apply them to real-world problems.	2- Understand
CO2	Select appropriate data collection methods and sampling techniques for surveys and experiments.	3-Apply
CO3	Analyze research data using statistical tools and interpret results effectively.	4- Analyze

Course Contents:

Unit 1	Introduction and Design of Research (L08)	COs Mapped: CO1

Meaning, objectives and significance of research, types and parameters of research, research process, identification and definition of the research problem, definition of construct and variables, pure and applied research design, exploratory and descriptive design methodology, qualitative vs. quantitative research methodology, field studies, field experiments vs. laboratory experiments, research design in social and physical sciences.

Unit 2	Data and Methods of Data Collection (L10)	COs Mapped: CO1, CO2

Survey, assessment and analysis: data collection, primary and secondary sources of data, Collection of primary data through questionnaire and schedules. Collection of secondary data, processing and analysis of data. Sample survey, simple random sampling, stratified random sampling, systematic sampling, cluster sampling, area sampling and multistage sampling. Pilot survey, scaling techniques, validity & reliability

Unit 3	Data Analysis (L10)	COs Mapped: CO1, CO2, CO3

Procedure for testing of hypothesis, the null hypothesis, determining levels of significance, type i and ii errors, grouped data distribution, measures of central tendency, measures of spread/dispersion, normal distribution, analysis of variance: one way, two-way, chi square test and its application, students 'T' distribution, non-parametric statistical techniques, binomial test. Correlation and regression analysis – discriminate analysis – factor analysis – cluster analysis, measures of relationship

Unit 4	Research Report Preparation and Presentation (L06)	COs Mapped: CO1, CO2, CO3

Review of literature: historical survey and its necessity, layout of research plan, meaning, techniques and precautions of interpretation, types of report: technical report, popular report, report writing – layout of research report, mechanics of writing a research report. Writing bibliography and references

Unit 5	Research in Chemical Engineering (L06)	COs Mapped: CO1, CO3

Current trends and future directions, Interdisciplinary research opportunities, Industry-academia collaboration

REFERENCE BOOKS:

1. Research Methodology: Methods and Techniques, C. R. Kothari, New Age International Publication Ltd., 2nd Edition.
2. Design and Analysis of Experiments, D. G. Montgomery, John Wiley India Edition, 8th Edition.
3. Applied Statistics & Probability for Engineers, D. C. Montgomery and G. C. Runger, Wiley, 7th Edition.
4. Principles of Intellectual Property, N. S. Gopalakrishnan and T. G. Agitha, Eastern Book Company, Lucknow, 1st Edition.
5. Ethics and Values in Industrial-Organizational Psychology, Joel Lefkowitz, Lawrence Erlbaum Associates, 1st Edition.
6. Mathematical Models in Applied Sciences, A. C. Fowler, Cambridge University Press, 1st Edition.
7. Research Ethics: A Psychological Approach, Barbara H. Stanley, Joan E. Sieber, and Gary B. Melton, University of Nebraska Press, 1st Edition.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Three Assignments on Unit-1, Unit-2, Unit-3 & 4	10
2	Group Presentation on Unit 5	05
3	LMS Test on Each Unit	05
	Total	**20**

K. K. Wagh Institute of Engineering Education and Research, Nashik

(Autonomous from Academic Year 2022-23)

Semester VII (B. Tech) Chemical Engineering
CHE224008: Innovation and Start-up

Teaching Scheme:	Credit Scheme: 2	Examination Scheme:
Theory: 2 hrs/week		Continuous Comprehensive Evaluation: 50 marks Total: 50 Marks

Prerequisite: Basic Knowledge of Industrial Management subject.

Course Objectives:

1. To introduce students to the fundamentals of Innovation and entrepreneurship.
2. To equip students with the tools to develop, evaluate, and pitch start-up ideas.
3. To foster innovation thinking within the field of chemical engineering.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Explain concepts of innovation and entrepreneurship, and emerging technologies in the context of chemical engineering.	2- understand
CO2	Apply principles of business model development, financial planning, and legal compliance to create a feasible start-up plan in the chemical engineering domain	3-Apply
CO3	Evaluate strategies for team management, marketing, and project execution through case studies of successful chemical start-ups	4-Analyze

Course Contents:

Unit 1	Introduction to Innovation and Entrepreneurship **(L06)**	COs Mapped: CO1, CO2

Definition and types of innovation, Difference between innovation and invention, Role of chemical engineers in innovation, The entrepreneurial mindset: creativity, problem-solving, risk-taking, Case studies of successful chemical engineering start-ups

Unit 2	Technology and Innovation in Chemical Engineering **(L06)**	COs Mapped: CO1, CO2

Emerging trends in chemical engineering: flow reactors (micro reactor), nanotechnology, green chemistry, Technology assessment and feasibility studies (technical, market, financial), Intellectual property rights (protecting innovative ideas).

Unit 3	Start-up Creation **(L06)**	COs Mapped: CO2, CO3

Developing a business model, Market research and competitive analysis, Financial planning: budgeting, funding sources, venture capital, Legal aspects of start-up creation: business structures, regulations.

Unit 4	Start-up Management & Case Studies **(L06)**	COs Mapped: CO3

Team building and leadership, Marketing and sales strategies for technical products, Project management and scaling operations Case studies: Chemical start-ups in India and globally, Guest lecture from chemical entrepreneurs.

REFERENCE BOOKS:

1. Innovation and Entrepreneurship, Peter F. Drucker, Harper Collins, 1st Edition.
2. The Lean Startup, Eric Ries, The Crown Publishing Group, 1st Edition.
3. Legal Aspects of Business, P. Saravanavel and S. Sumathi, Himalaya Publishing House, 1st Edition.
4. Intellectual Property Rights, Neeraj Pandey and Khushdeep Dharni, PHI Learning, 1st Edition.
5. Financial Intelligence for Entrepreneurs, Karen Berman and Joe Knight, Harvard Business Press, 1st Edition.
6. Startup India Learning Program, https://www.startupindia.gov.in

7. NITI Aayog Reports – National Innovation Index, Atal Innovation Mission, etc.		
Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Three Assignments on unit-1, Unit-2 and Unit-3	30
2	Group Presentation on Unit-4	10
3	LMS Test on Each Unit	10
	Total	**50**

Semester VII (B. Tech.) Chemical Engineering
CHE224009: Project Phase II

Teaching Scheme:	Credit Scheme: 04	Examination Scheme:
Practical:08 hrs/week		TW: 100 Marks Oral: 50 Marks Total: 150 Marks

Prerequisite: Chemical Engineering Fundamentals

Course Objectives:

1. To conduct systematic experimental work on the defined research problem using appropriate chemical engineering methodologies and safety protocols
2. To prepare a comprehensive project report with standardized sections (Abstract, Introduction, Experimental, Results, etc.) following prescribed formatting and anti-plagiarism guidelines.
3. To analyze experimental data rigorously, interpret results critically, and correlate findings with theoretical principles.
4. To develop a feasible plant layout and perform cost analysis, demonstrating practical scalability of the project.
5. To present research progress effectively through reviews, defend outcomes orally, and articulate technical knowledge via structured presentations.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Apply chemical engineering concepts, laboratory skills, and safety procedures to carry out experimental work for a defined research problem.	3- Apply
CO2	Analyze experimental data using appropriate tools, interpret observations, and relate the outcomes to theoretical principles.	4- Analyze
CO3	Evaluate the research findings by assessing the feasibility of process improvements or designs through plant layout planning and basic cost estimation.	5- Evaluate
CO4	Create a complete project report as per academic guidelines and effectively present and defend the research work through oral and visual communication.	6-Create

Guidelines for Report Preparation:

During the second term, the students are required to:

1. Carry out detailed experimental work on the previously defined (Phase I) research problem.
2. Write a Project Report, which should be broadly divided into the following sections:

a. Abstract
b. Introduction
c. Experimental
d. Results and Discussion
e. Conclusion
f. References

Project Report Format:

- Font: Times New Roman
- Font Size: 12 (Text), 14 (Headings)
- Spacing: 1.5

- Paper Size: A4 (typed on one side only)
- Include proportionate diagrams, figures, graphs, photographs, tables, etc.

Referencing Style:
Students must follow IEEE reference format. Examples for various types of documents are provided below:

1. Book
Format:
[Ref number] Author's initials. Author's Surname, *Book Title*, edition (if not first). Place of publication: Publisher, Year.
Example:
[1] I.A. Glover and P.M. Grant, *Digital Communications*, 3rd ed. Harlow: Prentice Hall, 2009.

2. Book Chapter
Format:
[Ref number] Author's initials. Author's Surname, "Title of chapter in book," in *Book Title*, edition (if not first), Editor's initials. Editor's Surname, Ed. Place of publication: Publisher, Year, pp. xxx–xxx.
Example:
[2] C. W. Li and G. J. Wang, "MEMS manufacturing techniques for tissue scaffolding devices," in *MEMS for Biomedical Applications*, S. Bhansali and A. Vasudev, Eds. Cambridge: Woodhead, 2012, pp. 192-217.

3. Electronic Book
Format:
[Ref number] Author's initials. Author's Surname. (Year, Month Day). *Book Title* (edition) [Type of medium]. Available: URL
Example:
[3] W. Zeng, H. Yu, C. Lin. (2013, Dec 19). *Multimedia Security Technologies for Digital Rights Management* [Online]. Available: http://goo.gl/xQ6doi

4. Journal Article
Format:
[Ref number] Author's initials. Author's Surname, "Title of article," *Journal Title Abbreviated*, vol. number, issue number, pages, Abbrev. Month Year.
Example:
[4] F. Yan et al., "Study on the interaction mechanism between laser and rock during perforation," *Optics and Laser Technology*, vol. 54, pp. 303-308, Dec 2013.

5. E-Journal Article
Example:
[5] M. Semilof. (1996, July). "Driving commerce to the web-corporate intranets and the internet: lines blur." *Communication Week* [Online], vol. 6, issue 19. Available: http://www.techweb.com/se/directlinkcgi?CWK19960715S0005

6. Conference Papers
Example:
[6] S. Adachi et al., "Intense vacuum-ultraviolet single-order harmonic pulse by a deep-ultraviolet driving laser," in *Conf. Lasers and Electro-Optics*, San Jose, CA, 2012, pp. 2118-2120.

7. Reports

Example:
[7] P. Diament and W. L. Luptakin, “V-line surface-wave radiation and scanning,” Dept. Elect. Eng., Columbia Univ., New York, Sci Rep. 85, 1991.

8. Patents
Example:
[8] J. P. Wilkinson, “Nonlinear resonant circuit devices,” U.S. Patent 3 624 125, July 16, 1990.

9. Standards
Example:
[9] *Shunt Power Capacitors*, IEEE Standard 18-2012, 2013.

10. Thesis/Dissertations
Example:
[10] J. O. Williams, “Narrow-band analyser,” Ph.D. dissertation, Dept. Elect. Eng., Harvard Univ., Cambridge, MA, 1993.

11. Datasheets
Example:
[11] Texas Instruments, “High speed CMOS logic analog multiplexers/demultiplexers,” 74HC4051 datasheet, Nov. 1997 [Revised Sept. 2002].

12. Online Documents & Websites
Example:
[12] BBC News. (2013, Nov. 11). *Microwave signals turned into electrical power* [Online]. Available: http://www.bbc.co.uk/news/technology-24897584

Guidelines for Project Evaluation and Assessment:

1. **Progress Presentation:** Each student must present their project work in two review presentations (10 minutes, 10-12 slides per presentation).
2. **Oral Examination:** Each student will face an oral exam for 50 marks, based on the project topic and related areas.
3. **Term Work:** Total 100 marks, evaluated based on work performed, progress made, depth of work, and overall quality.

Submission Requirements
The final Project Report must include:

- Cover Page (Project Title, Student Name(s), Guide Name, Exam Seat Number, Year)
- Certificate from Guide
- Certificate from Industry (if applicable)
- Index
- Detailed Project Report (including: Abstract, Introduction, Experimental, Results and Discussion, Conclusion and References)

Note: Students are encouraged to present their work at conferences, seminars, or competitions in consultation with their guide.

Semester VIII (B. Tech.) Chemical Engineering
CHE224011: Process Engineering and Plant Design

Teaching Scheme:	Credit Scheme: 3	Examination Scheme:
Theory: 3 hrs/week		Continuous Comprehensive Evaluation: 40 marks End Semesters Exam: 60 Marks Total: 100 Marks

Prerequisite: Knowledge of Chemical Engineering Subjects

Course Objectives:
1. To acquire understanding of the process development of Chemical engineering plants.
2. To apply the knowledge plant maintenance and safety consideration in the plant design of Chemical industries.
3. To optimize the various operations in Chemical process industries.
4. To apply the network techniques of project management to execute the project.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Express the overall chemical plant design procedure, including process development, equipment specification, optimization and piping materials selection, and demonstrate the concept of network techniques in project management and Plant maintenance and safety	2-Understand
CO2	Apply optimization techniques to determine the optimum design and cost-effective sizing of various chemical process equipment and evaluate pinch analysis and classify the plant maintenance and analyze the safety aspects	3-Apply
CO3	Analyze material selection for piping systems and valves based on process conditions and illustrate the plant maintenance and safety consideration in industry.	4-Analyze
CO4	Develop and evaluate detailed project schedules and networks using CPM and PERT methods to optimize time and cost in chemical plant project management.	5- Evaluate

Course Contents:

Unit 1	Chemical Engineering Plant Design (L07)	COs Mapped: CO1

Chemical Engineering Plant design procedure, Process Development pilot plant, scale up methods, Techno-economic feasibility study, flow sheet preparation, sketching techniques, equipment numbering, stream designation, Codes and Standards (ASME, ANSI, ISO), Plant Design: Design basis, , Process selection, study of alternative processes, selection of equipment, specification and design of equipment's, material of construction, plant location, plant layout and installation, safety, start up, shutdown and operating guidelines, loss prevention and Hazop study.

Unit 2	Optimization and Optimum Design (L08)	COs Mapped: CO1, CO2

Nature of optimization, uni-variable and multivariable systems, analytical, graphical and incremental methods of solution, Lagrange multiplier method, linear programming, other techniques and strategies establishing optimum conditions, break even chart for production schedule, optimum production rates in plant operation, optimum conditions in batch and cyclic operation.

Optimization of Different Process Equipment such as heat exchangers, evaporators, mass transfer equipments and reactors. determination of height and diameter of different process equipments at conditions of optimum cost. Pinch technology analysis.

Unit 3	**Materials for Piping System (L07)**	**COs Mapped: CO1, CO3**
Desirable properties of piping materials, materials for low, normal, and high temperature services, materials for corrosion resistance. Common ASTM and IS specifications for: Seamless / ERW pipes, pipe fittings, flanges, and fasteners, materials for valves. Gaskets: Functions and properties, types of gaskets and their selection. Design of pipeline for natural gas, pipeline design for transportation of crude oil.		
Unit 4	**Plant Maintenance and Safety (L07)**	**COs Mapped: CO1, CO2, CO3**
Necessity, types of plant maintenance, preventive, predictive, online, scheduled, corrective/breakdown, lubrication, plant start up and shut down procedure, maintenance of pumps, valves, compressors, piping. Process safety: Necessity, industrial accidents, (causes and preventive measures, safety measures, chemical hazards, fire hazard, fire prevention, industrial safety codes HAZOP, HAZAN studies, flame arrester, explosions.		
Unit 5	**Scheduling and Networking of Project (L07)**	**COs Mapped: CO1, CO4**
Role of project Management in Chemical plants, scheduling the project; Engineering design and drafting, the design report, organization of design report. Critical path method (CPM): events and activities; network diagramming; earliest start time and earliest finish time; latest start time and latest finish time; float, advantage of CPM; cost to finish t h e projects earlier than normal cost; precedence diagramming. programme evaluation and review technique (PERT): network and time estimates		

REFERENCE BOOKS:

1. Plant Design and Economics for Chemical Engineers, M. S. Peters and K. D. Timmerhaus, McGraw Hill, 5th Edition.
2. Coulson & Richardson's Chemical Engineering - Chemical Engineering Design (Vol. 6), R. K. Sinnott, Butterworth-Heinemann, 4th Edition.
3. Optimization of Chemical Processes, T. F. Edgar and D. M. Himmelblau, McGraw Hill, 2nd Edition.
4. PERT and CPM, L. S. Srinath, Affiliated East-West Press Pvt. Ltd., New York, 1st Edition.
5. Pipe Drafting and Design, Roy A. Parisher and Robert A. Rhea, Gulf Professional Publishing, 3rd Edition.
6. Plant Maintenance in Chemical Engineering, Clara Smith, Kindle Edition.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Four Written Assignments/LMS Tests of 10 marks each will be conducted at the end of each month and one at the end of semester, when students will report for review/presentation of Internship work.

Semester VIII (B. Tech.) Chemical Engineering
CHE224012A: Chemical Project Economics

Teaching Scheme:	Credit Scheme: 3	Examination Scheme:
Theory: 3 hrs/week		Continuous Comprehensive Evaluation: 40 marks End Semesters Exam: 60 Marks Total: 100 Marks

Prerequisite: Knowledge of Chemical Engineering Subjects

Course Objectives:
1. To acquire knowledge of Process Engineering and costing for Chemical Engineering Plants.
2. To apply knowledge in the Plant Design of Chemical industries.
3. To optimize the various operations in Chemical process industries.
4. To apply the network techniques of Project Management to execute the project.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Explain the principles of project economics, including time value of money, interest calculations, and types of investments relevant to chemical process industries.	2-Understand
CO2	Apply various depreciation and taxation methods to calculate cash flows and assess their impact on project financial decisions and estimate the total product cost and manufacturing cost	3-Apply
CO3	Analyze capital, operating cost elements and profitability, perform cost estimations, and prepare cash flow statements for chemical engineering projects.	4-Analyze
CO4	Evaluate project profitability and feasibility using methods like NPV, IRR, ROI, break-even, and sensitivity analysis under risk and uncertainty.	5- Evaluate

Course Contents:

Unit 1	**Introduction to Project Economics (L08)**	**COs Mapped: CO1**

Importance and scope of project economics in chemical engineering, Concept of time value of money, Interest calculations: simple, compound, continuous, present worth and discount, annuities, perpetuities and capitalized cost methods, Types of investment and projects.

Unit 2	**Depreciation and Taxation (L07)**	**COs Mapped: CO1, CO2**

Purpose and types of depreciation, Methods: straight-line, declining balance, sum-of-years-digits, MACRS, Effect of depreciation on cash flows, corporate taxes and incentives, Tax calculations and their impact on investment decisions

Unit 3	**Cost Estimation and Capital Requirements (L08)**	**COs Mapped: CO1, CO2, CO3**

Cash flow for industrial operations, cumulative cash position of cash flow for an industrial operation, capital investments, fixed capital cost, working capital cost, startup costs, process equipment cost estimation, cost index, cost factors in capital investment, methods of estimating capital investment, estimation of plant cost, estimation of total product cost, manufacturing cost, general expenses.

Unit 4	**Profitability Analysis and Project Evaluation (L07)**	**COs Mapped: CO1, CO3**

Criteria for project evaluation: NPV (Net Present Value), IRR (Internal Rate of Return), Payback Period, Discounted Payback Period, Return on Investment (ROI), Break-even analysis and sensitivity analysis, Project selection under risk and uncertainty, Replacement analysis.

Unit 5	Project Financing and Feasibility Studies (L07)	COs Mapped: CO1, CO4
Sources of project finance: equity, debt, venture capital, Cost of capital and capital structure, Feasibility studies: technical, financial, environmental, Case studies in chemical process industries.		
REFERENCE BOOKS:		
1. Plant Design and Economics for Chemical Engineers, M. S. Peters and K. D. Timmerhaus, McGraw Hill, 5th Edition. 2. Coulson & Richardson's Chemical Engineering - Chemical Engineering Design, Vol. 6, R. K. Sinnott, Butterworth-Heinemann, 4th Edition. 3. Chemical Project Economics, V. V. Mahajani and S. M. Mokashi, Infinity Press, Laxmi Publications, 2nd Edition.		
Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Four Written Assignments/LMS Tests of 10 marks each will be conducted at the end of each month and one at the end of semester, when students will report for review/presentation of Internship work.		

Semester VIII (B. Tech.) Chemical Engineering
CHE224012B: Membrane Technology

Teaching Scheme:	Credit Scheme: 3	Examination Scheme:
Theory: 3 hrs/week		Continuous Comprehensive Evaluation: 40 marks End Semesters Exam: 60 Marks Total: 100 Marks

Prerequisite: Basic knowledge of Mass Transfer and Separation Processes, Fundamentals of Thermodynamics, Understanding of Chemical Engineering Materials.

Course Objectives:

1. To introduce the fundamental concepts, types, and materials of membranes.
2. To develop an understanding of membrane transport mechanisms and performance characterization.
3. To explore the design and applications of various membrane separation processes.
4. To analyze hybrid and advanced membrane technologies for industrial and environmental use.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Describe membrane types, transport mechanisms, and applications in various membrane separation processes.	2-Understand
CO2	Apply membrane fabrication methods, transport models, and separation process knowledge to solve membrane-related industrial problems.	3-Apply
CO3	Analyze membrane morphology, fouling mechanisms, and operational behavior in pressure-driven and emerging membrane processes.	4-Analyze
CO4	Evaluate membrane systems based on performance, design configurations, and integration with hybrid separation processes for specific industrial applications.	5-Evaluate

Course Contents:

Unit 1	Introduction to Membranes and Membrane Materials (L07)	COs Mapped: CO1, CO2

Classification of membranes: symmetric vs. asymmetric, polymeric vs. inorganic; Overview of membrane materials and selection criteria; Physical and chemical properties of membrane materials; Fabrication of membranes: phase-inversion method; Preparation of composite membranes and inorganic membranes.

Unit 2	Membrane Characterization and Transport Phenomena (L07)	COs Mapped: CO1, CO2, CO3

Membrane morphology and structure analysis (MF and UF characterization); Concepts of osmotic pressure and permeability; Transport in porous vs. non-porous membranes; Models of membrane transport: solution-diffusion, pore flow, and sorption; Concentration polarization and fouling behavior.

Unit 3	Pressure-Driven Membrane Processes (L09)	COs Mapped: CO1, CO2, CO3

Reverse Osmosis (RO): Operating principles, transport models, applications; Nanofiltration (NF): Separation mechanisms, membrane performance; Ultrafiltration (UF): Basic principles, models, industrial applications; Micellar-enhanced and Affinity UF, Bioseparations;

Microfiltration (MF): Mechanisms, fouling, and cleaning strategies; Application-based problems and case studies on RO, UF, MF, and Dialysis.

Unit 4	**Ion-Exchange Membrane Processes (L06)**	**COs Mapped: CO1, CO2, CO4**

Electrodialysis: Ion transport mechanisms, membrane stack design, applications; Pervaporation: Principles, membrane selection, and separation applications; Design and problem-solving exercises related to ion-exchange processes.

Unit 5	**Emerging and Hybrid Membrane Technologies (L07)**	**COs Mapped: CO1, CO2, CO4**

Liquid Membranes: Supported and emulsion types, industrial use; Gas Separation Membranes: Selectivity, permeability, and industrial relevance; Membrane Distillation: Thermal-driven separation, configurations; Facilitated Transport Membranes: Carrier-mediated transport; Membrane Contactors: Design, operation, and novel applications; Integration with other separation processes and future trends.

REFERENCE BOOKS:

1. Membrane Technology and Applications, Richard W. Baker, Wiley, 3rd Edition.
2. Membrane Separation Processes, Kaushik Nath, PHI Learning Pvt. Ltd., 1st Edition.
3. Synthetic Membranes: Science, Engineering and Applications, P. Meares, Springer, 1st Edition.
4. Introduction to Membrane Science and Technology, Heinrich Strathmann, Wiley-VCH, 1st Edition.
5. Membrane Separations Technology: Principles and Applications, Z. F. Cui and H. S. Muralidhara, Butterworth-Heinemann, 1st Edition.
6. Principles of Membrane Technology, R. van der Bruggen and C. Vandecasteele, Elsevier, 1st Edition.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Four Written Assignments/LMS Tests of 10 marks each will be conducted at the end of each month and one at the end of semester, when students will report for review/presentation of Internship work.

Semester VIII (B. Tech.) Chemical Engineering
CHE224013: Entrepreneurship

Teaching Scheme:	Credit Scheme: 2	Examination Scheme:
Theory: 2 hrs/week		Continuous Comprehensive Evaluation: 50 marks Total: 50 Marks

Prerequisite: Basic understanding of process design, economics, and chemical industry operations.

Course Objectives:

1. To develop entrepreneurial competencies and an understanding of innovation, idea generation, and startup culture.
2. To introduce the concept of techno-commercial feasibility and business plan development.
3. To prepare students for starting and managing their own chemical/process-based enterprises.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Interpret entrepreneurial types, motivations, innovation tools, and ecosystem elements.	2-Understand
CO2	Apply idea evaluation, feasibility tools, and business planning techniques.	3-Apply
CO3	Analyze markets, cost structures, and funding sources for startups.	4-Analyze
CO4	Evaluate business models, risks, and IP strategies.	5 – Evaluate
CO5	Design sustainable entrepreneurial strategies using institutional support.	6 – Create

Course Contents:

Unit	Title	COs Mapped
Unit 1	**Foundations of Entrepreneurship (L05)**	**COs Mapped: CO1**
Definition, types, and characteristics of entrepreneurs, Entrepreneurial motivation and competencies, Intrapreneurship vs. entrepreneurship, Role of entrepreneurship in the chemical sector, Challenges in setting up a chemical-based startup.		
Unit 2	**Innovation and Opportunity Evaluation (L05)**	**COs Mapped: CO1, CO2**
Innovation in process and product development, Tools for idea generation: brainstorming, TRIZ, SCAMPER, Technology trends in chemical engineering, Opportunity identification and evaluation framework, Case studies from the chemical process industry.		
Unit 3	**Market Study and Techno-Commercial Feasibility (L05)**	**COs Mapped: CO2, CO3**
Basics of market research: demand analysis, customer profiling, Competitor analysis and SWOT, Cost estimation, pricing strategies, and break-even analysis, Sources of finance: angel investors, venture capital, loans, Government schemes for funding (e.g., PMEGP, Start-Up India).		
Unit 4	**Business Plan and Model Development (L06)**	**COs Mapped: CO2, CO4**
Components of a business plan: executive summary, product/service, operations, marketing, finance, Business Model Canvas, Risk analysis and contingency planning, Pitching and investor communication, IPR and patenting essentials for chemical products/processes.		
Unit 5	**Entrepreneurial Ecosystem and Support Systems (L05)**	**COs Mapped: CO1, CO5**
Role of incubators, accelerators, and industrial parks, Institutional support: DST, MSME, SIDBI, DBT, CSIR, Regulatory and statutory compliances (MSME registration, GST, safety		

norms), Networking: professional bodies, alumni, and industry forums, Ethics and sustainability in entrepreneurship.

REFERENCE BOOKS:

1. Entrepreneurship Development, S. S. Khanka, S. Chand, 1st Edition.
2. Entrepreneurship: Theory, Process and Practice, Donald F. Kuratko, Cengage Learning, 10th Edition.
3. Innovation and Entrepreneurship, Peter F. Drucker, Harper Collins, 1st Edition.
4. Entrepreneurship Development and Small Business Enterprises, Poornima M. Charantimath, Pearson Education, 2nd Edition.
5. Chemical Project Economics, V. V. Mahajani and S. M. Mokashi, Infinity Press, Laxmi Publications, 2nd Edition.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Four Assignments on Unit-1, Unit-2, Unit-3 and Unit-4	40
2	Group Presentation on Unit-5 at the end of semester	10
	Total	**50**

Semester VIII (B. Tech.) Chemical Engineering
CHE223014: Internship

Teaching Scheme:	Credit Scheme: 24	Examination Scheme:
Practical: 24 hrs./week		Term Work: 200 Marks Oral: 100 Marks Total: 300 Marks

Prerequisite: Core Chemical Engineering Fundamentals, Laboratory & Analytical Skills, Safety & Environmental Awareness

Course Objectives:

1. Familiarize students with authentic industrial settings, exposing them to practical challenges and solutions.
2. Cultivate analytical and managerial expertise crucial for success in business and industrial enterprises.
3. Offer hands-on experiences to impart skills such as professional communication, ethical conduct, and problem-solving, enhancing employability and research capabilities.

Course Outcomes: On completion of the course, learner will be able to:-

Sr. No.	Course Outcomes	Bloom's Level
CO1	Apply engineering concepts and safety practices to observe and understand ongoing processes, systems, and operations in an industrial environment.	3-Apply
CO2	Analyze technical problems, workflow patterns, and organizational practices to identify challenges and improvement opportunities within the industrial setup.	4-Analyze
CO3	Evaluate the effectiveness of industrial practices related to communication, teamwork, time management, ethics, and safety through reflective observation.	5 – Evaluate
CO4	Create a well-documented internship report and deliver a structured presentation highlighting key learnings, problem-solving experiences, and professional growth.	6 – Create

Internship Guidelines:

1. Interested students have to submit the Application Form (as per the prescribed format) to department T&P officer.
2. Internship under following two categories are considered:
   Case 1: Where a student is offered an internship through the college internship cell.
   Case 2: Where students can avail the internship with his/ her efforts in an industry / start up or research institute.
3. In case of an internship offered through the college selection process, (Case 1) the student is eligible for only one offer and cannot appear for further process once selected.
4. Only one application will be accepted from one student (in either Case 1 or 2) in the prescribed format available with the Internship cell.
5. The applications will be scrutinized by the internship approval committee at college / department level for its merit. The decision of the committee will be final and further grievances will not be entertained.

6. The duration of internship will be immediately commenced after completion of semester VII examinations. It will end on the date specified as per the academic calendar.
7. Students can join an internship only after getting an approval from the Internship-committee. An undertaking prescribed by the college signed by the student and parent needs to be submitted.
8. The college will assign a mentor for each student who will monitor the students' progress throughout the duration of the internship. The students are expected to be in contact with the mentor on a regular basis.
9. Students should maintain daily diary, attendance sheet during internship.
10. In case of any expenses towards internship within or outside Nashik due to traveling, stay etc. should be borne by the student undertaking the internship.
11. In case any student attempts to join an internship bypassing college procedure, it will not be considered for credit completion of semester VIII and hence for award of the B. Tech degree.
12. After completion of the internship students should submit duly signed Daily diary, Attendance sheet, Internship report, Industry evaluation/feedback, and internship certificate within 7 days from the date of completion to the respective internship mentor.