Academic Program: UG

Academic Year 2025-26

Syllabus

VII & VIII Semester B.E.

Chemical Engineering

SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF ENGINEERING & TECHNOLOGY,
DHARWAD – 580 002
(An Autonomous Institute approved by AICTE & Affiliated to VTU, Belagavi)

Ph: **0836-2447465** **Fax: 0836-2464638** **Web:** www.sdmcet.ac.in

SDM College of Engineering & Technology, Dharwad

It is certified that the scheme and syllabus for VII & VIII semester of UG program in Chemical Engineering is recommended by Board of Studies of Chemical Engineering Department and approved by the Academic Council, SDM College of Engineering & Technology, Dharwad. This scheme and syllabus will be in force from the academic year 2025-26 till further revision.

Principal Chairman BoS & HoD

College Vision and Mission

SDMCET –Vision

To develop competent professionals with human values.

SDMCET – Mission

- To have contextually relevant curricula.
- To promote effective teaching learning practices supported by modern educational tools and techniques.
- To enhance research culture.
- To involve industrial expertise for connecting classroom content to real life situations.
- To inculcate ethics and impart soft skills leading to overall personality development

SDMCET- Quality Policy

- In its quest to be a role model institution, committed to meet or exceed the utmost interest of all the stake holders.

SDMCET- Core Values

- Competency
- Commitment
- Equity
- Team work and
- Trust

Vision and mission of Department

Vision

To develop proficient Chemical Engineers to meet industrial and societal needs.

Mission

1. To design the curricula in tune with industry.
2. To inculcate research culture with ethics to disseminate knowledge.
3. To collaborate with industry and academia for sustainable growth.

Program Educational Objectives (PEOs)

The Chemical Engineering UG Programme at SDMCET is framed and designed such that within first few years after graduation, the graduates will be able to:

- **I.** Analyze, design and professionally practice in the area of Chemical Engineering and allied disciplines by acquiring good knowledge of basic sciences and Chemical Engineering.
- **II.** Create applications to solve real-life problems of Chemical Engineering in a broad range of career path to fulfill ethical, economical, environmental and social responsibilities.
- **III.** Pursue higher studies and carry out research in Chemical Engineering and allied Engineering and Management.
- **IV.** Work in multidisciplinary teams with good communication skills and leadership qualities to solve engineering problems and develop entrepreneural skills.

Program Outcomes (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific outcomes (PSOs)

13. **Plant operations and Control:** Conceptualize the knowledge and information gained in mass and energy balance, thermodynamics, transport phenomena, kinetics, unit operations, process control, equipment design that can be used in design, control and optimizing the Chemical processes.
14. **Quality, Feasibility and impact studies:** Develop an integrated process and modify it attributing to economy, environmental friendly, ethics coupled with safety by applying principles of chemical engineering.
15. **Development of engineering solutions through experiments:** Apply knowledge of chemical engineering in solving both industry and academic problems using experimental methods including design of experiments and simulation to analyze, interpret and present the data.

SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD
Department of Chemical Engineering
VII Semester
Scheme of Teaching and Examinations 2025-26

Sl. No	Course	Course code	Course Title	TD/PSB	Teaching Hours/Week			Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	22UCHC700	Process Dynamics and Control	CH	3	2	0	03	50	100	100	4
2	PEC	22UCHE7XX	Program Elective Course -IV	CH	3	0	0	03	50	100	100	3
3	PEC	22UCHE7XX	Program Elective Course -V	CH	3	0	0	03	50	100	100	3
4	OEC	22UCHO7XX	Open Elective Course -II	CH	3	0	0	03	50	100	100	3
5	PCCL	22UCHL701	Process Control Laboratory	CH	0	0	2	03	50	50	100	1
6	PROJ	22UCHL702	Major Project-I	CH	0	0	12	03	50	50	100	6
								Total			**600**	**20**
Program Elective Course -IV												
	PEC-IV	22UCHE721	Plant Utilities and Industrial Safety	CH	3	0	0	03	50	100	100	3
	PEC-IV	22UCHE722	Process Modelling and Simulation in Chemical Engineering	CH	3	0	0	03	50	100	100	3
	PEC-IV	22UCHE723	Artificial Intelligence and Machine Learning for Chemical Engineering	CH	3	0	0	03	50	100	100	3
Program Elective Course -V												
	PEC-V	22UCHE731	Transport Phenomena	CH	3	0	0	03	50	100	100	3
	PEC-V	22UCHE732	Sugar Technology	CH	3	0	0	03	50	100	100	3
	PEC-V	22UCHE733	Chemical Equipment Design	CH	3	0	0	03	50	100	100	3
Open Elective Course-II												
	OEC-II	22UCHO741	Biochemical Engineering	CH	3	0	0	03	50	100	100	3
	OEC-II	22UCHO742	Sustainable Engineering	CH	3	0	0	03	50	100	100	3
	OEC-II	22UCHO743	Nanotechnology	CH	3	0	0	03	50	100	100	3

PCC: Professional Core Course, PCCL: Professional Core Course laboratory, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous

Internal Evaluation, SEE: Semester End Evaluation. PEC: Program elective course, OEC: Open elective course, PROJ: Project. TD: Teaching department, PSB: Paper setting Board.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum numbers of students' strength for offering Open Elective Course are as prescribed by the DAP.

Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are entitled to opt for the open electives offered by their parent Department and other departments provided that they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course are as prescribed by the DAP.

Major Project-I: The objective of the project work is to encourage development of independent learning, innovative attitude, communication skills, organization, time management, presentation skills, team work, punctuality, setting and meeting deadlines. In Major project the students are expected to identify the state-of-the-art technology in their domain of interest by an extensive literature survey and select a topic from an emerging area relevant to their branch/interdisciplinary and define the problem for the project work. The project shall consist of a team of students not more than 2-4. Each batch shall be assigned with a faculty member. A committee constituted by HOD consisting of minimum 2 faculty members shall evaluate for CIE. There is SEE, a viva voce examination which shall be examined by two examiners constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the project work carried out, report, project presentation, communication skill and question and answer session.

AICTE activity point: Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the program. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case student fails to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD
Department of Chemical Engineering
VIII Semester
Scheme of Teaching and Examinations 2025-26

Sl. No	Course	Course code	Course Title	TD/PSB	Teaching Hours/Week			Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	TS	22UCHL800	Technical Seminar/Independent Study	CH	0	0	2	-	50	-	50	1
2	PROJ or INT	22UCHL801	Major Project-II/Internship	CH	12 Weeks			03	50	50	100	10
3	INT	22UCHL802	Summer Internship	CH	4 Weeks			03	50	50	100	3
								Total			**250**	**14**

L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation., TD: Teaching department, PSB: Paper setting Board, TS: Technical Seminar, PROJ: Project, INT: Internship

Technical Seminar/Independent study (TS): Students are expected to learn how to conduct a literature survey to identify the state-of-the-art technology in their chosen engineering domain. They are required to select an emerging topic beyond the syllabus relevant to their branch of study, understand the concept, analyse it, and present it effectively with technical innovations or novel work in a 15–20 minute session, followed by a 5-minute question and answers with their classmates and faculty. Additionally, students must develop effective communication skills and understand the modalities of technical interactions. They are required to submit a seminar report following the format provided by the DUGC. The technical seminar is evaluated for CIE based on the rubrics prescribed by the DUGC.

Summer Internship: Students must undergo an internship in private industries, R&D organizations, Center of Excellence, laboratories of reputed institutions, government and semi-government organizations, PSUs, construction companies, or entrepreneurial organizations to gain exposure to the external professional environment. The internship should be completed over a period of four weeks during the summer vacation after the IV or VI semester and must be completed before the VII semester. Students are required to prepare a report on the work carried out during the internship and submit both the report and the internship certificate during the VIII semester. The internal faculty will monitor student performance and award CIE marks in the VIII semester. Additionally, there will be a SEE, in which students must present their work before a panel of two examiners constituted by the HoD during the SEE of the VIII semester.

Major Project-II: This project work is intended for students who do not undertake an internship. The objective of the project is to foster independent learning, an innovative mindset, communication skills, organization, time management, presentation skills, teamwork, punctuality, and the ability to set and meet deadlines. In this project, students are expected to conduct an extensive literature survey to identify state-of-the-art technology in their domain of interest, select a topic from an emerging area relevant to their branch or an

interdisciplinary field, and define the problem for their project work. Each project team shall consist of 2 to 4 students and will be assigned a faculty mentor. The department shall conduct three project reviews as per the schedule provided by DAP, which must be recorded as part of the project evaluation for CIE, along with marks awarded by the faculty guide. A committee constituted by the HoD, consisting of a minimum of two faculty members, shall conduct the reviews and evaluate the CIE. For SEE, students must appear for a viva-voce examination, which will be assessed by a panel of two examiners—one internal and one external—constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the project work carried out, report, project presentation, communication skill and question and answer session.

Internship: The internship is intended for students who do not undertake a project. Students must undergo an internship in private industries, R&D organizations, Center of Excellence, laboratories of reputed institutions, government and semi-government organizations, PSUs, construction companies, or entrepreneurial organizations to gain exposure to the external professional environment. The internship shall be for a duration of 12 weeks during the VIII semester, either through placement or on an individual basis. Students are required to prepare a report on the work carried out during the internship and submit both the report and the internship certificate during the VIII semester. The department shall conduct three project reviews as per the schedule provided by DAP, which must be recorded as part of the project evaluation for CIE. A committee constituted by the HoD, consisting of a minimum of two faculty members, shall conduct the reviews and evaluate the CIE. For SEE, students must appear for a viva-voce examination, which will be assessed by a panel of two examiners—one internal and one external—constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the work carried out, report, project presentation, communication skill and question and answer session.

AICTE activity point: Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the program. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case student fails to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

Total credits offered for the third year: 34

VII Semester

22UCHC700	Process Dynamics and Control	(3-2-0) 4

Contact Hours: 52

Course Learning Objective (CLO):

1. The purpose of this course is to introduce the key concepts in automation of process plants.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		Mapping to POs (1-12)/ PSOs (13-15)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Outline the basic principles and importance of process control in industrial process plants.	13	1	-
CO-2	Formulate and study dynamic models of first order system.	-	2,3	13
CO-3	Formulate and study dynamic models for second order system and lag.	-	2,10	13
CO-4	Predict closed loop behavior using block diagram and analyze control valves.	-	2	13
CO-5	Analyze controllers and determine the stability of a closed-loop feed-back control system.	-	2,3	13

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	2.0	2.0	2.0	-	-	-	-	-	-	2.0	-	-	1.4	-	-

Course Content:

Unit-I

Introduction: Process control, objectives, benefits, PID diagrams, classification of variables, control configuration, classification of control systems. Mathematical modeling, Laplace transform, types of inputs- step, impulse, linear and sinusoidal. **10 Hrs.**

Unit-II

Process Dynamics: First order systems, transfer functions - mercury in glass thermometer, level, mixing tanks, stirred tank reactors, first order system in series: interacting and non-interacting systems, linearization of non-linear first order systems. **12 Hrs.**

Unit-III

Second Order Systems: U-tube manometer, damped oscillator, response equations, terms for underdamped system, transportation lag**.** **10 Hrs.**

Unit-IV

Block Diagram: Importance, reduction rules, servo and regulatory system, closed loop transfer function.

Final Control Element: control valves, types, actuators, positioners, valve characteristics. **10 Hrs.**

Unit-V

Controllers: Transfer functions for two position, proportional, Proportional +Reset (P+I), Proportional + Rate (P+D), Proportional + Reset + Rate controller (P+I+D).

Stability: Stability criterion, Routh Hurwitz test, Root Locus method. **10 Hrs.**

Reference Books:

1) Donald Coughanour and Steven Leblanc, “Process System Analysis and Control”, 3/e, McGraw Hill, New Delhi, McGraw Hill 1991.
2) Luyben, “Process Modeling, Simulation and Control for Chemical Engineers”, 2/e, McGraw Hill, 1990. ISBN -13: 978-0070391604
3) Coulson and Richardson, “Chemical Engineering” Vol, III, 3/e, Pengeman Press,2006.
4) George Stephanopoules, “Chemical Process Control” An Introduction to Theory and Practical, Pearson, New Delhi, 2014. ISBN - 9780131286290

22UCHL701 Process Control Laboratory (0-0-2)1

Contact Hours: 26

Course Learning Objective (CLO):

1. The purpose of this laboratory is to introduce the key concepts in automatic control and instrumentation of process plants.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12)/PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Apply fundamentals of industrial processes, process measurement and process control theory.	4, 15	9,10	-
CO-2	Analyze transient behavior of simple systems.	4, 15	9,10	-
CO-3	Analyze data from experiments and prepare well organized laboratory report.	4, 15	9,10	-

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	-	3.0	-	-	-	-	2.0	2.0	-	-	-	-	3.0

List of Experiments:

1. Step response of first order systems (Thermometer).
2. Step response for Single capacity System - first order System.
3. Step & Impulse response for two first order systems arranged in Non - Interacting mode.
4. Step & Impulse response for first order systems arranged in Interacting mode.
5. Step response of first order system (stirred tank heater).
6. Control Valve Characteristics.
7. Temperature sensors characteristics – RTD, Thermocouple, Thermistor.
8. Characteristics of Temperature Transmitter.
9. Characteristics of I/P and P/I converters.
10. Analysis of Flapper-Nozzle system.
11. Temperature Control Trainer– ON/OFF, P, PI, PD, PID action.

Note: Minimum 10 experiments to be conducted.

Reference Books:

1) Donald Coughanour and Steven Leblanc, “Process System Analysis and Control”, 3/e, McGraw Hill, New Delhi, McGraw Hill 1991.
2) Luyben, “Process Modeling, Simulation and Control for Chemical Engineers”, 2/e, McGraw Hill, 1990. ISBN -13: 978-0070391604

22UCHL702 Major Project-I (0-0-12) 6

Contact Hours: 156

Course Learning Objectives (CLOs):

1. To identify the problems in thrust areas of chemical engineering.
2. To plan experimental or theoretical work using multidisciplinary knowledge.
3. To apply the science, mathematical computational engineering and economics knowledge for solution of the problem selected.
4. To use various advanced instruments for the analysis with techniques.
5. To interact with industries, research centers and other colleges.
6. To understand the principle to work in teams and the concept of leadership.
7. To learn flow sheeting, designing and report writing skills.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12) PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify the topic of chemical engineering or integrated problems (allied fields).	2,10	8, 12	6, 7, 14
CO-2	Compare the literature review and select suitable materials and methodologies for selected topic.	3,4,5,15	8,11,12	7, 10, 14
CO-3	Interpret the experimental results with discussion and economic analysis.	11,15	8,10,12	9
CO-4	Prepare a precise report on the work done with proper guidelines and references.	10	8,15	9
CO-5	Organize and present the work carried out to justify the results obtained with conclusion	9, 10, 12	8, 11	2, 4

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	2.0	3.0	2.0	3.0	1.0	1.0	2.0	1.66	2.4	2.33	2.0	-	1.0	2.66

Course Content:

The objective of the project work is to encourage development of independent learning, innovative attitude, communication skills, organization, time management, presentation skills, team work, punctuality, setting and meeting deadlines. In Major project the students are expected to identify the state-of-the-art technology in their domain of interest by an extensive literature survey and select a topic from an emerging area relevant to their branch/interdisciplinary and define the problem for the project work. The project shall consist of a team of students not more than 2-4. Each batch shall be assigned with a faculty member. A committee constituted by HOD consisting of minimum 2 faculty members shall evaluate for CIE. There is SEE, a viva voce examination which shall be examined by two examiners constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the project work carried out, report, project presentation, communication skill and question and answer session.

Reference Books/Material:

Offline/online chemical engineering and its related field Journals.

Books in the area of chemical engineering and its related field

22UCHE721 Plant Utilities and Industrial Safety (3-0-0)3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To understand the utilities in a chemical process plant, types, role and their selection.
2. To understand the principles of safety with insight of safety analysis techniques and application of safety devices.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12)/ PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Comprehend the selection and role of utilities and appraise the generation, handling and role of water and steam.	-	3	14
CO-2	Appraise the generation, handling and role of air with the use of devices.	3	14	-
CO-3	Assess refrigerants, evaluate the performance and apply refrigeration.	3	7,14	-
CO-4	Prioritize safety aspects, plan and use safety devices in defiant situations in a chemical plant.	3	6,8	14
CO-5	Interpret safety analysis tools and techniques and translate to hazardous conditions.	3	7	14

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	2.8	-	-	2.0	2.0	2.0	-	-	-	-	-	1.4	-

Course content:

Unit-I

Introduction: Utilities and their role, selection criteria etc. **Water and Steam:** Resources, Cooling water-requirements and treatments, Water softening methods- Ion exchange, water pretreatment, recycle and reuse. Steam quality, consumption, distribution. **08 Hrs.**

Unit-II

Air: Compressed air for process and instruments, Blowers and Fans- Multistage Compression-features, Vacuum pumps, Air Drying-Pressure swing Adsorption with applications, Skarstrom cycle. **08 Hrs.**

Unit-III

Refrigeration: Carnot Cycle and Reverse Carnot Cycles, Primary and Secondary refrigerants, Vapor Compression Refrigeration; various refrigerants, Vapor Absorption Refrigeration, Comparison. **08 Hrs.**

Unit-IV

Process Safety and Devices: Safety aspect, safe design, Intrinsic and Extrinsic safety, Hazards, Risk, Toxicity, Flammability, Fire, Explosion, TLV, Sources of ignition, Hazardous materials, Reactive chemicals, Combustion and Flammability, Gas explosion, Dust Explosion, UCVCE, Static Electricity, Vacuum Hazards, Inert Gas Hazards, Gas Dispersion, Safety Devices; Pressure Relief Systems, Emergency relief devices. **08 Hrs.**

Unit-V

Safety Analysis and Case Studies: Hazard Analysis (HAZAN), Hazard and Operability studies (HAZOP), Comparison, Risk Analysis and Estimation, Safety check list. Case Studies: Bhopal, Jaipur, Flixborough, Mexico [LPG Fire]

07 Hrs.

Reference Books:

1) Perry's "Handbook of Chemical Engineers" 7/e, Mc-Graw Hill Publications.
2) Frank P. Lees, "Loss Prevention", Vol 1 and Vol 2.
3) Jack Broughton, "Process Utilities", I Chem publications.

22UCHE722 Process Modeling and Simulation in Chemical Engineering (3-0-0)3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To study basic concepts of modeling and formulation of mass and energy balance relationships and thereby it helps for the development of complex models.
2. To understand the advanced technologies in simulation field and the applicability in industries.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs (1,12)/ PSO (13-15)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Compare and apply the different fundamentals to develop the	1,3	2	5

	models for chemical engineering system.			
CO-2	Interpret and develop different mathematical methods for chemical engineering system.	3,13	1, 2	5
CO-3	Apply and assess different relevant software and models for solving chemical engineering problems.	5, 13	2,3	-
CO-4	Identify the different simulation tools and Ability to solve chemical engineering problems using numerical techniques	5, 13	2,3	-
CO-5	Demonstrate and analyse the different model solving ability for various chemical engineering process.	5, 13	2, 3	-

POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO -9	PO -10	PO -11	PO-12	PSO -13	PSO-14	PSO -15
Mapping Level	2.5	2.0	2.4	-	2.2	-	-	-	-	-	-	-	3.0	-	-

Course content:

Unit-I

Modeling in Chemical Engineering: Introduction, Principles of Formulation, Fundamental laws; Continuity Equation, Energy Equation, Equation of motion, Transport Equations, Equation of States, Equilibrium, Chemical Kinetics, Classification of Mathematical models. **08 Hrs.**

Unit-II

Numerical Techniques: Iterative convergence methods like bisection and secant method, Newton raphson method, Numerical integration of ordinary differential equations like Euler and Runge Kutta method. Numerical solution of partial differential equations of first order approximation with examples. **08 Hrs.**

Unit-III

Models in Chemical Engineering: Introduction, Series of Isothermal, Constant-Holdup CSTRs, CSTRs with Variable Holdups, Two Heated Tanks, Gas-Phase, Pressurized CSTR, Non-isothermal CSTR, Single-Component Vaporizer, Multicomponent Flash Drum, Batch Reactor, Reactor With Mass Transfer, Ideal Binary Distillation Column, Multicomponent Non-ideal Distillation Column Batch Distillation With Holdup. **08 Hrs.**

Unit-IV

Computer Simulation: Introduction to Simulation, Role of Computers and Numerical Methods in simulation, Iterative convergence methods, Explicit

Convergence methods, Explicit Numerical Integration algorithm, Implicit Methods, Numerical examples. **08 Hrs.**

Unit-V

Specific Simulation/ Model Development: Batch reactor, CSTR, Bioreactor, activity coefficient models, Distillation and equilibrium Flash vaporization. **07 Hrs.**

Reference Books:

1) William L. Luyben, "Process modeling, simulation and control for Chem. Engg.", Mc.Graw Hill, 1990.
2) Edger TF and Himmelblau D M, "Optimization of chem. Process" Mcgraw Hill, 1989.
3) Asghar Hussain, "Chemical process simulation", Wiley Eastern Ltd, 1986.
4) Roger G.E Franks, "Modeling and Simulation in Chemical Engineering" Wiley Inter science. New York, USA, 1972.

22UCHE723 Artificial Intelligence and Machine learning for Chemical Engineering (3-0-0)3

Contact Hours: 39

Course Learning Objectives (CLOs):

1) To provide an in-depth understanding of the applications of Artificial Intelligence (AI) in the field of Chemical Engineering.
2) To cover various AI algorithms and methodologies and explores their practical implementation in chemical engineering applications.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)/ PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Introduce the fundamental concepts of Artificial Intelligence and its relevance to chemical engineering.	1	2	5
CO-2	Familiarize students with various AI techniques and algorithms applicable to chemical engineering problems.	5	15, 2	3
CO-3	Develop an understanding of AI-driven modelling, optimization, control, and data analysis techniques.	5	15, 2	3
CO-4	Encourage critical thinking and problem-solving skills through the application of AI techniques to real-world chemical engineering scenarios.	5	15, 2	3
CO-5	Provide hands-on experience with	5, 15	6,7	8

	implementing AI algorithms using software tools commonly used in the chemical engineering industry.			

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	3.0	2.0	1.0	-	2.6	2.0	2.0	1.0	-	-	-	-	-	-	2.25

Course content:

Unit-I

Introduction to AI & ML in Chemical Engineering: Historical development and current trends in AI. Basics of Artificial Intelligence (AI) and Machine Learning (ML)**.** Relevance of AI in chemical engineering applications. AI and ML applications in Chemical Engineering**.** Overview of supervised, unsupervised, and reinforcement learning**.** Process optimization and automation using AI**.** Introduction to statistical analysis for AI in chemical engineering, Software tools for AI in chemical engineering. **07 Hrs.**

Unit-II

Machine Learning Techniques for Chemical Processes: Regression models (Linear, Polynomial, Multiple Regression)**.** Classification algorithms (Decision Trees, SVM, Naive Bayes)**.** Clustering techniques (K-Means, DBSCAN, Hierarchical)**.** Neural networks and deep learning for chemical process modelling**.** Model validation and performance evaluation techniques. Feature engineering and dimensionality reduction techniques. **09 Hrs.**

Unit-III

AI in Process Simulation & Control: Digital twins and AI-driven process simulations**.** Time-series analysis and forecasting using AI. AI in real-time process monitoring and fault detection**.** Reinforcement learning for process control**.** AI-based soft sensors and predictive maintenance**.** Handling big data in chemical engineering applications, Software tools for AI data analysis. Case studies: Smart reactors, distillation column optimization**.** **08 Hrs.**

Unit-IV

Data-Driven Chemical Engineering & Optimization: Big Data and IoT in chemical plants. Process modelling using AI and ML-based surrogate models**.** Optimization techniques (Genetic Algorithm, Particle Swarm Optimization)**.** AI for energy efficiency and sustainability**.** Ethical considerations and challenges in AI implementation in chemical engineering. AI applications in catalysis, reaction kinetics, and drug discovery**.** **08 Hrs.**

Unit-V

AI for Sustainability & Future Trends in Chemical Engineering: AI applications in hazard identification and risk assessment. Predictive maintenance and reliability analysis using AI. AI for carbon capture and CO_2 utilization**.** AI in wastewater treatment and environmental monitoring**.** Green chemistry and AI-driven sustainable materials**.** AI-driven approaches for energy efficiency and sustainability in chemical processes, Integration of AI techniques

with safety management systems. Future trends of AI-driven research in chemical engineering. **07 Hrs.**

Reference Books:

1) Quantrile, Thomas, Liu, Y. A, Artificial Intelligence in Chemical Engineering, Academic Press, 1/e, 1992. ISBN: 9780125695503
2) Dr. Suresh Namboothiri, Generative AI for Chemical Engineering: Unleashing the Power of Prompt Engineering in Chemical Engineering and AI Integration. 2023.
3) Jeong-Yeol Yoon, Chenxu Yu, Machine Learning and Artificial Intelligence in Chemical and Biological Sensing. 1/e, 2024. ISBN: 9780443220005

22UCHE731 Transport Phenomena (3-0-0)3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To provide basic understanding of laws governing transport processes and effect of various parameters.
2. To provide an understanding of steady state shell balances for velocity, temperature and concentration distribution under laminar flow.
3. To deal with equations of change and analogies amongst transport processes along with their applications

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)/ PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	State laws of momentum, energy and mass transport. Discuss effect of temperature and pressure on transport properties of fluid.	1	-	-
CO-2	Formulate velocity distribution equations under laminar flow conditions to solve transport problems.	-	2, 3, 13	1
CO-3	Formulate temperature distribution equations under laminar flow conditions to solve transport problems.	-	2, 3, 13	1
CO-4	Formulate concentration distribution equations under laminar flow conditions to solve transport problems.	-	2, 3, 13	1
CO-5	Apply equations of change for isothermal systems and write	-	2, 3, 13	1

	analogies between momentum, heat and mass transport problems.			

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	1.4	2.0	2.0	-	-	-	-	-	-	-	-	-	2.0	-	-

Prerequisites: Fluid Mechanics, Heat and Mass Transfer

Course content:

Unit-I

Introduction: Importance of transport phenomena in chemical engineering, Momentum, Energy and Mass transport, Newton's law of viscosity, Newtonian and Non-Newtonian fluids. Fourier's law of heat conduction, Ficks law of diffusion, effect of temperature and pressure on transport properties of fluids. Numerical problems using all law. **07 Hrs.**

Unit-II

Velocity Distribution in Laminar Flow: Steady state shell momentum balance, boundary conditions applicable to momentum transport problems, flow over a flat plate, flow through circular tube, flow through annulus, flow between parallel plates and slit. Numerical problems using the equation derived above. **09 Hrs.**

Unit-III

Temperature Distribution in Laminar Flow: Steady state shell balance, boundary conditions applicable to energy transport problems, heat conduction through compound walls, heat conduction with internal generation by electrical source, nuclear and viscous energy sources. Heat conduction in a cooling fin, Forced and free convection heat transfer. Numerical problems using equation derived above. **08 Hrs.**

Unit-IV

Concentration Distribution in Laminar Flow: Steady state shell balance, Boundary conditions applicable to mass transport problems, Diffusion through stagnant gas and liquid films, Equimolar counter diffusion, Diffusion into falling film, Forced convection mass transfer, Diffusion with homogeneous and heterogeneous reaction. Numerical problems using the equation derived above. **08 Hrs.**

Unit-V

Equation of Change of Isothermal Systems: Non isothermal systems and Multicomponent systems. Application of these equations in solving steady state problem.

Analogies and Navier Stokes equation: Simple numerical problems on it. Analogies between Momentum, Heat and mass transport and their numerical problems. **07 Hrs.**

Reference Books:

1) Bird, Stewart and Lightfoot, "Transport Phenomena", John Wiley, 2/e. 1994.

2) Robert Brodkey and Henry C. Hershey, “Transport Phenomena Unified Approach”, International Edition- 1988. ISBN-10: 0070079633
3) Bennet and J. E., “Momentum Heat and Mass Transfer”, Myer- McGraw Hill. 3/e. 1982.
4) Suryavanshi and Dongre, “Transport Phenomena”, Nirali Prakashan. 7/e. 2012. ISBN: 978-81962-56-5.

22UCHE732	Sugar Technology	(3-0-0) 3

Contact Hours: 39

Course Learning Objective (CLO):

1. To understand different cultivation and analytical methods, various unit operations and unit processes with practical difficulties encountered during the production of sugar.

Course Outcomes (COs):

Description of the course outcomes: At the end of the course student will be able to		Mapping to POs (1-12) /PSOs (13-15)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Comprehend overall scenario, sugar cane cultivation, analysis and milling process.	5	-	-
CO-2	Classify various purification methods and advantages.	1	-	-
CO-3	Outline various unit operations, equipments and advantages.	-	14	-
CO-4	Compare various production methods and distillation types.	3	-	5
CO-5	Compare different co-generation systems and efficiency along with pollution control measures.	7	3	-

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	3.0	-	2.5	-	2.0	-	3.0	-	-	-	-	-	-	2.0	-

Course content:

Unit- I

Over view of Sugar Industry: Overall scenario of sugar industry both globally and in India. Factory site, layout of the factory. Sugar cane, sugar plantation, plant protection of sugar cane crop. Sugar cane cultivation, harvesting and milling process. Composition of cane and juice, properties of sucrose and reducing sugars. Various analytical methods used in sugar industry. **08 Hrs.**

Unit- II

Purification: clarifying and bleaching agents, defecation process. Classification of sulphitation and carbonation methods. Advantages of carbonation over sulphitation. Methods for the clarification of the syrup. Filtration of scums.

08 Hrs.

Unit- III

Unit operations: Evaporation, multiple effect evaporation, various features of evaporators design, causes of entrainment, incrustation formation and removal, crystallization, boiling syrup massecuites, requirements of good pan boiling, rate of crystallization, factors affecting the crystal growth, various types of crystallizers, boiling schemes, condensers, centrifugal operation, dryers, grading of sugar. **08 Hrs.**

Unit- IV

Distillery: Molasses, storage, utilization, various distillation types, advantages. Production of ethanol by fermentation process, factors influencing the production of alcohol, design considerations for distillation column, distillery wastes, treatment, disposal. **08 Hrs.**

Unit- V

Co-generation: Types of co-generation systems, quality of bagasse and boilers used, efficiency, production of steam, quality of steam, pollution control measures for water, air, solid wastes and noise in sugar industries. **07 Hrs.**

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Reference Books:

1) Honing P (Ed), “Principles of Sugar Technology”, Vol I to III, Elsevier publishing company, 2010.
2) Jenkinos. G.H., “Introduction to cane sugar Technology”, Elsevier, 1966.
3) Mathur.R.B.L, “Handbook of cane Sugar Technology”, 2/e, Oxford and I.B.H. Publishing Co., 1997.
4) R.K. Rajputh, “A text book on Power Plant Engineering”, 2/e, Laxmi publications (p) Ltd., New Delhi, 2001.

22UCHE733	Chemical Equipment Design	(3-0-0)3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To develop key concepts and techniques with relevant codes and standard procedures of different equipment.
2. To study the detailed design considerations of different types of equipment used in chemical industries.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		Mapping to POs (1-12) /PSOs (13-15)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Congregate the data from relevant code books and identify the standard procedures for the design of chemical equipment.	13	1	3
CO-2	Design and evaluate the pressure vessels and its components	3, 13	2	1
CO-3	Design and evaluate the reaction vessels and its components.	3, 13	2	1
CO-4	Design and evaluate tall vertical vessels and its components.	3, 13	2	1
CO-5	Estimate the pipe size; pump rating with accessories and Congregate the data to design the storage vessels.	3, 13	2	1

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	1.2	2.0	2.6	-	-	-	-	-	-	-	-	-	3.0	-	-

Course content:

Unit-I

Introduction: Design procedure, equipment classification and components, design parameters, pressure vessel codes. Design considerations: Material selection, factors affecting design, stresses due to static and dynamic loads (Internal and External), temperature effects, and economic considerations.**07 Hrs.**

Unit-II

Design of Pressure Vessels: Design parameters, conditions and stresses. Design of shell and other vessel components. Vessel at low and high operating temperatures. Design of components, supports and selection of vessels accessories and mountings. Numerical problems. **09 Hrs.**

Unit-III

Design of Reaction Vessels: Design of reaction tanks-agitators, baffles, jackets, tank dimensions. Power calculations. Drive calculations and accessories. Support calculations for the system. Numerical problems. **07 Hrs.**

Unit-IV

Design of Tall Vertical Vessels: Vessels subjected to wind loads. Multi shell constructions. Determination of shell thickness. Supports for columns. Numerical problems. **07 Hrs.**

Unit-V

Pipe Line Design: Pipe thickness, pipe diameter. Optimum size of delivery line in pumping operations. Pump rating. Numerical problems.

Design of Storage Vessels: Process conditions and design parameters for

storage of volatile, nonvolatile fluids and gases. Design of components, supports and selection of vessels accessories and mountings. Roofs for vessel. Numerical problems **09 Hrs.**

Note: IS code book 2825 for pressure vessel design is permitted in the examinations for reference.

Reference Books:

1) V. V. Mahajani and S. B. Umarji, "Joshi's Process Equipment Design" – Trinity Press, Delhi, India 4/e.
2) S. D. Dawande, "Process Design of Equipment", Vol 1, Central Techno Publications. 3/e, 2003.
3) Brownell and Young, "Process equipment design" Willy student, 1/e, 2009
4) Don W. Green and Robert H. Perry, "Chemical Engineers Handbook", 6/e, McGraw Hill, 2014.
5) Code for United Pressure Vessel, IS 2825, Bureau of Indian standards, New Delhi, 1969.

22UCHO741	Biochemical Engineering	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To provide the forum to understand the principles and concepts of microbiology, cell biology and biochemistry and thereby apply chemical engineering principles to asses and evaluate the cell as a reactor.
2. To incorporate the principles of chemical engineering in understanding the upstream and downstream processing techniques in a biochemical industry.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12)/ PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify the microorganisms in the context of industrial and environmental microbiology and explain the chemicals of life with the properties and their derivates.		7	2
CO-2	Interpret and evaluate the enzyme kinetic parameters with different effects of the reactors.	13	3	2
CO-3	Analyze cell growth kinetics and solve problems of upstream bio processing.	13	3	2
CO-4	Explain the various configurations of bioreactors along with	12,13	3	2

	fermentation technology			
CO-5	Identify and explain the methods involved in product recovery and purification	12,14	3	2

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	1.0	2.0	-	-	-	2.0	-	-	-	-	3.0	3.0	3.0	-

Course content:

Unit-I

Microbiology: Scope, structure of cells: Prokaryotic and Eukaryotic, characterization and classification of microorganisms - Taxonomy and Whitaker's 5-Kingdom concept, environmental and industrial microbiology, control of microorganisms.

Biochemistry: Chemicals of life - Lipids, sugars and polysaccharides; amino acids, proteins and enzymes; vitamins, biopolymers, nucleic acids and their derivatives. **08 Hrs.**

Unit-II

Enzyme Catalyzed Reactions: Enzyme Nomenclature and classification, enzyme kinetics, Mechanism and kinetics of enzymatic reactions, evaluation of kinetic parameters, factors affecting enzyme activity, Inhibitors and inhibition kinetics, Industrial enzymes and applications, methods of immobilization of enzymes. **08 Hrs.**

Unit-III

Biomass Production in Cell Cultures: Ideal reactors for kinetic measurements - batch and continuous reactors, Monod's growth kinetics, Transient growth kinetics, Cell growth and kinetic patterns, Reactors and their configurations. **09 Hrs.**

Unit-IV

Fermentation Technology: Ideal bioreactors, medium formulation, operation and maintenance of typical aseptic aerobic fermentation processes, alternate bioreactor configurations. **07 Hrs.**

Unit-V

Downstream Processing: Steps involved in product recovery, operations involved - centrifugation, chromatography and emerging technologies including membrane separation techniques. **07 Hrs.**

Reference Books:

1) Jay Bailey, James Bailey and David F. Ollis, "Biochemical Engineering

Fundamentals", 2/e, McGraw Hill, 1986.
2) Michael L. Shuler and Fikret Kargi, "Bioprocess Engineering - Basic Concepts", 2/e, Prentice Hall of India (2003).
3) Michael J. Pelczar, E. C.S. Chan and Noel R. Krieg, "Microbiology Concepts and Applications", 5/e, McGraw Hill reprint 2001.
4) Syed Tanveer Ahmed Inamdar, “Biochemical Engg: Principles and Concepts” 3/e, Prentice Hall of India Learning Pvt. Ltd. (2012), New Delhi.

22UCHO742 Sustainable Engineering (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1) To introduce the concepts of sustainability and its importance in engineering to study the environmental, social, and economic impact of engineering projects.
2) To analyse the potential of technology in bringing sustainable engineering practices.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)/ PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Understand the relevance and the concept of sustainability and their role in engineering.	7	6	3, 8
CO-2	Explain the different types of environmental pollution problems and their sustainable solutions	7	6, 14	8, 15
CO-3	Discuss the environmental regulations and standards with management and conservation strategies.	7	6, 14	3, 8
CO-4	Outline the concepts related to conventional and non-conventional energy to evaluate energy efficient solutions.	7	6, 14	8, 15
CO-5	Demonstrate the real-world sustainable engineering practices by utilizing engineering knowledge and principles.	7	6, 14	8, 15

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	1.0	-	-	2.0	3.0	1.0	-	-	-	-	-	2.0	1.0

Course content:

Unit-I

Sustainability: Introduction, concept, evolution of the concept; Social, environmental, and economic sustainability concepts; Sustainable development, Principles and framework of sustainable engineering, Water, Energy and Food (WEF) nexus, Nexus between Technology and Sustainable development; Sustainability Models, Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM). **08 Hrs.**

Unit-II

Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 7R concepts in solid waste management; Environmental economics for sustainability, Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon capture and utilization, Carbon credits, carbon trading and carbon foot print, ecological and water foot print, Ethics and Legislations for environmental protection. **08 Hrs.**

Unit-III

Environmental management standards: ISO 14001:2015 frame work and benefits, Scope, and goal of Life Cycle Analysis and assessment (LCA), Circular economy, Bio-mimicking, Zero waste strategy, Environmental auditing, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis. **08 Hrs.**

Unit-IV

Resources and its utilization: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy, Energy storage technologies, Waste to energy technologies, Case studies with energy sustainability in engineering projects. **08 Hrs.**

Unit-V

Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Technology and Engineering, Sustainable Urbanization, Sustainable cities, Sustainable transport, digital sustainability, Eco design and sustainable product development, Case studies in sustainable engineering and practices. **07 Hrs.**

Reference Books

1) Allen, D. T. and Shonnard, D. R., “Sustainability Engineering: Concepts, Design and Case Studies,” Prentice Hall. 2012. ISBN-9780132756549
2) Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, CRC Press, 1/e, 1998. ISBN- 9781315138060
3) Twidell, J. W. and Weir, A. D., “Renewable Energy Resources”, Taylor and Francis, 3/e, 2015. ISBN- 0415584388
4) Purohit, S. S., “Green Technology - An approach for sustainable environment”, Agrobios Publication, 1/e, 2021. ISBN-9788177543438

22UCHO743	Nanotechnology	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To provide students with the knowledge of techniques used for synthesis and surface modification of nanomaterials.
2. To understand the structural, morphological, and surface composition of nanomaterials and their applications.

Course Outcomes (COs) :

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1,12)/ PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Describe the fundamentals of nanoscience and nanotechnology	-	2	1
CO-2	Analyze physical and chemical methods used for synthesis and processing of nanomaterials	13	2	1
CO-3	Compare and select suitable techniques for characterization of a given nanomaterial	1	2	-
CO-4	Use different techniques to process different types of nanocomposites and know the limitations of each process	1, 13	2	5
CO-5	Learn the importance and applications of Nanotechnology in chemical industries	-	7	6

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	2	2	-	-	1	1	1	-	-	-	-	-	3	-	-

Course Content:

Unit-I

Introduction to Nanotechnology: Nanomaterials and its classification, Zero dimensional, one-dimensional and two dimensional nanostructure materials - classification of solids: conductor, semiconductors, insulator, types of semiconductor, doping, diodes, current flow in semiconductors, ceramics and nanocomposites, Properties of individual nanoparticles, Methods of synthesis, Reactivity of nanoparticles. **07 Hrs.**

Unit-II

Methods of Synthesis of Nanomaterials: Ball Milling, physical and chemical vapour deposition methods and Electro deposition, Solution based Synthesis of

Nanoparticles, Inert gas condensation, Arc discharge, RF plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis and Molecular beam epitaxy, co-precipitation, sol-gel method, chemical reduction, photochemical synthesis, electrochemical synthesis, Spray pyrolysis method, flame spray pyrolysis, gas phase synthesis. **08 Hrs.**

Unit-III

Characterization Techniques: Optical Microscopy, Electron Microscopy, Secondary electron scattering, back scattering, Scanning Probe Microscopes, Focused Ion Beam Technique, X-ray imaging, Transmission Electron Microscope (TEM), Scanning Probe Microscope (SPM)- Atomic Force Microscope (AFM), Scanning Tunneling Microscope (STM), UV-VIS Spectrophotometers, IR/FTIR Spectrophotometers, and Raman spectroscopy. **08 Hrs.**

Unit-IV

Nanocomposites and their Applications: Need for composite materials. Classification of composites; Matrix: Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC); Reinforcement: particle reinforced composites, Fibre reinforced composites. Applications of composites. Fibre production techniques for glass, carbon and ceramic fibres. **08 Hrs.**

Unit-V

Nanomaterials For Chemical Industry: Nanocatalysts, Smart materials, Heterogenous nanostructures and composites, Nanoparticles for water purification-Photocatalytic mechanism, general pathways and kinetics-Treatment of Arsenic, Removal of Heavy metal ions by Iron and polymeric based nanoparticles, Magnetic Nanoparticles, Nanoscale carbon for contaminant separation -Nanostructures for Molecular recognition (Quantum dots, Nanorods, Nanotubes), Molecular Encapsulation and its applications – Nanoporous zeolites, Self assembled Nanoreactors. **08 Hrs.**

Reference Books:

1) M. H. Fulekar, “Nanotechnology importance and applications”, I. K. International Publishing House Pvt. Ltd., New Delhi, 2013.
2) Manasi Karkare, “Nanotechnology, Fundamentals and Applications”, I.K. International Publishing, New Delhi, 2008.
3) Jr. Poole, P. Charles and J. W. Frank, “Introduction to nanotechnology”, John Wiley & Sons, 2003.
4) G. Cao, “Nanostructures and Nanomaterials: Synthesis, properties and applications”, Imperial College Press, 2004.
5) C. C. Koch, “Nanostructured Materials: Processing, Properties and Applications”, 2/e 2007.

VIII Semester

22UCHL800	Technical Seminar	(0-0-2)1

Contact Hours: 26

Course Learning Objectives (CLOs):

1. To provide platform to focus on knowledge of technical data collection, communication skills and report writing.
2. To develop intellectual and professional competence and work on the chosen topic to improve skills in writing and oral presentation.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12) /PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Review and acquire knowledge on the chemical engineering topic outside the scope of curriculum	14	6,7,8,9,12	4, 5
CO-2	Outline and consolidate the required information on chosen topic	9	6,7,8	-
CO-3	Organize the technical matter in the required format and compile the same	12	9	-
CO-4	Interpret and communicate the topic with proper justification and conclusion	9, 10	-	-

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	-	1.0	1.0	2.0	2.0	2.0	2.5	3.0	-	2.5	-	3.0	-

Course content:

Technical Seminar/ Independent study: The students are expected to learn how to carry out literature survey to locate the state-of-the-art technology in engineering domain of their interest. They are required to carry out selection of an emerging topic beyond the syllabus relevant to the branch of study, understand the concept, analyze and present effectively for 15-20 minutes followed by 5 minutes of questions and answers before their classmates and faculty. They can also present the technical innovative/novel work carried out in the laboratory. They are also required to learn the effective communication and modalities of technical interactions. Further, they have to submit the seminar material in the form of a paper in IEEE format. All the students are required to attend all the session throughout the semester.

Procedure to conduct technical Seminar:

- All the students are informed to select a topic from the field of their interest from their branch or relevant to their branch and register the topic with the faculty(ies) In charge of Seminar.
- Two faculty members assigned to carry out this activity. The faculty

members prepare the schedule of the seminar spread over the entire semester and display the same in the notice board.

- Change of seminar topic is not allowed once registered, however in the case of genuine reasons only once change of topic may be permitted.
- Based on the number of hours mentioned in the scheme, 4-6 students shall present the seminar in one slot of 2/3 hours.
- The faculty members shall conduct the seminar session every week as per the schedule in the slot mentioned on the time table and carry out the evaluation.
- Attendance is compulsory for all the students for all the seminars.
- The students are required to submit two hard copies of report not exceeding 6 pages and one soft copy of seminar report one week prior to their date of presentation.
- Report shall be in IEEE format viz A4 size paper, Title**:** Bold, Times new Roman Font 14, Sub heading & Body of the text**:** Times new Roman font 12. Margin for left should be 1 ½.
- Student name, USN, seminar date should be mentioned on the report.
- Presentation is for about 15-20 minutes, followed by 5 minutes for questions and answers.
- Typical evaluation methodology: The seminar shall be evaluated for maximum 50 marks. The breakup of marks shall be:
  Presentation: a) 40 marks b) Report: 10 marks.

For presentation, the following points not limited to may be considered.
Concept, understanding, depth of the knowledge, originality of the topic, Quality of PPT, communication skills etc.
For report evaluation, the following points not limited to may be considered
Adherence to IEEE format, relevance of topic, subject depth, and originality in writing etc.

The seminar is aimed at as an educative program for the students. This is because, the students shall listen to 60- 70 seminars on different topics from emerging areas is as good as undergoing a course on latest happenings in the related branch of Engineering.

The departments going for **independent study** in place of technical seminar shall plan, prepare the modalities, and take the approval from Dean (AP).

Reference Books/Material:

Offline/online chemical engineering and its related field Journals.

Books in the area of chemical engineering and its related field.

22UCHL801 Major Project-II / Internship (12 Weeks) 10

Contact Hours: 12 Weeks

Course Learning Objectives (CLOs):

1. To identify the problems in thrust areas of chemical engineering.
2. To plan experimental or theoretical work using multidisciplinary knowledge.
3. To apply the science, mathematical computational engineering and economics knowledge for solution of the problem selected.
4. To use various advanced instruments for the analysis with techniques.
5. To interact with industries, research centers and other colleges.
6. To understand the principle to work in teams and the concept of leadership.
7. To learn flow sheeting, designing and report writing skills.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12) /PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify the topic of chemical engineering or integrated problems (allied fields).	2,10	8, 12	6, 7, 14
CO-2	Compare the literature review and select suitable materials and methodologies for selected topic.	3,4,5,15	8,11,12	7, 10, 14
CO-3	Interpret the experimental results with discussion and economic analysis.	11,15	8,10,12	9
CO-4	Prepare a precise report on the work done with proper guidelines and references.	10	8,15	9
CO-5	Organize and present the work carried out to justify the results obtained with conclusion	9, 10, 12	8, 11	2, 4

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	2.0	3.0	2.0	3.0	1.0	1.0	2.0	1.66	2.4	2.33	2.0	-	1.0	2.66

Course Content:

Major Project-II This project work is intended for students who do not undertake an internship. The objective of the project is to foster independent learning, an innovative mindset, communication skills, organization, time management, presentation skills, teamwork, punctuality, and the ability to set and meet deadlines. In this project, students are expected to conduct an extensive

literature survey to identify state-of-the-art technology in their domain of interest, select a topic from an emerging area relevant to their branch or an interdisciplinary field, and define the problem for their project work. Each project team shall consist of 2 to 4 students and will be assigned a faculty mentor. The department shall conduct three project reviews as per the schedule provided by DAP, which must be recorded as part of the project evaluation for CIE, along with marks awarded by the faculty guide. A committee constituted by the HoD, consisting of a minimum of two faculty members, shall conduct the reviews and evaluate the CIE. For SEE, students must appear for a viva-voce examination, which will be assessed by a panel of two examiners—one internal and one external—constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the project work carried out, report, project presentation, communication skill and question and answer session.

The reference materials for the project work are as listed below but not limited to:

Reference materials/books:

1. Engineering books.
2. Journals.
3. Manuals and data sheets.
4. Software packages.
5. Previous project reports.
6. Product information brochures.
7. Interaction with academia and industrial experts.
8. Internet etc.

Internship: The internship is intended for students who do not undertake a project. Students must undergo an internship in private industries, R&D organizations, Center of Excellence, laboratories of reputed institutions, government and semi-government organizations, PSUs, construction companies, or entrepreneurial organizations to gain exposure to the external professional environment. The internship shall be for a duration of 12 weeks during the VIII semester, either through placement or on an individual basis. Students are required to prepare a report on the work carried out during the internship and submit both the report and the internship certificate during the VIII semester. The department shall conduct three project reviews as per the schedule provided by DAP, which must be recorded as part of the project evaluation for CIE. A committee constituted by the HoD, consisting of a minimum of two faculty members, shall conduct the reviews and evaluate the CIE. For SEE, students must appear for a viva-voce examination, which will be assessed by a panel of two examiners—one internal and one external—constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the work carried out, report, project presentation, communication skill and question and answer session.

22UCHL802	Summer Internship	(4 Weeks) 3

Contact Hours: 4 weeks

Course Learning Objective (CLO):

1. The purpose of internship is student should be able to learn how to apply the knowledge acquired during internships in his future workplace.
2. The student should demonstrate to work in the interdisplinary approach and in a team with good communication skills.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12)/PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Analyze and gain knowledge on the recent developments in the area of chemical and allied engineering and integrate his theoretical knowledge with practical processes.	13, 15	11, 12	4, 6, 7
CO-2	Enhance his communication skills to work in interdisciplinary teams in industry.	9, 10	-	-
CO-3	Realize professional and ethical responsibility to work in a team and project management.	6, 7, 8	11, 12	-

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	-	1.0	-	2.0	2.0	3.0	3.0	3.0	2.0	2.0	3.0	-	3.0

Summer Internship: Students must undergo an internship in private industries, R&D organizations, Center of Excellence, laboratories of reputed institutions, government and semi-government organizations, PSUs, construction companies, or entrepreneurial organizations to gain exposure to the external professional environment. The internship should be completed over a period of four weeks during the summer vacation after the IV or VI semester and must be completed before the VII semester. Students are required to prepare a report on the work carried out during the internship and submit both the report and the internship certificate during the VIII semester. The internal faculty will monitor student performance and award CIE marks in the VIII semester. Additionally, there will be a SEE, in which students must present their work before a panel of two examiners constituted by the HoD during the SEE of the VIII semester.

CIE and SEE Evaluation (from 2022-23 batch)

Courses with LTP 3-0-0 and 4-0-0 or 2-2-0/3-2-0

Continuous Internal Evaluation (CIE):

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: 3 questions of 10 marks each with maximum of two sub divisions. Q.3 is compulsory and one question to be answered from Q.1 and Q.2.
- Course Teacher Assessment (CTA): Minimum two components such as quiz, seminar, written assignment, any technical activity related to course each of 5marks. Total CTA marks-10
- CIE=40 (from tests)+10(from CTA) =50 marks

Semester End Examination (SEE):

- SEE is conducted for100 marks with 3 hours duration. It is reduced to 50 marks.
- Question Paper pattern for SEE: Five units with built in choice. Each question with maximum of three sub divisions.
- Two questions are to be set from each unit with built in choice, for example Q1 or Q2 in unit –I, Q 3 or Q 4 in unit-II and so on.
- A total of 5 full questions to be answered choosing one full question from each unit. All five units are to be answered compulsorily.
- Each question is of 20 marks.
- The Question paper is to be set for duration of 3 hours both for 3 and 4 credits courses.
- The Question paper is to be set for 100 marks for 3 and 4 credits courses.