Academic Program: UG

Academic Year 2023-24

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)

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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 2023-24 till further revision.

Principal

Chairman BoS & HoD

SDM College of Engineering & Technology, Dharwad
Department of Chemical Engineering

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.

Scheme for VII Semester B. E

Course Code	Course category	Course Title	Teaching		Examination				
			L-T-P (Hrs/Week)	Course Credit	CIE	Theory (SEE)*		Practical (SEE)	
					Max Marks	Max Marks	Duration in Hrs	Max Marks	Duration in Hrs
18UCHC700	PC	Process Dynamics and Control	4-0-0	4	50	100	3	-	-
18UCHC701	PC	Chemical Technology	4-0-0	4	50	100	3	-	-
18UCHE70X	PE	Program Elective -4	3-0-0	3	50	100	3	-	-
18UCHO70X	OE	Open elective	3-0-0	3	50	100	3	-	-
18UCHL702	PC	Process Control Laboratory	0-0-2	1	50	-	-	50	3
18UCHL703	PC	Major Project – 1	0-0-4	2	50	-	-	50	3
18UCHL704	PC	Internship	4 Weeks	2	50	-	-	50	3
Total			**14-0-6**	**19**	**350**	**400**		**150**	
Electives									
18UCHE705	PE	Novel Separation Techniques	3-0-0	3	50	100	3	-	-
18UCHE706	PE	Process Instrumentation	3-0-0	3	50	100	3	-	-
18UCHE707	PE	Process Modeling and Simulation in Chemical Engineering	3-0-0	3	50	100	3		
18UCHO708	OE	Biochemical Engineering	3-0-0	3	50	100	3	-	-
18UCHO709	OE	Instrumental Methods of Analysis	3-0-0	3	50	100	3	-	-
18UCHO710	OE	Nanotechnology	3-0-0	3	50	100	3	-	-

CIE: Continuous Internal Evaluation **SEE**: Semester End Examination
L: Lecture **T**: Tutorials **P**: Practical
*SEE for theory courses is conducted for 100 marks and reduced to 50 marks.

Scheme for VIII Semester B. E

Course Code	Course category	Course Title	Teaching		Examination				
			L-T-P (Hrs/Week)	Course Credit	CIE	Theory (SEE)*		Practical (SEE)	
					Max Marks	Max Marks	Duration in Hrs	Max Marks	Duration in Hrs
18UCHC800	PC	Process Engineering Economics and Management	4-0-0	4	50	100	3	-	-
18UCHE80X	PE	Program Elective -5	3-0-0	3	50	100	3	-	-
18UCHO80X	OE	Open elective	3-0-0	3	50	100	3	-	-
18UCHL801	PC	Technical Seminar	0-0-2	1	50	-	-	-	-
18UCHL802	PC	Major Project –2	0-0-12	7	50	-	-	50	3
Total			**10-0-14**	**18**	**250**	**300**		**50**	
Electives									
18UCHE803	PE	Sugar Technology	3-0-0	3	50	100	3	-	-
18UCHE804	PE	Advance Bioprocess Engineering	3-0-0	3	50	100	3	-	-
18UCHE805	PE	Scale up in Chemical Process	3-0-0	3	50	100	3	-	-
18UCHO806	OE	Solid Waste Management	3-0-0	3	50	100	3	-	-
18UCHO807	OE	Green Technology	3-0-0	3	50	100	3	-	-
18UCHO808	OE	Environmental Impact Assessment	3-0-0	3	50	100	3	-	-

CIE: Continuous Internal Evaluation **SEE**: Semester End Examination

L: Lecture **T**: Tutorials **P**: Practical

*SEE for theory courses is conducted for 100 marks and reduced to 50 marks.

Total credits offered for the Fourth year: 37

VII Semester B.E.

18UCHC700	Process Dynamics and Control	(4-0-0) 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 introduction, objectives and 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, response of first order system in series: interacting and non-interacting systems, linearization of non-linear first order systems. **11 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), servo and regulator control system.

Stability: Concept of Stability, Stability criterion, Routh Herwitz test for stability, Root Locus method. Stability of linear control system, Routh –Hurwitz, Root Locus methods. **11Hrs.**

Reference Books:

1) Coughanour and Koppel, “Process System Analysis and Control”, 2/e, McGraw Hill, New Delhi, McGraw Hill 1991.
2) Luyben, “Process Modeling, Simulation and Control for Chemical Engineers”, 2/e, McGraw Hill, 1990.
3) Coulson and Richardson, “Chemical Engineering” Vol, III, 3/e, Pengeman Press.
4) George Stephanopoules, “Chemical Process Control” An Introduction to Theory and Practical, Prentice Hall, New Delhi, 1998.

18UCHC701	**Chemical Technology**	**(4-0-0) 4**

Contact Hours: 52

Course Learning Objectives (CLOs):

1. To understand the industry protocols used in the manufacture of chemicals both inorganic and organic with the use of reference flow sheets.
2. Identify major engineering problems associated with manufacturing processes.
3. Overcoming bottlenecks and trouble shooting.

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 impetus of Chemical Industry globally and summarize production process of industrial gases.	6,7	12	1

CO-2	Apply the concepts of unit operations and processes, reaction kinetics to Chlor-Alkali and acids production.	12,13,1	9,10, 14	3
CO-3	Illustrate the technology of manufacturing fertilizers and phosphorous compounds.	14	9, 12	--
CO-4	Interpret the concept of operation, process reactions and unit operation to pulp and paper and fermentation industries.	14	3, 6, 7	--
CO-5	Prioritize trouble shooting to overcome the bottlenecks in a process and develop the technology within realistic constraints of oils and fats and soap industries.	13,14	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	2.0	-	1.5	-	-	2.5	2.5	-	2.0	2.0	-	2.25	3.0	2.75	-

Course contents:

Unit-I

Introduction to Chemical Process Industries: Chemical Industry in this millennium, Scenario of Indian and World chemical industry.

Industrial and Fuel Gases: H_2, O_2, N_2, CO_2, Water gas, Producer gas. **10 Hrs.**

Unit-II

Chlor-Alkali Industry: Sodium chloride, Soda ash, Caustic soda, Chlorine, Bleaching powder

Acids: Sulfuric, Nitric, Hydrochloric and Phosphoric acids. **12 Hrs.**

Unit-III

Fertilizer Industry: Ammonia, Urea, Ammonium Nitrate, Ammonium Sulfate, DAP, Potash fertilizers, Bio-fertilizers.

Phosphorous Industry: Red and White phosphorous, Phosphorous pentoxide, Phosphate fertilizers, Super phosphate and Triple super phosphate. **10 Hrs**.

Unit-IV

Pulp and Paper Industry: Raw materials, manufacture of pulp and paper, recovery of chemicals.

Fermentation and Distillery: Manufacture of alcohol, beer, wine, vinegar.**10 Hrs**.

Unit-V

Oils and Fats Industry: Manufacture of oils (vegetable and industrial) processing and refining, essential oils and uses,

Soaps and detergent Industry: Types of soaps and detergents, manufacturing process and uses

10 Hrs.

Reference Books:

1) George T Austin: Shreves and Brink "Chemical Process Industries", Mc Graw Hill International ltd.
2) Gopal Rao and Marshall, "Dryden's Outlines of Chemical Technology", East-West Press.
3) S.D. Shukla and G.N. Pandey, "Text book of Chemical Technology" Vol.1 and 2, Vikas Publishing House Pvt. Ltd. New Delhi.
4) S.C. Bhatia, "Chemical Process Industries", Vol.1 and 2, CBS Publishers, New Delhi

18UCHL702	Process Control Laboratory	(0-0-2)1

Contact Hours: 30

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	Analyse transient behavior of simple systems.	4, 15	9,10	-
CO-3	Analyse 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 Tank 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 systems (stirred tank heater).

6. Temperature Control Trainer– ON/OFF, P, PI, PD, PID action.
7. Control Valve Characteristics.
8. Temperature sensors characteristics – RTD, Thermocouple, Thermistor.
9. Characteristics of Temperature Transmitter.
10. Characteristics of I/P and P/I converters.
11. Analysis of Flapper-Nozzle system.

Note: Minimum 10 experiments to be conducted.

Reference Books:

1) Coughanour and Koppel, “Process System Analysis and Control”, 2/e, McGraw Hill, New Delhi, McGraw Hill 1991.
2) Luyben, “Process Modeling, Simulation and Control for Chemical Engineers”, 2/e, McGraw Hill, 1990.
3) Process Control Laboratory Manual

18UCHL703	Major Project – 1	(0-0-4) 2

Contact Hours: 72

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-1 in which the students are expected to locate the state of the art technology in his 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 material collection, survey, visits, data collection, preliminary design, analysis etc. is to be done in this phase. The project shall consist of a team of students not more than 4. Each batch shall be assigned with a guide. A committee consisting of minimum 3 faculty members of which guide is a member shall evaluate at the end for CIE. The weightage of marks shall be 50% for the committee and 50% for the guide. There is a SEE (viva voce) examination which shall be examined by two internal examiners appointed by COE based on the suggestions by the respective HoD.

Reference Books/Material:

Offline/online chemical engineering and its related field Journals.
Books in the area of chemical engineering and its related fie

18UCHL704 Internship (4 Weeks) 2

Contact Hours: 30

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

Internship: The students are to undergo internship in Private industries/R&D organizations/Centres of Excellence/Laboratories of Reputed Institutions/Govt. & Semi Govt. organizations, PSUs, construction companies, entrepreneurial organizations, inter departments within the college etc. to get en exposure to the external world for a period of 4 weeks in the summer vacation after VI sem and before start of VII semester. The students are to prepare a report on the internship work carried out. The internal faculty shall monitor the student and award CIE marks. There is a SEE in which the student shall present his work before a panel of examiners consisting of HoD, Guide and one faculty member during VII semester. The performance shall be communicated to the CoE office and the same shall reflect in the VII semester grade card

18UCHE705 Novel Separation Techniques (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To provide an understanding of novel/newer separations using mass transfer and thermodynamic considerations.
2. To provide an understanding of their applications at different levels in industry, viz. refineries, biochemical processing, pharmaceuticals, gaseous separations, metallurgical etc.

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 use of separation factors and understand continuous adsorption processes with advanced chromatographic techniques.	4, 14	-	-
CO-2	Classify membrane based separations and explain their mass transfer and thermodynamic considerations with applications.	-	4,12	-

CO-3	Interpret the surfactant based micellar and foam separations with applications.	14	4, 12	-
CO-4	Comprehend Super Critical Fluid Extraction process with applications.	-	4, 12	14
CO-5	Outline the processes of gaseous diffusion, thermal diffusion, and electrophoresis.	4	-	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	-	-	-	2.4	-	-	-	-	-	-	-	2.0	-	2.0	-

Course content:

Unit-I

Introduction to Separations: Importance, principles and separation factors, economic significance etc.

Adsorptive Separations: Thermal swing adsorption, gradient chromatography, Ligand chromatography and unsteady state fixed bed adsorption etc. **08 Hrs.**

Unit-II

Membrane Separation Processes: Classification, structure and characteristics of membranes, membrane modules, concentration polarization and fouling of membranes, R.O., U.F, Pervaporation, and gaseous separations. **08Hrs.**

Unit-III

Surfactant Based Separations: Fundamentals of surfactants at surfaces and in solutions. Liquid membrane permeation, foam separations, micellar separations. **08 Hrs.**

Unit-IV

Super Critical Fluid Extraction: Physicochemical principles, supercritical fluids, process description. Applications and case study. **08 Hrs.**

Unit-V

Miscellaneous Separations: Gaseous diffusion, Thermal diffusion, electrophoresis and types. **07 Hrs.**

Reference Books:

1) P.C. Wankat, “Large scale adsorption chromatography” CRC Press, 1986.
2) R.W. Rousseu, “Handbook of separation process technology”, John Wiley and sons 1987.
3) S.Sourirajan and T. Matsura, “Reverse osmosis and Ultra filtration process principle”, NRC publication Ottawa, 1985.

4) Richard Baker, “Membrane Technology and Applications”, 2/e, John Wiley and Sons Ltd.

18UCHE706 Process Instrumentation (3-0-0) 3

Contact Hours: 39

Course Learning Objective (CLO):

1. To make students understand the Identification, classification construction, working principle and application of various transducers used for Displacement, Temperature, Level, flow and Miscellaneous measurement

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	Comprehend the fundamentals of instrumentation to control chemical processes.		1,13	3
CO-2	Explain process control instrumentation with principles and theory		1	3,13
CO-3	Apply correct practice to installation, calibration of instrument and analyze limitations of each measuring instruments.		3	1,13
CO-4	Troubleshoot, isolate and fix electronic instrumentation problems.		1,3,13	
CO-5	Design a simple instrumentation system.	3	1	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	-	2.6	-	-	-	-	-	-	-	-	-	1.4	-	-

Prerequisite: Chemistry and Fundamentals

Course content:

Unit-I

Introduction: classification, characteristics of instruments- static and dynamic. Sensor and Transducer: Definition, classification (active, passive, primary, secondary, mechanical, electrical, analog, digital).Transducer specifications.

Transmitters, Converters, Control panel, Recorders and monitors. Error: definition, classification**.** Different types of Flow Measurement. **08 Hrs**.

Unit-II

Pressure Measurement: Pressure scales, units and relations, classification, U-tube types, well type, inclined type manometer, micro manometer, bellows, diaphragm, bourdon tube, Vacuum Measurement Units and relations, McLeod gauge, Pirani gauge, thermocouple gauge, hot cathode ionization gauge, Knudsen gauge. **08 Hrs.**

Unit-III

Level Measurement: Need for Level Measurement, Classification of Level Measurement Techniques. Construction and working of Dipstick, displacer, float system, bubbler, capacitive devices for level measurement, ultrasonic level gauge, DP cell, vibrating type, radar, radioactive type level gauges, LASER type transducers, fiber optic level sensors. **07 Hrs.**

Unit-IV

Temperature Measurement: Temperature scales, classification of Temperature Sensors, a) Thermometers: Classification, Construction and working of different hermometers b) Resistance temperature detector (RTD):Principle, types, Configurations, construction and working of RTD, applications c) Thermistors: Principle, types (NTC and PTC), characteristics, Construction and working, materials, specifications of Thermistor, applications d) Thermocouples laws of thermocouple, types of thermocouple with characteristic curve. **08 Hrs**.

Unit-V

Displacement Measurement: a) Resistance potentiometer: piezo-resistive effect, ultrasonic transducer. LVDT, RVDT. Selection and properties of materials for LVDT, and general electromagnetic sensors. b) Capacitance type transducers: with applications, materials for capacitive, ultrasonic and elastic transducers. c) Digital transducer: translational and rotary encoders, Optical and magnetic pickups. d) Pneumatic transducer: flapper- nozzle transducer. Miscellaneous Transducers.

08 Hrs.

Reference Books:

1) Donald Eckman,"Automatic Process Control", Wiley Eastern Limited
2) John P. Bentley, "Principles of Measurement Systems", 3/e, Addison Wesley Longman Ltd., UK, 2000.
3) Doebelin E.O, "Measurement Systems - Application and Design", 4/e, McGraw-Hill International Edition, New York, 1992.
4) Stephanopoulos George, Chemical Process Control.

18UCHE707 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 models for chemical engineering system.	1,3	2	5
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.

18UCHO708	**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 fermentation technology	12,13	3	2
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 Whittaker'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.

18UCHO709 Instrumental Methods of Analysis (3-0-0) 3

Contact Hours: 39

Course Learning Objective (CLO):

1. To understand the principles and concepts behind the qualitative and quantitative analysis of molecules and compounds using instrumental methods with their applications.

2. To illustrate the working and analysis of the different instrumental techniques of AAS, Spectrophotometer, electrochemical, chromatography etc.

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	Demonstrate and analyze Flame photometry and AAS techniques and its application.	13	2	1
CO-2	Explain and analyze the electrochemical techniques and its application	13	2	1
CO-3	Identify the concepts for analysis of molecules and compounds using instrumental methods.	13	2	1

CO-4	Interpret and analyze the different spectroscopic techniques.	13	2	1
CO-5	Interpret and analyze the chromatography technique and its applications.	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	1.0	2.0	-	-	-	-	-	-	-	-	-	-	3	-	-

Prerequisite: Chemistry and Fundamentals

Course content:

Unit-I

Introduction to Flame Photometry and Atomic Absorption Spectroscopy: Introduction, Principle, Flame and flame spectra, variation of emission intensity with flame, Metallic spectra in flame, flame ground, Role of temperature on absorption emission and fluorescence. Comparative study of Flame Emission electroscopy (FES) and Atomic Absorption Spectroscopy (AAS) Instrumentation and Applications. Qualitative and quantitative determination of alkali and alkaline earth metals. **08 Hrs.**

Unit-II

Electrochemical Techniques: Introduction to Electrochemistry, Electrode Potential, Measurement, sign convention, Standard electrode potential, Cell Potential: Liquid junction potential, Effect of current. Polarization: Sources, over voltage, concentration polarization, Mechanism of mass transport. Potentiometric Methods: reference Electrodes- calomel electrode Ag- AgCl (s) electrode, Hydrogen electrode, Potentiometric titrations and applications. Membrane Electrodes: Classification of properties, Principle design, theory of ion selective electrodes Membrane potential, Selectivity, Crystalline liquid membrane and electrodes. **08 Hrs.**

Unit-III

Nuclear Magnetic Spectroscopy: Introduction, Chemical shifts, Mechanism of shielding and deshielding. Types of nuclei, Theory of population of nuclear magnetic energy levels, Spin –spin coupling, Rules of governing the interpretation of first order spectra, Low and high resolution NMR, Instrumentation and application to structure elucidation of simple organic molecules. **08 Hrs.**

Unit-IV

Mass Spectroscopy: Introduction, theory, Instrumentation of mass spectrometer, Methods of generation of positively charged ions, Mass analyzers, Resolving power, Molecular ion peak, Base peak, Metastable peak, Modes of fragmentations,

Application of mass spectrometry in Qualitative and Quantitative analysis. Structural elucidation of simple organic molecules **08 Hrs.**

Unit-V

Chromatography: Introduction to chromatographic techniques, General descriptions, definitions, terms and parameters used in chromatography. Classification of chromatographic methods, working principles, Instrumentation and applications of Thin layer chromatography (TLC), Gas chromatography(GC), High pressure liquid chromatography (HPLC). **07 Hrs.**

Reference Books:

1) Jaffery, G.H., Basset, J., et. al., "Vogel's Text book of Quantitative Inorganic Analysis", 5/e, ELBX, 1998.
2) Skoog, D.A., "Principles of Instrumental Analysis", 3/e, Saunders College publishing, 1985.
3) W.H. Willard, "Instrumental Methods of analysis", 7/e, L.L., Merritt and J.A. Dean, 1988.
4) B.K. Sharma, "Instrumental Methods of Chemical Analysis", Goel Publishing House Meerut, 2000.

18UCHO710	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, Focussed 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, “Naostructures and Nanomaterials: Synthesis, properties and applications”, Imperical College Press, 2004.
5) C. C. Koch, “Nanostructured Materials: Processing, Properties and Applications”, 2/e 2007.

VIII Semester

18UCHC800 Process Engineering Economics and Management (4–0–0)4

Contact Hours: 52

Course Learning Objective (CLO):

1. Prepare the students to analyse cost/revenue data and carry out economic analysis in the decision-making process to justify alternatives/projects on an economic basis and prepare to function in the business and management side of professional engineering practice.

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 concepts of plant location, layout, and feasibility survey and perform cost estimation.	-	9,10	12
CO-2	Apply economic concepts viz. depreciation, cash flow, profitability, replacement, breakeven analysis etc. in solving chemical engineering problems.	10,11	9,14	12
CO-3	Interpret production management with its virtues inclusive of automation, work study and method study applied to a chemical industry.	10,11	9,14	12
CO-4	Interpret material management with its virtues inclusive of value engineering applied to a chemical industry.	10,11	9	12
CO-5	Interpret marketing management with its virtues inclusive of product life cycle applied to a chemical industry.	10, 11	9	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	-	-	-	-	-	-	-	-	2.0	2.8	3.0	1.0	-	2.0	-

Course content:

Unit-I

Introduction Importance of economics and management, plant location and plant layout, feasibility survey.

Cost Estimation Factors involved in project cost estimation, methods employed for the total cost estimation, Cost Index. **12 Hrs.**

Unit-II

Depreciation: Different methods of Depreciation. Time value of money and its equivalence. Cash flow diagrams. Taxes and Insurance.

Profitability and Methods of Evaluation: Replacement and alternative investments. Break even analysis. Financial statements. **12 Hrs.**

Unit-III

Production Management: Types of production and planning, manufacturing planning, factory planning, production planning, schedule, work study, method study, incentives and bonus, Automation. Organization of production, planning and control department. **10 Hrs.**

Unit-IV

Material Management: Functions of purchasing. Quality standards and Inspection. Sources of supply, Inventory management. ABC analysis, EOQ model. Value analysis and engineering. **09 Hrs.**

Unit-V

Marketing Management: Functions of marketing, marketing and sales, marketing engineer, and Market research. Product life cycle, Promotion of sales. Pricing methods, advertisements etc. **09 Hrs.**

Reference Books:

1) Peters and Timmerhaus, “Plant design and Economics for Chemical Engineers”, McGraw Hill, 1991.
2) Banga and Sharma, “Industrial Organization and Engineering Economics”, Khanna Publications, 1999.
3) Tripathi and Reddy, “Principles of Management”, 5/e, Tata McGraw-Hill Education, 2004.

18UCHL801	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.

18UCHL802	Major Project – 2	(0-0-12)7

Contact Hours: 100

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-2 is the continuation from phase –I in which the students are expected to go for material collection, survey, visits, data collection, preliminary design, analysis, model development, code writing, field work etc. The same project team formed for phase –I will continue the work under the guidance of the same faculty member. For all the projects, problems may be domain specific or interdisciplinary also in nature. A committee consisting of minimum 3 faculty members of which guide is a member shall evaluate at the end for CIE. There is a viva voce examination which shall be examined by two examiners one internal and one external to the college appointed by COE based on the suggestions by the respective HoD.

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.

18UCHE803	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	Develop 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	-	-	-	-	-	-	-	-

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, 1953.
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.

18UCHE804 Advance Bioprocess Engineering (3-0-0)3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To provide the students with the basics of bioreactor engineering.
2. To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

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	Select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines and other	-	3, 7	2

	process criteria.			
CO-2	Design and analyse the scale up criteria for the different bioreactors.	5	2, 3, 7	-
CO-3	Understand the enzyme kinetics and design the immobilized enzyme bioreactors.	13	3, 7	-
CO-4	Apply modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.	5	3, 7	-
CO-5	Identify the different cell cultivation system to apply in the different bioreactors.	13	3, 7	-

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	-	1.5	2.0	-	3.0	-	2.0	-	-	-	-	-	3.0	-	

Course content:

Unit-I

Operational Modes of Bioreactors: Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, two stage cultivation. Packed bed reactor, airlift reactor, fluidized bed reactor and bubble column reactor. **08 Hrs**.

Unit-II

Bioreactor Scale-Up: Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed. **08 Hrs.**

Unit-III

Bioreactor Consideration in Enzyme Systems: Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors. **08 Hrs.**

Unit-IV

Modeling and Simulation of Bioprocesses: Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetic and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism. **08 Hrs**

Unit-V

Recombinant Cell Cultivation: Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, yeast Pichia pastoris/ Saccharomyces cereviseae, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High

cell density cultivation, process strategies, reactor considerations in the above system. **07 Hrs.**

Reference Books:

1) Jens Nielson, John Villadsen and Gunnar Liden, "Bioreaction engineering principles", 2/e, Kulwer Academic, 2002
2) Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, 2/e, CRC press, London. 1995.
3) James E. Bailey and David F. Ollis, "Biochemical Engineering Fundamentals", 2/e, McGraw Hill. Singapore. 1986
4) Atkinson, B, Mavituna, F, "Biochemical Engineering and Biotechnology Handbook" 2/e, Macmillan Publishers Ltd, New York, 1992.

18UCHE805 Scale up in Chemical Process (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To learn how to create and conduct a pilot plant study, analyze and evaluate pilot plant results, and apply process scale-up methods.
2. To study proper designs, modeling and processing and the importance of the process geometry.

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	Identify and explain the need for pilot plant and its demonstration with economic evaluation.	3	-	14
CO-2	Identify and develop different models and similarity studies for scale up methods.	5	2	13
CO-3	Illustrate and compare the different concepts of regime in scale up studies.	3	2	13
CO-4	Interpret and analyse different approaches for scale up studies in chemical engineering mixing system.	2, 3	5	13, 14
CO-5	Interpret and analyze different approaches for scale up studies in heat and mass transfer system.	2, 3	5	13, 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	-	2.5	3.0	-	2.3	-	-	-	-	-	-	-	1.0	1.0	-

Course contents:

Unit-I

Introduction: Process development, Need for pilot plants, Scale-up procedures, basic terminologies- prototypes, models, scale ratios and elements. Major issues, fundamental principles, Demonstration, Economic evaluation of scaling up. **08 Hrs.**

Unit-II

Dimensional Analysis and Principles of Similarity: Significance of Dimensionless Numbers**,** Generalized dimensionless equations from Differential equation for static systems, flow systems, thermal systems, mass transfer processes, Homogeneous and heterogeneous chemical processes. **Principles of Similarity:** Geometric similarity, Distorted similarity, Static, dynamic, kinematics, thermal and chemical similarity with examples. **08 Hrs.**

Unit-III

Regime: Static regime. Dynamic regime. Mixed regime concepts. Criteria to decide the regimes. Equations for scale criteria of static, dynamic processes, Extrapolation. Boundary effects. **08 Hrs.**

Unit-IV

Scale up of Mixing Process and Chemical Reactors: Mixing Processes: Scale-up relationships, Scale-up of polymerization units, Continuous stages gas liquid slurry processes. Fluid-fluid Reactors: Scale-up considerations in packed bed absorbers and bubble columns, Applicability of models to scale-up. **08 Hrs.**

Unit-V

Scale up of Mass and Heat Transfer Processes: Continuous Mass Transfer Process: Fundamental considerations scale-up procedure for distillation, Absorption, Stripping and extraction units. Scale up of momentum and heat transfer systems. **07 Hrs.**

Reference Books:

1) Attilio Bisio, Robert L. Kabel, “Scale up of Chemical Processes”, John Wiley Interscience publication, 1985.
2) Ibrahim and Kuloor, “Pilot plant and Scale up Studies”.
3) Johnstone and Thring, “Pilot Plants Models and scale up method in Chemical Engineering”, McGraw Hill, 1962.
4) Marko Zlokarnik, “Dimensional Analysis and Scale-up in Chemical Engg.", Springer Verlag, Berlin, Germany, 1986.

18UCHO806	Solid Waste Management	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To provide students with a comprehensive understanding of integrated solid waste management from an environmental and public health perspective.
2. To study the detailed engineered system of solid waste management system.

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 the components and characteristics of a solid waste management system.	6	7	3
CO-2	Identify the various collection, transfer and transport mechanisms of municipal solid waste management.	6	3,7	-
CO-3	Explain various processing, material and energy recovery facilities.	14	3	
CO-4	Describe different methods and safety precautions used in disposal of MSW.	6,7	14	
CO-5	Explain types of hazardous solid waste and Discuss safe methods of disposal of hazardous waste & their management principles.	6,7	14	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	-	-	1.5	-	-	3.0	2.5	-	-	-	-	-	-	2.3	-

Course content:

Unit I

Introduction to Solid Wastes: Definition, Characteristics, Types of solid waste, Physical, Chemical and Biological properties of Municipal Solid Waste, Overview of materials flow in society and 4R concept of solid waste management. Evolution of SWM, Effect on health and environment. Legislation and government agencies. **08 Hrs.**

Unit II

Engineered Systems for Solid Waste Management: Generation of solid waste, Quantities of solid Waste, Methods to measure solid waste quantities, Solid waste generation and collection, Factors affecting solid waste generation rate, Onsite

handling, Storage and Processing, Transfer and transport, Collection system and devices. **08 Hrs.**

Unit III

Processing Techniques and Recovery of Energy: Objectives of waste processing, component separation and volume reduction, various processing technologies — biological and chemical conversion methods, Composting, Factors affecting composting, Aerobic composting and anaerobic Digestion, Details of energy recovery system, heat recovery, gasification, pyrolysis and refuse derived fuels (RDFs). Municipal incinerators, Grates, Furnances of solid waste. Recovery, Material and Energy recovery operations. **08 Hrs.**

Unit IV

Disposal of Solid Wastes: Various disposal methods, landfills — site selection, site infrastructure, essential components of landfill; types of landfilling methods, landfill planning –leachate management and gas control; Environmental monitoring systems for landfill sites, closure and post-closure plans for landfills, landfill site rehabilitation, reclamation and remediation. **08 Hrs.**

Unit V

Hazardous Wastes: Definition, identification and classification of hazardous solid waste, Origin and reduction at source, Collection and handling, Management issues and planning methods, Environmental Act, E-waste handling and disposal, Biomedical waste.

Industrial Solid Waste Management: Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units. **07 Hrs.**

Reference Books:

1) George Tchobanoglous, “Integrated Solid waste Management-Engineering Principles and Management issues”, McGraw Hill, 1993.
2) Howard Peavy, “Environmental Engineering”, McGraw Hill,1986.
3) Dutta, “Industrial Solid waste Management and landfilling practice”, Narose Publication, 1999.

18UCHO807	Green Technology	(3-0-0) 3

Contact Hours: 39

Course Learning Objective (CLO):

1. To understand the principles and concepts of green technology with laws and standards.
2. To illustarte and demonstarte the tool and design of environmnetal freidnly technology.

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	Illustrate environment laws, carbon credits, ISO 14000 series	14	2	1
CO-2	Comprehend the principles of green chemistry.	-	2	1
CO-3	Summarize the importance of green technology in sustainable development	7, 14	-	-
CO-4	Apply and compare the tools of green technology and life cycle assessment.	7	-	1
CO-5	Conduct pollution prevention planning and develop the environment friendly design.	7	-	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	1.0	2.0	-	-	-	-	3.0	-	-	-	-	-	-	3.0	-

Course content:

Unit I

Introduction: Green chemistry and technology for sustainable development, Environmental laws, carbon credits, environmental management system standards- ISO 14000 series. **08 Hrs.**

Unit II

Green Chemistry: Principles of Green Chemistry, Atom efficiency, Energy conservation, Waste minimization, Substitution. **08 Hrs.**

Unit III

Life-Cycle Assessment: History, Process, Methodology, Streamlining and Application. **08 Hrs.**

Unit IV

Pollution prevention planning: Structure of the pollution prevention process, Environmental Audits, toxic release inventory. **08 Hrs.**

Unit V

Design for the environment and improvement in manufacturing operations, design for disassembly/DE manufacturing, Packaging, case studies. **07 Hrs.**

Reference Books:

1) Paul L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw Hill, 2000.
2) Anastas P.T., Warner J.C., Green Chemistry: Theory and Practice. Oxford Science Publications, Oxford, 1998.
3) Mike Lancaster, Green Chemistry- An Introductory Text, Royal Society of Chemistry Publishing, 2010 55
4) Boyle, Godfrey, Bob Everett, Janet Ramage, Energy Systems and Sustainability: Power for a Sustainable Future, Oxford University Press, 2004.

18UCHO808 Environmental Impact Assessment (3-0-0) 3

Contact Hours: 39

Course Learning Objective (CLO):

1. To understand the various aspects of Environment Impact Assessment methodologies and impact of development activities.
2. To study the Impact assessment on surface water, air and biological Environment.

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	Identify the environmental attributes to be considered for the EIA study	6	2	1
CO-2	Prepare the audit report of the EIA	6, 14	-	1
CO-3	Identify the suitable methodology and prepare Rapid EIA.	7, 14	2	1
CO-4	Indentify and incorporate mitigation measures of impact studies	6, 7, 14	-	1
CO-5	Formulate assessment report of impact studies on water and air	7, 14	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	1.0	2.0	-	-	-	3.0	3.0	-	-	-	-	-	-	3.0	-

Course content:

Unit - I

Basic concept of EIA : Objectives of EIA, Initial environmental Examination, Elements of EIA, - factors affecting EIA Impact evaluation and analysis, preparation

of Environmental Base map, Classification of environmental parameters. Types of EIA, Various types of Environmental Impacts: Direct Impacts, Indirect Impacts, Cumulative Impacts, Induced Impacts, EIA Methodologies: introduction, Criteria for the selection of EIA Methodology, EIA methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/benefit Analysis. **08 Hrs**.

Unit- II

Environmental Audit and Environmental legislation: Objectives of Environmental Audit, Types of environmental Audit, Audit protocel, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report, Post Audit activities. Related environmental legislation **08 Hrs**.

Unit- III

Creation of EIA Data Base, Compilation, Environmental Inventory: Baseline Data Generation, Environmental Monitoring Networking Design (EMND), Monitoring Stations, Data Products and Sources, Impact Identification (II) Methodologies, Interaction-Matrix Methods, Use of the Leopold Matrix, Checklist Methodologies: Simple Checklists, Descriptive Checklists, Uses of Checklists, Network Methodologies. **08 Hrs**.

Unit – IV

Impact Assessment: Assessment of impact of development activities on Vegetation and wildlife, environmental Impact of Deforestation, Soil quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures. **08 Hrs**.

Unit - V

Case studies: Impact Assessment, Significance and Assessment of the Impacts, Impact Mitigation Measures, Impacts on Water Environment, air environment. Case studies and preparation of Environmental Impact assessment statement for various Industries. **07 Hrs.**

Reference Books:

1) R.R. Barthwal., “Environmental Impact Assessment” New Age International Publications. 2012.
2) Canter, L,W., “Environmental Impact Assessment”, McGraw Hills New York, 1977.
3) M. Anji Reddy, “Environmental Impact Assessment: Theory and Practice”, BS Publications.
4) N.S.Raman , A.R. Gajbhiye, S.R. Khandeshwar Environmental Impact Assessment” 1/e, IK International publishing Ltd., 2014
5) Bhatia, H. S. - Environmental Pollution and Control, Galgotia Publication (P) Ltd, Delhi.