Subject: Process Design - DETCH15214

Type of course: Professional Core

Prerequisite: Basic knowledge of chemical engineering principles, unit operations, mass and energy balances, and engineering drawing.

Rationale: Systematic methodologies for designing chemical and mechanical processes, ensuring efficiency, safety, and cost-effectiveness in industrial applications. This subject fosters a strong understanding of process flow, equipment selection, material and energy balances, and optimization techniques, enabling diploma engineers to contribute effectively to process development, troubleshooting, and innovation in various industries.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
4	0	2	5	60	30	10	00	50	150

Legends: CI - Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE - Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

Sr. No.	Course content	Hrs	Weightage
1	**Introduction:** Importance of Process Design, Role of a Process Engineer in Industries, Basic Steps in Process Design, Types of Chemical Processes (Batch & Continuous), Process Flow Diagrams (PFD) and Piping & Instrumentation Diagrams (P&ID), Selection of Raw Materials and Feeds, Factors Affecting Process Selection (Economic, Environmental, and Safety Considerations), Case Studies of Simple Process Designs	10	20%
2	**Process Equipment Design:** Classification of Process Equipment, Design of Reactors (Batch & Continuous), Design of Heat Exchangers (Shell & Tube, Plate Type), Design of Distillation Columns (Tray & Packed Columns), Storage Vessels: Types and	15	25%

	Sizing, Selection of Pumps and Compressors, Safety Considerations in Equipment Design, Materials of Construction for Process Equipment		
3	**Mass and Energy Balance in Process Design:** Basics (Input-Output Concept), Steady-State and Unsteady-State Balances, Energy Balance and Heat Load Calculations, Combustion and Heat Transfer in Process Design, Application of Bernoulli's Equation, Recycle, Bypass, and Purge Streams in Process Design, Case Study on Industrial Process Balancing	20	30%
4	**Process Economics and Optimization:** Cost Estimation in Process Design (Capital & Operating Costs), Economic Evaluation of Process Plants (Payback Period, ROI, NPV), Process Optimization Techniques, Process Control and Instrumentation Basics, Environmental Impact and Sustainability, Risk Analysis and Hazard Assessment, Scale-Up and Pilot Plant Studies	15	25%

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1.	**Process Flow Diagram (PFD) Creation:** Draw a simple PFD for a common industrial process (Water purification or Sugar manufacturing) and upload on GMIU Web portal.	10
2.	**Material & Energy Balance Calculation:** Solve a real-world mass and energy balance problem using given process data (Heat exchanger or Distillation column) and upload on GMIU Web portal.	10
3.	**Equipment Selection Case Study**: Compare two different types of reactors or heat exchangers and justify the best choice for a specific process and upload on GMIU web portal.	10
Total		30

Suggested Specification table with Marks (Theory): 60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	15%	25%	20%	20%	20%	0%

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

After learning the course the students should be able to:	
CO1	Understand the fundamental concepts of process design, including process flow diagrams and factors affecting process selection
CO2	Apply knowledge of process equipment design to select and design reactors, heat exchangers, and distillation columns
CO3	Perform mass and energy balance calculations for industrial processes to optimize material and energy usage
CO4	Evaluate the economic feasibility of a process, including cost estimation, process optimization, and sustainability considerations

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students.
The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
From the content 10% topics are suggested for flipped mode instruction.
Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory
The internal evaluation will be done on the basis of Active Learning Assignment
Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] Backhurst, J. R. and Harker J. H.,"Coulson and Richardson Chemical Engineering", Vol. II, 5th Ed., 2002, Butterworth-Heinemann.
[2] Don W. Green, Robert H. Perry, Perry's Chemical Engineers' Handbook, 8th Edn., McGraw Hill, New York, 2008
[3] M. S. Peters and K. D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 4th ed., McGraw - Hill, New York, 1991.