Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-6 (B.Tech)

Subject: Sustainable Design and Manufacturing-BETCH16326

Type of course: Skill Enhancement Courses (SEC)

Prerequisite: Basic knowledge of chemical engineering processes, environmental impact, and industrial operations.

Rationale: This course enables students to understand green engineering, eco-friendly product design, and sustainable manufacturing practices expected in modern industries. It enhances practical skills in applying sustainability assessment tools and optimizing engineering processes for minimal waste and emissions.

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	
0	0	4	2	00	00	10	40	50	100

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

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Course Content:

Sr. No.	Course content
1	**Fundamentals of Sustainable Engineering and Circular Manufacturing** • Sustainability metrics, green chemistry principles • Mapping environmental hotspots
2	**Waste Minimization & Resource Efficiency in Chemical Industries** • Lean manufacturing basics • Mass & energy flow mapping
3	**Carbon Footprint and Energy Efficiency Assessment** • GHG calculation method • Energy audit of selected operations
4	**Life Cycle Assessment (LCA) – Case Study** • Software hands-on (OpenLCA/GaBi/Eco-indicator tools) • Comparison of environmental impacts
5	**Sustainable Product/Process Design Project** • Case work selection, modelling & sustainability improvement • Presentation and report submission

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Chemical Industries Details:** Students must conduct a resource efficiency assessment of a chemical laboratory or specific plant section and submit the report on the GMIU Portal.	10
2	**Poster Presentation:** Students will deliver a poster presentation on the carbon footprint calculation of a selected operation.	10
3	**Technical Video-Based presentation.** Students will create and present a video on the Life Cycle Assessment (LCA) of a chosen product and upload it on the GMIU Portal.	10
4	**Project** Students are required to prepare either a working or non-working eco-design project or a waste-reduction case study and submit a report along with the presentation, photographs, and a video on the GMIU Portal.	10
5	**Industrial Exposure.** Students will visit an industry to study a sustainable product and observe its complete manufacturing process—from raw materials to the final product. They will prepare a detailed report based on their observations and upload it to the GMIU Portal.	10
Total		50

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Suggested Specification table with Marks (Theory): NA

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

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	Explain sustainability principles in chemical engineering design.
CO2	Identify environmental hotspots and propose waste minimization strategies.
CO3	Perform carbon footprint & energy efficiency evaluations.
CO4	Conduct basic LCA using digital tools.
CO5	Develop sustainable improvements for real industrial processes.

List of Suggested Practical

Sr. No.	Suggested Practical	Unit No.	Hours
1	Familiarization with sustainability tools: carbon footprint calculator, energy audit instruments, and LCA software (OpenLCA / GaBi).	1	4
2	Study of sustainability metrics and green chemistry principles through real industrial examples.	1	4
3	Identification and mapping of environmental hotspots in a selected chemical process using flow diagrams.	1	4
4	Mass and energy flow mapping for selected industrial operations (manual + software-assisted).	2	4
5	Lean waste identification (7 wastes) exercise in a laboratory or simulated industrial setup.	2	4
6	Conducting a mini energy audit of laboratory equipment: measurement of power consumption and efficiency.	3	4
7	Calculation of carbon footprint for a selected operation using standard emission factors.	3	4
8	Hands-on training in OpenLCA: creation of process flow diagram and database linking.	4	4
9	LCA case study: comparison of two similar products or processes using OpenLCA/GaBi.	4	4
10	Identification of improvement possibilities in an existing product using eco-design principles.	5	4
11	Preparation of a sustainable process flowsheet integrating waste minimization strategies.	5	4
12	Final practical project: simulation, analysis, and presentation of a sustainable product or process design.	5	4
13	Assessment of water footprint for a selected laboratory or small-scale chemical process and identification of water-saving measures.	3	4
14	Study of waste valorization techniques: conversion of industrial solid waste into value-added products (case study–based analysis).	5	4
15	Sustainability performance evaluation using KPIs (energy intensity, material efficiency, emission intensity) for a selected process or product.	5	4

Instructional Method:

The course delivery method will depend upon the requirement of content and the needs of students. The teacher, in addition to conventional teaching methods by black board, may also use any 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. 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 the laboratory.

Reference Books:

[1] Allen & Shonnard — Green Engineering: Environmentally Conscious Design of Chemical Processes.

[2] Sikdar & Glavic — Sustainable Engineering

[3] Karl-Hill — Life Cycle Assessment Handbook

[4] UNEP Green Manufacturing Guidelines

[5] OpenLCA & Circular Economy Toolkits (Free Web Resources)