Course Title:	**Introduction to Sustainable Engineering**	Semester	I/II
Course Code:	**BETCK105D /205D**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L: T:P: S)	3:0:0:0	Exam Hours	03
Total Hours of Pedagogy	40 hours	Credits	03

Course Learning Objectives

CLO 1. To familiarize the students to the area of sustainability and concepts of sustainability engineering
CLO 2. To enable students with an understanding of principles and frame work of sustainable engineering
CLO 3. To provide students with an understanding of Life Cycle Assessment tool in sustainable engineering
CLO 4. To provide students with understanding of integration of sustainability with design.

Teaching-Learning Process

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

1. Explanation via real life problem, deliberate on solution and inquiry type teaching
2. Instructions with interactions in class room lectures (physical/hybrid)
3. Use of ICT Tools including You Tube videos and related MOOCs, AR/VR/MR tools
4. Flipped Classroom session (approx. 10% of classes)
5. Guest talks and competitions for learning beyond the syllabus
6. Students oral presentation of case studies

Module-1 (8 hours)

Sustainable Development and Role of Engineers: Introduction, Why and What is Sustainable Development, THE SDFs, Paris Agreement and Role of Engineering, Sustainable Development and the Engineering Profession, Key attributes of the Graduate Engineering Sustainable
Engineering Concepts: Key concepts – Factor 4 and Factor 10: Goals of sustainability, System Thinking, Life Cycle Thinking and Circular Economy.
Self-study: Efficient use of resources.
Applications: Designing and implementing sustainable solutions for infrastructure, buildings, and energy systems
(RBT Levels: L1, L2 and L3)

Module-2 (8 hours)

Sustainable Engineering and Concepts, Principles and Frame Work: Green Economy and Low Carbon Economy, Eco Efficiency, Triple bottom Line, Guiding principles of sustainable engineering, Frameworks for sustainable Engineering.
Tools for sustainability Assessment: Environmental Management System, Environmental

Auditing, Cleaner Production Assessment, Environmental Impact Assessment, Strategic Environmental

Self-study: Material Flow Analysis (MFA), and System thinking.

Applications: Industrial design and architectural urban planning

(RBT Levels: L1, L2 and L3)

Module-3 (8 hours)

Fundamentals of Life Cycle Assessment:

Why and What is LCA, LCA Goal and Scope, Life cycle inventory, Life Cycle Impact Assessment, Interpretation and presentation of Results, Iterative Nature of LCA, Methodological Choices, LCI Databases and LCA Software, Strength and Limitations of LCA.

Self-study: ISO 14040:2006 & ISO 14044:2006

Applications: Procurement, construction, operation, and decommissioning.

(RBT Levels: L1, L2 and L3)

Module-4 (8 hours)

Environmental Life Cycle Costing, Social Life Cycle Assessment, and Life Cycle Sustainability Assessment: Introduction, Environmental Life Cycle Costing, Social Life Cycle Assessment, Life Cycle Sustainability, LCA Applications in Engineering: Environmental Product Declarations and Product Category Rules, Carbon and Water Foot Printing, Energy systems, Buildings and the Built Environment, Chemical and Chemical Production Food and Agriculture

Introduction to Environmental Economics: Introduction – What Is Environmental Economics? Valuing the Environment, Market-based Incentives (or Economic Instruments) for Sustainability, Command-and-Control versus Economic Instruments, A Simple Model of Pollution Control

Self-study: Quantitatively analyse of life cycle of products/activities

Applications: Deployment of a new technology

(RBT Levels: L1, L2 and L3)

Module-5 (8 hours)

Integrating Sustainability in Engineering Design: Problems Solving in Engineering, conventional to Sustainable Engineering Design Process, Design for Life Guidelines and Strategies, Measuring Sustainability, Sustainable Design through sustainable procurement criteria, Case studies on sustainable Engineering Design Process – Sustainable Process Design, Sustainable Production Design Sustainable product design in Electronic Engineering.

Self-study: Global challenges

Applications: Efficient use of materials, reduction of waste, energy efficiency, and lifecycle thinking

(RBT Levels: L1, L2 and L3)

Course outcome

At the end of the course the student will be able to:

CO1: Elucidate the basics of sustainable development, sustainable engineering and its role in engineering

CO2: Application of Sustainable Engineering Concepts and Principles in Engineering

CO3: Apply the Principle, and methodology of Life Cycle Assessment Tool to engineering systems
CO4: Understand the concepts of environmental economics.
CO5:Understand sustainable project design

Course Assessment and Evaluation Details (both CIE and SEE)

Continuous Internal Evaluation: 50 marks		
Theory Assessment Tool	**Marks**	**Reduced marks**
IAT-1	25	25
IAT-2	25	
Assessment -1(activity based)	25	25
Assessment-2(activity based)	25	
Semester End Examination (SEE): 50 marks		
SEE	**Marks**	**Reduced marks**
Course end examination (Answer any one question from each unit – Internal choice)	100	50

Activity Based Learning / Practical Based learning Suggested Activities are:

- Present the case studies of successful sustainable engineering projects.
- Perform a life cycle assessment to evaluate its environmental impact from production to disposal.
- Conduct an energy audit of a building (e.g., a classroom, dormitory) to identify areas where energy is wasted and propose solutions to improve energy efficiency.
- Use simulation software to model and analyze sustainable engineering systems.
- Build small-scale models of renewable energy systems such as solar panels, wind turbines, or hydroelectric generators.
- Design a green building that incorporates sustainable practices such as energy-efficient lighting, natural ventilation, green roofs, and rainwater harvesting.
- Design and build a small-scale water filtration system using natural and recyclable materials.
- Develop a sustainable transportation plan for their campus or local community, considering options like cycling infrastructure, electric vehicles, and public transportation improvements.
- Create a comprehensive waste management and recycling program for their campus or community, including strategies for reducing waste, increasing recycling rates, and educating others.
- Calculate the carbon footprint of their daily activities or the operations of an institution or local business sectors
- Develop a small-scale sustainable agriculture project, such as a community garden using organic farming practices, permaculture, or hydroponics.
- Design and prototype an eco-friendly product, considering the entire lifecycle from materials sourcing to disposal.

- **Suggested Learning Resources:**

Text Books:

- Introduction to Sustainability for Engineers, ToolseeramRamjeawon, CRC Press, 1stEdn., 2020
- Sustainability Engineering: Concepts, Design and Case studies, Prentice Hall, 1stEdn, 2015
- System Analysis for sustainable Engineering: Theory and applications, Ni bin Chang, McGraw Hill Publications, 1stEdn., 2010

Reference Books:

- Engineering for Sustainable development: Delivery a sustainable development goals, UNESCO, International Centre for Engineering Education, France, 1stEdn., 2021
- Introduction to Sustainable Engineering, Rag. R.L. and Ramesh Lakshmi Dinachandran, PHI Learning Pvt. Ltd., 2ndEdn, 2016.

Web links and Video Lectures (e-Resources):

- VTU/EDUSAT/SWAYAM/NPTEL/MOOC.
- https://nptel.ac.in/courses/127105018
- https:/https://nptel.ac.in/courses/107103081/www.macfound.org
- https://unesdoc.unesco.org/
- https://unesdoc.unesco.org/ark:/48223/pf0000375644.locale=en
- https://engineeringforoneplanet.org

COs and POs Mapping (CO-PO mappings are only Indicative)

COs	POs											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	2					2	2	2		2		2
CO2	2	3	3	3	2	3	2	3	2	2		3
CO3	2	3	3		2	3	2	2			3	2
CO4	2	3	3		2	3	2		2			2
CO5	2	3	3		2	3	2		2			2

Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped