

SUSTAINABLE ENGINEERING

I Year B. Tech. I Semester

(Common to CHEM, CIVIL, ECE, ECE (VLSI), EEE, EEE (EV), MECH, MECH (R & AI))

Course Code:

L	T	P	C
2	0	0	1

Pre-requisites: None

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

CO1: Explain sustainability principles and challenges.

CO2: Explain climate change, EPR, CSR and ESG frameworks.

CO3: Perform basic carbon footprint analysis.

CO4: Explain 3R/5R frameworks and Life-Cycle Assessment.

CO5: Analyze the multidisciplinary approaches to sustainable engineering design.

UNIT I

Fundamentals of Sustainability

(6 Hours)

Human well-being and sustainability – Quality of life and resource consumption, economic and social dimensions; sustainable development; Sustainable Development Goals (SDGs); ecosystem goods and services; inter-generational and intra-generational equity; major sustainability challenges; role of engineers; sustainable engineering principles.

Learning outcomes:

At the end of the unit, the student will be able to

1. Explain the fundamental concepts and dimensions of sustainable development. (L2)
2. Describe the SDGs, ecosystem services and principles of inter-generational and intra-generational equity. (L2)
3. Explain major sustainability challenges and the role of engineers in achieving sustainable development. (L2)

UNIT II

Industrial Ecology, Resources, Governance and Policy

(6 Hours)

Energy and water security; industrial ecology and pollution prevention; climate change and decarbonisation; Extended Producer Responsibility (EPR); Corporate Social Responsibility (CSR) and introduction to ESG frameworks; sustainable production and consumption, environmental externalities, SWM Rules 2026 (4-stream segregation, BWG compliance, bio-mining, and RDF recovery).

Learning outcomes:

At the end of the unit, the student will be able to

1. Explain the importance of energy security, water security and resource conservation. (L2)
2. Describe the causes and impacts of climate change, pollution and decarbonisation. (L2)
3. Explain the basic concepts of EPR, CSR, ESG and environmental governance. (L2)

UNIT III

Sustainability Assessment and Footprint Analysis

(7 Hours)

Sustainability indicators and metrics; basic material and energy flows; carbon footprint estimation and greenhouse gas emissions, Global Warming Potential; introduction to GHG Protocol; water footprint; ecological footprint; carbon footprint calculations; Introduction to Environmental Impact Assessment (EIA).

Learning outcomes:

At the end of the unit, the student will be able to

1. Explain sustainability indicators, material and energy flows, greenhouse gases and GWP. (L2)
2. Calculate basic energy consumption, energy efficiency and greenhouse gas emissions. (L3)
3. Estimate a basic carbon footprint and explain the concepts of water footprint, ecological footprint. (L3)

UNIT IV

Energy, Materials and Life-Cycle Assessment

(7 Hours)

Energy efficiency and conservation; renewable energy — solar, wind, hydro and biomass; sustainable and resource-efficient materials; resource efficiency; 3R/5R frameworks; introduction to Life-Cycle Assessment (LCA); basic LCA stages; life-cycle thinking; key environmental impact categories — global warming, acidification, eutrophication and ozone depletion.

Learning outcomes:

At the end of the unit, the student will be able to

1. Explain the principles of energy efficiency, renewable energy and resource-efficient materials. (L2)
2. Explain the 3R/5R frameworks, circular economy and resource recovery. (L2)
3. Describe the basic stages of Life-Cycle Assessment and major environmental impact categories. (L2)

UNIT V

Sustainable Engineering Solutions

(6 Hours)

Green engineering and sustainable design; circular economy and resource recovery; sustainable manufacturing and services; sustainable transportation; green building concepts and rating systems; smart cities and sustainable infrastructure; AI, IoT and digital technologies for sustainability; sustainable electronics and green computing; green chemical processes, Waste to Energy systems.

Learning outcomes:

At the end of the unit, the student will be able to

1. Explain the principles of green engineering, sustainable design and sustainable manufacturing. (L2)
2. Describe the applications of sustainable transportation, green buildings, smart cities, AI and IoT for sustainability. (L2)
3. Apply sustainable engineering principles to propose solutions for simple environmental and resource-related problems. (L3)

Textbook:

1. Bhavik R. Bakshi (2019). Sustainable Engineering: Principles and Practice. 1st Ed. Cambridge University Press. tp. 490

References:

2. Bradley Striebig, Adebayo Ogundipe, Maria Papadakis (2015). Engineering Applications in Sustainable Design and Development. 1st Ed.s CL Engineering. tp. 608
3. David T. Allen, David R. Shonnard (2011). Sustainability Engineering: Concepts, Design and Case Studies, 1st Ed. Prentice Hall. tp. 223
4. Reddy, Krishna R., Cameselle, Claudio, Adams, Jeffrey A. (2025). Sustainable and Resilient Engineering: Drivers, Metrics, Tools, and Applications. 2nd Ed. John Wiley & Sons Inc. tp. 644
5. Sustainable Engineering Practice: An Introduction (2004). ASCE Press.