# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Master of Engineering**

**Level: Post Graduate**

**Subject Code: ME03000191**

**Subject Name: Sustainable Engineering Concepts and Life Cycle Analysis**

| | |
|---|---|
| w.e.f.Academic Year: | 2024-25 |
| Semester: | 3 |
| Category of the Course: | MOPEC |

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|---|---|
| **Prerequisite:** | Environmental Sciences, Introduction to Environmental Engineering. |
| **Rationale:** | This course will introduce students to the fundamental concepts related to interaction of industrial and environmental/ecological systems, sustainability challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society. Students will understand the concepts and the scientific method as it applies to a systems-based, trans-disciplinary approach to sustainability, and will be prepared to identify problems in sustainability and formulate appropriate solutions based on scientific research, applied science, social and economic issues. The basic concepts of life cycle assessment (LCA) will be discussed, along with life cycle inventory (LCI) and life cycle impact assessment (LCIA) including the social and economic dimensions. The application of life cycle assessment methodology using appropriate case studies will be presented. |

**Course Outcome:**

After Completion of the Course, Student will able to:

| No. | Course Outcomes |
|---|---|
| 01 | Understanding sustainability and identification of materials and their life cycles |
| 02 | Interpret the concept of Life cycle thinking and framework of Life cycle assessment. |
| 03 | Assimilate the computational structure behind LCA software packages |
| 04 | Write report/paper based on a LCA study and predict the environmental impacts of a product |

**Teaching and Examination Scheme:**

| Teaching Scheme(in Hours) | | | Total Credits L+T+(PR/2) | Assessment Pattern and Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tutorial/Practical | | |
| L | T | PR | C | ESE (E) | PA/ CA (M) | PA/CA(I) | ESE (V) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 0 | 0 | 100 |

**Course Content:**

| Unit No. | Content | No.of Hours | % of Weightage |
|---|---|---|---|
| **1.** | An Introduction to Sustainability Concepts and Life Cycle Analysis (Introduction, Material flow and waste management, What it all means for an engineer? Water energy and food nexus) | 4 | 10 |
| **2.** | Risk and Life Cycle Framework for Sustainability (Introduction, Risk, Environmental Risk Assessment, Example Chemicals and Health Effects, Character of Environmental Problems) | 6 | 14 |
| 3. | Environmental Data Collection and LCA Methodology (Environmental Data Collection Issues, Statistical Analysis of Environmental Data, Common Analytical Instruments, Overview of LCA Methodology - Goal Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Software tools) | 8 | 16 |
| 4. | Life Cycle Assessment – Detailed Methodology and ISO Framework (Detailed Example on LCA Comparisons, LCA Benefits and Drawbacks, Historical Development and LCA Steps from ISO Framework). Life Cycle Inventory and Impact Assessments (Unit Processes and System Boundary Data Quality, Procedure for Life Cycle Impact Assessment, LCIA in Practice with Examples, Interpretation of LCIA Results). Factors for Good LCA Study (ISO Terminologies, LCA Steps Recap, Chemical Release and Fate and Transport, and Green Sustainable Materials) | 16 | 40 |
| 5. | Design for Sustainability (Environmental Design for Sustainability: Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis) | 6 | 12 |
| 6. | Case Studies (e.g., Odour Removal for Organics Treatment Plant, Comparison of Hand Drying Methods, Biofuels for Transportation, Kerosene Lamp vs. Solar Lamp, Bioplastic etc.). | 5 | 8 |
| | **Total** | **45** | **100** |

**Suggested Specification Table with Marks (Theory):**

| Distribution of Theory Marks | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| **10** | **20** | **25** | **25** | **10** | **10** |

*WhereR:Remember;U:Understanding;A:Application,N:AnalyzeandE:EvaluateC:Create(asperRevisedBloom'sTaxonomy)*

**References/Suggested Learning Resources:**

**(a) Books:**

1. Environmental Life Cycle Analysis, Ciambrone , D.F., (2019)., Taylor and Francis Group, UK.
2. Handbook on Life Cycle Assessment: Operational guide to the ISO standards, JeroenGuinee, (2014) Springer, USA.
Reference Books: 1. Life Cycle Assessment - Theory and Practice, Hauschild, M. Z., Rosenbaum, R. K., & Olsen, S. I. (Eds.) (2018). Springer. https://doi.org/10.1007/978-3-319-56475-3
4. Environmental Impact Assessment- Theory and Practice, Wathern.P., Routledge Publishers, London, 2004.
5. Environmental Impact Assessment Methodologies, Anjaneyulu. Y., and Manickam. V., B.S. Publications, Hyderabad, 2007.
6. Bradley A S, Adebayo A O, Maria P, Engineering Applications Sustainable Design in and Development, Cengage Learning 2016
7. Jeffrey D S, The Age of Sustainable Development, Columbia University Press 2015
8. Surjya Narayana Pati, Life Cycle Assessment Future Challenges, CRC Press 2022
9. Guido Sonnemann Francesc Castells Marta Schuhmacher, Integrated Life Cycle And Risk Assessment For Industrial Processes, publications, 2004

**(b) Open source software and website:**

1.www.openlca.org
2. www.ecoinvent.org
3. www.gabi-software.com

**Suggested Project List:** ---

1. Case Histories on Life Cycle Analysis
2. Case studies on Statistical Analysis of Environmental Data
3.Visit to NGO/Environmental Audit Company
4. Site Visits and identification of Green Sustainable Materials

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