Sardar Patel College of Engineering
Munshi Nagar,
Andheri West Mumbai 400058

MINOR IN SUSTAINABILITY ENGINEERING AND MANAGEMENT
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Introduction to Sustainability and Sustainable Development (MI-BT031)

Course Code	Course Name
MI-BT031	Introduction to Sustainability and Sustainable Development
Course pre-requisites	NA

Course Objectives

1. This course provides an in-depth understanding of sustainability and sustainable development goals to create a better- informed engineer, which will lead to a more sustainable action by all and for all.

Course Outcomes

Students will be able to:

1. Explain the basic concept of Sustainability and Sustainable Development (SD), history of SD, the environmental, social and economic dimensions of SD and be able to discuss the SD concept on the national as well as on the global scale with respect to engineering
2. Apply the fundamental concepts related to interaction of industrial and environmental/ecological systems, sustainability challenges facing the current generation, and systems-based approaches required for creating sustainable solutions for society.
3. Apply sustainable practices by utilizing the engineering knowledge and principles.
4. Deliberate on potential strategic options and tools for assessing SD (efficiency, sufficiency).

Course Content

Module No	Contents	Time (Hrs)
1	**Introduction**: What is sustainability and sustainable development? – definitions, Concept & components of sustainability **Limits to exponential growth on a finite planet**, Complexity of growth and equity, Environmental issues and crisis, Resource degradation, greenhouse gases, global warming, desertification, social insecurity, industrialization, globalization. **An Engineers role in sustainability**	02
2	**Sustainability perspective for Energy, Materials, Water, Food and Shelter**: World energy usage, Problems with fossil fuels Alternatives - reduction, efficiency, renewable energy. Impacts of material production, sources of waste, Problems with current waste management, Suggestions for reducing the impact of material use Water resource and use worldwide, Associated problems with current water systems, Sustainable water management, World food production, Usage of resources and environmental impacts, Alternatives - organic/local Current building styles and associated problems, Retrofit vs new build	06

	Sustainable Architecture	
3	**Social & Economic Sustainability** Social sustainability - Components - equality, diversity, democracy, social cohesion, Issues - gender issue, poverty, environmental degradation, peace & justice, social sustainability performance - community engagement, community development, empowerment, health, volunteerism, etc. Economic sustainability - Relationship between macroeconomics policies, poverty and environment, Trade-offs between economic growth, social equity, and environmental sustainability, Role of international environmental agreements, green economy and climate change policies.	05
4	**Governance for Sustainable Development Systems**: Socio-economic policies for sustainable development, Strategies for implementing eco-development programmes, Policy responses to environmental degradation, Public participation - Demographic dynamics and sustainability, Integrated approach for resource protection and management.	03
5	**Strategies and measurements of SD**: Introduction to Sustainability assessment, Environment Sustainability metrics – simple and complex indicators, Sustainability methods and assessment - green buildings, Renewable energy, CSR, Biodiversity, Technologies, human development index (HDI), sustainability development index (SDI), LCA	03
6	**The road to Sustainable Development** - National and International Contribution: National Contribution: Societal transformations. Institutional theory, Rural and Urban development, Action plan for implementing sustainable development International Contribution - Brundtland, Rio summit, SDGs, Conventions, Protocols & Agreements, Action plan for implementing sustainable development, Moral obligations and Operational guidelines, Role of developed countries in the sustainable development.	03
7	**Project Presentations**	04

Text Books:

1. Harris, J.M., Basic Principles for Sustainable Development, Global Development and Environment Institute, working paper 00-04. Available at:http://ase.tufts.edu/gdae/publications/Working_Papers/Sustainable%20 Development.PDF
2. Mackenthun, K.M., Basic Concepts in Environmental Management, 1 st edition, Lewis Publication, London, 1998.
3. Hjorth, P. and A. Bagheri, Navigating towards Sustainable Development: A System Dynamics Approach, In Futures, 38(1): 74-92, 2006.
4. Mog, J.M., Struggling with Sustainability – A Comparative Framework for Evaluating Sustainable Development Programs, World Development 32(12): 2139–2160, 2004.

Reference Books:

1. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-
2. Rating System, TERI Publications – GRIHA Rating System
3. Indian Green Building Council, IGBC Green Buildings rating system (New & Existing) - Abridged Reference Guide, Pilot Version, 2017.

4. IISD Commentary on the OECD's Draft Principles for International Investor Participation in Infrastructure (PDF – 68 kb)
Courses to refer Sustainability and Engineering : https://rdmc.nottingham.ac.uk/bitstream/handle/internal/112/Engineering%20Sustailability

Sustainable Design in Engineering MI-BT032

Course Code	Course Name
MI-BT032	Sustainable Design in Engineering
Course pre-requisites	MI-BT031

Course Objectives

The objective of the course is to enable student to design solutions in technology and engineering using the concepts of sustainability and circular economy in mind

Course Outcomes

At the end of the course students will be able to

1) **Explain** the concepts of sustainability and sustainable development, and **analyse** the relationship between technology, energy use, and sustainability transitions using appropriate frameworks and indicators.
2) **Evaluate** technology/design-integrated systems using SDG frameworks, and **assess** the feasibility and challenges of achieving sustainability goals through case-based analysis.
3) **Apply** principles of environmental, economic, and social indicators in sustainable engineering design, infrastructure development, and renewable energy systems.
4) **Develop** sustainable product design solutions using nature-based and biomimetic approaches, and **present** integrated sustainability strategies through project-based learning.

Course Contents

Module No	Contents	Time (Hrs)
1	Introduction: Introduction to technology, sustainability, and sustainable development. Concepts of sustainability and sustainable development. Technology; concepts and definitions. Components of sustainability (Social, Economic, Environmental). Linkages between resource use, technology, and sustainability. Interactions between energy and technology, and their implications for environment and sustainable development. Technology diffusion and commercialization; Business and sustainability. Measuring and Benchmarking Sustainability - Sustainability proofing; Frameworks for measuring sustainability; Indicators of sustainability. Sustainability Transitions, Drivers and Barriers; Policy and Institutional Innovations. Sustainability transition Case Studies.	08
2	Design Integration: Understand, evaluate, define, and forecast sustainability. Morphology-based understanding of technology/design and detailed morphological analysis of each chosen design/technology Development of technology/design-integrated systems model.	08

	Consideration of 17 Sustainable Development Goals (SDGs) Coverage of the fundamental mandate of SDG-4 . Addressing feasibility, opportunities, challenges, and limitations in achieving sustainability. Case Studies	
3	Design For Sustainability Environmental design for sustainability: economic, environmental indicators, social performance indicators, sustainable engineering design principles and application	08
4	Sustainability in Infrastructure Climate and building design, Green Building concepts, Building energy efficiency and renewable energy assessment in buildings, Indoor air quality and wellness, Sustainable construction and maintainability, Low-carbon material and process Introduction to Sustainable Transportation Understanding the planning and implementation of active transportation, Water and wastewater engineering and reuse, solid waste management. Case Studies	08
5	Sustainability by Renewable Energy Introduction to Renewable Energy; Solar Energy, Wind Energy, Biomass and Bioenergy, Hydroelectric and Ocean Energy, Geothermal Energy, Energy Storage and Grid Integration, Renewable Energy Policies and Economic Environmental and Social Impacts, Future Trends and Innovations. Case studies	08
6	Sustainable Product Design Sustainable Design methods, Nature-Based Design Solutions Biophilic Design & Biomimicry, Case Studies	08
7	Project Presentations	08

Text Books:

1. David T. Allen David R. Shonnard Sustainable Engineering Concepts, Design and case Studies , Pearson, Edition1, 2015.
2. Harris, J.M., Basic Principles for Sustainable Development, Global Development and Environment Institute, working paper 00-04. Available at:http://ase.tufts.edu/gdae/publications/Working_Papers/Sustainable%20 Development.PDF
3. Mackenthun, K.M., Basic Concepts in Environmental Management, 1 st edition, Lewis Publication, London, 1998.
4. Mog, J.M., Struggling with Sustainability – A Comparative Framework for Evaluating Sustainable Development Programs, World Development 32(12): 2139–2160, 2004.

Reference Books:

1. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-
2. Rating System, TERI Publications – GRIHA Rating System
3. Indian Green Building Council, IGBC Green Buildings rating system (New & Existing) - Abridged Reference Guide, Pilot Version, 2017.

Courses to refer

Sustainability and Engineering : https://iisc.talentsprint.com/sustainable-engineering

Sustainability Assessment MI-BT033

Course Code	Course Name
MI-BT033	Sustainability Assessment
Course pre-requisites	MI-BT031, MI-BT032

Course Objectives

The objective of the course is to enable student to assess technology and engineering using the concepts of sustainability and circular economy in mind and make the correct choice of alternative

Course Outcomes

At the end of the course students will be able to

1. **Apply** Material Flow Analysis (MFA) and Life Cycle Assessment (LCA) techniques to assess environment al impacts, resource use, and system changes in anthropogenic systems.
2. **Analyse** the ISO framework, methodology, and tools for conducting LCA, including data collectio n, inventory analysis, impact assessment, and result interpretation.
3. **Evaluate** economic and social dimensions of sustainability using Life Cycle Cost Analysis (LCCA) and Social Life Cycle Assessment (S-LCA), incorporating real-world criteria and indicators.
4. **Interpret** sustainability standards, corporate sustainability assessments, and practical case studies across civil, architectural, and environmental domains to support informed decision-making.

Course Content

Module No	Contents	Time (Hrs)
1	Environmental assessment: (a) Materials Flow Analysis (MFA) 1. Analysis, evaluation and design of anthropogenic systems (companies, cities, countries, the world) 2. Use materials flow analysis to: - predict changes in the system regarding demand and emissions - interpret changes regarding the consequences for the environment, resource protection, employment rate or geopolitical conditions - identify possibilities to change systems in the desired direction 3. Terminologies, system definition, choice of indicators, vulnerability analysis, data harmonisation, dynamic modelling 4. MFA as precursor to Environmental Impact Assessment b) Life Cycle Assessment (LCA) 1. Modelling of different environmental effects of products and services (for example climate change, toxicity, land use) 2. Use of different methods for environmental impact assessment	16
2	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	10

	materials LCA - Data Collection And 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	
3	Socioeconomic analysis: (a) Life Cycle Cost Analysis (LCCA) 1. Cost categories, income categories, current value calculations, discounts and their importance 2. Differences in setting repayment periods pertaining to projects based on current value, introducing environment costs to integrate environmental and economic aspects in decision-making (b) Social Life Cycle Assessment (S-LCA) 1. Introduction to S-LCA methodology 2. Criteria and indicators 3. Case studies in the literature	14
4	Sustainability Standards :Corporate sustainability Assessment and Ass essment Tools, Sustainability Indices, Assessment Tools	08
5	Case Studies Architectural, environmental, transportation, water resources, and other areas	08

Text Books:

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3. An overview of sustainability assessment methodologies, March 2009, Ecological Indicators 15(2):189-212, 15(2):189-212, DOI:10.1016/j.ecolind.2008.05.011

Reference Books:

1. Sustainability Standards: A New Deal to Build Forward Better, 2021, International Trade Centre.
2. Mohammad Ali, Sustainability Assessment, Elsevier, 2023.

Assessment Tool

https://www.learningfornature.org/wp-content/uploads/2019/08/Sustainability-assessment-tool.xlsm

Circular Economy, Finance and Governance MI-BT034

Course Code	Course Name
MI-BT034	Circular Economy, Finance and Governance
Course pre-requisites	M031,M032,M033

Course Objectives

1. This course designed to empower participants with the knowledge and strategies essential to thrive in the era of advanced circular economy and finance

Course Outcomes

At the end of course students will be able to :

1. **Explain** the foundational principles and evolution of the Circular Economy and its role in promoting regenerative and sustainable systems.
2. **Analyse** the main components of the Circular Economy such as cradle-to-cradle design, product life extension, and sustainable material sourcing.
3. **Evaluate** the integration of Circular Economy principles into innovative business strategies and identify organisational benefits.
4. **Compare** European Circular Economy policies and practices and **assess** their relevance and applicability in the Indian context using case studies.
5. **Design** a basic circular business model considering product design, supply chain, and stakeholder engagement, with reference to real-world examples.

Course Content

Module No	Contents	Time (Hrs)
1	**Introduction and Overview of Circular Economy:** foundational principles and evolution of Circular Economy. Explore how this advanced paradigm goes beyond sustainability, focusing on regenerative systems, waste reduction, and the creation of a closed-loop economy. Understand the role of Circular Economy in addressing global challenges and creating long-term environmental and economic value.	12
2	**Main Concepts and Components of Circular Economy:** Delve into the core concepts and components that form the backbone of Circular Economy. Learn about cradle-to-cradle design, product life extension, recycling innovations, and sustainable material sourcing. Understand how these elements contribute to creating a circular and resilient economic ecosystem	10
3	**Circular Economy and Business Ideas and Benefits:** Explore the integration of circular economy principles into business strategies. Identify innovative business ideas that align with Circular Economy 3.0 and uncover the tangible benefits for organizations, including cost savings, enhanced brand reputation, and increased resilience in the face of environmental challenges.	10
4	**Europe and Circular Economy and Applicability to India :** Investigate the role of Europe as a leader in promoting and implementing Circular Economy practices. Analyze policies, initiatives, and success stories from European countries, gaining insights into the regional approaches to fostering sustainability and circularity. Explore the Applicability to Indian Context. Case Studies	10
5	**Circular Business Model and How to Start, How to Build?** Delve into the	14

	practical aspects of implementing a circular business model. Learn how to initiate and build a circular economy strategy within an organization, considering key factors such as product design, supply chain management, and stakeholder engagement. Explore case studies of successful circular businesses and gain actionable insights for implementation.	

Text Books:

1. **Santosh Ganesh, Kapila Mehta, The Circular Economy: A Blueprint for the Future of Business, Notion Press,** ISBN 9798892337397,2022
2. Ed Weenk, Rozanne Henzen, Mastering the circular Economy, KoganPage, ISBN 978 1 39860 274 8,2021

Courses to refer

https://www.coursera.org/learn/sustainability-and-the-circular-economy