ANNEXURE-V

DETAILED SYLLABUS

MINOR/HONOURS DEGREE IN

SUSTAINABILITY ENGINEERING

(Batch 2023 & Onwards)

PROGRAMME OBJECTIVES AND OUTCOMES

Minor/Honours Degree in Sustainability Engineering

Programme Objectives (POBs)

6. To impart comprehensive theoretical foundations and practical applications of sustainability principles encompassing environmental integrity, social equity, and economic viability.
7. To cultivate interdisciplinary competencies necessary for the evaluation, design, and implementation of holistic sustainable engineering solutions.
8. To develop analytical frameworks for critical assessment of infrastructure systems, waste management protocols, materials selection, and environmental conservation through sustainability paradigms.
9. To facilitate the application of internationally recognized sustainability frameworks, including the Sustainable Development Goals and Environmental Impact Assessment methodologies, within engineering practice.
10. To empower students to conceptualize and lead transformative sustainability initiatives through experiential and project-based pedagogical approaches.

Programme Outcomes (POs)

1. Students will demonstrate comprehensive understanding of sustainability principles and their practical applications within civil and environmental engineering contexts.
2. Students will exhibit proficiency in conducting environmental impact assessments, life cycle analyses, and designing interventions that enhance the sustainability of infrastructure systems.
3. Students will demonstrate capability in implementing sustainable materials selection and construction methodologies with consideration for lifecycle impacts and ecological preservation.
4. Students will formulate innovative engineering solutions addressing climate change mitigation, resource conservation strategies, and principles of social equity.
5. Students will successfully execute capstone projects that demonstrate the seamless integration of sustainability principles within design conceptualization, planning methodologies, and management frameworks.

PROGRAMME	Minor/Honours Degree in Sustainable Engineering
SEMESTER	3rd
COURSE TITLE	**Introduction to Sustainability**
COURSE CODE	CIV-246-C
COURSE CATEGORY	Professional Core Course

CREDITS AND CONTACT HOURS					
CREDITS	**L**	**T**	**P**	**S**	**TOTAL NO. OF CONTACT HOURS**
3	2	1	0	0	45

COURSE CONTENTS:

Units	Contents	Contact Hours
1	**A. Introduction to Sustainability** Definition of sustainability and its relevance in engineering and society. Historical context and evolution of sustainability concepts. The three pillars of sustainability: environmental, social, and economic aspects.	**06**
2	**B. Environmental Sustainability** Key environmental challenges and their impact on sustainability Resource depletion, pollution, and climate change, Sustainable resource management and conservation strategies.	**08**
3	**C. Social Sustainability** Social equity, justice, and inclusivity in sustainable development; Impacts of infrastructure projects on local communities and social well-being; Stakeholder engagement and participatory approaches in decision-making.	**08**
4	**D. Economic Sustainability** Economic dimensions of sustainability and the business case for sustainability; Life cycle costing and assessment of sustainability projects; Sustainable business practices and corporate social responsibility.	**08**
5	**E. Sustainable Development and Goals** Introduction to the United Nations Sustainable Development Goals (SDGs); Integrating the SDGs into engineering practice and project planning; Case studies on successful sustainable development projects.	**07**
6	**F. Sustainable Engineering and Design** Principles and strategies for sustainable engineering design; Sustainable materials selection and green building practices; Energy-efficient design and renewable energy technologies. **Sustainability standards and certifications (e.g., LEED, BREEAM);** Best practices and examples of sustainability in various industries and sectors;	**08**

	Case studies and guest lectures from professionals working in sustainability fields.	

COURSE OUTCOMES	
CO1	**Understanding Sustainability**
CO2	**Environmental Challenges Awareness**
CO3	**Sustainable Practices and Solutions**
CO4	**Critical Thinking and Problem-Solving**
CO5	**Understanding Sustainability**

TEXTBOOKS/ REFERENCES:

Title of Book
"Sustainability: A Comprehensive Foundation" by Tom Theis and Jonathan Tomkin
"The Sustainability Handbook: The Complete Management Guide to Achieving Social, Economic, and Environmental Responsibility" by William R. Blackburn.
"Sustainability: Principles and Practice" by Margaret Robertson.
"Sustainability: A History" by Jeremy L. Caradonna.
"Cradle to Cradle: Remaking the Way We Make Things" by William McDonough and Michael Braungart.
"Sustainability: A Comprehensive Foundation" by Tom Theis and Jonathan Tomkin

PROGRAMME	Minor/Honours Degree in Sustainable Engineering
SEMESTER	4th
COURSE TITLE	**Sustainable Infrastructure Design and Planning**
COURSE CODE	CIV-296-C
COURSE CATEGORY	Professional Core Course

CREDITS AND CONTACT HOURS					
CREDITS	**L**	**T**	**P**	**S**	**TOTAL NO. OF CONTACT HOURS**
3	2	1	0	0	45

COURSE CONTENTS:

Units	Contents	Contact Hours
1	**Overview of sustainable infrastructure and its importance in sustainable development:** Principles and goals of sustainable infrastructure design and planning; Integration of sustainability into infrastructure projects; Sustainable Site Selection and Assessment	**06**
2	**Factors to consider in selecting sustainable sites for infrastructure projects:** Site assessment techniques for environmental, social, and economic impacts; Mitigation of environmental risks and preservation of ecosystems.	**07**
3	**Sustainable Design Principles:** Sustainable design concepts and strategies for infrastructure projects, Energy-efficient design techniques and renewable energy integration; Water conservation and management in infrastructure design; Sustainable Materials and Construction Methods.	**07**
4	**Selection of sustainable materials for infrastructure construction:** Evaluation of construction techniques for minimizing environmental impacts; Waste management and recycling in construction projects; Green Infrastructure and Natural Systems	**07**
5	**Transportation and Mobility Planning:** Sustainable transportation planning principles; Integration of multi-modal transportation systems and non-motorized transportation; Strategies for reducing traffic congestion and promoting efficient mobility	**07**
6	**Resilient Infrastructure Design:** Design considerations for climate change adaptation and resilience; Incorporating resilience measures in infrastructure projects; Risk assessment and mitigation strategies; Social and Community Considerations in Infrastructure	**07**
7	**Case Studies and Project Analysis:** Analysis of real-world sustainable infrastructure projects; Examination of best practices and lessons learned; Group projects or case studies focusing on sustainable infrastructure design and planning.	**04**

COURSE OUTCOMES	
CO1	Integration of Sustainability Principles
CO2	Environmental Impact Assessment
CO3	Resilience and Climate Adaptation
CO4	Stakeholder Engagement and Participatory Design
CO5	Integration of Sustainability Principles

TEXTBOOKS/ REFERENCES:

Title of Book
1. "Sustainable Infrastructure: Principles into Practice" by Charles Ainger.
2. "Infrastructure Planning, Engineering, and Economics" by Robert L. Peurifoy, Clifford J. Schexnayder, and Aviad Shapira.
3. "Sustainable Infrastructure: The Guide to Green Engineering and Design" by S. Bry Sarte.
4. "Sustainable Infrastructure Development: A Life Cycle Approach to Green Building" by Bjørn Berge.
5. "Design for Sustainable Change: How Design and Designers Can Drive the Sustainability Agenda" by Anne Chick.
6. "Infrastructure Sustainability and Design" by Daniel Shearing and Michael Phillips.
7. "Infrastructure Finance: The Business of Infrastructure for a Sustainable Future" by Neil Grigg.
8. "The Green Infrastructure Handbook: A Guide to Creating Efficient and Sustainable Infrastructure" by Jeffery L. Bruce.

PROGRAMME	Minor/Honours Degree in Sustainable Engineering
SEMESTER	5th
COURSE TITLE	**Sustainable Material and Construction**
COURSE CODE	CIV-346-C
COURSE CATEGORY	Professional Core Course

CREDITS AND CONTACT HOURS					
CREDITS	**L**	**T**	**P**	**S**	**TOTAL NO. OF CONTACT HOURS**
3	2	1	0	0	45

COURSE CONTENTS:

Units	Contents	Contact Hours
1	**A Introduction to Sustainable Construction:** Definition and principles of sustainability in construction. Environmental, social, and economic aspects of sustainable construction. Sustainable development goals and their relevance to the built environment. Life Cycle Assessment (LCA) in Construction. Carbon footprint analysis.	**10**
2	**B Efficient building design principles & Emerging Trends in Sustainable Construction:** Passive design strategies (orientation, insulation, shading). High-performance building envelopes. Prefabrication and modular construction. Design for deconstruction and adaptability. Construction waste reduction and recycling. Smart buildings and the Internet of Things (IoT). Circular economy and cradle-to-cradle design	**12**
3	**C Materials its Properties and applications:** Concrete and Cementitious Materials. Supplementary cementitious materials (SCMs). Green concrete and low-carbon cements. Coarse and fine aggregates. Recycled and scrap steel in construction. Lightweight and high-strength alloys. Sustainable bricks and blocks. Masonry reinforcement alternatives. Recycled asphalt pavement (RAP). Porous and permeable pavements.	**12**
4	**D Emerging Trends in Sustainable Materials:** Nanotechnology in civil engineering materials. Self-healing and self-cleaning materials. Bio mimicry and nature-inspired materials. Recycled and reclaimed materials. Renewable materials and bio-based composites. Material selection criteria for sustainability.	**11**

TEXTBOOKS/ REFERENCES:

Title of Book
1. Sustainable Construction: Green Building Design and Delivery" by Charles J. Kibert.
2. Green Building: Principles and Practices in Residential Construction" by Abe Kruger and Carl Seville.
3. Materials for Sustainable Sites: A Complete Guide to the Evaluation, Selection, and Use of

Sustainable Construction Materials" by Meg Calkins.
4. Sustainable Construction: Towards a New Ethic in the Construction Culture" by David Johnston, Adrian Pitts, and Martin Muñoz.
5. Sustainable Construction and Building Materials: Select Proceedings of ICSCBM 2018" edited by Bibhuti Bhusan Das and Pradip Kumar Saha.
6. Sustainable Construction Materials: Copper Slag" by Mika Sillanpää and Olavi Selonen.
7. Sustainable Construction and Design" by Lisa M. Tucker and David R. Chasar.
8. Sustainable Construction: A Guide to Green Building Design and Delivery" by Richard Reed and Sara Wilkinson.
9. Sustainable Construction and Design: A Handbook for Green Building" by Steve G. Maslow, Wayne Tobiasson, and Tim Mrozowski.
10. Sustainable Building Systems and Construction for Designers" by Lisa M. Tucker

COURSE OUTCOMES	
CO1	Explain the principles of sustainable development and their application in construction.
CO2	Identify and discuss recent trends, innovations, and technologies in sustainable construction.
CO3	Understand the properties and characteristics of construction materials commonly used in the industry.
CO4	Apply decision-making frameworks to assess the viability and suitability of emerging sustainable materials

PROGRAMME	Minor/Honours Degree in Sustainable Engineering
SEMESTER	6th
COURSE TITLE	**Waste Management**
COURSE CODE	CIV-396-C
COURSE CATEGORY	Professional Core Course

CREDITS AND CONTACT HOURS					
CREDITS	**L**	**T**	**P**	**S**	**TOTAL NO. OF CONTACT HOURS**
3	2	1	0	0	45

COURSE CONTENTS:

Units	Contents	Contact Hours
1	**A: Sources and Composition of Municipal Solid Waste:** Sources of solid waste. Types of solid waste. Characteristics of Solid Waste, Composition of solid waste and its determination.	**09**
2	**B: Properties of Municipal Solid Waste:** Physical properties of Municipal Solid Waste, Chemical properties of Municipal Solid Waste, Biological properties of Municipal Solid Waste and Transformation of Municipal Solid Waste	**09**
3	**C: Solid Waste Generation and Collection**: Quantities of Solid Waste, Measurements, and methods to measure solid waste quantities. Solid waste generation and collection, Factors affecting solid waste generation rate, Quantities of materials recovered from MSW	**09**
4	**D: Handling, Separation, and Storage of Solid Waste**: Handling and separation of solid waste at site. Material separation by pick in, screens, float and separator magnets, and electromechanical separator, and other latest devices for material separation. Waste handling and separation at Commercial and industrial facilities. Storage of solid waste at the sources.	**09**
5	**E: Processing and disposal of Solid Waste**: Processing of solid waste at residence e.g. Storage, conveying, compacting, Shredding, pulping, granulating etc. Combustion and energy recovery of municipal solid waste, effects of combustion, undesirable effects of Combustion, Landfill: Classification, planning, sitting, permitting, landfill processes, landfill design, landfill operation, use Of old landfill, Differentiate sanitary land fill and incineration as final disposal system for solid waste, Biochemical processes: Methane generation by anaerobic digestion, composting and other biochemical Processes.	**09**

COURSE OUTCOMES	
CO1	Explain municipal solid waste management systems to their physical properties and associated critical considerations in view of emerging technologies
CO2	Outline sources, types and composition of solid waste with methods of handling, sampling and storage of solid waste.
CO3	Select the appropriate method for solid waste collection, transportation and redistribution.
CO4	Describe methods of disposal of municipal solid waste.

TEXTBOOKS/ REFERENCES:

Title of Book
1. Christensen, H. T., Solid Waste Technology & Management, Wiley, 2010, Volume 1 & 2.
2. Haug, T. R., The Practical Handbook of Compost Engineering, Lewis Publishers, 1993.
3. Reinhart, R. D. and Townsend, G. T., Landfill Bioreactor Design & Operation, CRC Press, 1997, 1st Edition.
4. Tchobanoglous, G. and Kreith, F., Handbook Of Solid Waste Management, McGraw Hill, 2002, 2nd Edition.
5. Tchobanoglous, G., Theisen and Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, 1993.
6. Manual on Municipal 1 Solid waste Management, CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi, 2000.

PROGRAMME	Minor/Honours Degree in Sustainable Engineering
SEMESTER	7th
COURSE TITLE	**Geo-Environmental Engineering**
COURSE CODE	CIV-446-C
COURSE CATEGORY	Professional Core Course

CREDITS AND CONTACT HOURS					
CREDITS	**L**	**T**	**P**	**S**	**TOTAL NO. OF CONTACT HOURS**
3	2	1	0	0	45

COURSE CONTENTS:

Units	Contents	Contact Hours
1	**A: Introduction and Soil-water-environment interaction**: Introduction to geo-environmental Engineering, Soil-water-environment interaction relating to geotechnical problems, Waste:-source, classification and management of waste, Physical, chemical and geotechnical characterization of municipal solid waste, Impact of waste dump and its remediation	**09**
2	**B: Geotechnical application of waste and disposal:** Geotechnical use of different types such as Thermal power plant waste, MSW, mine waste, industrial waste. Waste disposal facilities, Parameters controlling the selection of site for sanitary and industrial landfill. Site characterization. MoEF guidelines.	**09**
3	**C: Landfill Components :** Landfill layout and capacity, components of landfill and its functions. Types and functions of liner and cover systems, Compacted clay liner, selection of soil for liner, methodology of construction.	**09**
4	**D: Leachate, Gas Management and Geosynthetics:** Management of Leachate and gas. Various components of leachate collection and removal system and its design., gas disposal/utilization. Closure and post closure monitoring system Geosynthetics- Geo membranes - geosynthetics clay liners -testing and design aspects.	**09**
5	**E: Soil remediation**: Investigation of contaminated soil, sampling, assessment Transport of contaminants in saturated soil. Remediation of contaminated soil- in-situ / exit remediation, bio remediation, thermal remediation, pump and treat method, phyto remediation and electro-kinetic remediation	**09**

COURSE OUTCOMES	
CO1	Apply the knowledge of mathematics, Science and Engineering fundamentals for solution of problems of Environmental Engineering.
CO2	Develop solutions for Environmental Engineering problems and design system components and processes to meet the specified needs with appropriate consideration for the public health and safety.

CO3	Assess societal, health, safety and legal issues by applying Environmental Engineering knowledge
CO4	Practice ethical principles to fulfill responsibilities as Environmental Engineer.

TEXTBOOKS/ REFERENCES:

Title of Book
1. Daniel, D.E. (1993). Geotechnical Practice for Waste Disposal. Chapman, and Hall, London.
2. Koerner, R.M. (2005). Designing with Geosynthetics. Fifth Edition. Prentice Hall, New Jersey.
3. Reddi L.N and Inyang HI (2000) Geoenvironmental Engineering: Principles and Applications, Marcel Dekker Inc Publication
4. R. N. Yong (2000) Geoenvironmental Engineering: Contaminated Soils, Pollutant Fate, Mitigation Lewis Publication.
5. Dr. G V Rao and Dr. R S Sasidhar (2009) Solid waste Management and Engineered Landfills, Saimaster Geoenvironmental Services Pvt. Ltd. Publication.

PROGRAMME	Minor/Honours Degree in Sustainable Engineering
SEMESTER	8th
COURSE TITLE	**Capstone Project**
COURSE CODE	CIV-496-C
COURSE CATEGORY	Professional Core Course

CREDITS AND CONTACT HOURS					
CREDITS	**L**	**T**	**P**	**S**	**TOTAL NO. OF CONTACT HOURS**
3	0	0	6	0	90

COURSE OBJECTIVES	
1.	To synthesize knowledge from previous courses in sustainability engineering into a practical application.
2.	To solve real-world problems using sustainability-focused strategies and tools.
3.	To develop teamwork, project planning, and communication skills.
4.	To encourage innovation in environmental, social, or economic dimensions of sustainability.
5.	To synthesize knowledge from previous courses in sustainability engineering into a practical application.

COURSE CONTENT/MODUS OPERANDI:

S. No	**Description**	**Contact Hours**
1	Students will work individually or in small groups (2-3 members) on a real-world or research-based sustainability project under the guidance of a faculty supervisor. The work shall involve: 1. Identification of a sustainability problem or opportunity. 2. Literature review and case studies. 3. Design or planning of a sustainable intervention/solution. 4. Implementation or prototyping (if feasible). 5. Impact assessment, monitoring, and evaluation. 6. Preparation of technical report and final presentation.	**90**

EVALUATION MECHANISM	
Criteria	**Max. Marks**
Attendance and Regularity	10
Project Execution and Implementation	30
Report Quality and Technical Content	30
Final Presentation (With External Expert)	30