Vidyasagar University

Midnapore-721102, West Bengal

The Syllabus for
Post-Graduate Programme in
Environmental Science

[w.e.f. 2025-26]

Centre for Environmental Studies (CES)
(Under CCAE)

Detailed Curriculum of M.Sc. Environmental Science Program of Vidyasagar University

1. Introduction to M.Sc. Environmental Science in India

The Master of Science (M.Sc.) in Environmental Science represents a comprehensive two-year postgraduate degree program in India, meticulously designed to foster a profound understanding of escalating environmental challenges, core scientific principles, and effective management strategies. This program's architecture emphasizes both scientific rigor and practical application, aiming to cultivate a skilled workforce capable of addressing the complex environmental and developmental issues of the modern era.

The curriculum is structured to provide an inherently interdisciplinary education, integrating diverse fields of knowledge. This foundational breadth encompasses physical, chemical, and biological processes that govern the environment, alongside an examination of the socio-economic drivers of environmental pollution and degradation, and their far-reaching impacts on human populations, the atmosphere, various ecosystems, and other organisms. The consistent emphasis on interdisciplinary education and the integration of diverse fields, as evidenced by core subjects such as environmental chemistry, geology, ecology, biochemistry, toxicology, and microbiology across leading Indian universities, indicates that a robust curriculum prioritizes a broad scientific foundation. This comprehensive understanding is essential for analyzing and tackling complex environmental issues that inherently span multiple scientific and social domains.

A primary objective of the M.Sc. Environmental Science program is to empower learners with the necessary tools and knowledge to conduct independent assessments of complex environmental issues. Students are equipped to meticulously analyze and evaluate environmental systems and problems, formulate and propose sustainable solutions, and actively contribute to the development of effective policies and strategies for environmental planning. This progression from understanding to analysis, solution formulation, and policy influence is crucial. Learning outcomes further reinforce this by including the application of interdisciplinary principles of environmental science, understanding environmental concepts from ecology, chemistry, geology, and physics, and analyzing complex interactions within and between environmental systems. The program objectives consistently extend beyond mere scientific understanding, explicitly mentioning "effective management strategies," "sustainable solutions," and "policy development". This recurring theme signifies a critical pedagogical approach within leading Indian environmental science curricula: they aim to produce not just scientists, but environmental practitioners and leaders. This focus on actionable knowledge and policy influence is crucial for addressing the escalating environmental and developmental challenges by preparing graduates to translate scientific insights into practical interventions and governance.

This comprehensive approach aims to provide a holistic and representative view of what constitutes a high-quality M.Sc. Environmental Science education in the Indian context.

2. Overall Program Structure and Assessment Framework

The M.Sc. Environmental Science program in India is uniformly structured as a two-year postgraduate degree, typically spanning four semesters across all reviewed institutions. This standardized duration reflects a common academic framework for advanced studies in the field. However, while the program duration is consistent, the total credit allocation and the distribution of marks across theoretical, practical, and research components exhibit variations among universities.

For instance, at Vidyasagar University, the program totals 1100 marks and 88 credits, with an equal

distribution of 275 marks per semester. The breakdown includes 600 theoretical marks distributed across the first three semesters (175 marks per semester) and 300 practical marks (100 marks per semester for Semesters I-III). The final semester (Semester IV) is heavily weighted towards research and comprehensive assessment, with 100 marks allocated for the Research Dissertation Examination, 50 for the Research Dissertation Viva, 100 for the Grand Viva, and 25 for a Term Paper.

The consistent 2-year, 4-semester structure across all reviewed M.Sc. Environmental Science programs in India indicates a widely accepted academic standard for the duration of postgraduate study in this field. A robust curriculum strategically balances these components to align with its specific program objectives and the needs of the environmental sector.

The curricula are meticulously structured to incorporate a diverse range of course types. These typically include Core Theory courses, Core Practical components, Mandatory Credit courses, Elective Theory papers, dedicated Research components, and Experiential learning opportunities. This comprehensive approach ensures a well-rounded education. A notable feature in some curricula is the inclusion of non-credit compulsory courses. For instance, Vidyasagar University includes "Indian Knowledge System" (VU-ES-IKS106) and "Vidyasagar: Life and Philosophy" (VU-ES-NC102). These courses, while not contributing to credits, are mandatory for degree conferral. The explicit inclusion of non-credit compulsory courses signifies a pedagogical philosophy that extends beyond purely technical environmental science. This approach aims to instil broader ethical considerations, cultural awareness, critical thinking on contemporary issues and essential communication skills. Such integration suggests that a robust curriculum in India recognizes the importance of producing well-rounded professionals who are not only scientifically adept but also capable of engaging with the complex societal, ethical, and cultural dimensions inherent in environmental problem-solving, aligning with holistic education principles often emphasized in national education policies like NEP-2020.

Assessment typically involves a combination of internal and external evaluations. Internal assessment components commonly include seminar presentations, class tests, quizzes, and assignments, designed to gauge continuous learning and engagement. At Vidyasagar University, students must achieve a minimum of 20 marks in Theory Papers and 20 marks in Practical Papers. The grading system specifies 60% for a First Class and 50% for a Second Class, with no provision for a Third Class. Research dissertation and viva-voce examinations constitute significant components of the final semester's assessment, emphasizing independent research and comprehensive subject understanding.

Integration of MOOCs, Skill Development, and Holistic Education

The strategic adoption of MOOCs is evident, particularly at Vidyasagar University, which integrates "Energy and Environment" and "Climate Change Adaptation and Mitigation" as MOOC-based theoretical papers. This approach allows for flexible learning and access to specialized content, potentially from external experts or leading global platforms. Skill development is a clearly articulated distinctive feature of the curriculum. Vidyasagar University explicitly lists specific courses (e.g., VU-ES-IKS106, NC102, 202, 203, 204, 101, 102, 103, and 402) that contribute to employability, entrepreneurship, and skill enhancement. Beyond technical skills, there is an emphasis on holistic development. Non-credit course at Vidyasagar University ("Indian Knowledge System," "Vidyasagar: Life and Philosophy is designed to promote a broader understanding of societal, ethical, and communication aspects relevant to environmental science. The convergence of MOOC integration, an explicit focus on skill development, and the inclusion of non-credit courses

on ethics and scientific communication within leading M.Sc. Environmental Science curricula reveals a forward-thinking educational strategy. This multi-faceted approach aims to produce graduates who are not only technically competent in their scientific domain but also adaptable, ethically aware, and effective communicators. This blended learning model, combined with a strong emphasis on practical skills and crucial "soft skills" (such as critical thinking demonstrated through grand vivas), is designed to "future-proof" graduates, equipping them to navigate the complexities and evolving demands of the environmental sector and ensuring their long-term professional success.

Eligibility Criteria and Admission Processes in M.Sc. Environmental Science

Admission to the M.Sc. Environmental Science program typically requires a Bachelor's Degree from a recognized university in any discipline of Science, Engineering, Agriculture Sciences, Forestry, or Veterinary Science etc. Notably, candidates holding a B.Sc. degree in Geography and Economics are also deemed eligible, as are graduates with degrees in Engineering or Technology. For sponsored candidates, admission criteria are more flexible, generally requiring at least three years of experience in science laboratories, industries, or academic and research institutes. Specific intake capacities are noted, such as Vidyasagar University's total intake capacity of candidates 30, with an additional 5 potentially admitted with special permission for Semester I each year. The remarkably broad eligibility criteria, which welcome graduates from diverse scientific and technical backgrounds, are a significant indicator of the nature of M.Sc. Environmental Science programs.

Maximum intake capacity: 30 inclusive of all reservation

Table 1: M.Sc. Environmental Science Program Structure (Vidyasagar University)

Semester	Course Code	Title of the Paper	Full Marks	Marks Division (Internal Assessment / Examination)	Theoretical /Practical	Credits (L-T-P)	Exam. Time
Sem-I	EVSC401X0	Environmental Chemistry	50	10 / 40	Theory	4 (2-2-0)	2 hr.
	EVSC402X0	Earth Processes & Environmental Geology	50	10 / 40	Theory	4 (2-2-0)	2 hrs.
	EVSC403X0	Ecology & Ecosystem Dynamics	25	05 / 20	Theory	2 (1-1-0)	1 hrs.
	EVSO404VC	Indian Knowledge System	50	10 / 40	Theory	4 (2-2-0)	2 hrs.
	EVSO405NC	Vidyasagar: Life and Philosophy	Non-Credit	-	Theory	-	-
	EVSC406X9	Environmental Analysis Lab I A	50	Compulsory Field Visit/ Industry Visit (Notebook + Viva-Voce) = 25; Practical (Notebook + Viva-Voce) = 25	Practical	4 (0-0-4)	4 hrs.
	EVSC407X9	Environmental Analysis Lab I B	50	Notebook + Viva-Voce = 10; Practical = 40	Practical	4 (0-0-4)	4 hrs.
Total			**275**			**22**	
Sem-II	EVSC451X0	Environmental Pollution & Degradation	50	10 / 40	Theory	4 (2-2-0)	2 hr.
	EVSC452X0	Environmental Biochemistry, Toxicology & Microbiology	50	10 / 40	Theory	4 (2-2-0)	2 hrs.
	EVSC453X0	Advanced Environmental Geoscience	25	05 / 20	Theory	2 (1-1-0)	1 hrs.
	EVSC454X0	Energy and Environment	50	10 / 40	Theory	4 (2-2-0)	2 hrs.
	EVSC455X9	Environmental Analysis Lab II A	50	Notebook +Viva-Voce = 10; Practical = 40	Practical	4(0-0-4)	4 hrs.
	EVSC456X9	Environmental Analysis Lab II B	50	Notebook + Viva-Voce = 10; Practical = 40	Practical	4 (0-0-4)	4 hrs.
Total			**275**			**22**	

Sem-III	EVSO501X0	MOOC	50	15 / 35	Theory	4 (2-2-0)	2 hrs.
	EVSC502X0	Geospatial Technology in Environmental Science	50	10 / 40	Theory	4 (2-2-0)	2 hrs.
	EVSC503X0	Research Methodology and Ethics	25	05 / 20	Theory	2 (1-1-0)	1 hr.
	EVSE504A-F0	Elective Special Papers (Any One) #	50	10 / 40	Theory	4 (2-2-0)	2 hrs.
	EVSC504X9	Environmental Analysis	50	Practical = 40 Notebook + Viva-Voce =10;	Practical	4 (0-0-4)	4 hrs.
	EVSC505X9	Skill Enhancement Course	25	Practical = 20 Notebook + Viva-Voce = 5;	Practical	2 (0-0-2)	2 hrs.
	EVSC506X9	Field Visit/ Industry Visit	25	Field Report & Presentation = 20 Viva-Voce = 5	Practical	2 (0-0-2)	2 hrs.
Total			**275**			**22**	

Elective Special Paper (Any one) #Decided in the departmental committee meeting

1. EVSE503A0: Biodiversity Conservation and Management
2. EVSE503B0: Waste Management Technologies
3. EVSE503C0: Environmental Impact Assessment (Advanced)
4. EVSE503D0: Environmental Law and Policy
5. EVSE503E0: Sustainable Development
6. EVSE503F0: Water Resource Management

Sem-IV	EVSC551X9	Term paper	25	00 / 00	Practical	2 (0-0-2)	2 hrs.
	EVSC552X9	Research Dissertation (Examination)	100	00 / 00	Practical	8 (0-0-8)	4 hrs.
	EVSC553X9	Research Dissertation (Viva-Voce)	50	00 / 00	Practical	4 (0-0-4)	4 hrs.
	EVSC554X9	Grand-viva	100	00 / 00	Practical	8 (0-0-8)	4 hrs.
Total			**275**			**22**	
GRAND			**1100**			**88**	

Distinctive features of course content:

- **Value-added course:** EVSC401X0, EVSC403X0, EVSC451X0, EVSC454X0
- **Employability / Entrepreneurship /Skill Development:** EVSC402X0, EVSC452X0, EVSC502X0, EVSC505X9
- **Ethics, Environment & Sustainability:** EVSE503A-F0.
- **Field Survey (Academic Excursion):** EVSC401X0, EVSE503A-F0.
- **Internship (Optional):** EVSE503A-F0

Details Syllabus of M.Sc. Environmental Science

Semester-I

Semester I at Vidyasagar University carries a total of 275 marks and 22 credits. This semester is dedicated to establishing a strong foundational understanding across critical scientific disciplines.

Paper: EVSC401X0 Environmental Chemistry

Course Outcomes

- Understanding Environmental Chemistry Principles: Students will gain a comprehensive understanding of fundamental principles of chemistry as applied to environmental systems, including stoichiometry, chemical equilibria, and kinetics.
- Analyzing Elemental Cycles and Biogeochemical Processes: Students will learn to analyze elemental cycles (C, N, S, and O) and biogeochemical processes, understanding their environmental significance and impact on ecosystems.
- Assessing Environmental Impacts of Pollutants: Students will understand the chemistry of hydrocarbons and hazardous substances, including their destruction methods, and assess their environmental impacts.
- Evaluating Atmospheric and Water Quality Issues: Students will learn about the composition of the atmosphere, greenhouse gases, photochemical smog, and water quality, including wastewater treatment and the role of soaps and detergents in eutrophication.
- Applying Chemical Principles to Environmental Problem-Solving: Students will develop the ability to apply chemical principles to environmental problem-solving, including soil formation, chemical characteristics of hazardous waste, and chemical treatment methods for such wastes.

Course Content: Environmental Chemistry

1. **Fundamental Principles:** Stoichiometry, Chemical equilibria and kinetics, Acid-base reactions, Solubility product, Carbonate system.
2. **Elemental Cycles and Biogeochemical Processes:** Carbon cycle, Nitrogen cycle, Sulfur cycle, Oxygen cycle.
3. **Environmental Impacts of Pollutants:** Chemistry of hydrocarbons, Hazardous substances and their destruction methods, Environmental impacts of pollutants
4. **Atmospheric and Water Quality Issues:** Composition of the atmosphere, Greenhouse gases and climatic changes, Photochemical smog, Water quality and wastewater treatment, Role of soaps and detergents in eutrophication.
5. **Soil and Waste Management:** Soil formation and chemical characteristics, Chemical classes of hazardous waste, Chemical treatment methods for hazardous waste.
6. **Application of Chemical Principles:** Applying chemical principles to environmental problem-solving, Understanding environmental significance and impact on ecosystems.

Paper: EVSC402X0, Earth Processes & Environmental Geology

Course Outcomes

- Understanding Earth's Internal Structure and Geological Evolution: Students will gain a comprehensive understanding of the Earth's internal structure and geological evolution, including the formation of the core, mantle, crust, atmosphere, and hydrosphere.
- Analyzing Geological Processes and Landform Formation: Students will learn to analyze geological processes, including weathering and erosion, and understand the formation of landforms, such as mountains, valleys, and plateaus.
- Assessing Environmental Impacts of Natural Hazards: Students will understand the impact of natural hazards, such as earthquakes, tsunamis, volcanoes, landslides, and floods, on the environment and human settlements.
- Evaluating Environmental Consequences of Human Activities: Students will learn to evaluate the environmental consequences of human activities, including mining, and understand the importance of sustainable management of geological resources.
- Applying Geological Knowledge to Environmental Problem-Solving: Students will develop the ability to apply geological knowledge to environmental problem-solving, including mitigating the impacts of natural hazards and managing geological resources sustainably.

Course Content: EVSC402X0, Earth Processes & Environmental Geology

1) **Earth's Internal Structure and Geological Evolution:** Geological time scale, Internal structure of Earth, Geotectonic, Continental drift and mountain building (plate tectonics),Formation of core, mantle, crust, atmosphere, and hydrosphere
2) **Geological Processes and Landform Formation:** Weathering and erosion, Landform formation (mountains, valleys, plateaus)
3) **Natural Hazards and Environmental Impacts:** Earthquakes, Tsunamis, Volcanoes, Landslides, Floods
4) **Environmental Consequences of Human Activities:** Mining, Sustainable management of geological resources
5) **Applying Geological Knowledge:** Mitigating natural hazards, Managing geological resources sustainably

Paper: EVSC403X0 Ecology & Ecosystem Dynamics

Course Outcomes

- Understanding Ecological Principles: Students will gain a comprehensive understanding of the core principles and scope of ecology, including the structure and functions of ecosystems.
- Analyzing Ecosystem Dynamics: Students will learn to analyze ecosystem dynamics, including energy flow, material cycling, trophic pyramids, and food webs.
- Understanding Population and Community Dynamics: Students will understand population growth, interactions, species diversity, and community.

- Understanding Ecological Succession and Productivity: Students will learn about ecological succession, including primary and secondary processes, and understand the concept of primary productivity.
- Applying Ecological Knowledge to Real-World Problems: Students will develop the ability to apply ecological knowledge to real-world problems, including understanding the impact of human activities on ecosystems and managing ecosystems sustainably.

Course Content: EVSC403X0, Ecology & Ecosystem Dynamics

1) **Ecological Principles:** Structure and functions of ecosystems, Abiotic and biotic components
2) **Ecosystem Dynamics:** Energy flow, Material cycling (water, carbon, nitrogen, phosphorus),Trophic pyramids, Food webs
3) **Population and Community Dynamics:** Population growth, Interactions (parasitism, predation, competition, mutualism), Species diversity, Ecological succession
4) **Primary Productivity:** Understanding primary productivity

Paper: EVSO404VC Indian Knowledge System

Course Outcomes

- Understanding Indian Knowledge System (IKS): Students will gain a comprehensive understanding of the Indian Knowledge System, including its definition, characteristics, and features, rooted in ancient Indian traditions and philosophies.
- Appreciating Traditional Wisdom: Students will learn to appreciate traditional wisdom related to nature, environment, and sustainability, including historical environmental practices and indigenous resource management techniques.
- Integrating Local Context: Students will understand the importance of integrating local context and traditional wisdom within the environmental science curriculum, recognizing the value of indigenous knowledge in addressing contemporary environmental challenges.
- Analyzing Philosophical Underpinnings: Students will analyze the philosophical underpinnings related to nature in India, including concepts like Dharma, Ahimsa (non-violence), and Satya (truth), and their relevance to modern environmental issues.
- Applying IKS to Contemporary Issues: Students will learn to apply the principles of IKS to contemporary environmental issues, including sustainable development, ecological balance, and environmental conservation, promoting a holistic understanding of human-nature relationships.

Course Content: EVSO404VC, Indian Knowledge System

1) **Understanding IKS:** Definition, characteristics, and features, Ancient Indian traditions and philosophies.
2) **Traditional Wisdom:** Historical environmental practices, Indigenous resource management

techniques

3) **Integrating Local Context:** Importance of integrating local context and traditional wisdom, Value of indigenous knowledge in addressing environmental challenges
4) **Philosophical Underpinnings:** Concepts like Dharma, Ahimsa (non-violence), and Satya (truth), Relevance to modern environmental issues
5) **Applying IKS:** Sustainable development, Ecological balance, Environmental conservation

Paper: EVSO405NC Syllabus of Vidyasagar Life and Philosophy (Non- Credit Course)

Section-A

A) Early Life and Education: (3 Classes)

1. Birth and Lineage
2. A Journey from Iswar Chandra Bondopadhaya to Iswar Chandra Vidyasagar

B) Vidyasagar and Indian Education: (5 Classes)

1. The then Indian education system
2. Vidyasagarian plan for reformation of Indian education- Vidyasagar as teacher, Vidyasagar as writer, planner and reformer of Indian education.

C) Vidyasagar and Women Emancipation: (4 Classers)

1. Introduction of widow remarriage
2. Struggle to stop child marriage

Section-B

D) Philanthropist Vidyasagar: (2 Classes)

1. Vidyasagar's philanthropy as narrated by others

E) Vidyasagar: Traditions and modernity: (6 Classes)

1. Tradition
2. Modernity
3. Vidyasagara as Traditional moderniser

F) Relevance of Vidyasagarian thoughts and values: (4 Classes)

1. Vidyasagar and the then Society of Bengal
2. Lesson for future generations

Paper: EVSC406X9 & EVSC407X9 Environmental Analysis Lab I A & B

These practical courses provide hands-on training in fundamental environmental analysis techniques, which include field visits to diverse ecosystems (forest patches, wetlands, coasts) for data collection and report preparation. Laboratory experiments cover basic water quality parameters such as Jar test for coagulant optimization, determination of residual chlorine, total dissolved solids/suspended solids, biotreatment of industrial effluents, biogas production from organic waste, solid waste estimation and segregation exercises, and air quality surveys. These initial practical courses are crucial for developing foundational laboratory and field skills, enabling students to collect, analyze, and interpret environmental data, which is indispensable for any environmental professional.

Paper: EVSC406X9 ENVIRONMENTAL ANALYSIS LAB IA:

I. Compulsory Field Visit [15 (Report Writing) + 10 (Viva Voce) = 25]

II. Hands on [15 (Practical) + 10 (Viva Voce) = 25]

1. Measurement and preparation of Oxygen Profile in aquatic ecosystem.

2. Macroscopic identification of igneous, sedimentary and metamorphic rocks, common minerals; Study of fossils with reference to paleo-environment.

3. Study of pond biota – phytoplankton, zooplankton and macrophytes.

4. Physico-chemical analysis of water and soil parameters.

a) Meteorological parameters: nitrate-nitrogen, ammonical-nitrogen, residual chlorine, sodium and potassium, Hardness, Alkalinity.

5. Laboratory Note book and Viva-voce.

Paper: EVSC407X9 ENVIRONMENTAL ANALYSIS LAB IB:

(I) Notebook + Viva-Voce = 10; Practical = 40

1. Analysis of vegetation: Frequency, density, abundance, cover and basal area, dominance, Importance Value Index (IVI) and phytograph.

2. Determination of species diversity by diversity indices in plant community.

3. Layout of experimental design (RBD; split-plot etc.,); Sampling techniques and statistical analysis of experimental design.

4. Biogas production from organic waste, Vermicomposting, solid waste estimation and segregation exercises, and air quality surveys.

5. Estimation of biomass by crop growth analysis.

6. Laboratory Note book and Viva-voce.

Semester I: Suggested Readings

Paper: EVSC401X0 Environmental Chemistry

1. Chemistry for environmental engineering and science (5th edition) By Clair N. Sawyer, Perry L. McCarty, Gene F. Parkin McGrawHill Professional
2. Chemistry of Environmental Systems by James E. Girard, Principles of environmental chemistry by Girard, James Publication date 2005. Publisher Sudbury, MA. Includes bibliographical references and index.
3. Environmental Chemistry B.K. Sharma, Environmental Chemistry by B.K. Sharma Publisher Krishna Prakashan Media (P) Ltd. ISBN-13: 978-8182836839. Publication date 1 January 2014.
4. Environmental Chemistry by A.K. De, Environmental Chemistry By A K DE ; ISBN: 9788122472271 ; Edition: 10th 10 th Ed Book, Publisher: VAPS KNOWLEDGE, Publication Date. 3 April 2024.
5. Eugene R. Weiner Applications of Environmental Chemistry 2000 CRC Press, LLC.
6. Manahan, Stanley E. Fundamentals of Environmental Chemistry Boca Raton: CRC Press LLC,2001
7. Strong Chemistry of the Environment by Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L.Elsevier Science & Technology Books 2002.

Paper:EVSC402X0 Earth Processes & Environmental Geology

1. Mineral deposits, their exploration and environmental management by Sarkar, S.C. 2002CSME Bulletin, v.13, p.6-28.
2. New Views on an Old Planet 2nd Edition by Van Andel T, (2002), Cambridge University Press
3. Paleoclimatology: Reconstructing Climates of the Quaternary 3rd Edition by Bradley R. S, (2014), Academic Press
4. Reconstructing Quaternary Environments 2nd Edition by Lowe J.J and Walker M.J.C., (1997), Routledge
5. The Great Ice Age: Climate Change and Life by Wilson, R. C. L.; Drury, S. A. and Chapman, J. A., (2000), Routledge The Open University.
6. Tracers in the Sea by Broecker V.S. and Peng T.H (1982), Lamont-Doherty Geological Observatory.
7. Use of proxies in Paleonceanography : Examples from the South Atlantic by Fischer G. and Wefer G., (1999), Springer.

Paper:EVSC403X0 Ecology & Ecosystem Dynamics

1. Communities and Ecosystems by Whittaker, Robert H. (1975). 2d ed. Macmillan, New York. 385.
2. Forest Succession: Concepts and Application by West, D C., Daniel B. Botkin, and Herman H. Shugart, eds. (1981), Springer-Verlag, New York.
3. Pattern and Process in a Forested Ecosystem: Disturbance, Development, and the Steady

State Based On the Hubbard Brook Ecosystem Study by Bormann, F. Herbert, and Gene E. Likens. (1979), Springer-Verlag, New York. 253 pp.
4. Plant Succession: Theory and Prediction by Glenn-Lewin, David C., R K. Peet, and Thomas T. Veblen, eds. (1992). Chapman & Hall, London. 352 pp.
5. Plants in Changing Environments: Linking Physiological, Population, and Community ecology by Bazzaz, F. A. (1996), Cambridge: Cambridge University Press, 320 pp.

Paper: EVSO404VC Indian Knowledge System

1. An Introduction to Indian Philosophy by Satishchandra Chatterjee (2012), ISBN NO: 978-8129111951.
2. Ancient Indian Knowledge System: Archaeological Perspective by Dr. Vasant Shinde (2017), ISBN NO: 978-8193141090.
3. Ancient Indian Sciences by Swami Chidatman Jee Maharaj (2009), ISBN NO: 978-8126136148
4. Echoes of Ancient Indian Wisdom by Dr. Shantha N Nair (2010), ISBN NO: 978-8122310207.
5. Indian Cultures as Heritage: Contemporary Pasts by Romila Thapar (2018), ISBN NO: 978-9384067359
6. Indians: A Brief History of a Civilization by Namit Arora (2021), ISBN NO: 978-0670090433.
7. Maths Sutra: The Art of Indian Speed Calculation by Gaurav Tekriwal (2015), ISBN NO: 978-0143425021.
8. Political Thought in Ancient India: Emergence of the State, Evolution of Kingship Based on the Saptanga Theory (Reconstructing Indian History and Culture) by G. P. Singh (2003), ISBN NO: 978-8124600016.
9. Principles and Applications of Vastu Shastra: The Ancient Indian Science Of Architecture and Layout For Today's Modern World by Dr. B.V. Raman (2020), ISBN NO: 978-1608692637.
10. State and Government in Ancient India by A. S. Altekar (2016), ISBN NO: 978-8120810099.

Paper: EVSO405NC Vidyasagar Life and Philosophy

1. Amalesh Tripathi: Vidyasagar: the Traditional Moderniser , Cambridge University Press,2011
2. Asok Sen: Iswar Chandra Vidyasagar and His Elusive Milestone, Riddhi-Indian, 28 Beniatola Lane, Cal-9.
3. Binoy Ghosh: Vidyasagar O Bangali Samaj, Orient Blacksoan,2011.
4. Brian A.Hatcher(Trans) : Vidyasagar : The Life and After Life of Eminent Indian, Routledge, New Delhi, 2014.
5. Revisiting Modern Indian Thought: Themes and Perspective, (Ed. Suratha Kumar Malik and Ankit Tomar), Routledge, New York and Londan, 2022 (First South Asian Edition).
6. Vidyasagar o Bangali Samaj, Binoy Ghosh, Orient Blacksoan,2011 .

Semester-II:

Semester II at Vidyasagar University also accounts for 275 marks and 22 credits. This semester builds upon the foundational knowledge by delving into specific environmental challenges and core scientific disciplines crucial for understanding and addressing them.

Paper: EVSC451X0 Environmental Pollution & Degradation

This course provides a comprehensive overview of environmental pollution. It covers natural and anthropogenic sources of pollution, categorizes pollutants into primary and secondary types, and discusses their transport, diffusion, monitoring methods, and control strategies for various media (air, water, soil). Specific effects of pollutants on human beings, plants, animals, materials, and climate are examined, including phenomena like acid rain. The course also addresses water quality standards, sewage and wastewater treatment, industrial waste effluents, heavy metals, and solid waste management.

Course Outcomes:

- Understanding of Environmental Pollution: Students will gain a comprehensive understanding of the sources, types, and effects of environmental pollution, including air, water, and soil pollution.
- Analysis of Pollutant Transport and Fate: Students will learn to analyze the transport and fate of pollutants in various environmental media, including air, water, and soil.
- Application of Monitoring and Control Strategies: Students will understand the methods for monitoring and controlling environmental pollution, including strategies for reducing pollutant emissions and mitigating their impacts.
- Assessment of Environmental Impacts: Students will be able to assess the specific effects of pollutants on human health, ecosystems, materials, and climate, including phenomena like acid rain.
- Development of Sustainable Solutions: Students will learn to develop and implement sustainable solutions for managing environmental pollution, including water quality standards, wastewater treatment, and solid waste management.

Course Content: EVSC451X0, Environmental Pollution & Degradation

1) **Understanding Environmental Pollution:** Sources, types, and effects of pollution (air, water, soil), Primary and secondary pollutants
2) **Analysis of Pollutant Transport and Fate:** Transport and fate in air, water, and soil
3) **Monitoring and Control Strategies:** Methods for monitoring and controlling pollution, Strategies for reducing emissions and mitigating impacts
4) **Assessment of Environmental Impacts:** Effects on human health, ecosystems, materials, and climate, Acid rain and other phenomena
5) **Sustainable Solutions:** Water quality standards, Wastewater treatment, Solid waste management

Paper: EVSC452X0 Environmental Biochemistry, Toxicology & Microbiology

Course Outcome:

- Understanding Biochemical Interactions: Students will gain a deep understanding of biochemical interactions within living systems and their responses to environmental stressors and toxicants.
- Analysis of Environmental Pollutants: Students will learn to analyze the effects of environmental pollutants on living systems, including biochemical approaches to detoxification of xenobiotic.
- Mechanisms of Toxicity: Students will understand the mechanisms of toxicity, including altered membrane permeability, free radical formation, and lipid peroxidation.
- Application of Toxicogenomics and Epidemiology: Students will learn to apply toxicogenomics, pharmacogenomics, and epidemiology to understand the impact of environmental pollutants on human health.
- Understanding Microbial Diversity: Students will gain a comprehensive understanding of microorganisms, including their general characteristics, nutritional types, and diversity.
- Microbial Interactions and Roles: Students will learn about the interactions between microorganisms and plants, and the role of microorganisms in soil fertility and ecosystem functioning.
- Microbial Adaptations and Extremophiles: Students will understand the adaptations of microorganisms in extreme environments and their significance in various ecosystems.

Course Content: EVSC452X0, Environmental Biochemistry, Toxicology & Microbiology

1) **Biochemical Interactions:** Environmental physiology, Oxygen uptake and respiration**,** Electron transport systems
2) **Mechanisms of Toxicity:** Altered membrane permeability, Free radical formation.
3) **Environmental Pollutants:** Effects on living systems, Biochemical approaches to detoxification
4) **Toxic genomics and Epidemiology:** Application to understand environmental pollutants' impact
5) **Assessment of Environmental Health Risks:** Carcinogens, Metal toxicity, Immunological responses
6) **Microbial Diversity, Microbial Interactions and Roles, Microbial Adaptations:** General characteristics, Nutritional types, Microbial diversity, Interactions between microorganisms and plants, Role in soil fertility and ecosystem functioning, Adaptations in extreme environments, Significance in various ecosystems.
7) **Environmental and Health Impacts:** Microbial toxins, Pathogens, Diseases (including plant diseases)

Paper: EVSC453X0 Advanced Environmental Geo-Science

Course Outcome:

- Synthesize Physiographic Data for Risk Mitigation: Students will be able to integrate GIS data with geomorphological theory to predict landscape evolution and assess risks related to natural hazards like landslides, erosion, and tectonic shifts.
- Evaluate the Lifecycle of Mineral Resources: Graduates will demonstrate the ability to analyze the geochemical formation of ore bodies and design comprehensive environmental management plans that address the full "cradle-to-grave" impact of mineral extraction, specifically targeting the mitigation of acid mine drainage.
- Model Geo-environmental Contaminant Transport: Students will acquire the technical proficiency to model the movement of pollutants through complex geological media, allowing them to design effective remediation strategies for contaminated groundwater and soil in industrial or urban settings.
- Appraise Geogenic Health Risks: Students will be capable of identifying the pathways through which geological materials—such as radon gas, arsenic-bearing aquifers, or mineral dust—interact with human physiology, enabling them to contribute to public health policy and site-specific medical geology interventions.

Course Content: EVSC453X0, Advanced Environmental Geo-Science

1. **Physiography and Dynamic Landforms:** Analysis of geomorphological processes and their environmental implications. Evolution of landscapes, the mechanics of tectonic and weathering processes, and the use of GIS (Geographic Information Systems) to model terrain stability and natural hazard susceptibility.
2. **Genesis and Impact of Mineral Deposits:** A technical study of ore-forming environments and the lifecycle of mineral extraction. Focus is placed on the geochemical signatures of deposits, the environmental footprint of large-scale mining operations, and the development of sustainable remediation strategies for acid mine drainage and heavy metal dispersal.
3. **Geo-environmental Assessment and Management:** Essential Elements in earth's crust, soil and plants; Concept of major, trace, and rare earth elements (REE); interaction between anthropogenic activities and geological substrates, hydrogeology of contaminant transport, the mechanics of waste disposal in geological repositories, and the evaluation of soil and groundwater pollution through advanced geochemical modelling.
4. **Medical Geology and Public Health:** A specialized look at the relationship between geological materials and human health, trace element deficiencies or toxicities (e.g., arsenic, fluoride, or radon), the epidemiology of geogenic diseases, and the role of mineral dusts in respiratory health.

Paper: EVSC454X0 Energy and Environment

Course Outcomes

- Differentiate between various energy resources and explain the Earth's energy budget and global consumption patterns.
- Analyze the environmental implications of fossil fuel use, including greenhouse gas emissions and their role in global climate change.
- Evaluate the technical principles and environmental impacts of solar and bio-energy technologies.
- Compare alternative energy sources (wind, tidal, nuclear, etc.) based on their principles, techno-economic feasibility, and ecological footprint.
- Propose strategies for energy conservation and efficiency within the Indian and global context.

Course Content: EVSC454X0, Energy and Environment

1. **Energy Dynamics and Global Perspectives:** Concepts, Definition and classification of renewable, non-renewable, conventional, and non-conventional resources. Earth's Energy Balance: Detailed study of the energy and heat budget of the Earth. Global and National Trends: Patterns of global energy use; current energy status, future prospects, and energy security challenges in India.
2. **Conventional Energy and Climate Impact:** Fossil Fuels: Classification, chemical composition, and physical characteristics of coal, petroleum, and natural gas. Energy Valuation: Determination of energy values and physico-chemical properties of fuels. Atmospheric Consequences: The link between energy combustion, Greenhouse Gases (GHG), Global Warming, and Climate Change (Global vs. Indian perspectives).Mitigation: Principles of energy conservation and energy efficiency; benchmarking global and Indian initiatives.
3. **Solar and Thermal Energy Systems:** Solar Fundamentals: Characteristics of solar radiation, including irradiation and insolation. Theory and practice of Photovoltaic (PV) cells and Solar Thermal systems. Working principles of Solar Ponds, Heliostats, and Concentrated Solar Power (CSP).Advanced Materials: Introduction to Energy Phase Change Materials (PCM) and their environmental applications/impacts.
4. **Bio-Energy and Alternative Sources: Biomass Energy:** Characteristics of biomass; methods of energy extraction (thermochemical and biochemical); prospects and hurdles in the Indian context. Bio-fuels: Concepts, production, and environmental significance of bio-ethanol and bio-diesel. Mechanical & Geothermal Energy: Basic principles and applications of Wind, Hydal, Tidal, Wave, and Ocean Thermal Energy Conversion (OTEC).
5. **Environmental Impact Assessment of Energy:** Ecological Footprint: Impact of large-scale energy exploitation on terrestrial and aquatic ecosystems. Land Use Changes: Analysis of how energy infrastructure (dams, mining, solar farms) alters land use patterns. Sustainability: Assessing the long-term environmental viability of different energy mixes.

Paper: EVSC455X9 & EVSC456X9 Environmental Analysis Lab II A & B

This laboratory course provides hands-on experience in environmental analysis, focusing on microbiological, chemical, and physical parameters. Students develop practical skills in collecting and analysing environmental samples, operating specialized equipment like High Volume Samplers and spectrophotometers, and interpreting results. Key topics include microbiological analysis of air, water, and soil, air pollution sampling and monitoring, noise level measurement, and detection of heavy metals and microbiological parameters. Through experiments and projects, students apply advanced analytical techniques and develop critical thinking and communication skills, preparing them for careers in environmental science, research, and industry.

Course Outcomes:

1. Develop Practical Skills: Students will develop practical skills in collecting, isolating, and studying microorganisms in air, water, and soil, as well as handling meteorological data recording equipment.
2. Analyze Environmental Pollution: Students will learn to analyze environmental pollution, including air pollution sampling and monitoring using High Volume Samplers, and measuring noise levels.
3. Detect and Estimate Pollutants: Students will be able to detect and estimate noise pollution, heavy metals (Hg, Pb, Cd), and microbiological parameters (Coliforms, E. coli, Streptococcus etc.) in environmental samples.
4. Computer based modern Remote Sensing and GIS tools will be used for Environmental monitoring.
5. Develop Critical Thinking and Communication Skills: Students will develop critical thinking and communication skills through laboratory notebook maintenance, viva-voce, and interpretation of results.

Paper: EVSC455X9 Environmental Analysis Lab I A: Total Marks: 50
Practical (Notebook + Viva-Voce = 10; Practical = 40)

Course Content

1. Handling of meteorological data recording equipment correlate with global warming.
2. Pollution sampling, monitoring and analysis by instrument (Air, Water, and Soil).
3. Basics of Digital Image processing by open sources software.
4. Environmental monitoring by Geoscience.
5. Laboratory Note book and Viva-voce.

Paper: EVSC456X9 Environmental Analysis Lab II B: Total Marks: 50
Practical (Notebook + Viva-Voce = 10; Practical = 40)

Course Content

1. **Environmental monitoring and assessment:** Spectrophotometric, flame photometric, and turbidity metric methods. Observation of curd microorganisms.
2. **Detection and Estimation of Pollution:** Detect and estimate noise pollution, lux meter, heavy metals (Hg, Pb, Cd), and mirobiological parameters (Coliforms, E. coli, Streptococcus etc.) in environmental samples.
3. **Gram staining of Bacteria:** Demonstration of Alcohol from low cost substrate and alcohol content determination, Antifungal and antibacterial activity of toxic compounds.
4. Laboratory Note book and Viva-voce.

Semester II: Suggested Readings

Paper: EVSC451X0 Environmental Pollution & Degradation

1. A textbook of environmental chemistry and pollution control, Dara, S. S., & Mishra, D. D. (2006).S. Chand Publishing.
2. Environmental Science: Toward a Sustainable Future by Richard T. Wright and Dorothy F. Boorse (ISBN: 9780134446400)
3. Environmental and pollution science (3rd ed) by Brusseau, M. L., Pepper, I. L., & Gerba, C. P.(2019), Academic Press.
4. The science of environmental pollution (4th ed.) by Spellman, F. R. (2021). CRC Press
5. Environmental Pollution: A Comprehensive Review (no specific author or ISBN available)

Paper: EVSC452X0 Environmental Biochemistry, Toxicology and Microbiology

1. Environmental Biochemistry (no specific author or ISBN available)
2. Toxicology: Principles and Applications by Elaine M. Faustman and Gilbert S. Omenn (ISBN: 9780470085113)
3. Environmental Microbiology and Microbial Ecology by Larry L. Barton and Robert J. C. McLean (ISBN: 9781118966280)
4. Environmental Microbiology: Advanced Research and Multidisciplinary Applications edited by Arun Karnwal and Abdel Rahman Mohammad Said Al-Tawaha (ISBN: 9781681089591)
5. Manual of Environmental Microbiology by Marylynn V. Yates, Cindy H. Nakatsu, Robert V. Miller, and Suresh D. Pillai (ISBN: 9781555818821)
6. Handbook of Media for Environmental Microbiology by Ronald M. Atlas (ISBN: 9780849335600).

Paper: EVSC453X0 Advanced Environmental Geoscience

1. Fundamentals of Geomorphology by Richard J. Huggett Routledge fundamentals of physical geography series, Psychology Press, 2003, 0415241464, 9780415241465.
2. Introduction to Ore-forming Processes by Laurence Robb, Blackwell Publishing, Oxford, 2004. ISBN 0-632-06378.
3. Applied hydrogeology / C.W. Fetter.--4th ed. p.cm. Includes bibliographical references.

ISBN 0-13-088239-9.

4. Essentials of Medical Geology BY Pokras M. Impacts of the Natural Environment on Public Health. Environ Health Perspect. 2005 Nov; 113(11): A780. PMCID: PMC1310961.
5. Introduction to environmental geology/ Edward A. Keller—5th ed. Bem: Includes bibliographical references and index. ISBN-13: 978-0.

Paper: EVSC454X0 Energy and Environment

1. **Twidell, J., & Weir, T. (2015).** Renewable Energy Resources. Routledge. (Comprehensive coverage of solar, wind, and OTEC principles).
2. **Hinrichs, R. A., & Kleinbach, M. (2012).** Energy: Its Use and the Environment. Cengage Learning. (Focuses on thermodynamics, fossil fuels, and climate impacts).
3. **Abbasi, T., & Abbasi, S. A. (2011).** Renewable Energy Sources: Their Impact on Global Warming and Pollution. PHI Learning. (Ideal for Indian perspectives and energy security).
4. **Da Rosa, A. V. (2012).** Fundamentals of Renewable Energy Processes. Academic Press. (Deep dive into the physics of PV cells, fuel cells, and biomass).

Semester-III:

Paper: EVSO501X0 MOOC

Paper: EVSC502X0 Geospatial Technology in Environmental Science

Course Outcomes:

- Understanding Principles of Geospatial Technology: Students will gain a comprehensive understanding of the fundamental principles Geospatial Technology and their applications in environmental science.
- Application of Geospatial Technology in Environmental Domains: Students will learn to apply Geospatial Technology in various environmental domains, including land, water resources, cryosphere, disaster management, and defense studies.
- Practical Use of Geospatial Software: Students will develop practical skills in using specialized open sources software for solving environmental problems.
- Environmental Problem-Solving: Students will be able to use RS and GIS to solve environmental problems, including groundwater exploration, rainwater harvesting, biomass analysis, and georesource evaluation.
- Early Warning Systems and Disaster Management: Students will learn to apply Geospatial Technology in early warning systems for natural disasters, management and environmental monitoring, enabling them to contribute to disaster management and mitigation efforts.

Course Content: Geospatial Technology in Environmental Science

1) **Understanding Principles of Geospatial Technology:** Fundamental principles of Geospatial Technology
2) **Applications of Geospatial Technology**: Land, water resources, cryosphere, disaster management, defense studies
3) **Geospatial Software:** Practical use of open-source and available softwares.
4) **Environmental Problem-Solving:** Groundwater exploration, rainwater harvesting, biomass analysis, georesource evaluation
5) **Early Warning Systems and Disaster Management:** Applying RS and GIS in early warning systems and disaster management

Paper: EVSC503X0 Research Methodology and Ethics

Course Outcomes

- Understanding Research Principles: Students will gain a comprehensive understanding of the principles and practices of sound scientific research, including research design, methodology, and ethics.
- Academic Integrity and Ethics: Students will learn about the importance of academic integrity, including avoiding plagiarism, paraphrasing, and copyright violation, and understand the consequences of unethical behaviour.
- Scientific Writing and Communication: Students will develop skills in scientific writing, including crafting clear titles, abstracts, introductions, methods, results, and discussion sections, and using proper citation and referencing techniques.
- Statistical Analysis and Data Interpretation: Students will understand statistical concepts relevant to research methodology, including hypothesis testing and data analysis, and learn to interpret research findings.
- Responsible Research Practices: Students will develop rigorous research practices and foster academic integrity, ensuring that they conduct and report their studies responsibly and ethically as future environmental scientists.

Course Content: Research Methodology and Ethics

1) **Research Principles:** Principles and practices of sound scientific research.
2) **Academic Integrity and Ethics:** Avoiding plagiarism, paraphrasing, copyright violation.
3) **Scientific Writing and Communication:** Crafting clear titles, abstracts, introductions, methods, results, and discussion sections.
4) **Statistical Analysis and Data Interpretation:** Hypothesis testing, data analysis, interpreting research findings.
5) **Responsible Research Practices:** Developing rigorous research practices and fostering academic integrity.

Paper: EVSE504A-F0 Elective Special Papers:

(Any one: Decided in the departmental committee meeting)

VU-ES-T304A0: Biodiversity Conservation and Management

Course Outcomes

- Understanding Biodiversity Concepts: Students will gain a comprehensive understanding of biodiversity, including its definition, composition, types, zonation and measures.
- Appreciation of Biodiversity Values and Ecosystem Services: Students will learn to

appreciate the values of biodiversity and ecosystem services, including ecological, economic, and social benefits.

- Conservation Strategies and Practices: Students will understand various conservation strategies, including in-situ and ex-situ conservation, and learn to apply them in different contexts.
- Analysis of Human Impacts on Biodiversity: Students will be able to analyze the impacts of human activities on biodiversity, including habitat destruction, overexploitation, and climate change.
- Application of Biodiversity Management Principles: Students will learn to apply principles of biodiversity management, including ecosystem approach, community-based conservation, and policy-making, to conserve and manage biodiversity effectively.

Course Content: Biodiversity Conservation and Management

1) **Biodiversity Concepts:** Definition, composition, types, zonation and measures of biodiversity
2) **Biodiversity Values and Ecosystem Services:** Ecological, economic, and social benefits.
3) **Conservation Strategies:** Species based In-situ and ex-situ conservation
4) **Human Impacts on Biodiversity:** Habitat destruction, overexploitation, climate change

Paper: EVSE504B0 Waste Management Technologies

Course Outcomes

- Comprehensive Understanding of Waste Management: Students will gain a thorough understanding of waste definition, types, sources, characteristics, and environmental impacts.
- Application of Waste Management Technologies: Students will learn to apply various waste treatment technologies, including physical, chemical, and biological methods, and disposal methods like landfilling and incineration.
- Waste Minimization and Reduction Strategies: Students will understand waste reduction strategies, including reduce, reuse, and recycle, and learn to implement waste minimization techniques.
- Management of Hazardous and Biomedical Waste: Students will learn to handle, store, and dispose of hazardous and biomedical waste, and understand treatment technologies for these waste types.
- Sustainable Waste Management Practices: Students will understand principles of sustainable waste management, including reduces, reuse, recycle, and recover, and learn from case studies of successful waste management initiatives.

Course Content: Waste Management Technologies

1) **Waste Management Principles:** Waste definition, types, sources, characteristics, environmental impacts
2) **Waste Treatment Technologies:** Physical, chemical, and biological methods.
3) **Waste Minimization and Reduction:** Reduce, reuse, and recycle.
4) **Hazardous and Biomedical Waste Management:** Handling, storage, disposal, treatment technologies.

Paper: EVSE504C0 Environmental Impact Assessment

Course Outcomes

- Analyze the specific impact of projects on Forests (biodiversity loss), urban areas (congestion/pollution), and Industry (effluent discharge).
- Interpret and navigate the legal landscape of Indian environmental law.
- Appropriate identification techniques such as Checklists, Matrices, or Networks to map potential impacts.
- Evaluate environmental systems using quantitative and qualitative models to determine the magnitude of change.
- Synthesize findings into a professional EIA report that can withstand legal and technical scrutiny.

Course Content: Environmental Impact Assessment

1) **EIA Methodologies :**Impact identification techniques, environmental evaluation systems
2) **Regulatory Framework:** EIA Notification 2006, Coastal Zone Notification 1991
3) **Public Participation:** Importance, methods, role in decision-making
4) **Environmental Management Plans:** Preparation, implementation, role in environmental management
5) **EIA Based case study:** Forest, Urban, Industry etc..

Paper: EVSE504D0 Environmental Law and Policy

Course Outcomes

- Understanding Environmental Law and Policy: Students will gain a comprehensive understanding of international and Indian environmental laws, policies, and regulations.
- Application of Environmental Laws: Students will learn to apply environmental laws and policies in various contexts, including industrial, agricultural, and urban settings.
- Environmental Equity and Justice: Students will understand the concept of environmental justice and equity, and learn to analyze the impact of environmental

degradation on vulnerable populations.

- Role of Courts and Regulatory Bodies: Students will learn about the role of judiciary and regulatory bodies in environmental law, including enforcement mechanisms and compliance.
- Critical Thinking and Problem-Solving: Students will develop critical thinking and problem-solving skills to address emerging issues and challenges in environmental law and policy, including climate change and sustainable development.

Course Content: Environmental Law and Policy

1) **Indian Environmental Law:** Constitutional provisions, key environmental laws
2) **International Environmental Law:** Evolution, key agreements, role of international organizations
3) **Environmental Policy:** Principles, policy-making process, role of government, NGOs, stakeholders
4) **Environmental Law and Policy Integrated approach:** Community, Local, National and International approaches based Environmental Law and Policy making.

Paper: EVSE504E0 Sustainable Development

Course Outcomes

- Understanding Sustainable Development Concepts: Students will gain a comprehensive understanding of sustainable development concepts, including its definition, history, and importance.
- Application of Sustainable Development Strategies: Students will learn to apply strategies for sustainable development, including efficiency, green growth, and sufficiency, and understand the role of technology and innovation.
- Measurement and Evaluation of Sustainable Development: Students will understand indicators and metrics for sustainable development, including GDP, GPI, and HDI, and learn to measure progress towards sustainable development goals (SDGs).
- Integration of Economic, Social, and Environmental Sustainability: Students will learn to integrate economic, social, and environmental sustainability, including green economy, human rights, and conservation.
- Critical Thinking and Problem-Solving for Sustainable Development: Students will develop critical thinking and problem-solving skills to address challenges and opportunities for sustainable development in different contexts, and learn from case studies and best practices.

Course Content: Sustainable Development

1) **Sustainable Development Concepts:** Definition, history, importance, limitation
2) **Strategies for Sustainable Development:** Efficiency, green growth, sufficiency

3) **Measurement and Evaluation, SDG:** Indicators and metrics for sustainable development
4) **Integrated Approaches:** Frameworks and their applications in policy and practice, Critically evaluate governance structures, economic policies, and environmental regulations
5) **Social Hazards and Sustainability:** Development-induced displacement, water scarcity, and poverty reduction initiatives to propose viable policy solutions.

Paper: EVSE504F0 Water Resource Management

Course Outcomes

- Understanding Water Resources and Hydrology: Students will gain a comprehensive understanding of the hydrological cycle, surface and groundwater resources, and water quality criteria.
- Water Management Strategies and Practices: Students will learn to apply water management strategies, including water conservation, water harvesting, and watershed management, and understand the importance of sustainable water management practices.
- Groundwater Management and Protection: Students will understand groundwater problems, including over-extraction and contamination, and learn to develop effective groundwater management strategies.
- Water Policy and Legislation: Students will learn about water laws and regulations, water policy and governance, and the role of legislation in water resource management.
- Critical Thinking and Problem: Solving for Water Resource Management: Students will develop critical thinking and problem-solving skills to address water-related challenges and opportunities, and learn from case studies and best practices in water resource management.

Course Content: Water Resource Management

1) **Hydrological Cycle and Water Resources:** Surface and groundwater resources, water quality criteria
2) **Water Management Strategies:** Water conservation, water harvesting, and watershed management
3) **Groundwater Problems and Management:** Over-extraction, contamination, management strategies.
4) **Integrated water resources management:** Development, Management and Issue, water conservation, reuse, restoration, and protection, Water Infrastructure.
5) **Challenges in water resource management:** Gender Responsive, Water quantity and quality, Climate change, politics of water allocation and conflicts and disasters.
6) **Water Policy and Governance:** Public Policies, tools and techniques of water governance, role of institutions and policies in managing water resources.

Paper: EVSC505X9 Environmental Analysis Lab

This practical course continues the development of advanced analytical skills, building upon the foundations laid in theoretical paper. It likely involves more complex instrumental analysis, data interpretation, and problem-solving scenarios related to the theoretical courses of Semester III.

Course Outcome:

- Interpret and integrate spatial data across diverse physical and strategic landscapes.
- Demonstrate technical competency in digital mapping and spatial analysis software like QGIS, GRASS, or SAGA.
- Troubleshoot common data errors such as coordinate system mismatches or topology issues etc.
- Spatial modeling techniques to solve resource scarcity and management challenges, like Groundwater Exploration using thematic overlays
- Also predictive models and response frameworks for natural and man-made hazards. Protecting lives and assets through predictive mapping

Course Content: Environmental Analysis Lab

1) **Applications of Geospatial Technology**: Land, water resources, cryosphere, disaster management, defense studies
2) **Geospatial Software:** Practical use of open-source and available softwares.
3) **Environmental Problem-Solving:** Groundwater exploration, rainwater harvesting, biomass analysis, georesource evaluation
4) **Early Warning Systems and Disaster Management:** Applying Geo-spatial technologies in early warning systems and disaster management
5) **Case Studies and Project-Based Learning:** Real-world case studies and project-based learning to apply geospatial techniques

Paper: EVSC506X9 Skill Enhancement Course: Sustainable E-waste Management:

Course Outcome:

- Identity Skill Students will be able to quantify and categorize the e-waste crisis.
- Technical & Digital Skills: Learners can generate spreadsheets, presentations, and documents, understand AI basics, analyze data using tools like SPSS, or utilize specific software for field-specific tasks.
- Life Skills & Employability: Students can demonstrate time management, conflict resolution, and self-management, while gaining confidence for professional interviews and career planning.
- Students will be able to differentiate between primitive disposal and scientific recycling and circular economy solutions.
- Students will be able to apply national and international regulations to waste management scenarios.

- Practical Application: Ability to apply theoretical knowledge to solve real-world problems, such as in entrepreneurship (business planning), agriculture (biofertilizers), or communication (digital literacy).

Course Content: Skill Enhancement Course

1. **Introduction to E-Waste:** Understanding the global and Indian scenario, growth of the electronics industry, composition of e-waste, and health/environmental implications.
2. **Regulatory Framework:** Study of India's E-waste (Management) Rules (2016 and updates), Extended Producer Responsibility (EPR), and international treaties like the Basel Convention.
3. **Management and Recycling Technologies:** Analysis of disposal methods (landfilling, burning) versus modern recovery techniques like sorting, crushing, and Life Cycle Assessment (LCA).
4. **Emerging Trends & Case Studies:** Exploration of advanced recovery technologies, environmentally sound treatment facility guidelines, and global success stories in circular economy practices.

Paper: EVSC507X9 Field Visit/Industry Visit

Course content: Field Visit/Industry Visit

1. **Experiential Learning:** Bridging theoretical knowledge with real-world application
2. **Field/Project Work:** Mandatory for all students in Semester III
3. **Mini-Projects:** Climate change adaptation and mitigation, involving field work, data collection, analysis, mapping, and report submission
4. **Industrial Visits:** Renewable energy technology, focusing on data collection, analysis, and report submission.

Semester III Suggested Readings

Paper: EVSC502X0 Geospatial Technology in Environmental Science

1. Concepts and Techniques of Geographic Information Systems by C.P. Lo and Albert K.W. Yeung.
2. Fundamentals of Geographic Information Systems, by Demers, Michael N., (2012), Willy. Introductory Digital Image Processing: A Remote Sensing Perspective, Jensen, J. R. (2004), Prentice Hall.
3. Fundamentals of Remote Sensing by George Joseph
4. Fundamentals of Remote Sensing. By Joseph, G. (2005), United Press India.
5. Geographic Information Systems and Science by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind
6. Remote Sensing and Geographic Information Systems by M. Anji Reddy
7. Remote Sensing and Image Interpretation by Lilles and, T. M., Kiefer, R. W. and Chipman, J. W. (2004), Wiley (Wiley Student Edition).
8. Remote Sensing of the Environment: An Earth Resource Perspective by John R. Jensen

Paper: EVSC503X0 Research Methodology and Ethics

1. Intellectual Property Law by Lionel Bently and Brad Sherman,, Oxford University Press.
2. Intellectual Property Law by P. Narayanan, Eastern Law House.
3. Intellectual Property: Patents, Copyrights, Trade Marks and Allied Rights, Sweet & Maxwell by W. R. Cornish and D. Llewellyn.
4. Law of Copyright and Industrial Designs; Eastern law House, Delhi, VU-ES-T304 by P. Narayanan (2010): Elective Special Papers.
5. Law Relating to Intellectual Property by B. L. Wadehra,, Universal Law Publishing Co.
6. Research Ethics: A Philosophical Guide by Michael R. Kline (ISBN: 9780367274495).
7. Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar (ISBN: 9781446269968).
8. Scientific Writing and Communication: Papers, Proposals, and Presentations by Angelika H. Hofmann (ISBN: 9780195393443**).**

Paper: EVSE504A0 Biodiversity Conservation and Management

1. Biodiversity Conservation and Management by K. R. Solomon (ISBN: 9788175336844)
2. Complexity, diversity, and stability by Justus, J (2008) in S. Sarkar & A. Plutynski (eds.),

A Companion to the Philosophy of Biology, Hoboken, NJ: Wiley, pp. 321–350. doi:10.1002/9780470696590.ch18
3. Conservation Biology: Foundations, Concepts, Applications by Fred Van Dyke (ISBN: 9781402055086**)**
4. Incorporating multiple criteria into the design of conservation area networks: A minireview with recommendations by Moffett, A. and S. Sarkar (2006), Diversity and Distributions, 12(2): 125–137.
5. Making Sense of Science in Policy and Politics by Pielke, R.A (2007), Cambridge: Cambridge University Press.
6. Operationalizing biodiversity for conservation planning by Sarkar, S. and C. Margules, (2002), Journal of Biosciences, 27(4): 299–308.
7. Protecting the wild: Parks and wilderness, the foundation for conservation by Wuerthner, G., Crist, E. and Butler, T. (eds.) (2015) Washington, DC: Island Press.

Paper: EVSE504B0 Waste Management Technologies

1. Waste Management: Principles and Practice by Hosam El-Din M. Saleh and Rehab O. Abdel Rahman (ISBN: 9780128114478)
2. Solid Waste Management: Principles and Practice by Hosam El-Din M. Saleh (ISBN: 9780128114485)
3. Innovative Waste Management Technologies for Sustainable Development by Rouf Ahmad Bhat, Humaira Qadri, Gowhar Hamid Dar, and Mohammad Aneesul Mehmood (August, 2019) , IGI Global Scientific Publishing, 701 E. Chocolate Avenue Hershey, PA 17033, USA, EISBN13: 9781799800330. DOI: 10.4018/978-1-7998-0031-6.
4. Waste Management for a Sustainable Future - Technologies, Strategies and Global Perspectives by M. Saleh, H., & I. Hassan, A. (Eds). (2024). IntechOpen. https://doi.org/10.5772/intechopen.1004499.

Paper: EVSE504C0 Environmental Impact Assessment (Advanced)

1. Environmental Impact Assessment: Theory and Practice by Peter Wathern (ISBN: 9780047110069)
2. Environmental Impact Assessment: A Comparative Review by Christopher Wood (ISBN: 9780582298681). \
3. Green Technologies for Waste Management: A Wealth from Waste Approach Rai, J.P.N., & Saraswat, S (2023).CRC Press. https://doi.org/10.1201/9781003279136.
4. Handbook of Environmental Impact Assessment by Alberto Fonseca (2022), Easy Access System Europe, Mustamäe tee 50, 10621 Tallinn, Estonia, Print ISBN: 9781800379626 amd eISBN: 9781800379633.

Paper: EVSE504D0 Environmental Law and Policy

1. Environmental Law and Policy by James Salzman and Barton H. Thompson Jr. (ISBN: 9781683288639).

2. Environmental Law: Text, Cases, and Materials by Colin T. Reid (ISBN: 9781473905444).
3. Environmental Law in India by Shyam Divan and Armin Rosencranz.
4. Environmental Law and Policy by Kailash Chandra Mishra.
5. Indian Environmental Law by S. C. Shastri.
6. Environmental Jurisprudence in India by K. L. Meena.
7. Environmental Law and Policy in India: Cases, Materials, and Statutes by Armin Rosencranz, Shyam Divan, and Martha L. Noble.

Paper: EVSE504E0 Sustainable Development

1. India's Path to Sustainable Development: A Multifaceted Approach edited by Kanchan Chopra and Pushpam Kumar.
2. Sustainable Development and Environmental Management: An Indian Perspective by C. S. P. Ojha and A. K. Gosain.
3. Sustainable Development Goals and India edited by Sachin Chaturvedi and Sabyasachi Saha.
4. Sustainable Development in India: Progress, Challenges, and Opportunities by Kirit S. Parikh and R. Radhakrishna.
5. Sustainable Development: An Appraisal from the Lisbon Summit by Patrick ten Brink (ISBN: 9789289486111).
6. Sustainable Development: An Indian Perspective by S. K. Singh.
7. Sustainable Development: Principles, Frameworks, and Case Studies by Okechukwu Ukaga, Chris Maser, and Michael T. Houck (ISBN: 9781420085710).

Paper: EVSE504F0 Water Resource Management

1. Bogardi, J. J., Aureli, A., & Bogardi, J. F. M. (Eds.). (2021). Integrated Water Resources Management: Concepts, Research, and Implementation. Springer.
2. Cech, T. V. (2016). Principles of Water Resources: History, Development, Management, and Policy. John Wiley & Sons.
3. Pennington, K. L., Cech, T. V., & Heins, C. (2021). Introduction to Water Resources and Environmental Issues. Cambridge University Press.
4. Water Policy and Management in India by M. V. Shibu and K. V. Raju.
5. Water Resource Management: Principles, Regulations, and Cases by Neil S. Grigg (ISBN: 9780071623601).
6. Water Resources Management in India: Challenges and Solutions edited by Ashok Kumar Singh and C. S. P. Ojha.
7. Water Resources Management: A Case Study of India by R. K. Srivastava and S. K. Singh.
8. Water Resources Management: Innovative and Adaptive Approaches by Cecilia Tortajada, Yugal Kishore Joshi, and Asaf Tzachor (ISBN: 9780367506909).

Semester-IV

Semester IV: Research, Application, and Comprehensive Evaluation

Semester IV at Vidyasagar University, the final semester, also accounts for 275 marks and 22 credits. This semester is heavily focused on independent research, application of knowledge, and a comprehensive evaluation of the student's overall understanding.

Paper: EVSC551X9 Term Paper

This practical component typically involves the submission of an in-depth review paper or a short research paper on a selected environmental topic. It is listed as a "new course introduced" at Vidyasagar University, indicating a contemporary emphasis on written academic output and critical synthesis of information. The term paper serves as an opportunity for students to synthesize knowledge, conduct literature reviews, and articulate complex environmental issues in a structured academic format.

Paper: EVSC552X9 Research Dissertation (Examination)

This is a major capstone experience where students undertake an independent research project. Students are typically given a maximum of 5 months to complete their dissertation work, which is conducted under the supervision of a faculty member. The process involves supervisor assignment based on academic interest and consent, with work commencing in the 3rd semester and culminating in the 4th semester with the writing and submission of the dissertation. TERI SAS also features a "Major project" as a core component in its final semester. The research dissertation is the pinnacle of the program, allowing students to apply their accumulated theoretical knowledge and practical skills to an original research problem, fostering critical thinking, problem-solving, and independent inquiry. It is explicitly identified as a significant "employability/skill development" component.

Paper: EVSC553X9 Research Dissertation (Viva-Voce)

This component involves an oral defines of the research dissertation before an expert committee. It assesses the student's in-depth understanding of their research, their ability to articulate findings, and their defense of methodologies and conclusions, simulating real-world academic and professional presentations.

Paper: EVSC554X9 Grand-Viva

This is a comprehensive viva-voce examination designed to assess the student's overall understanding of the entire M.Sc. Environmental Science subject matter. An optional internship opportunity is available under this component at Vidyasagar University. The Grand Viva ensures a holistic assessment of the student's integrated knowledge across all semesters, promoting a deep and interconnected understanding of environmental science. The optional internship provides a practical bridge to professional careers. The substantial credit weightage and compulsory nature of the Research Dissertation (Examination and Viva-Voce) and the Grand Viva in Semester IV across multiple leading universities underscore that independent research and comprehensive understanding are considered the ultimate learning outcomes of the M.Sc. program. This signifies that robust curricula are meticulously designed to culminate in the demonstration of advanced research capabilities, critical thinking, and the ability to synthesize knowledge across diverse environmental disciplines. This rigorous final assessment directly prepares students for advanced research, academic pursuits, or demanding industry roles that require sophisticated problem-solving, analytical skills, and the capacity to integrate complex information.