Punyashlok Ahilyadevi Holkar Solapur University, Solapur

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।
NAAC Accredited-2022
'B++' Grade (CGPA-2.96)

Name of the Faculty: Science & Technology

Syllabus: ENVIRONMENTAL SCIENCE

As per National Education Policy (NEP 2020)

Name of the Course: B.Sc. Part- III (Sem V & VI)

[Syllabus to be implemented from June- 2026]

B.Sc. Part- III Environmental Science NEP 2020 Structure w.e.f. June- 2026

B.Sc. Part- III Environmental Science NEP 2020 Structure							
SEM	**Faculty**		**GE/OE**	**VSC**	**IKS**	**Field Project**	**Credits**
	DSC	**DSE**					
V	DSC1-7 (3+2) **Pollution Sciences** (45 Period) DSC1-8 (3+2) **Environmental Instrumentations** (45 Period) DSC1-9 (3+2) **Wildlife Management** (45 Period)	DSE1-1 (2+1) **Agriculture and Rural Environment** (30 Period) or DSE1-2 (2+1) **Hazards and Natural Disaster Management** (30 Period)	---	VSC 5 (2) (Hands on training related to DSE) **Natural Resource Conservation and Disaster Preparedness**	IKS2 (2) (Related to Major subject) **Traditional Ecological and Environmental Knowledge of Maharashtra and India**	---	22
VI	DSC1-10 (3+2) **Solid waste Management** (45 Period) DSC1-11 (3+2) **Environmental legislation, policies and treaties** (45 Period) DSC1-12 (3+2) **Ecological footprint and carbon trading** (45 Period)	DSE1-3 (2+1) **ETP Design and Environmental compliance** (30 Period) Or DSE1-4 (2+1) **Environmental Audit and Environmental clearance** (30 Period)	---	VSC 6 (2) (Hands on training related to DSE) **Environmental Compliance and Pollution Control Practices**	---	FP2/CEP2/OJT1 (2) **Field-Based Environmental Assessment, Industrial visit and Reporting**	22

- **PREAMBLE**

The purpose of education is to develop the integrated personality of learners by providing scientific knowledge, practical skills, ethical values, environmental awareness, and sustainable life practices. Environmental Science is an interdisciplinary and applied scientific discipline that focuses on the understanding of the environment, natural resources, ecosystems, biodiversity, pollution, climate change, environmental management, and sustainable development for the welfare of society and nature.

Environmental Science integrates concepts from biology, chemistry, physics, geology, geography, agriculture, biotechnology, economics, public health, geoinformatics, environmental engineering, and social sciences to understand the complex interactions between humans and the environment. The subject provides knowledge regarding environmental systems, ecological processes, environmental pollution, natural resource conservation, environmental monitoring, disaster management, climate change, renewable energy, environmental laws, and sustainable environmental practices.

The present syllabus includes fundamental and applied aspects of Environmental Science such as environmental chemistry, ecology, biodiversity conservation, water and watershed management, air, water and soil pollution, environmental biotechnology, environmental geology, GIS and remote sensing, environmental monitoring, ESG, environmental economics, occupational health and safety, forest and wildlife management, environmental ethics, Indian Knowledge System, climate change, and sustainable development. The syllabus also emphasizes field-based learning, laboratory practicals, hands-on training, project work, environmental surveys, data analysis, and use of modern environmental technologies.

The curriculum is designed according to UGC and NEP 2020 guidelines with multidisciplinary, skill-oriented, research-based, and experiential learning approaches. It aims to develop scientific temper, critical thinking, problem-solving ability, environmental ethics, communication skills, entrepreneurship, digital literacy, and employability among students. The syllabus also promotes awareness regarding local, regional, national, and global environmental challenges with special reference to Maharashtra and India.

The Environmental Science programme provides opportunities for students to gain knowledge and practical exposure through Discipline Specific Courses (DSC), Skill Enhancement Courses (SEC), Ability Enhancement Courses (AEC), Value Added Courses (VAC), field visits, internships, research projects, community engagement, and environmental outreach activities. The programme prepares students for higher education, research,

environmental consultancy, industries, NGOs, government sectors, entrepreneurship, and various career opportunities related to environmental protection, sustainability, and natural resource management.

- **GENERAL GUIDELINES:**

1. The University follows Semester system.
2. Each B.Sc. course shall consist of four years i.e. eight semesters
3. An academic year shall consist of two semesters.
4. B. Sc. Part-III shall consist of two semesters: Semester V and Semester VI. In semester –V, there will be three theory papers of 75 marks for each. Similarly, in semester –VI there will be three theory papers of 75 marks for each. DSE 1-1 and DSE 1-2 (Sem- V) & DSE 1-3 and DSE 1-4 are Discipline specific elective. Student should select either DSE- 1-1 or DSE-2-2 in V semester. **If Student selected DSE 1-1 for Semester V then student must be select DSE 1-3 in semester VI & If Student selected DSE 1-2 for Semester V then student must be select DSE 1-4 in semester VI.**
5. Scheme of evaluation: The scheme of evaluation of performance of candidates shall be based on University assessment as well as College internal assessment. For B. Sc. Part III Sem V& VI the internal assessment will be based on Unit tests, Home assignment, viva, practicals etc. as given below. Practical course examination of 400 marks shall be conducted at the end of each semester. Each practical examination of 50 marks shall also consist of 30 marks for University practical assessment and 20 marks for college internal assessment. For University practical examination there will be two external examiners and will be appointed by the University. The internal practical assessment shall be done.

- **Multiple Entry and Multiple Exit Options**

In accordance with the NEP 2020, the BSc Geology program incorporates a Multiple Entry and Multiple Exit framework, offering students the flexibility to enter or exit the program at various stages. This approach ensures that students can tailor their educational journey according to their personal and professional goals, with options to earn certificates, diplomas, or degrees based on the duration of study completed.

- **Year 1:**

Upon completion of the first year, students may exit with a **Certificate in Environmental Science**.

- **Year 2:**

After two years, students may choose to exit with a **Diploma in Environmental Science**.

- **Year 3:**

  Completion of the third year qualifies students for a **B.Sc. Degree in Environmental Science**.

- **Year 4:**

  The fourth year offers an advanced curriculum with a focus on research, allowing students to graduate with an **Honors Degree in Environmental Science**.

Objectives:

1. To develop a comprehensive understanding of fundamental concepts, principles, and processes in Environmental Science and environmental systems.
2. To develop the ability to identify, analyze, and address real environmental problems through field-based investigations and scientific approaches.
3. To inculcate scientific communication skills and the ability to read, write, present, and discuss environmental issues effectively using appropriate environmental terminology.
4. To enhance broad and balanced knowledge regarding environmental resources, biodiversity conservation, pollution control, climate change, sustainable development, and environmental management practices.
5. To develop practical and analytical skills through laboratory experiments, environmental monitoring, data analysis, and field-based studies.
6. To develop the ability to apply theoretical and practical knowledge acquired in classrooms and laboratories during field visits, environmental surveys, and project work.
7. To enhance digital literacy, geospatial thinking, and technical skills through the application of Remote Sensing, GIS, GPS, drones, environmental data analysis, and modern digital tools in Environmental Science.
8. To understand interdisciplinary applications and linkages of Environmental Science with subjects such as Geography, Geology, Chemistry, Physics, Biology, Agriculture, Biotechnology, Economics, and Public Health.
9. To promote environmental ethics, human values, social responsibility, and sustainable lifestyle practices for environmental protection and conservation.
10. To prepare students for higher education, research, entrepreneurship, environmental consultancy, industries, NGOs, government sectors, and skill-based employment opportunities in the field of Environmental Science.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

B.Sc. Part- III Subject: Environmental Science

[According to NEP 2020 WEF June 2026]

Sem.	Paper	Title of Paper	Credits		Marks			
			T	PR	T-CA	PR- CA	T-UA	PR-UA
SEMESTER - V								
V	**DSC 1-7**	Pollution Sciences	**3**	**2**	**30**	**20**	**45**	**30**
V	**DSC 1-8**	Environmental Instrumentations	**3**	**2**	**30**	**20**	**45**	**30**
V	**DSC 1-9**	Wildlife Management	**3**	**2**	**30**	**20**	**45**	**30**
V	**DSE 1-1**	Agriculture and Rural Environment	**2**	**1**	**20**	**10**	**30**	**15**
V	**DSE 1-2**	Hazards and Natural Disaster Management	**2**	**1**	**20**	**10**	**30**	**15**
V	**VSC 5**	**Hands on training related to DSE:** Natural Resource Conservation and Disaster Preparedness	**---**	**2**	**--**	**20**	**--**	**30**
V	**IKS-2**	Traditional Ecological and Environmental Knowledge of Maharashtra and India	**2**	**---**	**20**	**---**	**30**	**---**
SEMESTER - VI								
VI	**DSC 1-10**	Solid waste management	**3**	**2**	**30**	**20**	**45**	**30**
VI	**DSC 1-11**	Environmental Legislation, policies and treaties	**3**	**2**	**30**	**20**	**45**	**30**
VI	**DSC 1-12**	Ecological footprint and carbon trading	**3**	**2**	**30**	**20**	**45**	**30**
VI	**DSE 1-3**	ETP Design and Environmental Compliance	**2**	**1**	**20**	**10**	**30**	**15**
VI	**DSE 1-4**	Environmental Audit and Environmental clearance	**2**	**1**	**20**	**10**	**30**	**15**
VI	**VSC 6**	**Hands on training related to DSE:** Environmental Compliance and Pollution Control Practices	**---**	**2**	**--**	**20**	**--**	**30**
VI	**FP2/CEP 2/OJT1**	Field-Based Environmental Assessment, Industrial visit and Reporting's	**---**	**2**	**--**	**20**	**--**	**30**

Program Outcome (PO)

1. **Disciplinary Knowledge**

   Demonstrate comprehensive knowledge and understanding of Environmental Science including ecology, biodiversity, environmental chemistry, geology, pollution, climate

change, natural resource management, environmental monitoring, GIS and Remote Sensing, ESG, environmental economics, sustainability, and environmental management practices.

2. **Critical Thinking and Problem Solving**

   Apply scientific, analytical, and critical thinking skills to identify, analyze, interpret, and solve environmental problems related to pollution, resource degradation, biodiversity loss, climate change, and environmental health using sustainable approaches.

3. **Practical, Laboratory and Field Skills**

   Develop practical competency in environmental sampling, laboratory analysis, environmental monitoring, GIS/GPS applications, data collection, field surveys, report writing, and interpretation of environmental data through hands-on training and field-based learning.

4. **Research-related Skills and Scientific Temper**

   Develop scientific temper, research aptitude, innovation, and analytical skills through experimentation, project work, environmental assessment, hypothesis development, statistical analysis, and interpretation of environmental data using modern scientific tools and techniques.

5. **Environmental Monitoring and Technological Competence**

   Apply modern environmental technologies such as Remote Sensing, GIS, GPS, drones, environmental sensors, statistical software, and digital tools for environmental mapping, monitoring, management, and decision-making.

6. **Trans-disciplinary and Integrated Knowledge**

   Integrate concepts of Environmental Science with Geography, Geology, Chemistry, Physics, Biology, Agriculture, Biotechnology, Economics, Public Health, ESG, and social sciences to address complex environmental and sustainability challenges.

7. **Social Competence and Communication Skills**

   Demonstrate effective communication, teamwork, leadership, scientific writing, presentation, environmental awareness, and community participation skills for environmental education, outreach, and sustainable development initiatives.

8. **Personal and Professional Competence**

   Perform independently and collaboratively in academic, research, industrial, governmental, NGO, and consultancy sectors with professional ethics, adaptability, self-motivation, entrepreneurship, and lifelong learning abilities.

9. **Environmental Ethics and Responsible Citizenship**

   Develop environmental ethics, human values, social responsibility, and commitment towards biodiversity conservation, environmental protection, equity, and sustainable lifestyle practices for national and global environmental welfare.

10. **Environment and Sustainability**

    Understand environmental issues and the impact of human activities on ecosystems and society, and apply principles of sustainable development, circular economy, green technologies, watershed management, renewable energy, and climate resilience for environmental sustainability.

11. **Environmental Policy, Governance and ESG**

    Understand environmental laws, Environmental Impact Assessment (EIA), environmental governance, sustainability frameworks, ESG principles, CSR practices, environmental auditing, and national and international environmental policies and agreements.

12. **Employability and Entrepreneurship Skills**

    Develop employability, technical competency, digital literacy, innovation, and entrepreneurship skills for careers in environmental consultancy, industries, laboratories, research institutions, government organizations, NGOs, sustainability sectors, and green technologies.

13. **Self-directed and Lifelong Learning**

    Acquire the ability for self-learning, continuous professional development, skill enhancement, and adaptation to emerging environmental, scientific, and technological advancements at local, national, and global levels.

Program Specific Outcome (PSO):

PSO1. Academic and Environmental Knowledge Competence

1) Demonstrate comprehensive knowledge of environmental systems including ecology, biodiversity, environmental chemistry, geology, hydrology, climatology, pollution, natural resources, and sustainable development.
2) Explain environmental processes, ecosystem dynamics, climate change, environmental degradation, and conservation strategies at local, regional, and global levels.
3) Apply interdisciplinary scientific concepts and environmental principles for understanding environmental issues and sustainable resource management.

4) Pursue higher education, research, and professional careers in Environmental Science and allied disciplines with scientific understanding and practical competency.

PSO2. Practical, Technical and Professional Competence

1) Develop competency in environmental laboratory techniques, environmental monitoring, sampling, analysis of air, water, soil, and biodiversity parameters.
2) Apply modern environmental tools and technologies such as GIS, Remote Sensing, GPS, drones, statistical software, and digital environmental data analysis techniques.
3) Demonstrate field-based skills through environmental surveys, watershed studies, biodiversity assessment, pollution monitoring, and environmental impact analysis.
4) Communicate environmental concepts, scientific observations, and technical reports effectively through presentations, documentation, and scientific writing.

PSO3. Research and Environmental Management Competence

1) Develop research aptitude and analytical skills for environmental investigations, project work, hypothesis formulation, data interpretation, and scientific reporting.
2) Interpret environmental data using statistical, geospatial, and environmental assessment methods for solving environmental problems.
3) Apply environmental management principles, ESG frameworks, environmental economics, environmental auditing, EIA, waste management, and sustainability practices in real-world situations.
4) Integrate scientific knowledge and practical approaches for climate change mitigation, biodiversity conservation, pollution control, and sustainable environmental management.

PSO4. Entrepreneurial, Social and Ethical Competence

1) Apply environmental knowledge and sustainable practices for societal welfare, environmental conservation, and community development.
2) Demonstrate environmental ethics, leadership qualities, teamwork, social responsibility, and professional values during fieldwork, research, and environmental awareness activities.
3) Develop entrepreneurship and employability skills in environmental consultancy, green technologies, waste management, ecotourism, ESG, environmental monitoring, and sustainability sectors.
4) Exhibit communication skills, problem-solving ability, lifelong learning attitude, and professional competence required for careers in industries, NGOs, government organizations, research institutions, and environmental management sectors.

SEMESTER- V

DSC 1-7: Pollution Sciences

Credits: 3+2 **Lectures: 45**

Course Outcome: At the end of the course the student will acquire:

1. Understand the concepts, sources, types, characteristics, and impacts of various environmental pollutants and pollution problems.
2. Acquire knowledge of pollution monitoring methods, environmental quality assessment techniques, and pollution control technologies for air, water, soil, and noise pollution.
3. Develop practical skills in environmental sampling, pollution assessment, field investigations, and interpretation of environmental data.
4. Apply sustainable pollution management approaches, environmental regulations, environmental auditing, ESG principles, and environmental protection strategies for solving environmental problems.

Unit	Contents	Lectures
1.	**Introduction of Pollution Sciences** Introduction to Pollution Science; concept, scope, and importance of pollution studies; classification of pollutants; sources, types, and characteristics of pollutants; Air Pollution, Water Pollution, Soil Pollution, Noise Pollution, Thermal Pollution, Radioactive Pollution, Marine Pollution, Plastic Pollution, E-waste Pollution, Light Pollution, and Biological Pollution; point and non-point sources of pollution; causes and impacts of pollution on ecosystems, biodiversity, environmental quality, and human health.	**15**
2.	**Pollution Monitoring and Control Techniques** Environmental monitoring and assessment; sampling and analysis of air, water, soil, and noise pollution; environmental quality assessment methods; air pollution monitoring and control technologies; wastewater treatment and water pollution control; soil pollution management and remediation; solid waste and hazardous waste management; noise pollution monitoring and control measures.	**15**
3.	**Sustainable Pollution Management and Environmental Protection** Integrated pollution management approaches; cleaner production and green technologies; pollution prevention and waste minimization; environmental auditing and Environmental Impact Assessment (EIA); pollution and climate change; circular economy and sustainable resource management; environmental policies and legislation.	**15**

DSC 1-7: Pollution Sciences (Practical)

Sr. No.	Practical	No. of Practical's
1	1. Determination of pH and EC of water samples. 2. Determination of Turbidity and Total Dissolved Solids (TDS) in water. 3. Estimation of Dissolved Oxygen (DO) in water. 4. Determination of soil moisture, pH and EC of soil samples. 5. Measurement of ambient noise levels using sound level meter/mobile applications. 6. Study of particulate matter (dust fall) using simple air pollution monitoring methods. 7. Characterization and segregation of municipal solid waste. 8. Survey and mapping of pollution sources in local urban/rural areas. 9. Noise pollution survey in residential, commercial, silent, and industrial zones. 10. Assessment of solid waste management practices in campus/community. 11. Field visit to ETP, STP, WTP, CETP for studying pollution control measures and management. 12. Visit to landfill site, recycling unit, composting facility, or hazardous waste management facility. 13. Community survey on pollution awareness and environmental health issues. 14. Practical based on the availability of laboratory instrument facilities.	9

Books Recommended:

1. Environmental Pollution by V. K. Ahluwalia, published by Scientific Publishers, Jodhpur.
2. Environmental Science by S. C. Santra, published by New Central Book Agency (NCBA), Kolkata.
3. Environmental Studies: From Crisis to Cure by R. Rajagopalan, published by Oxford University Press, New Delhi.
4. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha, published by Universities Press (India) Pvt. Ltd., Hyderabad.
5. Environmental Chemistry by A. K. De, published by New Age International Publishers, New Delhi.
6. Environmental Pollution and Control Engineering by C. S. Rao, published by New Age International Publishers, New Delhi.
7. Air Pollution by M. N. Rao and H. V. N. Rao, published by Tata McGraw-Hill Publishing Company, New Delhi.
8. Water Pollution by P. K. Goel, published by New Age International Publishers, New Delhi.
9. Solid Waste Management: Principles and Practice by Ramesha Chandrappa and Diganta Das, published by Springer Publications.
10. Environmental Management by T. V. Ramachandra, published by TERI Press.
11. Environmental monitoring manuals, guidelines, and reports published by the Central Pollution Control Board.

12. Environmental status reports, pollution control guidelines, and technical publications of the Maharashtra Pollution Control Board.

DSC 1-8: Environmental Instrumentations

Credits: 3+2 **Lectures: 45**

Course Outcome: At the end of the course the student will acquire:

1. Understand the principles, operation, calibration and applications of basic, advanced and field-based environmental monitoring instruments used in environmental studies.
2. Acquire knowledge of environmental sampling, pollution monitoring, analytical techniques, quality assurance procedures and environmental data collection methods.
3. Develop practical skills in operating environmental instruments, conducting laboratory and field investigations, and interpreting environmental monitoring data.
4. Apply environmental instrumentation, geospatial technologies and analytical techniques for pollution assessment, environmental management, environmental auditing and sustainable environmental decision-making.

Unit	Contents	Lectures
1.	**Environmental Instrumentation and Basic Monitoring Instruments** Introduction to environmental instrumentation; principles and importance of environmental monitoring; concepts of accuracy, precision, calibration, sensitivity, detection limits, quality assurance and quality control (QA/QC); environmental sampling techniques; laboratory safety and Good Laboratory Practices (GLP); basic instruments used in environmental monitoring including thermometer, hygrometer, barometer, rain gauge, anemometer, lux meter, pH meter, conductivity meter, TDS meter, turbidity meter, dissolved oxygen meter, soil moisture meter.	15
2.	**Environmental Pollution Monitoring and Analytical Instruments** Water quality monitoring instruments: spectrophotometer, colorimeter, BOD incubator, COD digester, flame photometer, water quality analyzer and multiparameter probe; air quality monitoring instruments: high volume air sampler, respirable dust sampler, $PM_{2.5}$ and PM_{10} monitors, stack monitoring instruments, gas analyzers (SO_2, NOx, CO, CO_2, O_3), aerosol monitors and meteorological instruments; soil analysis instruments: soil testing kits, EC meter and soil nutrient analyzers; noise and vibration monitoring instruments; environmental microbiology instruments including autoclave, incubator, laminar airflow chamber.	15

3.	**Advanced Environmental Instrumentation, Geospatial Technologies and Data Analysis** Advanced analytical instruments- UV-Visible Spectrophotometer, Atomic Absorption Spectrophotometer (AAS), Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Inductively Coupled Plasma Mass Spectrometry (ICP-MS),	**15**

DSC 1-8: Environmental Instrumentations (Practical's)

Sr. No.	Practical	No. of Practical's
1.	1) Calibration and operation studies of pH and EC. 2) Calibration and operation studies of DO. 3) Calibration and operation studies of TDS. 4) Calibration and operation studies of Colorimeter and spectrophotometer. 5) Calibration and operation studies BOD incubator, COD digester, noise/sound meter, 6) Calibration and operation studies noise/sound meter, 7) Calibration and operation studies of Dust sampler. 8) Calibration and operation studies of UV chamber, TKN, flame photometer, elemental analyzer. 9) Calibration and operation studies of TKN. 10) Calibration and operation studies of flame photometer. 11) Calibration and operation studies of elemental analyzer. 12) Ambient air quality monitoring using portable air quality monitoring devices. 13) Visit to Instrumentation Centre for Advanced Instrumentation studies and preparation of instrument inventory report. 14) Practical based on the availability of laboratory instrument facilities.	9

Books Recommended:

1) Environmental Monitoring and Analysis by P. Thangavel and Sridevi, published by Daya Publishing House, New Delhi.
2) Environmental Chemistry and Instrumental Methods of Analysis by S. M. Khopkar, published by New Age International Publishers, New Delhi.
3) Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal and Sham K. Anand, published by Himalaya Publishing House, Mumbai.
4) Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler and Stanley R. Crouch, published by Cengage Learning, USA.

5) Environmental Instrumentation and Analysis Handbook by R. D. Down and J. H. Lehr, published by Wiley-Interscience Publications.
6) Environmental Science by S. C. Santra, published by New Central Book Agency, Kolkata.
7) Remote Sensing and GIS by Basudeb Bhatta, published by Oxford University Press, New Delhi.
8) Standard Methods for the Examination of Water and Wastewater by APHA, AWWA and WEF, published by American Public Health Association, Washington D.C.
9) Technical manuals, environmental monitoring protocols and guidelines published by the Central Pollution Control Board.
10) Environmental monitoring manuals and standards published by the Ministry of Environment, Forest and Climate Change.

DSC 1-9: Wildlife Management

Credits: 3+2 **Lectures: 45**

Course Outcome: On successful completion of the course:

1) Understand the concepts, principles, ecological significance, and conservation needs of wildlife and wildlife habitats.
2) Acquire knowledge of wildlife conservation strategies, protected area management, wildlife laws, and biodiversity conservation practices.
3) Develop practical skills in wildlife survey, habitat assessment, biodiversity monitoring, and application of GPS, GIS, and modern wildlife management techniques.
4) Apply scientific approaches for wildlife conservation, habitat management, human-wildlife conflict mitigation, and sustainable management of biodiversity resources.

Unit	Contents	Lectures
1.	**Fundamentals of Wildlife Management** Introduction to wildlife and wildlife management; concept, scope, objectives, and importance of wildlife conservation; wildlife diversity of India and Maharashtra; classification of wildlife; population ecology of wildlife; endangered, vulnerable, endemic, and threatened species; causes of wildlife depletion; human-wildlife conflicts and management strategies.	15
2.	**Wildlife Conservation and Protected Area Management** Wildlife conservation principles and approaches; in-situ and ex-situ conservation methods; protected area network of India and Maharashtra including national parks, wildlife sanctuaries, biosphere reserves, conservation reserves, hotspots in India and community reserves; wildlife census and monitoring techniques; wildlife corridors and landscape ecology; role of zoos, rescue centers, and captive breeding programs.	15

3.	**Wildlife Monitoring, Management and Emerging Issues** Wildlife survey and monitoring techniques; direct and indirect methods of wildlife assessment; camera trapping, transect methods, quadrat methods, GPS, GIS, Remote Sensing and Drone applications in wildlife studies; wildlife (Aves and mammals) diseases and health management; community participation in wildlife management; eco-tourism; GIB conservation in Solapur District.	**15**

DSC 1-9: Wildlife Management (Practical's)

Sr. No.	Practical	No. of Practical's
1	1. Identification of common wildlife species using photographs, field guides, and digital databases. 2. Study of wildlife classification and conservation status (IUCN categories). 3. Study of Red Data Book for Animal Listing. 4. Study of wildlife census methods and survey techniques. 5. Identification of animal tracks, signs, pellets, nests, and feeding marks. 6. Preparation of wildlife distribution charts and species inventory. 7. Case study analysis of endangered wildlife species of Maharashtra. 8. Observation and identification of birds, mammals, reptiles, and insects. 9. Transect and quadrat methods for wildlife and habitat assessment. 10. GPS-based mapping of wildlife habitats and biodiversity-rich areas. 11. Visit to wildlife sanctuary, national park, biodiversity park, or zoological park. 12. Camera trap demonstration and wildlife monitoring techniques. 13. Study of Pugmarks	9

Books Recommended:

1) Wildlife Ecology, Conservation and Management by Anthony R. E. Sinclair, John M. Fryxell and Graeme Caughley, published by Wiley-Blackwell Publications.
2) Fundamentals of Wildlife Management by Paul R. Krausman, published by Johns Hopkins University Press.
3) Wildlife Biology: An Indian Perspective by S. K. Gupta and V. B. Sawarkar, published by Pointer Publishers, Jaipur.

4) Introduction to Wildlife Conservation in India by S. A. Hussain, published by Natraj Publishers, Dehradun.
5) Wildlife Management and Conservation by P. D. Sharma, published by Rastogi Publications, Meerut.
6) A Textbook of Environmental Studies by Erach Bharucha, published by Universities Press, Hyderabad.
7) Environmental Science by S. C. Santra, published by New Central Book Agency, Kolkata.
8) Biodiversity and Conservation by K. V. Krishnamurthy, published by Oxford and IBH Publishing Co., New Delhi.
9) The Book of Indian Birds by Salim Ali, published by Oxford University Press, New Delhi.
10) Wildlife Protected Areas of India by Rodgers, Panwar and Mathur, published by Wildlife Institute of India, Dehradun.
11) Conservation Biology by Richard B. Primack, published by Sinauer Associates Publications.
12) Remote Sensing and GIS Applications in Wildlife Management by Basudeb Bhatta, published by Oxford University Press, New Delhi.
13) Manuals, reports, and wildlife management guidelines published by the Wildlife Institute of India.
14) Technical publications and wildlife conservation reports published by the National Biodiversity Authority.
15) Wildlife conservation guidelines and protected area management manuals published by the Ministry of Environment, Forest and Climate Change.

DSE 1-1: Agriculture and Rural Environment

Credits: 2+1 **Lectures: 30**

Course Outcome: At the end of the course the student will acquire:

1. Understand sustainable agricultural systems, natural resource management, and environmental challenges affecting rural ecosystems.
2. Apply soil, water, biodiversity, and climate-resilient management practices for sustainable agriculture and rural development.
3. Develop practical skills in agricultural resource assessment, watershed management, environmental monitoring, and village-level environmental planning.

Unit	Contents	Lectures
1.	**Agricultural Resources and Environmental Sustainability** Agricultural ecosystems and agroecology; soil, water, biodiversity and climate as agricultural resources; land capability and land-use planning; sustainable agriculture and environmental management; organic farming, natural farming and regenerative agriculture; integrated nutrient management; biofertilizers and biopesticides; climate change and agriculture.	10

2.	**Rural Resource Management and Climate-Resilient Agriculture** Soil and water conservation techniques; watershed management for rural development; rainwater harvesting and micro-irrigation systems; drought management and climate-smart agriculture; agroforestry and social forestry; sustainable livelihood approaches; government schemes and policies related to agriculture, water, and rural development.	**10**
3.	**Applied Agriculture, Rural Development and Environmental Assessment** Village ecosystem assessment and natural resource inventory; rural environmental issues and management strategies; environmental health, sanitation and waste management in villages; farmer producer organizations (FPOs), self-help groups (SHGs) and community participation; case studies of successful watershed, preparation of village environmental management plans.	**10**

DSE 1-1: Agriculture and Rural Environment (Practical's)

Sr. No.	Practical	No. of Practical's
1	1. Identification and study of different soil types and soil profiles. 2. Preparation and demonstration of compost and vermicompost production. 3. Identification and application of biofertilizers and biopesticides. 4. Preparation of organic manure and nutrient management plan. 5. Water quality assessment for irrigation purposes. 6. Demonstration of rainwater harvesting models. 7. Preparation of agroecosystem and nutrient cycle charts/models. 8. Watershed survey and mapping of local watershed components. 9. Agroforestry and social forestry assessment in rural areas. 10. Village ecosystem assessment and natural resource inventory. 11. Field study of micro-irrigation systems (drip and sprinkler irrigation). 12. Field visit and study to organic farming, natural farming, or regenerative agriculture sites, Farmer Producer Organizations (FPOs), Self-Help Groups (SHGs), and community participation in rural development	7

Books Recommended:

1. Agricultural Ecology by L. R. Gliessman, published by CRC Press, USA.
2. Sustainable Agriculture and Environment by M. S. Swaminathan, published by Konark Publishers, New Delhi.
3. Environmental Science by S. C. Santra, published by New Central Book Agency, Kolkata.
4. Fundamentals of Agriculture by Arnon I. T. and Dutta, published by Oxford and IBH Publishing Co., New Delhi.
5. Soil and Water Conservation Engineering by R. Suresh, published by Standard Publishers Distributors, New Delhi.
6. Organic Farming: Theory and Practice by S. P. Palaniappan and K. Annadurai, published by Scientific Publishers, Jodhpur.
7. Agroforestry Systems and Practices by P. K. Ramachandran Nair, published by Springer Publications.
8. Rural Development in India by S. N. Tripathy, published by Discovery Publishing House, New Delhi.
9. Agriculture and Rural Development by A. N. Agrawal, published by Vikas Publishing House, New Delhi.
10. Watershed Management by J. V. S. Murthy, published by New Age International Publishers, New Delhi.

DSE 1-2: Hazards and Natural Disaster Management

Credits: 2+1 **Lectures: 30**

Course Outcome:

1. Understand various natural hazards, disaster processes, vulnerability factors, and environmental impacts associated with disasters.
2. Develop practical skills in hazard assessment, disaster preparedness, risk reduction, emergency response, and the use of GIS/GPS-based disaster management tools.
3. Apply principles of disaster risk reduction, environmental resilience, and sustainable disaster management for community safety and environmental protection.

Unit	Contents	Lectures
1.	**Fundamentals of Hazards and Natural Disasters** Introduction to hazards and disasters; concepts, classification and significance; natural and anthropogenic hazards; geological hazards (earthquakes, volcanic eruptions, landslides, tsunamis); hydrological hazards (floods, droughts, cyclones); climatological and meteorological	10

	hazards (heat waves, cold waves, lightning, forest fires); environmental and industrial disasters.	
2.	**Disaster Risk Reduction, Preparedness and Mitigation** Disaster risk assessment and hazard mapping; disaster preparedness and response planning; early warning systems and forecasting techniques; community-based disaster management; disaster mitigation strategies; climate change and disaster risk; disaster management cycle (prevention, preparedness, response, recovery and rehabilitation); role of national and international agencies in disaster management.	**10**
3.	**Applied Disaster Management and Environmental Resilience** Environmental impacts of disasters; post-disaster environmental assessment; disaster-resilient infrastructure and sustainable development; watershed management and flood control; drought management and climate adaptation; emergency response, relief and rehabilitation measures; case studies of major disasters in India; preparation of disaster management plans.	**10**

DSE 1-2: Hazards and Natural Disaster Management (Practical's)

Sr. No.	Practical	No. of Practical's
1	1. Identification and classification of different hazards and disasters. 2. Preparation of hazard zonation and risk assessment charts & Maps. 3. Analysis of disaster case studies from Maharashtra and India. 4. Interpretation of weather maps and disaster warning information. 5. Demonstration of first aid and emergency safety procedures. 6. Survey of disaster-prone areas and vulnerable communities. 7. Hazard mapping of local areas using GPS/mobile applications. 8. Field visit to flood-prone, drought-prone, landslide-prone, or coastal hazard areas (where applicable). 9. Visit to disaster management authority, meteorological center, or emergency response center. 10. Community survey on disaster awareness and preparedness. 11. Preparation of village/campus disaster management plan.	7

Text/ Reference Books:

1. Disaster Management by Anil K. Gupta, published by Universities Press (India) Pvt. Ltd., Hyderabad.
2. Natural Hazards and Disaster Management by S. K. Singh, published by Pravalika Publications, Allahabad.
3. Disaster Management and Preparedness by R. B. Singh, published by Rawat Publications, Jaipur.
4. Environmental Hazards and Disaster Management by B. K. Sharma, published by Krishna Prakashan Media Pvt. Ltd., Meerut.
5. Disaster Management: Future Challenges and Opportunities by Jagbir Singh, published by I.K. International Publishing House, New Delhi.
6. Introduction to Disaster Management by D. K. Lal, published by Shree Publishers and Distributors, New Delhi.
7. Environmental Science by S. C. Santra, published by New Central Book Agency, Kolkata.
8. Remote Sensing and GIS by Basudeb Bhatta, published by Oxford University Press, New Delhi.
9. Guidelines, manuals and training materials published by the National Disaster Management Authority.
10. Disaster preparedness and risk reduction manuals published by the National Institute of Disaster Management.
11. Disaster management reports and guidelines published by the India Meteorological Department.

VSC - 5: Hands on Training

Credits: 2

Hands on training related to DSE: a) Agriculture and Rural Environment b) Hazards and Natural Disaster Management

VSC 5: Natural Resource Conservation and Disaster Preparedness

Laboratory and Field-Based Hands-on Training Practical's

Perform any one activity as a hands-on training from the following and students submit their hands on training report:

Laboratory-Based Practical's

1. Soil erosion assessment using demonstration models.
2. Preparation of rainwater harvesting and watershed management models.

Field-Based Practical's

1. Field study of watershed management practices.

2. Survey of rainwater harvesting structures and their effectiveness.

Demonstration Activities

1. Rainwater harvesting system demonstration.
2. Contour bunding and soil conservation techniques.

Mini Project / Report

Preparation of a field-based report on **Natural Resource Conservation and Disaster Preparedness** in a selected village, watershed, institution, or community area, including resource mapping, hazard assessment, conservation measures, and recommendations for resilience building.

IKS - 2: Traditional Ecological and Environmental Knowledge of Maharashtra and India

Credits: 2 **Lectures: 30**

Unit	Contents	Lectures
1.	**Foundations of Traditional Ecological Knowledge** Traditional Ecological Knowledge (TEK): concept, scope and importance; indigenous environmental ethics; sustainable living in Indian traditions; Panchamahabhuta and ecological balance; sacred groves (Devrai); tribal ecological knowledge; traditional biodiversity conservation practices; role of festivals and culture in environmental conservation.	**10**
2.	**Traditional Natural Resource Management Systems** Traditional water conservation systems; indigenous watershed management; traditional agriculture and organic farming; soil conservation practices; ethnobotany and medicinal plants; traditional use of plant and animal products, community forestry; traditional weather forecasting; role of tribal communities in natural resource conservation.	**10**
3.	**Contemporary Relevance and Applications of TEK** Traditional ecological knowledge and climate change adaptation; disaster management; integration of traditional and modern environmental science; TEK and Sustainable Development Goals (SDGs); community-based conservation; eco-friendly lifestyles; biodiversity conservation; government initiatives and policies; IPR and protection of traditional knowledge; future prospects of TEK in sustainability.	**10**

Recommended Books

1. Traditional Knowledge Systems in India: Sustainability, Ecology and Resource Governance — Ranbir Chander Sobti, Sudarshan Verma and Vipin Sobti.
2. Traditional Ecological Knowledge of Resource Management in Asia — Suresh Chand Rai and Prabuddha Kumar Mishra.
3. Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge — P.S. Ramakrishnan.
4. Indigenous Traditional Knowledge and Biodiversity Conservation — K.P. Acharjyo and S. Patnaik.
5. The Routledge Handbook of Indigenous Environmental Knowledge — Thomas F. Thornton and Shonil A. Bhagwat.
6. Human Values and Environmental Studies — Anubha Kaushik and C.P. Kaushik.
7. Traditional Ecological Knowledge and Climate Change Adaptation — Various Authors.
8. Publications and reports of Ministry of Environment, Forest and Climate Change, UNESCO, United Nations Environment Programme, and Indian Council of Forestry Research and Education.

SEMESTER- VI

DSC 1-10: Solid Waste Management

Credits: 3+2 **Lectures: 45**

Course Outcome: At the end of the course the student will acquire:

1. Understand the sources, characteristics, environmental impacts, and management principles of various types of solid waste including municipal, industrial, biomedical, plastic, hazardous and e-waste.
2. Acquire knowledge of waste segregation, collection, treatment, recycling, resource recovery, waste-to-energy technologies and sustainable waste management practices.
3. Develop practical skills in waste characterization, waste auditing, composting, recycling assessment, environmental monitoring and preparation of waste management plans.
4. Apply integrated solid waste management approaches, environmental regulations, ESG principles and circular economy concepts for sustainable waste governance and environmental protection.

Unit	Contents	Lectures
1.	**Fundamentals of Solid Waste and Waste Characterization** Introduction to solid waste management; concept, scope and importance; sources and types of solid waste; municipal solid waste, agricultural waste, industrial waste, biomedical waste, plastic waste, e-waste, construction and demolition waste, hazardous waste, mining waste and radioactive waste; physical, chemical and biological characteristics of solid waste; waste management hierarchy (Reduce, Reuse, Recycle, Recover and Dispose).	15
2.	**Waste Collection, Treatment and Resource Recovery Technologies** Waste segregation and storage; collection, transportation and transfer systems; material recovery facilities; recycling and resource recovery; composting, vermicomposting and Biomethanation; refuse-derived fuel (RDF); waste-to-energy technologies; incineration, pyrolysis and gasification; management of plastic waste, biomedical waste, hazardous waste and e-waste; landfill design, operation and leachate management; role of local bodies and stakeholders in waste management.	15
3.	**Applied Solid Waste Management and Sustainable Waste Governance** Integrated solid waste management; waste auditing and waste minimization techniques; environmental monitoring of waste disposal	15

	sites; ESG and sustainability approaches in waste management; smart waste management technologies; community participation and awareness programmes; Swachh Bharat Mission and waste management initiatives in India; future challenges and opportunities in sustainable waste management.	

DSC 1-10: Solid Waste Management (Practical's)

Sr. No.	Practical	No. of Practical's
1	1. Identification and classification of different types of solid waste. 2. Physical characterization of municipal solid waste. 3. Determination of moisture content of solid waste. 4. Waste segregation and composition analysis. 5. Preparation and monitoring of composting units. 6. Vermicomposting and assessment of compost quality. 7. Study of recycling and resource recovery techniques. 8. Waste audit of classroom, laboratory or campus. 9. Visit to municipal solid waste processing facility. 10. Visit to composting, vermicomposting or Biomethanation plant. 11. Survey of plastic waste and e-waste management practices. 12. Assessment of biomedical waste management in hospitals or healthcare facilities.	9

Books Recommended:

1. Solid Waste Management: Principles and Practice by Ramesha Chandrappa and Diganta Das, published by Springer Publications.
2. Integrated Solid Waste Management: Engineering Principles and Management Issues by George Tchobanoglous and Frank Kreith, published by McGraw-Hill Education.
3. Handbook of Solid Waste Management by George Tchobanoglous and Frank Kreith, published by McGraw-Hill Publications.
4. Municipal Solid Waste Management by P. Jayarama Reddy, published by BS Publications, Hyderabad.
5. Environmental Science by S. C. Santra, published by New Central Book Agency, Kolkata.
6. Textbook of Environmental Studies by Erach Bharucha, published by Universities Press, Hyderabad.
7. Environmental Pollution and Control Engineering by C. S. Rao, published by New Age International Publishers, New Delhi.
8. Environmental Engineering by Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, published by McGraw-Hill International Editions.

9. Waste Management and Resource Recovery by P. Aarne Vesilind, William A. Worrell and Debra R. Reinhart, published by Cengage Learning.
10. Solid and Hazardous Waste Management by M. N. Rao and H. V. N. Rao, published by CBS Publishers and Distributors, New Delhi.
11. E-Waste Management by Rakesh Johri, published by TERI Press, New Delhi.
12. Biomedical Waste Management by S. K. Agarwal, published by APH Publishing Corporation, New Delhi.
13. Solid Waste Management Rules, manuals and technical guidelines published by the Central Pollution Control Board.
14. Waste management guidelines and environmental standards published by the Ministry of Environment, Forest and Climate Change.
15. Technical reports and waste management publications of the National Environmental Engineering Research Institute.

DSC 1-11: Environmental Legislation, Policies and Treaties

Credits: 3+2 **Lectures: 45**

Course Outcome: At the end of the course, students will acquire:

1. Understand the principles, framework, and significance of environmental legislation, governance, and regulatory mechanisms for environmental protection.
2. Acquire knowledge of major environmental laws, policies, environmental institutions, and legal provisions related to pollution control, biodiversity conservation, and natural resource management.
3. Develop the ability to analyze environmental policies, legal case studies, EIA reports, environmental compliance requirements, and treaty implementation mechanisms.
4. Apply environmental laws, international treaties, sustainability principles, and environmental governance approaches for effective environmental management and sustainable development.

Unit	Contents	Lectures
1.	**Fundamentals of Environmental Legislation and Governance** Introduction to environmental legislation and governance; need and importance of environmental laws; principles of environmental law (Precautionary Principle, Polluter Pays Principle, Animal Ethical rules, Sustainable Development); environmental rights and duties; environmental governance framework in India; role of central and state governments; environmental regulatory institutions.	15
2.	**Environmental Policies and Major Environmental Laws in India** National Environment Policy and environmental planning in India; Environment (Protection) Act, 1986; Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981;	15

	Wildlife (Protection) Act, 1972; Forest (Conservation) Act, 1980; Biological Diversity Act, 2002; Public Liability Insurance Act, 1991; National Green Tribunal (NGT) Act, 2010; Environmental Impact Assessment (EIA) Notification; Coastal Regulation Zone (CRZ) Notification.	
3.	**International Environmental Treaties and Sustainable Development** Global environmental issues and international cooperation; major international conventions and treaties: Stockholm Conference (1972), Convention on Biological Diversity (CBD), Ramsar Convention, CITES, UNFCCC, Kyoto Protocol, Paris Agreement, Montreal Protocol,	**15**

DSC 1-11: Environmental Legislation, Policies and Treaties (Practical's)

Sr. No.	Practical	No. Of Practical's
1	1. Study of constitutional provisions related to environmental protection in India. 2. Comparative analysis of major environmental laws and policies. 3. Preparation of flowcharts showing environmental governance structures. 4. Case study analysis of landmark environmental court judgments. 5. Mock environmental public hearing exercise. 6. Preparation of environmental legislation and treaty database. 7. Survey of local environmental issues and related legal provisions. 8. Interaction with environmental officers, legal experts, NGOs, or environmental activists. 9. Observation of environmental management practices in industries or institutions. 10. Zoo rules. 11. Visit to environmental regulatory agencies, pollution control boards, or environmental laboratories. 12. Visit to industries for understanding environmental compliance and regulatory requirements.	9

Books Recommended:

1. Environmental Law and Policy in India by Shyam Divan and Armin Rosencranz, published by Oxford University Press, New Delhi.
2. Environmental Law by P. Leelakrishnan, published by LexisNexis Butterworths, New Delhi.
3. Introduction to Environmental Law by Kailash Thakur, published by Allahabad Law Agency, Faridabad.
4. Environmental Studies: From Crisis to Cure by R. Rajagopalan, published by Oxford University Press, New Delhi.
5. Environmental Science by S. C. Santra, published by New Central Book Agency, Kolkata.

6. Textbook of Environmental Studies by Erach Bharucha, published by Universities Press, Hyderabad.
7. International Environmental Law and Policy by Edith Brown Weiss, Stephen C. McCaffrey, Daniel B. Magraw and A. Dan Tarlock, published by Aspen Publishers, USA.
8. Principles of International Environmental Law by Philippe Sands and Jacqueline Peel, published by Cambridge University Press, UK.
9. Environmental Governance and Sustainable Development by M. K. Tolba and Osama El-Kholy, published by Butterworth-Heinemann Publications.
10. Environmental Policies and Programmes in India by R. B. Singh, published by Concept Publishing Company, New Delhi.
11. Biodiversity and Environmental Laws of India by K. Sahasranaman, published by National Book Trust, New Delhi.
12. Manuals, guidelines and notifications published by the Ministry of Environment, Forest and Climate Change.
13. Environmental standards, reports and legal guidelines published by the Central Pollution Control Board.
14. Publications and environmental assessment reports of the United Nations Environment Programme.
15. Climate change reports and treaty documents published by the United Nations Framework Convention on Climate Change.

DSC 1-12: Ecological Footprint and Carbon Trading

Credits: 3+2 **Lectures: 45**

Course Outcome: At the end of the course the student will acquire:

1. Understand the concepts of ecological footprint, carbon footprint, carrying capacity, carbon cycles, and their significance in environmental sustainability and climate change.
2. Acquire knowledge of carbon accounting, carbon sequestration, carbon credits, carbon markets, carbon trading mechanisms, and net-zero emission strategies.
3. Develop practical skills in ecological footprint assessment, carbon footprint estimation, carbon auditing, greenhouse gas inventory preparation, and sustainability reporting.
4. Apply principles of carbon management, climate change mitigation, ESG frameworks, renewable energy, and sustainable development for reducing environmental impacts and promoting low-carbon growth.

Unit	Contents	Lectures
1.	**Fundamentals of Ecological Footprint and Carbon Footprint** Introduction to ecological footprint; concept, scope and significance; carrying capacity and ecological sustainability; biocapacity and ecological overshoot; components of ecological footprint (food, energy, water, transportation, housing, goods and services); ecological footprint assessment methods; concept of carbon footprint	**15**

2.	**Carbon Accounting, Carbon Markets and Carbon Trading** Introduction to carbon accounting and greenhouse gas inventories; carbon emission estimation methods; carbon sequestration and carbon sinks; forests, wetlands and blue carbon ecosystems; carbon neutrality and net-zero emissions; carbon credits and carbon offsets; principles of carbon trading; voluntary and compliance carbon markets; Clean Development Mechanism (CDM); carbon finance and carbon pricing; carbon taxes and emissions trading systems; international carbon markets.	**15**
3.	**Sustainable Carbon Management and Climate Action** Climate change mitigation and adaptation strategies; carbon footprint reduction approaches; renewable energy and low-carbon technologies; sustainable transportation and green infrastructure; circular economy and resource efficiency; carbon auditing and reporting; ESG and sustainability reporting frameworks; National Action Plan on Climate Change (NAPCC); carbon management in agriculture, industries and institutions;	**15**

DSC 1-12: Ecological Footprint and Carbon Trading (Practical's)

Sr. No.	Practical	No. Of Practical's
1.	1. Calculation of personal ecological footprint. 2. Estimation of household carbon footprint. 3. Carbon footprint assessment of educational institutions. 4. Calculation of carbon emissions from transportation activities. 5. Estimation of carbon sequestration potential of trees. 6. Carbon accounting and carbon audit exercises. 7. Analysis of carbon credit and carbon trading case studies. 8. Ecological footprint and sustainability assessment using online tools and datasets. 9. Tree biomass estimation and carbon stock assessment. 10. Ecological footprint assessment of a village, campus or community. 11. Design and invent new ideas for control and reduction of carbon emission. 12. Study of waste management and circular economy practices for carbon reduction. 13. Field visit to afforestation, carbon sequestration or watershed projects.	9

Books Recommended:

1. Ecological Footprint: Managing Our Biocapacity Budget by Mathis Wackernagel and William Rees, published by New Society Publishers, Canada.
2. Our Ecological Footprint: Reducing Human Impact on the Earth by Mathis Wackernagel and William Rees, published by New Society Publishers, Canada.
3. Carbon Management and Carbon Trading by V. K. Ahluwalia, published by The Energy and Resources Institute (TERI), New Delhi.
4. Climate Change and Carbon Trading by A. K. Gupta, published by Atlantic Publishers and Distributors, New Delhi.
5. Carbon Trading: Law and Practice by Yogesh Chauhan, published by Oxford University Press, New Delhi.
6. Climate Change and Sustainable Development by Anil Kumar De, published by New Age International Publishers, New Delhi.
7. Environmental Science by S. C. Santra, published by New Central Book Agency, Kolkata.
8. Environmental Economics by R. K. Lekhi and Joginder Singh, published by Kalyani Publishers, New Delhi.
9. Environmental Economics and Sustainable Development by Mohan Munasinghe, published by World Bank Publications, Washington D.C.
10. Climate Change 2023: Synthesis Report published by the Intergovernmental Panel on Climate Change.
11. Manuals and technical documents published by the United Nations Framework Convention on Climate Change.
12. Carbon market and sustainability reports published by the The Energy and Resources Institute.
13. Climate action and carbon accounting guidelines published by the United Nations Environment Programme.
14. National climate and carbon management reports published by the Ministry of Environment, Forest and Climate Change.

DSE 1-3: ETP Design and Environmental Compliance

Credits: 2+1 **Lectures: 30**

Course Outcome: At the end of the course the student will acquire:

1. Understand the characteristics of industrial wastewater, treatment requirements, environmental impacts, and regulatory standards related to effluent management.
2. Acquire knowledge of ETP design principles, wastewater treatment technologies, sludge management, and operation and maintenance of treatment systems.
3. Develop practical skills in wastewater sampling, analysis, treatment efficiency evaluation, ETP process assessment, and environmental monitoring.
4. Apply environmental compliance requirements, environmental auditing, wastewater reuse, ESG principles, and sustainable wastewater management practices in industrial and environmental sectors.

Unit	Contents	Lectures
1.	**Fundamentals of Effluent Treatment and Industrial Wastewater Management** Introduction to industrial wastewater and effluent generation; sources and characteristics of industrial effluents; physical, chemical and biological characteristics of wastewater; environmental impacts of industrial effluent discharge; overview of Effluent Treatment Plants (ETPs); industrial sectors generating wastewater; regulatory requirements and discharge standards.	**10**
2.	**ETP Design and Treatment Technologies** Principles of wastewater treatment; preliminary treatment units (screening, grit removal, oil and grease traps, equalization tanks); primary treatment processes (sedimentation, clarification, coagulation and flocculation); secondary treatment processes (activated sludge process, trickling filters, oxidation ponds, aeration systems); tertiary and advanced treatment technologies (filtration, adsorption, membrane filtration, reverse osmosis, disinfection); sludge treatment and disposal.	**10**
3.	**Environmental Compliance, Monitoring and Sustainable Wastewater Management** Environmental compliance and industrial environmental management; consent to establish (CTE) and consent to operate (CTO); environmental monitoring and reporting requirements; environmental audits and compliance assessment; Zero Liquid Discharge (ZLD) concept; ESG and sustainability in wastewater management; wastewater reuse and recycling; industrial water conservation practices; environmental legislation related to wastewater management; role of CPCB, SPCBs and regulatory agencies.	**10**

DSE 1-3: ETP Design and Environmental Compliance (Practical's)

Sr. No.	Practical	No. Of Practical's
1.	1. Field study of wastewater collection and treatment systems. 2. Sampling of industrial wastewater and treated effluent. 3. Jar test for coagulation and flocculation studies. 4. Study and demonstration of sedimentation and filtration processes. 5. Determination of treatment efficiency of wastewater treatment units. 6. Preparation of flow diagrams of ETP processes. 7. Design calculations for equalization tanks, sedimentation tanks and aeration units (basic level). 8. Analysis of industrial effluent quality data and compliance standards. 9. Study of sludge management and disposal practices. 10. Assessment of water recycling and reuse practices in industries. 11. Review of environmental compliance documents and consent conditions. 12. Visit to industrial Effluent Treatment Plant (ETP) and Common Effluent Treatment Plant (CETP). 13. Preparation of field report on ETP operation and environmental compliance.	7

Books Recommended:

1. Wastewater Engineering: Treatment and Resource Recovery by Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, published by McGraw-Hill Education.
2. Industrial Water Pollution Control by Wesley Eckenfelder, published by McGraw-Hill International Editions.
3. Water Supply and Sanitary Engineering by G. S. Birdie and J. S. Birdie, published by Dhanpat Rai Publishing Company, New Delhi.
4. Environmental Engineering by Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, published by McGraw-Hill Publications.
5. Environmental Pollution Control Engineering by C. S. Rao, published by New Age International Publishers, New Delhi.
6. Industrial Wastewater Management, Treatment and Disposal by Water Environment Federation, published by McGraw-Hill Publications.
7. Wastewater Treatment: Principles and Design by M. J. Hammer and M. J. Hammer Jr., published by Prentice Hall Publications.
8. Environmental Science by S. C. Santra, published by New Central Book Agency, Kolkata.
9. Textbook of Environmental Studies by Erach Bharucha, published by Universities

Press, Hyderabad.
10. Environmental Laws and Compliance in India by P. Leelakrishnan, published by LexisNexis Butterworths, New Delhi.
11. Technical manuals, standards and guidelines published by the Central Pollution Control Board.
12. Environmental compliance guidelines and wastewater discharge standards published by the Ministry of Environment, Forest and Climate Change.
13. Technical reports and industrial wastewater management publications of the National Environmental Engineering Research Institute.
14. Industry-specific wastewater treatment manuals published by the Water Environment Federation.

DSE 1-4: Environmental Audit and Environmental Clearance

Credits: 2+1 **Lectures: 30**

Course Outcome: At the end of the course the student will acquire:

1. Understand the principles, procedures, and significance of environmental auditing, environmental management systems, environmental clearance processes, and regulatory compliance requirements.
2. Develop skills in environmental audit preparation, EIA review, compliance assessment, environmental monitoring, sustainability reporting, and environmental performance evaluation.
3. Apply environmental audit methodologies, environmental clearance procedures, ESG principles, and environmental governance frameworks for sustainable environmental management and regulatory compliance.

Unit	Contents	Lectures
1.	**Fundamentals of Environmental Audit and Environmental Management** Introduction to environmental auditing; concept, objectives, scope and significance of environmental audit; types of environmental audits (compliance audit, management audit, waste audit, energy audit, water audit and environmental performance audit); environmental management systems (EMS); ISO 14001 standards and certification; environmental monitoring and reporting.	**10**
2.	**Environmental Clearance and Regulatory Framework** Environmental legislation and regulatory framework in India; Environmental Impact Assessment (EIA) process; environmental clearance procedures for developmental projects; screening, scoping, baseline studies, impact assessment and mitigation measures; environmental management plan (EMP); public hearing and stakeholder participation; environmental compliance requirements.	**10**
3.	**Applied Environmental Audit, Compliance and Sustainability Assessment** Environmental audit methodology and reporting; environmental compliance assessment; environmental statement and environmental reporting; ESG and	**10**

	sustainability audits; carbon audit, water audit and waste audit; environmental risk assessment; environmental due diligence; industrial and institutional environmental audit practices; preparation of environmental audit reports.	

DSE 1-4: Environmental Audit and Environmental Clearance (Practical's)

Sr. No.	Practical	No. Of Practical's
1.	1. Study of environmental audit formats and checklists. 2. Analysis of Environmental Impact Assessment (EIA) reports. 3. Review of environmental clearance documents and conditions. 4. Preparation of environmental monitoring and compliance records. 5. Environmental audit report writing and presentation. 6. Environmental audit of selected departments/buildings/campus facilities. 7. Visit to industry/institution implementing Environmental Management Systems (EMS). 8. Visit to pollution control laboratories or environmental consultancy organizations.	7

Books Recommended:

1. Environmental Audit by R. K. Trivedy and P. K. Goel, published by Environmental Publications, Karad.
2. Environmental Management by N. K. Uberoi, published by Excel Books, New Delhi.
3. Environmental Impact Assessment: Methodologies by Y. Anjaneyulu and Valli Manickam, published by BS Publications, Hyderabad.
4. Environmental Impact Assessment and Environmental Audit by D. P. Khandelwal, published by Book Enclave, Jaipur.
5. Environmental Management Systems and ISO 14001 by Christopher Sheldon, published by Earthscan Publications, London.
6. Environmental Law and Policy in India by Shyam Divan and Armin Rosencranz, published by Oxford University Press, New Delhi.
7. Environmental Governance and Sustainable Development by M. K. Tolba and Osama El-Kholy, published by Butterworth-Heinemann Publications.
8. Environmental Economics and Sustainable Development by Mohan Munasinghe, published by World Bank Publications.
9. Environmental audit manuals and compliance guidelines published by the Central Pollution Control Board.
10. Environmental clearance notifications, EIA guidelines and policy documents published by the Ministry of Environment, Forest and Climate Change.

11. Environmental management and audit publications of the National Environmental Engineering Research Institute.
12. ISO 14001 Environmental Management System guidelines published by the International Organization for Standardization.

VSC - 6: Hands on Training

Credits: 2

Hands on training related to DSE: ETP Design and Environmental Compliance and Environmental Audit and Environmental Clearance

VSC 6: Environmental Compliance and Pollution Control Practices

(Students shall complete any one hands-on training/project from the following topics)

1. **Environmental Audit of Campus/Industry**
   Assessment of water use, energy use, waste generation, pollution control measures, and preparation of an environmental audit report.
2. **Solid Waste Management and Compliance Assessment**
   Study of waste segregation, recycling, disposal practices, and compliance with waste management rules.
3. **Environmental Monitoring and Reporting Practices**
   Preparation of environmental monitoring records, compliance reports, and environmental performance indicators.
4. **ESG and Sustainability Compliance Assessment**
   Evaluation of environmental, social, and governance (ESG) practices of industries or institutions.

FP2/CEP2/OJT1

Credits: 2

Arrange a **3 to 5 days Environmental Science Excursion / Field Tour** for field-based learning, environmental mapping, industrial exposure, biodiversity assessment, and environmental report writing.

Suggested Practical Activities related to field area:

1. Environmental quality assessment survey
2. Water, air, soil, or noise monitoring activity
3. Industrial/environmental project visit
4. Biodiversity and land-use survey
5. GPS/GIS-based field data collection
6. Waste management assessment
7. ESG and sustainability assessment
8. Community awareness activity
9. Environmental audit/report preparation
10. Mini field project and presentation

Short Guidelines for Completion of Field Project

1. **Select Topic/Study Area**
   Choose a suitable environmental topic, industry, or field area.
2. **Define Objectives**
   Prepare objectives and methodology for field work.
3. **Conduct Field Visit/Survey**
   Collect observations, photographs, GPS locations, and environmental data.
4. **Maintain Field Diary**
   Record all observations, survey details, and activities systematically.
5. **Analyze and Interpret Data**
   Organize collected information using tables, graphs, charts, or maps.
6. **Prepare Project Report**
   Format Includes:
   - Title
   - Objectives
   - Study Area
   - Methodology
   - Observations and Results
   - Conclusion
   - References
   - Photographs
7. **Presentation and Viva**
   Present findings through seminar/poster/PPT and appear for viva-voce.