Deccan Education Society's

Fergusson College (Autonomous) Pune

Learning Outcomes-Based Curriculum

For 3/4 years B. Sc. / B. Sc. (Honours) Programme

As per guidelines of

NEP-2020

For

T. Y. B. Sc. (Environmental Science)

With effect from Academic Year

2025-2026

Deccan Education Society's
Fergusson College (Autonomous), Pune-4
Department of **ENVIRONMENTAL SCIENCE**

Syllabi NEP 1.0
Implemented from Academic Year 2025-26
T.Y.B.Sc. Semester: V

Program Specific Outcomes (PSOs)

PSO	Outcomes
PSO1	**Academic competence:** (i)Apply the knowledge, facts, and rules of basic and applied sciences (Chemistry, Geology, Biotechnology, Botany, Microbiology and Zoology) for understanding elements of Environmental Science. (ii) Identify basic elements and systems of the natural world and modern world. iii) Gaining in-depth knowledge on natural processes that sustain life and direct economy
PSO2	**Personal and Professional Competence:** (i)Demonstrates the ability to understand and mitigate environmental issues (ii) Predicting the consequences of human actions on the web of life, global economy and quality of human life. (iii) Adopting sustainability as a practice in life, society and industry.
PSO3	**Research Competence:** i) Developing critical thinking for determining strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development. ii) Acquiring values and attitudes towards understanding complex environmental economic-social challenges, and participating actively in solving current environmental problems and preventing the future ones.
PSO4	**Entrepreneurial and Social competence:** i) Employ the process of thinking independently, taking initiative, working in a team effectively, preparing project reports and developing capability to lead the team through real life situations ii) To augment the acumen to analyze geological and environmental research problems of social relevance

Deccan Education Society's Fergusson College (Autonomous), Pune

T.Y.B.Sc. Environmental Science (Pattern 2025)

Under NEP-CBCS Pattern (2025) Effective from June 2025

T.Y. B.Sc. (NEP 1.0)						
Semester	Paper	Paper Code	Title	Type	Credits	Exam Type
V	Major	EVS-301	Natural Ecosystems Management	Theory	2	CE+ESE
		EVS-302	Technological Approaches To Environmental Treatment	Theory	2	CE+ESE
		EVS-303	Remote Sensing and GIS	Theory	2	CE+ESE
	Elective	EVS-304 OR EVS-305	Basics of Environmental Statistics	Theory	2	CE+ESE
			Or Environmental Data Analysis and Interpretation	Theory	2	CE+ESE
		EVS-306 OR EVS-307	Trends in Climate Change and Sustainability	Theory	2	CE+ESE
			Or Smart Cities and Environmental Sustainability	Theory	2	CE+ESE
	Major	EVS-311	Environmental Science Practical-5	Practical	2	CE+ESE
		EVS-312	EVS Practical-6	Practical	2	CE+ESE
	VSC	EVS-331	Design and Development of Eco-friendly Products	Theory	2	CE
		EVS-332	Environmental Science EVS Practical-7	Practical	2	CE
	Minor	EVS-321	Issues in Environmental Science	Theory	2	CE+ESE
	FP	EVS-345	Field Project	Practical	2	CE
VI	Major	EVS-351	Environmental Biotechnology	Theory	2	CE+ESE
		EVS-352	Environment Impact Assessment and Management	Theory	2	CE+ESE
		EVS-353	Environmental Governance and Ethics	Theory	2	CE+ESE
	Elective	EVS-354 OR EVS-355	Wildlife Biology and Habitat Conservation	Theory	2	CE+ESE
			OR Environmental Economics	Theory	2	CE+ESE
		EVS-356 OR EVS-357	Biodiversity and Conservation	Theory	2	CE+ESE
			OR Ecological Restoration	Theory	2	CE+ESE
	Major	EVS-361	Environmental Science Practical-8	Practical	2	CE+ESE
		EVS-362	Environmental Science Practical-9	Practical	2	CE+ESE
	VSC	EVS-382	Environmental Science Practical-10	Practical	2	CE
	Minor	EVS-371	Techniques in Environmental Assessment	Theory	2	CE+ESE
	OJT	EVS-395	OJT	Practical	4	CE

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	15 / 30	1 / 2	25	10	15
2	30 / 60	2 / 4	50	20	30
3	45 / 90	3 / 6	75	30	45
4	60 / 120	4 / 8	100	40	60

Eligibility: As per the rules and regulations of Savitribai Phule Pune University (SPPU)

T.Y. B.Sc. SEMESTER V		
	EVS-301 - Natural Ecosystems Management **Major -Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		**Bloom's Cognitive level**
CO1	To encourage recognition of an "ecosystem approach" to understanding natural and anthropogenic environments	**1**
CO2	To understand major pathways by which carbon, nitrogen, phosphorus and water cycle, and energy passes through, ecosystems	**2**
CO3	To reconcile the apparently contradictory "taxonomic blindness" versus "taxonomic primacy" embodied within the ecosystem concept.	**3**
CO4	Gain knowledge of the principles of Ecosystem Ecology.	**4**
CO5	Apply their skills for ecosystem studies for Research and social awareness.	**5**
CO6	Recognize the value of various ecosystem states and conditions to human society	**6**

EVS-301 - Natural Ecosystems Management
(Major –Theory)

Unit. No.	Title of Unit and Contents	No. of hours
1	**Introduction** ● The Terrestrial Environment, The terrestrial biota and biogeographic regions ● General structure of terrestrial communities. ● The soil subsystem, the vegetation subsystem, parameters of the terrestrial environment ● Hotspots in India: Western Ghats and Eastern Himalaya.	**5**
2	**Terrestrial Biomes** ● Introduction, concept, types ● Tundra, Northern conifer forests, Temperate deciduous and rain forests, temperate grassland, chaparral, desert, Tropical Rainforest, tropical deciduous forest, tropical scrub forest, tropical grassland and savanna, mountains. ● Role of Local Government and people in conservation	**5**
3	**Terrestrial ecosystem services and management** ● Aesthetic and cultural benefits, tourism and recreation, industry, drugs and medicines, carbon pool and sequestration potential, etc. ● Methods of terrestrial ecosystem management: remote sensing geographical information system, Joint Forest Management	**5**
4	**Ecology of Aquatic ecosystems** ● Elements of structure, functions and processes in fresh- water (lakes and rivers),marine and estuarine ecosystems with respect to hydrology, productivity, and biodiversity ● Stratification and zonation in rivers, lakes and oceans with respect to light, temperature, and pressure ● Water quality and pollution of lakes, reservoirs, rivers, and marine waters	**5**

	Aquatic Biomes: Lentic Ecosystems ● Lakes and reservoirs: Community organization, productivity, trophic levels and food webs ● Eutrophication and trophic state index; biological adaptations nutrient dynamics, methanogenesis, ● Carbon cycle, climate change and impact on lakes and reservoirs	
5	**Aquatic Biomes: Lotic Ecosystems** ● Rivers: Types of rivers, geomorphology, longitudinal profile and classification of drainage network ● Rivers and ecological continuum, riparian and floodplain wetlands ● River biodiversity, community organization; trophic structure and food webs; energy flow. **Marine Biomes** ● Estuary types and genesis; organisms (plants, animals, microbes) in various ecological zones, community organization, productivity, nutrient cycling and dynamics, upwelling and down welling of nutrients,· ● Structure and function of marine ecosystems ● Mangroves, Coral reefs	**5**
6	**.Aquatic biodiversity, Ecosystem services** ● Landscape ecological concepts Coastal regulation zone ● International conventions & protocols ● Ramsar Convention, Convention on Biological Diversity, Ramsar sites in India. ● Remote sensing and GIS in aquatic ecosystem management, biodiversity conservation ● Climate change and aquatic ecosystem response	**5**

Sr. No.	References
1	Groom. B. & Jenkins. M. 2000. Global Biodiversity: Earth's Living Resources 21stCentury. World Conservation Press, Cambridge, UK, Gurevitch, J., Scheiner, Fox, G. A. 2002.
2	The Ecology of Plants. Sinauer Associates Incorporated. Loreau, M. & Inchausti, P. 2002.
3	Biodiversity and Ecosystem Functioning: Synthesis and Perspectives. Oxford Univ Press, Oxford, UK, Odum, E. P. 1971.
4	Fundamentals of Ecology. W. B. Sounders, Pandit, M. K., White, S. M. & PM. J. O., 2014.
5	The Contrasting Effects of Genome Size, Chromosome Number and P Level on Plant Invasiveness: A Global Analysis. New Phytologist 203: 697-703. Pimentel, D. (Ed.). 2011.
6	Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal Microbe Species. CRC Press. Singh, J. S., Singh, S. P. & Gupta, S. R. 2006.
7	Ecology, Environment And Resource Conservation. Anamaya Publications. Wilson, E. O. 1985.
8	The Biological Diversity Crisis. Bioscience 35: 700-706.

	EVS-302 - Technological Approaches to Environmental Treatment **Major -Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		**Bloom's Cognitive level**
CO1	Describe the principles, techniques, and technologies used for treating biomedical, hazardous, air, water, soil, noise, and radiation-related pollution.	**1**
CO2	Demonstrate the use of treatment technologies in practical scenarios to manage environmental contaminants.	**2**
CO3	Evaluate the effectiveness of various treatment technologies using case studies and real-world data.	**3**
CO4	Assess the alignment of treatment technologies with national and global environmental standards.	**4**
CO5	Propose innovative and sustainable treatment protocols for specific environmental challenges.	**5**
CO6	Link treatment technologies to broader goals of environmental sustainability and human health protection.	**6**

EVS-302 - Technological Approaches to Environmental Treatment
(Major - Theory)

Unit. No.	Title of Unit and Contents	No. of hours
1	**Biomedical and Hazardous Waste Treatment** • Classification of biomedical and hazardous waste. • Treatment methods: segregation, incineration, autoclaving, shredding, deep burial. • Hazardous waste management technologies: solidification, encapsulation, and stabilization. • Laws and guidelines: BMW Rules (2016) and Hazardous Waste Management Rules (2016). • **Case Study:** Biomedical waste management practices during the COVID-19 pandemic in India.	**5**
2	**Air Pollution Treatment Technologies** • Principles of air pollution control: source reduction, dispersion, and capture. • Devices for particulate matter: cyclones, electrostatic precipitators, fabric filters. • Gaseous pollutants treatment: scrubbers, adsorption, and catalytic converters. • Innovations: biofilters and green buildings. • **Case Study:** Implementation of smog towers in Delhi to combat air pollution.	**5**
3	**Water Treatment Technologies** • Overview of water treatment processes: primary, secondary, and tertiary treatments. • Biological treatments: activated sludge process, anaerobic digestion, and biofilms.	**5**

	• Chemical treatments: coagulation, flocculation, chlorination, ozonation. • Advanced technologies: membrane filtration, reverse osmosis, and constructed wetlands. • **Case Study:** Water treatment solutions for arsenic contamination in West Bengal.	
4	**Land and Soil Treatment Technologies** • Land remediation: bioremediation, phytoremediation, thermal desorption, and soil washing. • Waste stabilization and landfill technologies: sanitary landfills, composting, and vermicomposting. • Land application of treated sewage sludge. • Guidelines for contaminated soil management. • **Case Study:** Phytoremediation of heavy metals in industrial areas.	**5**
5	**Noise Pollution Mitigation** • Fundamentals of noise pollution and its effects on health and environment. • Noise control technologies: acoustic barriers, soundproofing, active noise control. • Urban noise management strategies: zoning, green belts, and traffic management. • Laws and standards: Noise Pollution (Regulation and Control) Rules (2000). • **Case Study:** Noise pollution reduction during the Ganesh festival in Pune.	**5**
6	**Radiation Treatment and Safety** • Types of radiation: ionizing and non-ionizing radiation. • Radiation sources: natural and anthropogenic. • Radiation safety technologies: shielding, monitoring, and controlled disposal. • Management of radioactive waste: vitrification, encapsulation, and geological disposal. • **Case Study:** Management of nuclear waste from the Kudankulam or any other Nuclear Power Plant.	**5**

Sr. No.	References
1	Soil and water conservation engineering by R. Suresh – Standard Publishers and Distributors ISBN 8180140008
2	Land and Soil Monitoring: A guide for SoE and Regional Council Reporting;New Zealand Published by the Land Monitoring Forum, New Zealand. 2009
3	Nuclear Energy – Principles, practice and prospects: S. K. Agarwal; APH Publishing Corporation
4	Bio-Energy Resources: Chaturvedi; Concept Pub.
5	Destruction of hazards chemicals in the laboratory : G. Lunn and E.B. Sansone.
6	Environmental Chemistry : M. Satake, ., Do, S. Sethi, S.A. Eqbal
7	Waste water engineering, Met Calf & Eddy ;INC, Tata mc Graw Hill
8	Waste water treatment for pollution control, Dr. Arceivala, Tata Mc Graw Hill.
9	Source book on atomic energy - S. Glasstone, D. Van Nastrand & Germany.

10	Environmental radioactivity – M. Eisendbud, Academic press
11	Essentials of nuclear chemistry – II, T. Arnikar, Wiley easter.
12	Nuclear chemistry through problems – II, T. Arnikar & N. S. Rajurkar, New age Int. (P) Ltd

	EVS-303 - Remote Sensing and GIS **Major -Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		**Bloom's Cognitive level**
CO1	Understand the basic principles of remote sensing and geographic information systems (GIS).	**1**
CO2	Analyze different types of satellite data and their applications.	**2**
CO3	Apply GIS tools for spatial data collection, analysis, and visualization.	**3**
CO4	Evaluate the role of remote sensing and GIS in environmental management and natural resource monitoring.	**4**
CO5	Investigate case studies showcasing the practical applications of remote sensing and GIS in various fields.	**5**
CO6	Develop hands-on skills in using GIS software and processing remote sensing data for real-world applications.	**6**

EVS-303 - Remote Sensing and GIS
(Major - Theory)

Unit. No.	Title of Unit and Contents	No. of hours
1	**Fundamentals of Remote Sensing** ● Definition, history, and scope of remote sensing. ● Principles of remote sensing: electromagnetic radiation, interaction with the atmosphere and Earth's surface. ● Types of remote sensing: passive and active. ● Platforms and sensors: aerial photography, satellites, and drones.	**5**
2	**Satellite Remote Sensing** ● Overview of satellite systems: Landsat, Sentinel, MODIS, and others. ● Types of satellite imagery: optical, thermal, and microwave. ● Resolution: spatial, spectral, temporal, and radiometric. ● Image processing: pre-processing, enhancement, classification, and interpretation.	**5**
3	**Basics of Geographic Information Systems (GIS)** ● Definition and components of GIS: hardware, software, data, people, and methods. ● Spatial data: types, formats, and sources. ● Coordinate systems and map projections. ● Data input, editing, and georeferencing.	**5**
4	**Spatial Analysis in GIS** ● Vector and raster data models: concepts and applications. ● Overlay analysis, buffer analysis, and network analysis. ● Spatial interpolation and digital elevation models (DEM). ● Geospatial statistics and data visualization.	**5**
5	**Applications of Remote Sensing and GIS** ● Environmental management: land use/land cover mapping, deforestation, and wetland monitoring.	**5**

	• Disaster management: flood, drought, and forest fire monitoring. • Agriculture: crop monitoring, soil analysis, and irrigation planning. • Urban planning: mapping infrastructure, population density, and urban sprawl.	
6	**Advanced Topics and Emerging Trends** • Integration of remote sensing and GIS. • Role of GPS in spatial data collection. • Use of drones and UAVs in geospatial studies. • Big data and artificial intelligence in remote sensing and GIS applications.	**5**

Sr. No.	References
1	Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). *Remote Sensing and Image Interpretation*. Wiley.
2	Jensen, J. R. (2007). *Remote Sensing of the Environment: An Earth Resource Perspective*. Pearson.
3	Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing*. Guilford Press.
4	Chang, K. T. (2018). *Introduction to Geographic Information Systems*. McGraw-Hill Education.
5	Burrough, P. A., & McDonnell, R. A. (1998). *Principles of Geographical Information Systems*. Oxford University Press.
6	Singh, R. B., & Murai, S. (1998). *Space Informatics for Sustainable Development*. Oxford & IBH Publishing.

	EVS-304 - Basics of Environmental Statistics Elective -Theory	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to		**Bloom's Cognitive level**
CO1	Describe concept of population and sample in Environmental statistics	**1**
CO2	Express variables in diagrammatic and graphical form	**2**
CO3	Evaluate Environmental datasets and calculate its central component.	**3**
CO4	Compute measures of dispersion with the help of suitable tools	**4**
CO5	Select suitable dispersion measures and apply it.	**5**
CO6	Apply their skills of Environmental statistics and construct various indices	**6**

EVS-304 - Basics of Environmental Statistics
(Elective – Theory)

Unit. No.	Title of Unit and Contents	No. of hours
1	**Introduction** • Role of statistics in Environmental research • Introduction to concept of Statistics, Population, Sample, Data • Concept of univariate, bivariate data • Sampling • Types of sampling - Random and non-random	**5**
2	**Data Presentation** • Types of data: Discrete and continuous data, • Frequency and non-frequency data • Frequency distributions • Sample collection and data presentation methods • Diagrammatic methods • Graphical methods	**5**
3	**Experiment design** • Experimental Design and sample collection • Statistical Inference • Hypothesis Testing, p-value • Types of Hypothesis	**5**
4	**Measures of Central Tendency** • Arithmetic mean • Median • Mode • Geometric mean • Harmonic mean	**5**
5	**Measures of Dispersion** • Range • Mean deviation • Variance • Standard deviation • Skewness and Kurtosis	**5**

6	**Applications** • Introduction to indices used for various Environmental studies • Examples based on ecology and ecosystem, weather and air quality monitoring, soil quality data, water and effluent data, etc.	**5**

Sr. No.	References
1	Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C. S., Jansson, B. O. Levin, S., Maler, K. G., Perrings, C., Pimentel, D. 1995. Economic Growth, Carrying Capacity and the Environment. Ecological Economics 15: 91-95.
2	Hanley, N., Shogren, J. F., & White, B. 2007. Environmental Economics: In Theory and Practice. Palgrave Macmillan.
3	Kolstad, C. D. 2010. Environmental Economics. Oxford University Press.
4	Perman, R. 2003. Natural Resource and Environmental Economics. Pearson Education.
5	Singh, K. & Shishodia, A. 2007. Environmental Economics: Theory and Applications.Sage Publications.
6	Thomas, J. M. & Callan, S.J. 2007.Environmental Economics. Thomson Learning Inc.
7	Tietenberg, T. 2004. Environmental and Natural Resource Economics (6th edition). Pearson Education Pvt. Ltd.
8	Tietenberg, T. H. & Lewis, L. 2010. Environmental Economics and Policy. Addison -Wesley.
9	Turner, R. K., Pearce, D., & Bateman, I. 1994. Environmental Economics: An Elementary Introduction. Harvester Wheatsheaf.

	EVS-305 - Environmental Data Analysis and Interpretation Elective-Theory	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to		**Bloom's Cognitive level**
CO1	Define key terms and concepts related to environmental data, types of data, and data collection methods.	**1**
CO2	Explain the importance of statistical tools in the analysis of environmental data.	**2**
CO3	Use statistical software tools to perform basic data analysis.	**3**
CO4	Analyze Environmental data for trends, correlations, and patterns using appropriate statistical and visualization techniques.	**4**
CO5	Critically assess the quality, reliability, and validity of environmental data and its interpretation.	**5**
CO6	Design and present reports and visualizations to communicate the findings of Environmental data analysis	**6**

EVS-305 - Environmental Data Analysis and Interpretation (Elective-Theory)

Unit. No.	Title of Unit and Contents	No. of hours
1	**Introduction to Environmental data** • Types of Environmental Data: Qualitative and Quantitative • Sources of Environmental Data • Data Collection Methods -Sampling, Surveys, Geospatial • Introduction to Environmental Databases and platforms	**5**
2	**Statistical Tools for Data Analysis** • Introduction to Statistics in Environmental Science • Descriptive Statistics: Mean, Median, Mode, Range, Standard Deviation • Inferential Statistics: Hypothesis Testing, Confidence Intervals • Software Tools for Statistical Analysis	**5**
3	**Data visualization techniques** • Importance of Data Visualization in Environmental Science • Types of Graphs: Bar Charts, Histograms, Pie Charts • Scatter Plots, Line Graphs, Histogram and Time Series Plots • Creating Effective Visualizations Using Excel, PAST, etc	**5**
4	**Environmental Modelling** • Introduction to Environmental Modelling • Types of Environmental Models (Deterministic, Stochastic) • Importance of Calibration and Validation • Application of Models in Environmental Impact Assessment	**5**
5	**Interpretation of Environmental data** • Understanding Environmental Data Trends and Patterns • Identifying Outliers and Anomalies • Statistical Significance in Environmental Data	**5**

	• Case Studies in Data Interpretation: Climate Change, Pollution Studies, etc • Decisions making based on data	
6	**Communicating Environmental data** • Scientific data communication for research publication • Communicating Results to Policy Makers, Public awareness • Visual Representation of Data in Presentations • Case Studies of Successful Communication in Environmental Science	**5**

Sr. No.	References
1	Lal, R. (2016). *Soil and Environmental Data Collection and Interpretation: A Global Perspective*. Springer.
2	Kirkwood, B. R., & Sterne, J. A. C. (2003). *Essential Medical Statistics* (2nd ed.). Blackwell Science.
3	Turner, R. K., & Clark, J. A. (1999). *Environmental Economics: An Introduction to Sustainable Development*. Routledge.
4	McCarty, G. W., & Munn, R. S. (2014). *Environmental Data Analysis with MATLAB*. Wiley.
5	Helsel, D. R., & Hirsch, R. M. (2002). *Statistical Methods in Water Resources* (Techniques of Water-Resources Investigations). U.S. Geological Survey.
6	Wilkinson, L., & Friendly, M. (2009). *The Grammar of Graphics*. Springer.
7	Maidment, D. R. (2002). *ArcGIS for Environmental Data Management*. ESRI Press.
8	Voinov, A., & Bousquet, F. (2010). *Modelling with Stakeholders: Methods and Tools for Integrated Environmental Assessment*. Springer.
9	Sokal, R. R., & Rohlf, F. J. (2012). *Biometry: The Principles and Practice of Statistics in Biological Research* (4th ed.). W.H. Freeman and Company.
10	Babbie, E. (2017). The Practice of Social Research (14th ed.). Cengage Learning.

	EVS-306 - Trends in Climate Change and Sustainability Elective -Theory	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to		Bloom's Cognitive level
CO1	Understand the global climate system, and drivers of climate change.	**1**
CO2	Analyze the socio-economic and ecological impacts of climate change.	**2**
CO3	Evaluate national and international policies, efforts to address climate change.	**3**
CO4	Explore strategies and frameworks for achieving sustainable development goals.	**4**
CO5	Develop technical skills for environmental conservation and sustainability assessments.	**5**
CO6	Investigate new developments in sustainability practices and tools.	**6**

EVS-306 - Trends in Climate Change and Sustainability
(Elective-Theory)

Unit. No.	Title of Unit and Contents	No. of hours
1	**Global Climate System and Challenges** • Understanding the global climate system: Internal variability and external climate forces. • Evidence and measurement of climate change: Historical and contemporary trends. • Impacts of climate change on life, vegetation, fauna, and biodiversity. • Economics of climate change: Water scarcity, food security, and socio-economic challenges. • Case study: Climate change effects on agriculture in India.	**5**
2	**Confronting Climate Change: Policies and Efforts** • National Action Plan on Climate Change (NAPCC) and its missions. • National Adaptation Fund on Climate Change (NAFCC) and mitigation programs. • UNFCCC, IPCC reports, and international agreements like the Paris Agreement. • Role of organizations like NASA and ISRO in climate change research. • Flagship Initiatives by United Nations • Digitalisation and Decarbonisation • Case study: India's adaptation strategies for rising temperatures.	**5**
3	**Mitigation Approaches in Climate Change** • Climate change modelling and prediction tools. • Carbon emission reduction technologies and carbon sequestration.	**5**

	• Governance and policy frameworks for climate change mitigation. • Integrated Assessment Models (IAMs) for economic evaluation of mitigation strategies. • Climate-resilient infrastructure • Case study: Successful carbon capture initiatives in developed nations.	
4	**Sustainable Development Goals and Strategies** • The 2030 Agenda for Sustainable Development and UN Sustainable Development Knowledge Platform. • Criticisms and challenges in achieving sustainability goals, with a focus on gender equality and education. • Role of public engagement in sustainable development. • Water conservation and sustainable urbanization: Challenges and frameworks. • Sustainable Livelihoods and Adaptation to Climate Change (SLACC) • Case study: Implementation of sustainable cities initiatives in India.	**5**
5	**Environmental Conservation and Sustainability** • Technical skills for environmental sustainability: GIS and remote sensing applications. • Environmental governance and the role of sustainability in economic development. • Challenges in energy, food, forest, and agricultural sustainability. • Risk Management and Agricultural Insurance • Urbanization and its impact on sustainable cities. • Case study: Role of CSR in environmental conservation in Indian industries.	**5**
6	**New Developments in Sustainability** • Appropriate technologies for sustainable development. • Sustainability metrics and indices: Ecological and carbon footprints. • Life cycle assessment (LCA) as a tool for sustainability measurement. • Sustainability assessment of food and agriculture (SAFA). • Digital Climate Advisory Services (DCAS) • Case study: Corporate sustainability practices in global organizations.	**5**

Sr. No.	References
1	"Sustainable Development: India's Journey" by G.K. Karanth, Sage Publications, 2012. ISBN: 978-8132114142
2	"Environmental Studies: From Crisis to Cure" by R. Rajagopalan, Oxford University Press, 2016. ISBN: 978-0198064594
3	"Climate Change and Sustainable Development: A Profile of India" by M. Partha Das, Oxford University Press, 2015. ISBN: 978-0199458904

4	"Environmental Impact Assessment: Theory and Practice" by S.K. Agarwal, APH Publishing, 2004. ISBN: 978-8176486976
5	"Environmental Governance in India: Institutions and Practices" by Chandra Sekhar S. and Venugopalan R., Sage Publications, 2019. ISBN: 978-9353284317
6	"Climate Change: A Very Short Introduction" by Mark Maslin, Oxford University Press, 2014. ISBN: 978-0199606171
7	"The Economics of Climate Change: The Stern Review" by Nicholas Stern, Cambridge University Press, 2007. ISBN: 978-0521700801
8	"Sustainability: A History" by Jeremy L. Caradonna, Oxford University Press, 2014. ISBN: 978-0199366542
9	"Environmental Governance: Power and Knowledge in a Local-Global World" by James Evans, Routledge, 2012. ISBN: 978-0415572977
10	"Environmental Policy and Public Health: Air Pollution, Global Climate Change, and Wilderness" by Barry L. Johnson, Elsevier, 2012. ISBN: 978-0123946125

	EVS-307 - Smart Cities and Environmental Sustainability Elective -Theory	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to		Bloom's Cognitive level
CO1	Understand the concept of smart cities and their role in achieving environmental sustainability.	**1**
CO2	Analyze the integration of technology and urban planning for sustainable development.	**2**
CO3	Evaluate energy-efficient, resource-conserving, and environmentally friendly solutions in smart cities.	**3**
CO4	Assess case studies of smart city projects in India and abroad.	**4**
CO5	Explore innovative approaches to waste management, water conservation, and urban resilience.	**5**
CO6	Develop interdisciplinary strategies to improve urban sustainability in a smart city context.	**6**

EVS-307 - Smart Cities and Environmental Sustainability (Elective –Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Introduction to Smart Cities** • Definition, principles, and components of smart cities. • Evolution of smart cities: Global and Indian perspectives. • Role of technology in smart cities: IoT, AI, and big data. • Challenges in smart city implementation in developing countries. • Case study: Smart City Mission in India – Overview and progress.	**5**
2	**Environmental Sustainability in Smart Cities** • Integration of sustainability in smart city planning. • Urban ecosystem management and green infrastructure. • Renewable energy solutions and energy-efficient systems • Sustainable transport: Electric vehicles and smart mobility. • Climate Smart Cities Assessment Framework • Case study: Masdar City (UAE) – A model for sustainability.	**5**
3	**Urban Waste and Water Management** • Smart solutions for waste management • Water conservation techniques in urban settings. • Water grid systems: Real-time monitoring and management. • Circular economy principles in waste and water systems. • Case study: Indore's waste management system.	**5**
4	**Urban Resilience and Climate Adaptation** • Resilience planning for climate change in urban areas. • Disaster risk reduction strategies for smart cities. • Smart city approaches to urban flooding and heatwaves. • Role of citizen participation in urban climate adaptation. • Case study: Copenhagen's climate adaptation strategies.	**5**

5	**Smart Governance and Policy Frameworks** • Governance models for smart and sustainable cities. • Policies supporting smart city development in India. • Public-private partnerships (PPPs) in urban sustainability. • Financial mechanisms for smart city projects. • Pune Smart City Development Corporation Limited.	**5**
6	**Innovations and Future Trends in Smart Cities** • Emerging technologies in smart city development: Blockchain and drones. • AI-driven urban planning and decision-making tools. • Smart city indices and benchmarking. • Urban farming and smart food systems. • Songdo International Business District (South Korea).	**5**

Sr. No.	References
1	"Smart Cities: Unbundling Urban Infrastructure" by V. S. Kharbanda and S. P. Bansal, Tata McGraw-Hill, 2020.
2	"Sustainable Urban Development in India" by Isher Judge Ahluwalia, Oxford University Press, 2014.
3	"Urban Development and Governance in India" by Ramakrishna Nallathiga, Routledge India, 2020.
4	"India's Smart Cities Mission: A Framework for Urban Resilience" by Gopal Krishna and P. C. Mohanan, Sage Publications India, 2021.
5	"Environmental Sustainability in Urban India" by Shyamala Mani, Springer India, 2018.
6	"Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia" by Anthony M. Townsend, W.W. Norton & Company, 2013.
7	"The Smart Enough City: Putting Technology in Its Place to Reclaim Our Urban Future" by Ben Green, MIT Press, 2019.
8	"Sustainable Urban Development" by Stephen Wheeler, Routledge, 2013.
9	"Eco-Cities: A Global Survey 2020" by Richard Register, Green Books, 2020.
10	"Urban Sustainability and Resilience: Concepts, Principles, and Practices" by Yoshiki Yamagata and Hiroshi Maruyama, Springer, 2016.

	EVS-311 - Environmental Science Practical-5 **Major-Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Understanding importance and values of wetland and mangrove ecosystem	**1**
CO2	Evaluate the impact of pollution with reference to process of eutrophication	**2**
CO3	Assess case studies of different ecosystems	**3**
CO4	To Compare different microflora from soil	**4**
CO5	To assess the impact of pollution on different water quality parameters	**5**
CO6	To design STP/ETP based on given data	**6**

EVS-311 - Environmental Science Practical-5
(Major-Practical)

Practical's Based on EVS-301:

1. Assessment of values of a wetland
2. Comparative analysis of oligotrophic and eutrophic water bodies by using Indices
3. Study of threat assessment model for an ecosystem
4. Study of soil microflora from root nodules
5. Study of keystone species from a forest region
6. Study of swamp (mangrove) ecosystem of Konkan coast (Visit),Studies on benthic fauna
7. Study of wetland ecosystem (field practical)
8. Estimation of chlorophyll content from given plant material

Practical's Based on EVS-302: Technological Approaches to Environmental Treatment

1. Characterization of domestic/municipal/college waste.
2. Treatment of biological waste by anaerobic digestion.
3. Design of ETP / STP by using given data.
4. Measurement of equivalent noise level by SLM from silent, industrial, residential and commercial zones.
5. Estimation of chemical oxygen demand from given wastewater sample.
6. Estimation of biological oxygen demand from given wastewater sample.
7. Study of a jar test for wastewater treatment.
8. Visit to hazardous waste/biomedical waste treatment facility/ ETP/ STP.

Practical's Based on EVS-303:

1. Introduction to GIS Software: Hands-on training on GIS software (e.g., QGIS or ArcGIS).
2. Image Interpretation and Analysis: Interpretation of satellite imagery for land use and land cover mapping.
3. Data Georeferencing: Georeferencing scanned maps and satellite images.
4. Digitization and Attribute Data Handling: Digitization of features such as roads, rivers, and administrative boundaries.
5. Spatial Analysis: Performing buffer, overlay, and proximity analysis in GIS.
6. DEM Creation and Analysis: Generation of Digital Elevation Models and slope/contour mapping.
7. Change Detection Using Remote Sensing: Analyzing temporal changes in land use using multi-temporal satellite data.

Field Data Integration: Collecting GPS data and integrating it into GIS for mapping and analysis.

	EVS-312 - Environmental Science Practical-6 **Major -Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Apply statistical and data analysis tools to process and interpret environmental datasets for scientific and practical use.	**1**
CO2	Use data visualization techniques and software to communicate environmental insights and trends effectively.	**2**
CO3	Utilize tools and methods to assess environmental sustainability, climate impacts, and resource management.	**3**
CO4	Analyze and evaluate smart city solutions, focusing on sustainability, energy efficiency, and urban infrastructure.	**4**
CO5	Evaluate and apply statistical tools and data visualization methods to assess and communicate environmental trends, impacts, and decision-making.	**5**
CO6	Apply data analysis, modeling tools, and sustainability assessments to evaluate environmental impacts.	**6**

EVS-312 - Environmental Science Practical-6
(Major - Practical)

SEM V

Practical's Based on EVS-304

1. Using Excel, create a frequency polygon for provided dataset, including class intervals and frequency calculations.
2. Using Excel, create a dual-axis bar and line chart with standard deviation (SD) values, ensuring all elements are clearly labelled.
3. Prepare four types of suitable charts from the given data separately for each parameter by using features of MS excel. Also, show standard deviation in chart.
4. Using the provided dataset, perform a correlation analysis between two specified
    i. variables and interpret the results
5. Using Power BI, create a sales dashboard that includes visualizations, insights, and filters for selected attributes.
6. Using PAST software, perform Principal Component Analysis, Classical Clustering, and Similarity-Distance Indices for the data.
7. Using Excel, calculate the skewness of the provided dataset and generate a corresponding skewness curve.
8. Calculate the measures of central tendency (mean, median, and mode) for the given
    a. grouped data using excel and present the results
9. Calculate the mean, variance, and standard deviation for the given frequency grouped data table using the appropriate statistical formulas
10. Perform an assessment of the descriptive statistics including percentile, frequency table and histogram for the given data set using Microsoft Excel
11. Using Excel, calculate the measures of dispersion (variance and standard deviation) for the given grouped data.

Practical's Based on EVS-305

1. Explore Environmental Data by various using Methods, Sources
2. Apply statistical tools analysing Environmental data -From Basics to Advanced

3. Learn data visualization techniques for scientific communication
4. Understand Environmental Modelling Approaches
5. Use Data Collection and Analysis methods in Environmental Science
6. Interpreting Environmental Data -Identifying Trends and Making Decisions like Time series analysis
7. Statistical analysis in Environmental Science using open source software
8. Evaluate effective communication methods from Research to Policy
9. Understanding and using Environmental Data for Impact Assessment
10. Turning primary Environmental Data into applications by analysis and visualization tools

Practical Based on EVS-306

1. Analyze global fish production trends using FAO FISHTAT and explore projected climate changes for South Asia using the IPCC Interactive Atlas.
2. Perform a life cycle assessment for a PET bottle using the Open LCA software.
3. Calculate the crop water requirements for a selected location in Maharashtra state.
4. Conduct forward and backward trajectory analysis during cyclonic period for any Indian city.
5. Predict temperature changes and key environmental impacts using a climate change simulator under various conditions.
6. Estimate carbon emissions based on the provided case study example.
7. Compute the carbon footprint using three software tools and compare the obtained results.
8. Utilize the National Forest Monitoring System (NFMS) tool to assess forest-related data and generate insights.
9. Conduct a sustainability assessment for a selected area using the Municipal Government Self-Assessment Sustainability Tool
10. Use the Farm Sustainability Assessment (FSA) Tool to assess, improve, and validate on-farm sustainability in their supply chains
11. Compare wind patterns for four Indian cities using Envitrans and analyze factors affecting wind direction & speed
12. Conduct a case study analysis of Tuvalu Island's adaptation strategies to combat the impacts of climate change
13. Using the Basic Sustainability Assessment Tool (BSAT), evaluate the sustainability of a project of your choice.
14. Utilizing the Net-Zero Ambition Assessment Tool (NZAAT), assess the net-zero ambitions of an organization of your choice.
15. Assessing sustainability: Assessment of Food and Agriculture Systems

Practical Based on EVS-307

1. Study the components of smart cities by analyzing local examples and comparing global standards.
2. Analyze the evolution of smart cities by examining case studies from India and global perspectives.
3. Implement IoT-based solutions for smart city monitoring by collecting real-time data from various urban sectors.
4. Identify challenges in smart city implementation by conducting a survey in developing countries to assess technology gaps.
5. Assess the progress of India’s Smart City Mission through case studies, focusing on challenges and achievements.
6. Evaluate urban sustainability integration in smart city planning by comparing different city models.

7. Measure green infrastructure in urban areas by studying urban ecosystem management and sustainable landscaping practices.
8. Analyze renewable energy applications in smart cities, focusing on energy-efficient systems like solar and wind power.
9. Study electric vehicles and smart mobility solutions by analyzing their role in reducing urban emissions and traffic congestion.
10. Examine the sustainability model of Masdar City in the UAE, focusing on its energy and waste management systems.
11. Implement smart waste management solutions by monitoring the effectiveness of automated waste sorting and collection systems.
12. Design water conservation techniques for urban settings by evaluating rainwater harvesting and wastewater treatment systems.
13. Study real-time water grid systems by using smart sensors and monitoring software to assess water distribution efficiency.
14. Analyze circular economy principles in waste and water systems by studying closed-loop recycling in urban contexts.
15. Evaluate Indore's waste management system through field research, focusing on waste segregation and recycling processes.

	EVS-331 - Design and Development of Eco-friendly Products VSC-Theory	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to		Bloom's Cognitive level
CO1	Outline the concept of Eco-design.	**1**
CO2	Articulate the importance of various supporting schemes and organizations for startups.	**2**
CO3	Apply skills of circular economy for evaluating sustainability	**3**
CO4	Analyse Eco Friendly products with various tools and interpret impacts	**4**
CO5	Review and connect the social and environmental needs with employment generation	**5**
CO6	Design and develop eco products using natural raw material	**6**

EVS-331 - Design and Development of Eco-friendly Products (VSC - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Eco design** • Concept and Principles, • Factors and Guidelines for implementation • Tools used in Eco designing **Eco-mark scheme** • Eco-labelling for eco-friendly products, • Eco-mark scheme, • BIS implementation guidelines **Circular Economy** • Sustainable consumption and production pattern • Phases of Circular economy • Methods and sustainability in process • Case studies	**5**
2	**Eco-friendly products:** • Need and Scope • Harmful effects of existing products in the market, Effect • on environment: water, soil, plants etc., • Adverse effects Human health, Benefits of eco products • **Marketing aspects:** Market research for product, • **Examples**: Herbal colours, soaps and dish washing liquid Etc. from natural ingredients etc. • Eco Friendly product formulation	**5**
3	**Waste to Wealth:** • Product formulation using waste material, • Paper and fabrics products • Organic waste to value added product formation • **Fuel pallets:** Alternative to non-renewable energy resource. Raw material,	**5**

4	**Herbal and eco-friendly cleaning products:** • Soap making: • Raw material: Availability, cost, ingredients, importance • Additional accessories, Safety measures, Production • process: hot and cold process, Benefits and limitations **Bio enzymes:** Raw material, production process, Environmental Significance • Homemade dishwashing liquid: Raw availability, cost, • preparation, benefits and limitations	**5**
5	**Government schemes to support start up:** • Pradhan Mantri Mudra Yojana, Ministry of Micro, Small • and Medium Enterprises, Govt. of India, Government • funding for startup, Startup India Network, **Connect with Incubators**: Find incubators in your region that can support your startup's growth, **Connect with Government:** • Reach out to the relevant Ministries or Departments **Organizations:** • Governmental and nongovernmental organizations • Examples: KVIC support etc.	**5**
6	**Cost benefit analysis:** • Product cost and environmental cost of existing products in the market Eco alternative products. • Success stories of Eco-pruners.	**5**
	Course conduct: • Classroom teaching, videos, demonstrations, interaction with experts, workshop on entrepreneurship, training program, field survey. • **Assessment:** 1. Practical skill, involvement of student, feedback and remark by interaction with NGO/ agency 2. Work in sales/ marketing of products, submission of reports etc. 3. Development of one eco-friendly product	

Sr. No.	References
1	Bharagava, R. N., & Chowdhary, P. (Eds.). (2019). *Emerging and eco-friendly approaches for waste management* (pp. 245-269). Berlin, Germany:: Springer.
2	Chahal, K. S., & Solanki, T. (Eds.). (2022). *Green Chemistry for the Development of Eco-friendly Products*. IGI Global.
3	Isaacs, S. M. (2015). *Consumer perceptions of eco-friendly products*. Walden University.
4	Loux, R. (2008). *Easy green living: the ultimate guide to simple, eco-friendly choices for you and your home*. Rodale Books.
5	Singh, A. K., & Raj, A. (2020). Emerging and eco-friendly approaches for waste management: a book review.
6	Soto, H. F., & Lively, P. (2014). Eco-Friendly Sustainability: Ebooks and the American Market. *Manuel Brito (ed.)*, 99.

	EVS-332 - Environmental Science Practical-7 **VSC -Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Outline the concept of Eco-design.	**1**
CO2	Articulate the importance of various supporting schemes and organizations for startups.	**2**
CO3	Apply skills of circular economy for evaluating sustainability	**3**
CO4	Analyse Eco Friendly products with various tools and interpret impacts	**4**
CO5	Review and connect the social and environmental needs with employment generation	**5**
CO6	Design and develop eco products using natural raw material	**6**

EVS-332 - Environmental Science Practical-7
(VSC - Practical)

Practical Based on EVS-332 (VSC practical)

1. Bio-enzyme cleaner preparation
2. Preparation of fuel pallets using waste material
3. Conduct a market survey for eco-friendly product
4. Preparation of herbal products .e.g herbal colour, hand sanitizer, shampoo
5. Preparation of Single Cell Protein (SCP)
6. Demonstration / Preparation of Compost, Vermi- compost etc
7. Cost benefit Analysis of Eco-friendly Vs synthetic product
8. Interview of successful eco entrepreneur
9. Production of Herbal mosquito repellent eco paints,
10. Preparation of Eco-bricks
11. Herbal cosmetic Products. e.g face cream, Organic lip bam etc.
12. Any other practical relevant to Eco friendly product design and development

Learning Resources

1. Kozuch, J. J. (2012). Clean tech intellectual property: eco-marks, green patents, and green innovation.
2. Lane, E. L. (2009). Consumer protection in the eco-mark era: A preliminary survey and assessment of anti-greenwashing activity and eco-mark enforcement. *J. Marshall Rev. Intell. Prop. L.*, *9*, i.
3. Morel, M., & Kwakye, F. (2012). Green marketing: consumers Attitude towards Eco-friendly products and purchase intention in the Fast Moving Consumer Goods (FMCG) sector.
4. Ottman, J. (2017). *The new rules of green marketing: Strategies, tools, and inspiration for sustainable branding*. Routledge.
5. Sivertsen, L., & Sivertsen, T. (2008). *Generation Green: The Ultimate Teen Guide to Living an Eco-Friendly Life*. Simon and Schuster.
6. Thakur, V. K., & Thakur, M. K. (Eds.). (2015). *Eco-friendly polymer nanocomposites: chemistry and applications* (Vol. 74). Springer.

	EVS-321 - Issues in Environmental Science Minor -Theory	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to		**Bloom's Cognitive level**
CO1	Understand the major environmental issues and their causes.	**1**
CO2	Analyze the interconnections between environmental, social, and economic dimensions of sustainability.	**2**
CO3	Evaluate the impact of pollution, resource depletion, and climate change on ecosystems and human health.	**3**
CO4	Examine the role of environmental policies, laws, and organizations in addressing environmental issues.	**4**
CO5	Investigate emerging global environmental challenges and potential mitigation strategies.	**5**
CO6	Develop critical thinking and problem-solving skills to address real-world environmental problems.	**6**

EVS-321 - Issues in Environmental Science
(Minor - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Fundamentals of Environmental Science** ● Definition, scope, and importance of environmental science. ● Concept of sustainability and sustainable development. ● Interdependence of ecological, social, and economic systems. ● Role of science and technology in solving environmental issues.	**5**
2	**Pollution and Environmental Degradation** ● Air pollution: sources, effects, and control measures. ● Water pollution: types, causes, and impact on aquatic ecosystems. ● Soil pollution and land degradation: causes and restoration strategies. ● Noise and light pollution: effects on health and biodiversity.	**5**
3	**Climate Change and Global Warming** ● Greenhouse gases and their effects on global temperature. ● Impacts of climate change on ecosystems, agriculture, and human health. ● International agreements: Kyoto Protocol, Paris Agreement, and IPCC reports. ● Mitigation and adaptation strategies to combat climate change.	**5**
4	**Resource Depletion and Waste Management** ● Depletion of natural resources: water, soil, minerals, and forests. ● Solid waste management: municipal, industrial, and hazardous waste. ● Principles of 3Rs: reduce, reuse, and recycle.	**5**

	• E-waste and plastic waste: challenges and management strategies.	
5	**Biodiversity Loss and Conservation** • Causes of biodiversity loss: habitat destruction, invasive species, and overexploitation. • Importance of biodiversity and ecosystem services. • Strategies for conservation: in-situ and ex-situ methods. • Role of community participation in biodiversity conservation.	**5**
6	**Emerging Environmental Issues** • Environmental impact of urbanization and industrialization. • Environmental health and diseases: air and waterborne diseases. • Renewable energy sources and their role in sustainable development. • Role of environmental education, ethics, and awareness in tackling environmental issues.	**5**

Sr. No.	References
1	Cunningham, W. P., & Cunningham, M. A. (2018). *Environmental Science: A Global Concern*. McGraw-Hill Education.
2	Tyler Miller, G., & Spoolman, S. (2019). *Living in the Environment: Principles, Connections, and Solutions*. Cengage Learning.
3	Chapman, J. L., & Reiss, M. J. (2005). *Ecology: Principles and Applications*. Cambridge University Press.
4	Odum, E. P., & Barrett, G. W. (2004). *Fundamentals of Ecology*. Brooks Cole.
5	Carson, R. (1962). *Silent Spring*. Houghton Mifflin.Smith, T. M., & Smith, R. L. (2015). *Elements of Ecology*. Pearson.

	EVS-345 - Field Project **FP-Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Apply field-based research methods to investigate environmental issues.	**1**
CO2	Demonstrate skills in data collection, analysis, and interpretation.	**2**
CO3	Assess ecosystem components, biodiversity, and environmental quality.	**3**
CO4	Examine human-environment interactions and sustainability challenges.	**4**
CO5	Communicate findings effectively through reports and presentations.	**5**
CO6	Propose practical solutions for local environmental concerns.	**6**

Students are required to complete a field project as part of their academic coursework, working in small groups while submitting individual reports. The project should align with environmental science topics such as biodiversity, pollution, or sustainability. Before starting, a proposal outlining objectives, methodology, and expected outcomes needs to be submitted. Maintaining a weekly progress record and updating the supervisor is essential. Field visits should follow ethical and safety guidelines, with necessary permissions obtained. Accurate data collection and proper documentation of findings are important. A final report detailing methodology, analysis, and conclusions must be submitted on time, accompanied by a presentation summarizing the project work and key learnings. Active participation, teamwork, and adherence to deadlines will be considered in the evaluation.

T.Y. B.Sc. SEMESTER VI		
	EVS-351 - Environmental Biotechnology **Major -Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Recall the basic concepts, objectives and scope of Environmental Biotechnology and enlist applications of biotechnology in the field of Environment.	**1**
CO2	Explain the terms biopolymers, bioindicators and biosensors. Discuss the role bioindicators and biosensors play in the monitoring of environmental pollutants.	**2**
CO3	Apply the knowledge of biotechnology in the field of agriculture with reference to biopesticides, biofertilizers, composting and vermicomposting Demonstrate process of phytoremediation and select appropriate method and plants suitable for phytoremediation process.	**3**
CO4	Compare methods used for bioleaching and recognize role of microbes in the recovery of metals and oil. Explain the concepts of bio-augmentation and bio-stimulation. Identify the factors affecting bioremediation process.	**4**
CO5	Review the concept, Environmental ethical social and health problems associated with GMO's.	**5**
CO6	Prepare a flow chart for production of biopesticides and biofertilizers.	**6**

EVS-351 - Environmental Biotechnology
(Major - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Environmental Biotechnology** • Meaning, objectives, need and scope • Applications of environmental biotechnology **Genetically Modified Organisms (GMOs)** • GMO's concept • Environmental, ethical, social and health • Problems associated with GMO's • Biosafety regulations, Cartagena protocol	**5**
2	**Biotechnology for Sustainable Agriculture** **Biopesticides** • Classification of biopesticides • Microbial biopesticides • Production process, stabilization, formulation, mode of action • Plant Product as biopesticides e.g. Neem pesticides **Biofertilizers** • Types of biofertilizers, Production and role in soil fertility,	**5**

	• Agro based solid waste & its use	
3	**Composting** Composting technology and methods of production, Design aspects and factors influencing the process, Temperature trends and influencing factors, Composition and quality of compost **Vermicomposting** Earthworm life cycle, Operating process, Characteristics of vermicomposting	**5**
4	**Bioremediation** • Microbial Remediation Process • Principles of bioremediation, • Concept of bio augmentation and bio stimulation, • Factors affecting the bioremediation process: microbial metabolism, environmental conditions and nature of pollutants, • Types of Bioremediation	**5**
5	**Phytoremediation** • Concept, factors affecting phytoremediation, • Plants useful for phytoremediation, removal of metals and • organic pollutants • Types of phytoremediation: • Phytoextraction, Phytostabilization, Rhizofiltration, • Phytotransformation, Phytovolatilization, Current developments in the process.	**5**
6	**Biopolymers, Biosensors and Bioindicators** **Biopolymers and bioplastics** • Concept of biopolymers • Types of biopolymers and its applications **Biosensor** • Concept of Biosensors • Design and components, • Applications of biosensors in environmental monitoring **Bioindicators** • Concept of bioindicators, • Microbial indicators organisms • Indicators of water pollution: Plankton community as an indicators • Microbiological quality of potable water • Indicators of air pollution: lichens as indicators. • Indicators of climate change	**5**

Sr. No.	References
1	Environmental Biotechnology. M. H. Fulekar.
2	Environmental Biotechnology: Basic Concepts and Applications. InduShekhar Thakur, I. K. International Pvt. Ltd.
3	Environmental Biotechnology. Alan Scragg, Oxford University
4	Handbook of Organic Waste Conversion by Bewik M.W.M.

	EVS-352 - Environment Impact Assessment and Management Major-Theory	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Analyze the scope, importance, and opportunities in EIA practices in relation to sustainable development.	**1**
CO2	Examine methods for impact assessment and prediction.	**2**
CO3	Assess the Environmental Management Plan and mitigation measures.	**3**
CO4	Discuss important guidelines of Environmental Management System standards.	**4**
CO5	Illustrate standard practices of management and development of standards.	**5**
CO6	Demonstrate skills for performing Environmental Audits.	**6**

EVS-352 - Environment Impact Assessment and Management
(Major - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**EIA** • EIA: Scope and Objectives • Relationship between EIA and sustainable development • Key provisions of EIA Notification 1994 & 2006 (with amendments) • Role of statutory bodies (MoEFCC, CPCB, SPCBs) • International guidelines on EIA (World Bank, UNEP, EU Directives) • Components and Process- Screening, scoping, impact analysis, mitigation, reporting, public participation • Baseline Data - Physical, biological, and socio-economic components, Methods of data collection • Challenges in EIA implementation	**5**
2	**Methods** • Qualitative & Quantitative Approaches • Ad Hoc Method – Expert judgment and rapid assessment • Checklists – Simple, descriptive, and weighted checklists • Matrices – Leopold and other impact matrices • Networks – Cause-effect relationships • Simulation Modelling – Predictive models for environmental changes • Overlays and GIS Applications – Spatial analysis and mapping for impact assessment	**5**
3	**EMP** • Identification of significant environmental impacts • Mitigation Plans, Relief & Rehabilitation • Risk Assessment and Disaster Management Plan • Hazard identification, exposure assessment, risk characterization • Review of Environmental Management Plan	**5**

	• Draft of EIA report-Structure and content of an EIA report	
4	**EMS** • Introduction to Environment management systems • Organization's approach to the Environment • Environmental and economic sustainability • Concept of EMAS and EMS standards and tools • Projecting EMS: planning, implementation, general requirements, control tasks • Evaluation of Environmental performance	**5**
5	**ISO 14001:2015** • ISO governance, structure and functions • PDCA cycle • ISO 14000 family of standards • Introduction to ISO 14001:2015: Guidelines for implementation of standard	**5**
6	**Environmental Audit** • Requirement of Rule 14, Environment (Protection) Act,1986 • Environmental Audit: Need & Importance • Process of Environmental Audit • Types of Audit	**5**

Sr. No.	References
1	Barrow, C. J. 2000. Social Impact Assessment: An Introduction. Oxford University Press.
2	Glasson, J., Therivel, R., Chadwick, A. 1994. Introduction to Environmental Impact Assessment. London, Research Press, UK.
3	Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science.
4	Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA

	EVS-353 - Environmental Governance and Ethics **Major -Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Understand constitutional provisions and policies for environmental protection in India.	**1**
CO2	Analyze anti-pollution acts, rules, and conservation laws for effective environmental governance.	**2**
CO3	Evaluate amendments to environmental conservation acts and their implementation.	**3**
CO4	Examine ethical principles and their application to environmental issues in India and globally.	**4**
CO5	Assess the role of Indian culture and global philosophies in shaping environmental ethics.	**5**
CO6	Propose solutions to contemporary ethical challenges in environmental sustainability.	**6**

EVS-353 - Environmental Governance and Ethics
(Major - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Constitutional Provisions and National Policies** • Constitutional provisions for environmental protection in India. • National Environmental Policy and National Forest Policy. • Eco-mark Scheme and National Conservation Strategy. • Public Interest Litigation: Role and impact on environmental protection. • Case study: Judicial interventions in India for environmental governance/policy. • Noteworthy Court Orders in Relation to Constitutional and Statutory Laws	**5**
2	**Anti-pollution Acts and Important Amendments** • The Air (Prevention and Control of Pollution) Act, 1981. • The Water (Prevention and Control of Pollution) Act, 1974. • Environment (Protection) Act, 1986. • The Motor Vehicles Act, 1988, and its environmental implications. • Case study: Implementation of the Public Liability Insurance Act, 1991. • Important Judgements & Orders on above laws	**5**
3	**Anti-pollution Rules and Management** • The Noise Pollution (Regulation and Control) Rules, 2000. • E-waste (Management) Rules, 2016. • Plastic Waste Management Rules, 2016. • Hazardous Waste Management Rules • Bio-Medical Waste Management Rules, 2016. • Case study: Solid Waste Management Rules 2016 – Impact and challenges. • Key Court Decisions Shaping Legal Framework on Rules	**5**

4	**Environmental Conservation Acts with Amendments** • The Wild Life (Protection) Act, 1972. • Biological Diversity Act, 2002, and Forest (Conservation) Act, 1980. • Prevention of Cruelty to Animals Act, 1960. • Protection of Plant Varieties and Farmers' Rights Act, 2001. • Case study: Regulatory framework for genetically engineered plants in India. • Pivotal Judgments Influencing Legislative Interpretation	**5**
5	**Environmental Ethics and India** • Origin of environmental ethics and value education. • Ethical theories applied to environmental protection. • Role of Indian culture in the development of environmental ethics. • Policies in India addressing environmental ethics. • Legal Foundations of Environmental Ethics in India • Case study: Development and ethical issues in India's urbanization	**5**
6	**Global Perspectives on Environmental Ethics** • Earth ethics and business ethics for environmental sustainability. • Role of Western philosophers in environmental ethics. • Religions and their contributions to environmental ethics. • Ethics and sustainability: Challenges in the contemporary world. • Ethical Consumerism and Corporate Accountability • Case study: International efforts to address global environmental ethics.	**5**

Sr. No.	References
1	"Environmental Law in India" by Shyam Divan and Armin Rosencranz, Oxford University Press, 2021.
2	"Environmental Ethics in India" by R. Rajagopalan, Oxford University Press, 2020.
3	"Environmental Jurisprudence" by C. M. Abraham, Kluwer Law International, 2019.
4	"The Forest Conservation Act: Principles and Practice" by M. K. Ranjitsinh, Natraj Publishers, 2018.
5	"Environmental Governance in India" by P. S. Jaswal and Nishtha Jaswal, APH Publishing, 2017.
6	"Environmental Ethics: An Introduction to Environmental Philosophy" by Joseph R. DesJardins, Wadsworth Publishing, 2020.
7	"A Sand County Almanac" by Aldo Leopold, Oxford University Press, 1968.
8	"Earth in the Balance" by Al Gore, Rodale Books, 2006.
9	"Environmental Philosophy: An Introduction" by John Benson, Routledge, 2000.
10	"Ethics and the Environment: An Introduction" by Dale Jamieson, Cambridge University Press, 2008.

	EVS-354 - Wildlife Biology and Habitat Conservation Elective -Theory	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to		**Bloom's Cognitive level**
CO1	Understand the fundamental concepts of wildlife biology and its significance in ecosystems.	**1**
CO2	Analyze the ecological requirements of different wildlife species and their habitats.	**2**
CO3	Assess the threats to wildlife and their habitats and evaluate conservation strategies.	**3**
CO4	Examine the role of habitat management and restoration in biodiversity conservation.	**4**
CO5	Investigate the role of legislation, policies, and organizations in wildlife and habitat conservation.	**5**
CO6	Develop skills for conducting wildlife habitat surveys, monitoring, and management.	**6**

EVS-354 - Wildlife Biology and Habitat Conservation
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Introduction to Wildlife Biology and Ecology** • Definition, scope, and significance of wildlife biology. • Classification and distribution of wildlife: mammals, birds, reptiles, amphibians, and invertebrates. • Ecological concepts: habitat, niche, territory, and home range. • Role of wildlife in ecosystems: ecological, economic, and cultural values.	**5**
2	**Habitat Types and Wildlife Ecology** • Major habitat types: forests, grasslands, wetlands, deserts, and marine ecosystems. • Wildlife adaptations to different habitats. • Ecological interactions: predation, competition, mutualism, and parasitism. • Wildlife migration and dispersal: causes and significance.	**5**
3	**Threats to Wildlife and Habitats** • Habitat loss, fragmentation, and degradation. • Overexploitation of wildlife and illegal wildlife trade. • Human-wildlife conflicts and their socio-economic impact. • Effects of climate change on wildlife and habitats.	**5**
4	**Habitat Conservation and Management** • Principles of habitat conservation and management. • Restoration ecology: reforestation, wetland restoration, and corridor development. • Management of protected areas: national parks, wildlife sanctuaries, and community reserves. • Role of ecotourism in habitat conservation.	**5**

5	**Wildlife and Habitat Conservation Policies** • Overview of Wildlife Protection Act (India) and Forest Conservation Act. • International agreements: Ramsar Convention, CITES, and CBD. • Role of organizations: IUCN, UNEP, WWF, and TRAFFIC. • Conservation strategies: in-situ and ex-situ conservation.	**5**
6	**Wildlife Monitoring and Research Techniques** • Methods of wildlife census: line transects, point counts, and camera trapping. • Habitat monitoring techniques: vegetation analysis and remote sensing. • Use of technology: GIS, GPS, and drone surveys in wildlife management. • Community involvement in wildlife and habitat conservation.	**5**

Sr. No.	References
1	Sutherland, W. J. (2000). *The Conservation Handbook: Research, Management, and Policy*. Wiley-Blackwell.
2	Primack, R. B. (2014). *Essentials of Conservation Biology*. Sinauer Associates.
3	Sharma, B. K., Singh, H., & Rahmani, A. R. (2013). *Wildlife of India*. Bloomsbury Publishing.
4	Hunter, M. L., & Gibbs, J. P. (2007). *Fundamentals of Conservation Biology*. Wiley-Blackwell.
5	Rodgers, W. A., & Panwar, H. S. (1988). *Planning a Wildlife Protected Area Network in India*. Wildlife Institute of India.
6	Gadgil, M., & Guha, R. (1993). *This Fissured Land: An Ecological History of India*. Oxford University Press.

	EVS-355 - Environmental Economics **Elective -Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Understand the basic concepts and principles of environmental economics.	**1**
CO2	Analyze the relationship between economic activities and environmental issues.	**2**
CO3	Evaluate economic tools and policies for environmental management.	**3**
CO4	Assess the concept of natural resource valuation and sustainable development.	**4**
CO5	Investigate market failures, externalities, and public goods in environmental contexts.	**5**
CO6	Apply economic principles to solve real-world environmental challenges.	**6**

EVS-355 - Environmental Economics
(Elective –Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Introduction to Environmental Economics** ● Definition, scope, and significance of environmental economics. ● Relationship between environment and economy. ● Environmental problems and economic development. ● Concept of market failure and externalities.	**5**
2	**Economic Valuation of Natural Resources** ● Types of natural resources: renewable and non-renewable. ● Methods of resource valuation: market and non-market valuation techniques. ● Cost-benefit analysis in environmental decision-making. ● Ecosystem services and their economic importance.	**5**
3	**Environmental Policy and Instruments** ● Environmental policies: objectives and types. ● Economic instruments: taxes, subsidies, tradable permits, and pollution charges. ● Command-and-control approaches vs. market-based instruments. ● Case studies on the implementation of environmental policies.	**5**
4	**Economics of Pollution and Climate Change** ● Types of pollution: air, water, soil, and noise. ● Economic impact of pollution on health, agriculture, and biodiversity. ● Climate change economics: causes, impacts, and mitigation strategies. ● Role of international agreements (e.g., Kyoto Protocol, Paris Agreement).	**5**
5	**Sustainable Development and Green Economy** ● Concept and indicators of sustainable development. ● Economic approaches to sustainable resource use.	**5**

	● Green economy: principles, benefits, and challenges. ● Circular economy and its role in waste management.	
6	**Global Environmental Issues and Economic Solutions** ● Deforestation, biodiversity loss, and desertification. ● Economics of renewable energy and energy efficiency. ● Environmental justice and equity issues. ● Role of institutions and NGOs in environmental conservation.	**5**

Sr. No.	References
1	Field, B. C., & Field, M. K. (2016). *Environmental Economics: An Introduction*. McGraw-Hill Education.
2	Tietenberg, T., & Lewis, L. (2018). *Environmental and Natural Resource Economics*. Pearson.
3	Hanley, N., Shogren, J. F., & White, B. (2007). *Environmental Economics in Theory and Practice*. Palgrave Macmillan.
4	Perman, R., Ma, Y., McGilvray, J., & Common, M. (2011). *Natural Resource and Environmental Economics*. Pearson Education.
5	Daly, H. E., & Farley, J. (2010). *Ecological Economics: Principles and Applications*. Island Press.Kolstad, C. D. (2011). *Environmental Economics*. Oxford University Press.

	EVS-356 - Biodiversity and Conservation **Elective -Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Define levels of biodiversity, including microbial, genetic, species, ecosystem, and landscape,	**1**
CO2	Analyze the magnitude, distribution, and evolution of biodiversity.	**2**
CO3	Evaluate biodiversity assessment methods and indicators, applying sampling techniques.	**3**
CO4	Synthesizing conservation strategies, including ex-situ and in-situ approaches, and developing solutions for sustainable use of biodiversity.	**4**
CO5	Examine the consequences of biodiversity loss on ecosystem services	**5**
CO6	Apply the principles of agrobiodiversity to evaluate the importance of cultivated species diversity.	**6**

EVS-356 - Biodiversity and Conservation
(Elective - Theory)

Unit. No.	Title of Unit and Contents	No. of hours
1	• Definition of biodiversity, • clarification of terms (taxonomic, spatial levels, endemism), levels of biodiversity (microbial, genetic, species, ecosystem, landscape), • drivers of biodiversity	**5**
2	• Magnitude and Distribution of biodiversity • Evolution of biodiversity, • overview of ecological communities, number of species worldwide, • change in biodiversity over time in different regions of the world, • concept of diversity hot-spots; • Biodiversity in India: In the past and present. • Global distribution of biodiversity (latitudinal diversity gradient).	**5**
3	• Assessment and Monitoring of biodiversity • Indicators for Biodiversity. • Methodology of assessment and analysis of different species groups, monitoring of different species groups, • Fieldwork on different plant communities with simple sampling methods and analysis • Presenting and discussion of results	**5**
4	• Biodiversity–ecosystem functioning–Ecosystem Services (ES) • Biodiversity loss and its consequences • Estimates of extinction rates worldwide and in India, • Analysing and discussion of causes and extinction/changes in biodiversity,	**5**

	• Summarising causes and consequences (Causes: Vulnerability to extinction; changing of the environment (Habitat fragmentation and destruction) climate change, overexploitation; Consequences: loss of gene pool, loss of ecosystem services, livelihood)	
5	• Conservation strategies Theoretical background: overview of genetic variability: population biology of endangered species, conservation genetics, wildlife biology • Ex-situ conservation: (facilities, establishment of new populations, captive breeding, reintroduction, discussion of advantages and disadvantages, • Field trip (Katraj Zoo) • In-situ conservation: (assessment of adequate areas, design and management of protected areas; • problems protected areas in India, connectivity and corridors, • sustainable use of biodiversity, • conservation and society, • conservation networks • Tutorial on Kaimowitz and Sheil (2007)	**5**
6	• Introduction, Origin and Evolution of Cultivated Species Diversity • Diversity in Domesticated species, Land Races, Advanced Cultivars, Wild relatives of Cultivated plants, Wild Plants • Importance of Agrobiodiversity in changing climate patterns	**5**

Sr. No.	References
1	Medicinal Plants of India's Hotspots. Daya Publishing House, New Delhi.
2	Gary K Meffe and Ronald Carroll C .1994, Principles of Conservation Biology. Sinauer Associates Inc., Massachusetts. Groombridge B (Ed.) 1992. Global Biodiversity Status of the Earths Living Resources. Chapman & Hall, London.
3	IUCN. 1992.Global Biodiversity and Strategy.
4	Sharma PD .2000. Ecology and Environment. Rastogi Publications, Meerut, India.
5	Singh MP, Singh BS and Soma S. Dey .2004. Conservation of Biodiversity and Natural Resources. Daya Publishing House, New Delhi.
6	Virchow D .1998. Conservation and Genetic Resources, Springer-Verlag, Berlin.
7	Singh B, 1992.Social Forestry for Rural Development, Anmol Publishers, New Delhi.
8	Murthy J.V.S., 1994, Watershed Management in India.
9	John Wiley ,1984, Raymond F Dasmann, Environmental Conservation.
10	Kato, M. The Biology of Biodiversity, 1999, Springer Verlag, Tokyo.
11	Kotwal, P.C. and S. Banerjee. Biodiversity Conservation – In Managed forest and Protected areas, 2002. Agrobios, India. Krishnamurthy, K.V. An Advanced Textbook on Biodiversity – Principles and Practice, 2003. Oxford and IBH Publishing, New Delhi.
12	Negi, S.S., 1993. Biodiversity and its conservation in India. Indus Publishing Co., New Delhi
13	Singh and Vijaykumar, 2001. Economics of PA's and its effect on biodiversity. APH Publishing Corporation, New Delhi.

	EVS-357 - Restoration Ecology **Elective Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	To study Key ecological principles used for restoration of terrestrial and aquatic ecosystems.	**1**
CO2	To focus upon the role conservation and restoration play within the larger context of natural resource management.	**2**
CO3	To study restoration approaches that require careful assessment of alternatives constrained by complex ecological, sociological and political realities.	**3**
CO4	Gain knowledge of the principles of Restoration Ecology...	**4**
CO5	Apply their skills for ecosystem restoration for Research and social awareness.	**5**
CO6	To recognize the value of various ecosystems which have been improved after restoration	**6**

EVS-357 - Restoration Ecology
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Introduction** **Restoration Ecology** • Eco Restoration • Definition • Principles, Significances, Guidelines, Principles of Restoration • Applications of Restoration Ecology.	**5**
2	**Theory of Restoration** • Theoretical basis for understanding restoration potential • Concepts of resilience and ecosystem change as they relate to aquatic and terrestrial systems, • Social, economic and political realities of restoration	**5**
3	**Urban Restoration** • Restoration of Urban Ecosystem Ponds, lakes, river banks, avenue tree, • Biodiversity restoration through gardens, park, restoration of dumping ground, • Restoration of ecosystem on hills, Restoration of soil in urban areas, • Ground water resource – replenishment, Sewage or wastewater - recycling for supporting ecosystems Case studies	**5**
4	**Industrial Restoration** • Eco-restoration and Industrial Environment • Eco-restoration of mines (Open-cast), restoration of solid waste dumping sites, Improving aesthetics by partial restoration at industrial sites, Case studies	**5**

5	**Restoration of Natural Habitats** • Restoration of other Natural Habitats / Ecosystems • Mangroves, Grasslands, Wetlands, Restoration of streams • Degraded forest patches, Coastal ecosystems, Case Studies	**5**
6	**Restoration Toolbox** • Terrestrial techniques • fire • mechanical • chemical and rest • Aquatic techniques • geomorphic structures • hydrologic regimes • riparian structures and processes	**5**

Sr. No.	References
1	Restoration of Nature by Prakash Gole.
2	Restoration Ecology the New Frontier - Edited by Jelte Van Andel and James Aronso Wiley-Blackwell Publication, ISBN9781444336368.
3	A Source Book for Ecological Restoration by Foundation for Ecological Security, 2008.
4	Foundations of Restoration Ecology (The Science and Practice of Ecological Restoration Series) - Donald A. Falk, Margaret Palmer, Joy Zedler, Richard J. Hobbs.
5	Watershed Manual by B. K. Kakade (BAIF and LEAD India Publication).
6	Water Harvesting and Sustainable Supply in India by R. N. Athavale Centre for Environment Education, ISBN: 8170337526.
7	Watershed Hydrology by Peter Black, Lewis Publishers, ISBN1575040271.
8	Soil and Water Conservation Engineering by R. Suresh - Standard Publishers and Distributors, ISBN8180140008

	EVS-361 - Environmental Science Practical-8 **(Practical's based on EVS-351, EVS-352, EVS-353)** **Major -Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Recall bioindicators of water and soil pollution	**1**
CO2	Compare various methods of composting	**2**
CO3	Conduct environmental audits and assessments using relevant techniques to evaluate industrial and developmental impacts.	**3**
CO4	Analyze and prepare environmental reports using EIA tools and surveys to assess project impacts on the environment and society.	**4**
CO5	Assess the effectiveness of environmental laws and legal actions in protecting the environment.	**5**
CO6	Examine the impact of legal judgments and environmental regulations on conservation and sustainable development.	**6**

EVS-361 - Environmental Science Practical-8
(Practical based on EVS-351, EVS-352, EVS-353)
(Major - Practical)

Practical Based on EVS-351: Environmental Biotechnology:

1. Use of microorganisms as bioindicators for water / soil pollution monitoring
2. Identification and classification of bacteria by Gram staining technique
3. Preparation of compost by using different methods of composting
4. Study of vermicomposting techniques for solid waste management.
5. Qualitative and quantitative estimation of compost and vermicompost.
6. Study of phytoremediation techniques for removal of pollutants.
7. Isolation of Phosphate solubilizing microbes and testing of phosphate solubilization efficiency of microbes
8. Visit to the biotechnology laboratory / research center.

*Any other relevant practical to environmental biotechnology

Practical Based on EVS-352: Environment Impact Assessment and Management

1. To Study Environmental Audit of Sugar Industry with Reference to Environment Protection Act (Form 5)
2. Evaluation of EIA by using Leopold Matrix Technique: A Case Study of Mining Site
3. Environmental and Social Survey Based on Questionnaire: A Case Study of Construction Site
4. To Understand Structure of Form 1 for Obtaining Prior Environmental Clearance
5. Preparation of checklist and network diagrams for environmental impacts
6. Preparation of Outline of EIA Report: A Case Study of Dam Site
7. Prepare a report based on biological diversity observed by you and threat of environmental impacts associated with them

Practical Based on EVS-353: Environmental Governance and Ethics

1. To Study Drawbacks Associated with Selected Environmental Laws
2. To Understand Process of Filing Public Interest Litigation
3. Preparation of Report on Major Judgement by Court on Selected Law: Divya Pharmacy Case Study (Biological Diversity Act)

4. Preparation of Report on Major Judgement by Court on Selected Law: Kani Tribe Case Study (Biological Diversity Act)
5. Law Specific Case Study on Violation in Selected Area: Taj Trapezium Case Study (Environment Protection Act)
6. Record the Observations in Relation with Coastal Regulation Zone Notification based on Field Visit
7. Prepare Detailed Account on Applicable Provisions with Reference to Wildlife Act, Forest Act and Biological Diversity Act based on Study Visit
8. Climate Change, Corporate Accountability, Indigenous Struggles for Land and Mining: A Case Study of Niyamgiri Movement in Odisha
9. Outline the Major Environmental Judgements Ordered by Supreme and High Court

	EVS-362 - Environmental Science Practical-9 **(Practical's based on EVS-354, EVS-355, EVS-356, EVS-357)** **Major-Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Recall methods of wildlife survey techniques.	**1**
CO2	Estimate Economic cost of Environmental resources.	**2**
CO3	Identify and study of venomous & poisonous plants and animals,	**3**
CO4	Estimate of stomatal index in leaves in various climatic conditions.	**4**
CO5	Analyzing an area for understanding biophysical factors	**5**
CO6	Design restoration plan for any one type of ecosystem.	**6**

EVS-362 - Environmental Science Practical-9
(Practical based on EVS-354, EVS-355, EVS-356, EVS-357)
(Major-Practical)

Practical's based on EVS 354:

1. Wildlife Census Techniques: Study of direct (line transect, point count) and indirect (pugmarks, scat analysis) methods.
2. Identification of Wildlife: Field identification of mammals, birds, reptiles, and amphibians using keys and guides.
3. Habitat Assessment: Analysis of vegetation structure, water resources, and habitat quality.
4. Mapping Wildlife Habitats: Using GIS and remote sensing tools for habitat mapping.
5. Human-Wildlife Conflict Analysis: Case study of conflict zones and mitigation strategies.
6. Biodiversity Surveys: Estimation of species diversity and abundance in a forest, wetland, or grassland ecosystem.
7. Field Study of Protected Areas: Visit to a national park, sanctuary, or reserve and report on its management practices.
8. Habitat Restoration Activities: Hands-on participation in habitat restoration projects like tree planting or wetland conservation.

Practical based on EVS 355:

1. Estimation of Environmental Costs: Assessing externalities in industries or agriculture.
2. Economic Valuation of Ecosystem Services: Applying contingent valuation or travel cost methods.
3. Cost-Benefit Analysis of Environmental Projects: Case study of a renewable energy or conservation project.
4. Market-Based Instruments Simulation: Analyzing the effectiveness of taxes or tradable permits for pollution control.
5. Data Analysis on Pollution Trends: Statistical analysis of air, water, or soil pollution using real-world data.
6. Sustainability Index Calculation: Evaluating sustainable development indicators for a region or sector.
7. Economic Impact of Climate Change: Modelling the cost of climate change mitigation or adaptation strategies.
8. Field Study on Environmental Policy Implementation: Surveying a community or industry to assess the impact of environmental regulations.

Practical based on EVS 356:

1. Identification and study of venomous & poisonous plants and animals, action of their venom -
   Stinging nettle, *Mucuna pruriens*, Physalia, scorpion, tarantula, honey-bee, *Conus*, scorpion fish
   First aid for snake bites - Cobra (spectacled & monocled), Common krait, Banded krait, Russell's Viper, Saw scaled Viper, Pit vipers (Bamboo, Green, Malabar)
2. Extract chlorophyll from leaves of two plant species (garden plants: one shade loving and another sun loving). Spectrophotometrically estimate chlorophyll a and b and find out the chlorophyll a: b ratio and comment on the results.
3. Stomatal Index Estimation and Pigment Analysis across Different Leaf Types and Micro-Climatic Conditions"
4. Collect matured leaves (minimum fifty for a class) from two different plants (e.g. Mango tree & False Ashoka). Measure and record the length (in cm.) along the midrib using a flexible thread.
5. Tabulate the data into a frequency distribution table, make frequency polygon and calculate
   weighted mean.
6. Morphological Analysis of Leaf Variability: A Comparative Study Using Frequency Polygons, Descriptive Statistics, and t-Test Evaluation
7. To assess the biodiversity of a local ecosystem by identifying and cataloging various species (plants, animals, fungi).
8. To evaluate the conservation status of the identified species using IUCN Red List data.
9. To examine the human impact on the biodiversity of the area (e.g., pollution, deforestation, urbanization).
10. To propose conservation measures based on field observations and research.

Practical's based on EVS-357:

1. Visit to restoration Site
2. Undertaking various surveys for understanding a problem (Contour Survey, satellite image, socio-economic survey etc.)
3. Comparison of water quality parameters from a phytoremediation unit
4. Comparison of biophysical factors from degraded and restored area
5. Analyzing an area for understanding biophysical factors
6. Prepare a plan of Restoration
7. Use different economic methods for assessing success of Restoration
8. Use of different ecological methods for assessing success of Restoration

	EVS-382 - Environmental Science Practical-10 VSC-Practical	
Course Outcomes (COs) On completion of the course, the students will be able to		Bloom's Cognitive level
CO1	Conduct environmental analyses to assess impacts on ecosystems and sustainability.	**1**
CO2	Set up and use instruments for measuring environmental parameters.	**2**
CO3	Use models and simulations to predict environmental impacts and sustainability.	**3**
CO4	Evaluate environmental systems like waste management, water treatment, and energy use.	**4**
CO5	Implement and assess solutions for conservation, efficiency, and pollution control.	**5**
CO6	Analyze the effectiveness of environmental policies and sustainability practices.	**6**

EVS-382 - Environmental Science Practical-10
(VSC - Practical)

Vocational Skill Course
Practical EVS-382

1. Perform soil analysis to determine fertility, texture, and contamination using lab equipment.
2. Set up and calibrate weather stations for measuring temperature, humidity, and wind speed.
3. Model environmental data in software to predict climate change impacts on ecosystems.
4. Analyze wastewater treatment efficiency by evaluating filtration and treatment processes.
5. Conduct life cycle assessment (LCA) to evaluate environmental impacts of products.
6. Perform carbon footprint analysis for sectors like transportation, agriculture, and industry.
7. Simulate deforestation effects on local climates using environmental models.
8. Conduct environmental impact assessments (EIA) for proposed development projects.
9. Measure groundwater quality by testing for contaminants.
10. Design and implement rainwater-harvesting systems for water conservation.
11. Design waste management systems for recycling and disposal of municipal waste.
12. Conduct energy audits to assess building energy efficiency.
13. Set up and maintain solar power systems for renewable energy production.
14. Conduct environmental health assessments to evaluate environmental impacts on health.
15. Monitor air pollution effects on vegetation by measuring pollutant exposure and growth.
16. Measure particulate matter and CO in ambient air with sampling equipment.
17. Survey wildlife populations using field methods like camera traps and transect sampling.
18. Test water treatment efficiency by evaluating contaminant removal through filtration.
19. Design and analyze constructed wetlands for wastewater treatment.
20. Assess renewable energy potential by analyzing solar, wind, and hydro sources.
21. Map flood-prone areas using GIS and historical data for flood risk management.
22. Evaluate water stress levels using indicators like precipitation and water consumption.
23. Monitor urban heat islands by comparing temperatures in urban and rural areas.
24. Design green buildings using sustainable methods and energy-efficient materials.
25. Assess invasive species impact on ecosystems through field surveys.
26. Conduct waste audits to assess waste generation and management practices.
27. Study of online web simulators/calculators for environmental impacts.
28. Assess soil erosion by measuring soil loss and vegetation cover.

29. Evaluate pollution control devices effectiveness in reducing industrial emissions.
30. Perform environmental audits to assess corporate sustainability practices.
31. Design a recycling program in a community to reduce waste and promote recovery.
32. Use modeling software for climate scenario analysis to predict environmental changes.
33. Comparative Analysis of Sustainability Reports form Selected industries

	EVS-371 - Techniques in Environmental Assessment Minor-Theory	
Course Outcomes (COs) On completion of the course, the students will be able to		Bloom's Cognitive level
CO1	Identify and explain environmental parameters for weather, air, water, soil, and biodiversity.	**1**
CO2	Demonstrate the use of instruments and techniques for monitoring environmental parameters.	**2**
CO3	Interpret environmental data collected from assessments of weather, air, water, soil, and biodiversity.	**3**
CO4	Assess environmental monitoring data against national and global standards.	**4**
CO5	Design protocols for site selection, sampling, and analysis based on monitoring objectives.	**5**
CO6	Propose monitoring-based solutions for environmental issues, including pollution control and resource management.	**6**

EVS-371 - Techniques in Environmental Assessment
(Minor - Theory)

Unit. No.	Title of Unit and Contents	No. of hours
1	**Weather Monitoring** • Introduction to weather systems and parameters: light, rainfall, wind direction, wind velocity, temperature, pressure, humidity, etc. • Principles of monitoring tools/instruments: anemometers, barometers, rain gauges, hygrometers, thermometers, and pyrometers. • Data recording and interpretation techniques. • **Case Study:** Impact of weather parameters on agricultural planning in Maharashtra.	**5**
2	**Air Quality Monitoring** • National standards for ambient air quality: CPCB guidelines. • Site selection and parameter prioritization: PM10, PM2.5, SOx, NOx, CO, and VOCs. • Techniques for ambient air and work zone air quality monitoring. • Principles of monitoring tools: HVS, RSPM samplers, and gas analyzers. • **Case Study:** Air quality analysis during Diwali in urban areas of India.	**5**
3	**Water Quality Monitoring** • Objectives and importance of water monitoring. • Sampling techniques and frequency for groundwater and surface water. • Monitoring physical (temperature, turbidity), chemical (pH, TDS, DO, BOD, COD), and biological (SPC, MPN, planktons) parameters. • Standards: IS 10500 and WHO drinking water standards, effluent and stream standards.	**5**

	• **Case Study:** Monitoring of Ganga River water under the Namami Gange Programme.	
4	**Soil Quality Monitoring** • Objectives and methodologies for soil monitoring. • Sampling techniques: site selection, timing, frequency, and in-field sampling. • Key soil quality indicators: pH, electrical conductivity, organic carbon, macro/micronutrients. • Handling and storage of samples, and instrument calibration. • Case Study: Soil quality assessment for sustainable agriculture and soil health cards.	**5**
5	**Biodiversity Monitoring** • Definition and scope of biodiversity monitoring. • Vegetation assessment: height, girth, biomass, frequency, density, diversity indices. • Vertebrate monitoring: transects, point counts, pugmark analysis, camera trapping. • Invertebrate monitoring: net swipe, light traps, pit traps, and aquatic invertebrates. • **Case Study:** Biodiversity changes in Western Ghats due to land use change.	**5**
6	**Environmental Instrumentation** • Principles and applications: pH meter, Conductivity meter, Colorimeter, UV-Vis Spectrophotometer, Atomic Absorption Spectrometer, Gas Chromatography, and Mass Spectroscopy. • Instruments for air monitoring: Online air monitoring, HVS, RSPM 2.5 samplers. • Soil and water testing equipment: TKN analyzers, Hot air oven, Autoclave. • **Case Study:** Instrumentation role in analyzing Delhi's air quality.	**5**

Sr. No.	References
1	Waste water engineering , Met Calf and Eddy, INC, Tata Mc Graw Hill
2	Indian Standard For Drinking Water, BSI, New Delhi. Environmental Pollution Control, C.S.Rao, Wiley Eastern Ltd.,1993
3	Air Pollution Control and Engineering, De Nevers, Mc Graw Hills, 1993 10
4	Fundamentals of Air Pollution, Samuel, J.W., 1971, Addison Wesley Publishing
5	Fundamentals of Environmental Pollution, Krishnan Khannan, S. Chand and Company Ltd.,1994.
6	Noise Pollution, Vandana Pandey, Meerut Publishers,1995.
7	Environmental Pollution Control, C.S. Rao, Wiley Eastern Ltd.,1993
8	Air Pollution Control and Engineering, De Nevers, Mc Graw Hills, 1993 Fundamentals of Environmental Pollution, Krishnan Khannan, S.Chand and Company Ltd., 1994.
9	Environmental Chemistry, A.K.De.,New Age Intl. pub Co, New Delhi, 1990.
10	Environmental Pollution Anlysis- Khopkar

	EVS-395 - On-Job Training **OJT-Practical**	
	Number of Credits: 04 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to**		Bloom's Cognitive level
CO1	Apply theoretical knowledge to real-world environmental practices.	**1**
CO2	Develop technical and analytical skills through hands-on training.	**2**
CO3	Demonstrate proficiency in data collection, monitoring, and reporting.	**3**
CO4	Evaluate industrial, governmental, or NGO-based environmental management.	**4**
CO5	Enhance problem-solving and decision-making in professional settings.	**5**
CO6	Communicate effectively through documentation, teamwork, and interactions.	**6**

Students are required to complete On-Job Training (OJT) as part of their curriculum, following the assigned schedule and maintaining workplace discipline. Keeping a daily logbook to record tasks, observations, and learning outcomes is essential. Active participation in assigned duties and fieldwork activities is expected, with reports documenting experiences and findings submitted on time. Attendance is mandatory, and any absence should be informed in advance. Professional behavior, punctuality, and appropriate conduct are important throughout the training. Effective communication with mentors and seeking guidance when needed will enhance learning. Feedback forms and evaluations need to be completed as per OJT requirements. At the end of the training, students will present their learnings and suggest improvements in environmental practices.