Savitribai Phule Pune University

(Formerly University of Pune)

Four-Year B.Sc. Degree Program in Environmental Science

(Faculty of Science & Technology)

T. Y. B. Sc. Environmental Science Syllabi in NEP-2020

National Education Policy Syllabus

To be implemented from Academic Year 2024-2025

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Credit Framework for Undergraduate (UG) B.Sc. Environmental Science Subject Code: EVS

Level/ Difficulty	Sem.	Credits Related to Major				Minor	Total
		Major Core	Major Elective	VSC	FP/OJT/CEP		
5.5/ 300	V	**EVS 301 MJ** Water and Soil Quality Management [4T] **EVS 302 MJ** Atmosphere and Global Climate Change [4 T] **EVS 303 MJP** Practicals based on EVS301MJ and EVS302MJ [4 P]	**(Select any one of the following)** **EVS 310 MJE** Terrestrial Ecosystem and Management [2 T] ***OR*** **EVS 311 MJE** Wildlife Biology and Management [2 T] **(Select any one of the following)** **EVS 312 MJPE** Practicals Based on EVS310MJE [2 P] **OR** **EVS 313 MJPE** Practicals Based on EVS311MJE [2 P]	**EVS 321 VSC** Environmental Legislation and Policy [2T]	**FP/CEP 331 EVS** Field Project and report writing [2 FP]	**EVS 341 MN** Environmental Biotechnology [2 T]	**22**
	VI	**EVS 351 MJ** Air and Noise Quality [4T] **EVS 352 MJ** Environmental Governance: EMS, EIA and ISO14000 [4 T] **EVS 353 MJP** Practical Based on EVS351MJ and EVS352MJ [4 P]	**(Select any one of the following)** **EVS 360 MJE** Aquatic Ecosystem and Management [2 T] ***OR*** **EVS 361 MJE** Nature Conservation [2 T] **(Select any one of the following)** **EVS 362 MJPE** Practicals Based on EVS360MJE [2 P] ***OR*** **EVS 363 MJPE** Practicals Based on EVS363MJPE [2 P]	**EVS 371 VSC** Remote Sensing and GIS [2 T]	**OJT 381 EVS** [4 OJT]		**22**
Total 3 Year		**44**	**8**	**8**	**10**	**18**	**132**

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Major Core Theory

Course Code – EVS 301 MJ

Course Title: Water and Soil Quality Management

[No. of Credits: 4 C] **[No. of Lectures: L]**

Objectives:

1. To understand the current status of water and soil resources in the context of climate change and anthropogenic pressure.
2. To identify emerging water pollutants (microplastics, pharmaceuticals, PFAS) and their environmental & health impacts.
3. To learn modern water treatment technologies, circular economy approaches, and water quality management frameworks.
4. To comprehend soil degradation, contamination, and advanced remediation techniques, including nature-based solutions.
5. To apply geospatial tools (GIS, remote sensing) and artificial intelligence (AI) in water and soil resource monitoring and management.
6. To align learning with Sustainable Development Goals (SDG 6 – Clean Water & Sanitation, SDG 15 – Life on Land).

Course Outcome:

Upon completion of this course, students will be able to:

1. Assess water and soil quality using modern analytical techniques and interpret data in the context of current environmental challenges.
2. Identify and evaluate emerging contaminants (microplastics, antibiotics, heavy metals) in water and soil systems.
3. Design and propose appropriate treatment technologies (including nature-based solutions) for polluted water and soil.
4. Apply GIS, remote sensing, and AI-based tools for real-time monitoring and management of water and soil resources.
5. Analyse case studies on river rejuvenation (e.g., Namami Gange), soil health missions, and climate-resilient agriculture.
6. Develop integrated water-soil management plans that incorporate circular-economy principles, policy frameworks, and community participation.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	**Water Resources and Quality in the 21st Century**	• Global and Indian water scenario: availability, demand, water scarcity, and water footprint. • Climate change impacts on water resources: altered monsoon patterns, glacial melt, sea-level rise, and groundwater depletion. • Physico-chemical and biological parameters of water (turbidity, pH, DO, BOD, COD, TDS, heavy metals, microbial load). • **Emerging contaminants:** Microplastics, pharmaceuticals and personal care products (PPCPs), endocrine disruptors, PFAS (forever chemicals) – sources, pathways, and risks. • Water quality indices (WQI) and their applications.	**12**

2	**Water Pollution: Contemporary Issues**	• Point and non-point source pollution – agricultural runoff (fertilisers, pesticides), industrial effluents, urban stormwater. • **Eutrophication and harmful algal blooms (HABs):** Causes, consequences (dead zones), case studies (Loktak Lake, Vembanad Lake). • Groundwater contamination: Arsenic, Fluoride, Nitrate, and Salinity intrusion – Indian case studies (West Bengal, Assam, Rajasthan, Punjab). • River pollution in India: Status of Ganga, Yamuna, Godavari, Cauvery – pollution hotspots and source apportionment. • Waterborne diseases: Cholera, Typhoid, Hepatitis A, and emerging water-related health risks (antibiotic resistance in water systems). • Water stress, water conflict, and environmental justice.	**12**
3	**Modern Water Pollution Management**	• **Water quality standards:** BIS (IS 10500:2012), WHO, CPCB standards for drinking, bathing, and industrial uses. • **Advanced water treatment technologies:** - Primary, Secondary (activated sludge, biofilm reactors), Tertiary treatment (membrane filtration, reverse osmosis, UV, advanced oxidation processes). - Nature-based solutions: Constructed wetlands, phytoremediation, riverbank filtration. • **Decentralised wastewater treatment: STPs, FSTP (faecal** sludge treatment plants), and reuse of treated water (circular economy). • **Legal framework:** Water (Prevention & Control of Pollution) Act, 1974; National Water Policy; Central and State Pollution Control Boards. • **Flagship programs:** Namami Gange Mission, National River Conservation Plan (NRCP), Atal Mission for Rejuvenation and Urban Transformation (AMRUT). • **Application of GIS, Remote Sensing, and AI/ML** for water quality monitoring, pollution source tracking, and flood/drought management.	**12**
4	**Soil Health, Degradation and Emerging Contaminants**	• Soil: Definition, formation, composition (mineral, organic matter, water, air). • **Soil health vs soil fertility:** Indicators of soil health (physical, chemical, biological). • Soil reactions: pH, buffering capacity, CEC, salinity, and sodicity. • Macro and micronutrients (NPK, S, Zn, Fe, B) – deficiency symptoms and management. • **Emerging soil contaminants:** Microplastics, pharmaceutical residues, heavy metals (Cd, Pb, As, Hg), e-waste leachates, and perchlorates. • Soil acidification, salinisation, and alkalization – causes and reclamation methods. • **Soil degradation:** Soil erosion (water, wind), desertification, loss of organic carbon, and soil biodiversity decline.	**12**

5	**Soil Pollution, Remediation and Sustainable Management**	• **Sources of soil pollution:** Industrial waste, mining, agricultural chemicals (pesticides, fertilisers), urban solid waste (landfills, leachates), and untreated wastewater irrigation. • **Soil toxicology:** Impact on soil microbiota, plants, and human health (food chain contamination). • **Remediation technologies:** - Physical: Soil washing, thermal desorption. - Chemical: Chemical oxidation, stabilisation/solidification. - Biological: Bioremediation (bioaugmentation, biostimulation), phytoremediation (phytoextraction, rhizofiltration), mycoremediation. - Nature-based solutions: Biochar application, green amendments. • **Soil conservation techniques:** Contour farming, strip cropping, terracing, agroforestry, conservation tillage, cover cropping. • **Government initiatives:** Soil Health Card Scheme, National Mission for Sustainable Agriculture (NMSA), Organic farming promotion. • **Application of GIS, remote sensing, and AI** for soil mapping, erosion risk assessment, and precision agriculture. • **Integrated Water-Soil Management (IWSM)** for climate resilience, carbon sequestration, and achieving SDG 6 & 15.	**12**

References:

1. CPCB (Central Pollution Control Board). (2023). Water and Soil Quality Reports – India. Ministry of Environment, Forest and Climate Change.
2. World Health Organisation (WHO). (2022). *Guidelines for Drinking-water Quality (4th Edition incorporating 1st & 2nd Addenda)*.
3. BIS (Bureau of Indian Standards). (2012). IS 10500:2012 – Drinking Water Specification.
4. Cunningham, W.P. & Cunningham, M.A. (2021). Principles of Environmental Science (10th Ed.). McGraw-Hill.
5. Singh, J.S., Singh, S.P. & Gupta, S.R. (2018). Ecology, Environment and Resource Conservation (3rd Ed.). Anamaya Publications.
6. Foth, H.D. & Ellis, B.G. (2019). Fundamentals of Soil Science (15th Ed.). CRC Press.
7. Khopkar, S.M. (2020). Environmental Pollution Analysis (2nd Ed.). New Age International.
8. APHA, AWWA, WEF. (2023). Standard Methods for the Examination of Water and Wastewater (24th Ed.). American Public Health Association.
9. Trivedy, R.K. (2021). Low-Cost Wastewater Treatment Technologies and the Circular Economy. Environmental Publications.
10. Tan, K.H. (2019). Principles of Soil Chemistry (5th Ed.). CRC Press.
11. NITI Aayog. (2021). Composite Water Management Index & Groundwater Reports. Government of India.
12. Lillesand, T.M., Kiefer, R.W. & Chipman, J.W. (2020). Remote Sensing and Image Interpretation (8th Ed.). Wiley.
13. UNEP. (2022). Global Water Quality and Soil Pollution Reports. United Nations Environment Programme.

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Major Core Theory

Course Code – EVS 302 MJ

Course Title: Atmosphere and Global Climate Change

[No. of Credits: 4 C] **[No. of Lectures: 60 L]**

Objectives:

1. To understand the basic structure and composition of Earth's atmosphere.
2. To learn about weather, climate, and atmospheric circulation patterns.
3. To understand the causes and effects of global warming and climate change.
4. To know about international agreements and India's role in climate action.
5. To study basic meteorological parameters and their influence on air quality.

Course Outcome:

Upon completion of this course, students will be able to:

1. Describe the layers of the atmosphere and the greenhouse effect.
2. Explain simple weather phenomena like monsoon, cyclones, and El Niño.
3. Identify the major causes of global warming and climate change.
4. Discuss the impacts of climate change on India (agriculture, water, health).
5. List important climate agreements (Kyoto, Paris) and India's climate commitments.
6. Understand basic weather parameters like temperature, wind, and rainfall.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	**The Atmosphere: Structure and Greenhouse Effect**	• What is atmosphere? Importance of atmosphere for life on Earth. • Layers of atmosphere: Troposphere, Stratosphere, Mesosphere, Thermosphere (basic features only). • Composition of air: Nitrogen, Oxygen, Carbon dioxide, water vapour, and other gases. • Solar radiation and heat balance of Earth. • **Greenhouse effect:** What is it? Natural vs enhanced greenhouse effect. • **Greenhouse gases (GHGs):** CO_2, Methane (CH_4), Nitrous oxide (N_2O), Water vapour – their sources (natural and artificial). • Simple concept of Global Warming Potential (GWP).	**12**
2	**Atmospheric Circulation and Weather Systems**	• **Wind systems:** What causes wind? High and low-pressure areas. • Global wind patterns: Trade winds, Westerlies, Jet streams (basic idea). • **Cyclones and Anticyclones:** How they form; tropical cyclones (examples: Cyclone Tauktae, Cyclone Amphan). • **Ocean effects on climate:** El Niño and La Niña – meaning and effects on the Indian climate. • **Indian Monsoon:** What is monsoon? How does it form? Onset and retreat of monsoon in India.	**12**

		• Effect of monsoon on Indian agriculture and economy. • **Urban heat island:** Why cities are warmer than villages (simple explanation).	
3	**Basic Meteorology and Air Quality**	• **Weather vs. Climate:** Difference between weather and climate. • **Important weather terms:** Temperature, humidity, wind speed & direction, rainfall, air pressure. • **Temperature inversion:** What is it? Why does it happen? How does it trap pollutants (e.g., winter smog in Delhi). • **Atmospheric stability:** Stable vs. unstable air – simple understanding. • **Air Quality Index (AQI):** What is AQI? Different categories (Good, Moderate, Poor, Very Poor, Severe). • Air pollution episodes in Indian cities (Delhi, Mumbai, Kolkata). • Basic idea of how pollutants disperse in air (plume behavior – simple description).	**12**
4	**Global Warming and Climate Change: Causes & Impacts**	• **Global warming:** What is it? Rising global temperatures (simple data: Earth has warmed about 1.2°C since pre-industrial times). • **Causes of global warming:** Burning of fossil fuels (coal, oil, gas), deforestation, agriculture, industrial activities. • **Observed changes:** Melting of glaciers (Himalayan glaciers), shrinking Arctic sea ice, rising sea levels. • **Impacts of climate change in India:** - More frequent heatwaves (example: 2022, 2023 heatwaves in North India). - Changes in monsoon pattern (delayed monsoon, heavy rainfall events, floods). - Droughts in some regions (Marathwada, Bundelkhand). - Effect on farming (wheat, rice, sugarcane yields). - Sea level rise threat to coastal cities (Mumbai, Chennai, Sundarbans). - Health effects: Heat strokes, spread of diseases (malaria, dengue). - Glacial lake outburst floods (GLOF) – example: Sikkim 2023 flood.	**12**
5	**Climate Policy and India's Climate Action**	• **International efforts to control climate change:** - Montreal Protocol (1987), Kyoto Protocol (1997) Paris Agreement (2015), Nationally Determined Contributions (NDCs). • **Simple concepts:** Carbon credit, Carbon trading, Clean Development Mechanism	**12**

		(CDM). • **India's climate commitments and• India's major climate programs (simple overview):** - National Solar Mission (promoting solar energy). - National Water Mission (water conservation). - National Mission for Green India (increase forest cover). - National Mission for Sustainable Agriculture (climate-resilient farming). • **Simple case studies:** - Solar energy success in India (example: Bhadla Solar Park, Rajasthan). - Climate-resilient farming in rainfed areas (example: Andhra Pradesh). - Mumbai Climate Action Plan (basic idea).	

References:

1. IPCC. (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report. Cambridge University Press.
2. IPCC. (2023). AR6 Synthesis Report: Climate Change 2023. Cambridge University Press.
3. Ministry of Earth Sciences (MoES), Government of India. (2023). Climate Change over India: An Assessment Report. MoES, New Delhi.
4. NITI Aayog & DST. (2022). Climate Vulnerability Assessment for Indian States. Government of India.
5. UNFCCC. (2015). Paris Agreement. United Nations.
6. UNEP. (2024). Emissions Gap Report 2024. United Nations Environment Programme.
7. Barry, R.G. & Hall-McKim, E.A. (2022). Atmosphere, Weather and Climate (12th ed.). Routledge Press, UK.
8. Manahan, S.E. (2022). Environmental Chemistry (11th ed.). CRC Press, Taylor and Francis Group.

14. Maslin, M. (2021). Climate Change: A Very Short Introduction (4th ed.). Oxford University Press.

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Major Core Practical

Course Code – EVS 303 MJP

Course Title: Practical's based on EVS 301 MJ and EVS 302 MJ

[No. of Credits: 4 C] **[No. of Lectures: 60 L]**

Objectives:

1. To develop skills in sampling, analysis, and interpretation of water and soil quality parameters.
2. To train students in modern analytical techniques for water and soil pollution assessment.
3. To understand meteorological observations and air quality monitoring methods.
4. To apply statistical and graphical tools for environmental data analysis.
5. To integrate field observations with theoretical knowledge of climate and pollution.

Course Outcome:

Upon completion of this course, students will be able to:

1. Collect and preserve water and soil samples from different environmental settings.
2. Analyze physico-chemical and biological parameters of water and soil using standard methods.
3. Operate basic meteorological instruments and interpret weather data.
4. Assess air quality using simple monitoring techniques and AQI calculation.
5. Prepare scientific reports and maintain laboratory records systematically.
6. Relate practical findings to environmental quality standards and climate concepts.

List of Practicals (Total: 16 Practicals)

Sr. No.	Title of the Practical	No. of Practicals
1	Sampling of water from different polluted sites (lake, river, groundwater, tap water) – techniques, preservation, and labeling	1
2	Sampling of soil from different land use sites (agricultural, industrial, landfill, garden) – techniques and handling	1
3	Analysis of pH, Temperature, Electrical Conductivity (EC), and Total Dissolved Solids (TDS) of different water samples	1
4	Estimation of Dissolved Oxygen (DO) and Free CO_2 in water samples (Winkler's method)	1
5	Determination of Chemical Oxygen Demand (COD) in water/wastewater samples	1
6	Determination of Biochemical Oxygen Demand (BOD) of water sample (3-day or 5-day incubation)	1
7	Determination of Nitrates (NO_3^-) and Phosphates (PO_4^{3-}) from water samples (Spectrophotometric method)	1
8	Determination of Most Probable Number (MPN) of coliforms in drinking water samples	1
9	Determination of Soil pH, Electrical Conductivity (EC), and Organic Carbon content	1
10	Determination of Soil Bulk Density, Particle Density, and Porosity	1
11	Determination of Available Nitrogen (N), Phosphorus (P), and Potassium (K) in soil sample	1
12	Study of meteorological parameters – measurement of temperature (maximum, minimum, dry bulb, wet bulb), relative humidity, rainfall, wind speed and direction	1

13	Measurement of ambient air quality – determination of Particulate Matter (RSPM/SPM/$PM_{2.5}$) by High Volume Sampler or Gravimetric method	1
14	Determination of Sulphur Dioxide (SO_2) from ambient air samples (Modified West & Gaeke method)	1
15	Determination of Oxides of Nitrogen (NOx) from ambient air samples (Jacob & Hochheiser method)	1
16	Calculation of Air Quality Index (AQI) from given pollutant concentration data ($PM_{2.5}$, PM_{10}, SO_2, NOx, CO, O_3) and interpretation of health impacts	1

References:

1. APHA, AWWA, WEF. (2023). Standard Methods for the Examination of Water and Wastewater (24th ed.). American Public Health Association, Washington D.C.
2. Trivedy, R.K. & Goel, P.K. (2020). Chemical and Biological Methods for Water Pollution Studies. Environmental Publications.
3. Gupta, P.K. (2018). Methods in Environmental Analysis: Water, Soil and Air. Agrobios Publications.
4. Maiti, S.K. (2019). Handbook of Methods in Environmental Studies (Vol. I & II). ABD Publishers.
5. CPCB. (2022). Guide Manual for Water and Wastewater Analysis. Central Pollution Control Board, New Delhi.
15. CPCB. (2021). Air Quality Monitoring and Analysis Guidelines. Central Pollution Control Board, New Delhi.

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Major Elective Theory

Course Code – EVS 310 MJE

Course Title: Terrestrial Ecosystem and Management

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

Objectives:

1. To understand the structure, components, and functioning of terrestrial ecosystems.
2. To study the biogeographic regions, biodiversity hotspots, and keystone species of India.
3. To learn the various methods of vegetation sampling and data analysis.
4. To analyze the threats to terrestrial ecosystems and sustainable management practices.
5. To understand the role of communities, NGOs, and the government in ecosystem conservation.

Course Outcome:

Upon completion of this course, students will be able to:

1. Describe the parameters, biota, and soil subsystem of terrestrial ecosystems.
2. Identify the biogeographic regions of India and the world, and explain interspecies relationships.
3. Evaluate terrestrial ecosystem services including carbon sequestration potential.
4. Apply remote sensing, GIS, and traditional methods for terrestrial ecosystem management.
5. Demonstrate vegetation sampling techniques using quadrat, transect, and point frame methods.
6. Analyse causes of exploitation and suggest sustainable management strategies with case studies.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Terrestrial Ecology	• Introduction to Terrestrial Environment. • Parameters of terrestrial environment (climatic, edaphic, topographic, biotic). • The terrestrial biota and biogeographic regions of India (Trans-Himalayan, Himalayan, Desert, Semi-arid, Western Ghats, Deccan Peninsula, Gangetic Plain, Coasts, North-East, Islands). • The Soil subsystem – soil formation, profile, types, and soil biota. • Biodiversity hotspots in India: Western Ghats, Eastern Himalayas, Andaman & Nicobar Islands, Sundaland (Nicobar component). •IUCN Red List 2024-25 status of Indian terrestrial species.	06
2	Terrestrial Biodiversity	• Introduction and concept of biodiversity. • Types of biomes: Tropical rainforest, tropical deciduous forest, temperate forest, taiga, tundra, grassland, savanna, desert, Mediterranean. • Biogeographic regions of the world (Palaearctic, Nearctic, Neotropical, Afrotropical, Indomalayan, Australasian, Oceanian, Antarctic).	06

		• General structure of terrestrial communities – stratification, edge effect, ecotone. • Distribution patterns of species (cosmopolitan, endemic, disjunct). • Keystone species – concept and examples (Indian elephant, fig trees, tigers, bees). • Interspecies relationships: Competition, predation, parasitism, mutualism, commensalism, amensalism.	
3	Terrestrial Ecosystem Services	• Definition and classification of ecosystem services (Millennium Ecosystem Assessment – provisioning, regulating, cultural, supporting). • Aesthetic and cultural benefits – sacred groves, cultural landscapes, and traditional knowledge. • Tourism and recreation – eco-tourism, wildlife tourism, carrying capacity. • Industrial products – timber, non-timber forest products (NTFP), resins, gums, medicinal plants. • Drugs and medicines – phytopharmaceuticals, traditional medicine systems (Ayurveda, Siddha, Ethnobotany). • Carbon pool and sequestration potential – forest carbon stocks, blue carbon, REDD+ mechanism. • **Case studies:** Sacred groves of Western Ghats (Kavus of Kerala, Devrais of Maharashtra).	06
4	Methods of Terrestrial Ecosystem Management	• Remote sensing – principles, satellite data sources (Landsat, Sentinel, IRS), applications in forest cover mapping. • Geographical Information System (GIS) – spatial analysis, land use/land cover (LULC) mapping, habitat suitability modelling. • Community-based forest management – Joint Forest Management (JFM), Community Forest Rights (FRA 2006), Van Panchayats. • Traditional methods – sacred groves, traditional water harvesting, shifting cultivation (Jhum) – benefits and challenges. • Forest fire – reasons (natural and anthropogenic), effects (on biodiversity, soil, air quality), control measures (fire lines, controlled burning, early warning systems), and management. •National Action Plan on Forest Fires (NAPFF), Forest Fire Alert System (FAST).	06
5	Exploitation and Sustainable Utilization	• Reasons for exploitation: Population growth, poverty, market demand, weak enforcement. • Threats of exploitation: Deforestation, habitat fragmentation, poaching, illegal wildlife trade, overgrazing, invasive species. • Sustainable management methods: Sustainable forest management (SFM), certification (FSC), participatory forest management, landscape approach. • Role of People, NGOs, Community, and Local Government in conservation. • Community Based terrestrial ecosystem management	06

		methods – village forest committees, eco-development committees, biodiversity management committees (BMC). • **Case studies:** - Chipko Movement (Uttarakhand) - Appiko Movement (Karnataka) - Joint Forest Management in West Bengal (Arabari model) - Community conservation of Great Indian Bustard in Maharashtra (Nannaj).	

References:

1. Gurevitch, J., Scheiner, S.M. & Fox, G.A. (2021). The Ecology of Plants (3rd ed.). Sinauer Associates Incorporated.
2. Loreau, M. & Inchausti, P. (2022). Biodiversity and Ecosystem Functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
3. Odum, E.P. & Barrett, G.W. (2017). Fundamentals of Ecology (5th ed.). Cengage Learning.
4. Singh, J.S., Singh, S.P. & Gupta, S.R. (2018). Ecology, Environment and Resource Conservation (3rd ed.). Anamaya Publications, New Delhi.
5. Wilson, E.O. (2016). The Biological Diversity Crisis – Half-Earth: Our Planet's Fight for Life. Liveright Publishing.
6. Rodgers, W.A. & Panwar, H.S. (2018). Biogeographic Classification of India (Revised). Wildlife Institute of India, Dehradun.
7. FSI. (2023). India State of Forest Report 2023. Forest Survey of India, Dehradun.
8. MoEFCC. (2024). National Action Plan on Forest Fires. Ministry of Environment, Forest and Climate Change, Government of India.
9. IUCN. (2024). *IUCN Red List of Threatened Species – Version 2024-2*. International Union for Conservation of Nature.
10. Gadgil, M. & Guha, R. (2020). Ecology and Equity: The Use and Abuse of Nature in Contemporary India. Routledge.
11. Karanth, K.U. & Nichols, J.D. (2017). Methods for Monitoring Tiger and Prey Populations. Springer.
12. Champion, H.G. & Seth, S.K. (2020). A Revised Survey of the Forest Types of India. Natraj Publishers.

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Major Elective Theory

Course Code – EVS 311 MJE

Course Title: Wildlife Biology and Management

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

Objectives:

1. To understand the basic concepts of wildlife biology and habitat characteristics.
2. To study the classification of wildlife species (flora and fauna).
3. To identify threats to wildlife and their conservation needs.
4. To learn habitat analysis and population assessment techniques.
5. To understand modern and sustainable wildlife management practices.

Course Outcome:

Upon completion of this course, students will be able to:

1. Explain different types of wildlife habitats (aquatic and terrestrial).
2. Classify plant and animal groups found in wildlife ecosystems.
3. Identify major threats to wildlife including human-wildlife conflict.
4. Apply population assessment techniques like direct and indirect counts.
5. Describe modern wildlife management techniques including bio-telemetry.
6. Explain eco-tourism and conservation of genetic resources.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Introduction to Wildlife Biology	• Introduction to Wildlife Biology. • Definition of Wildlife Biology. • Study of characteristics of wildlife habitats: - Aquatic Habitat: Marine, Freshwater, Estuaries. - Terrestrial Habitat: Forest, Grassland, Desert, Landscape.	06
2	Groups of Wildlife Species	• Plant Classification: Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms (Monocot and Dicot). • Animal Classification: - Arthropods (Insects, Arachnids, Crustaceans, Millipedes, Centipedes). - Vertebrates (Mammals, Birds, Fish, Reptiles, Amphibians).	06
3	Threats to Wildlife	• Habitat Destruction. • Developmental Projects and Urbanization. • Agriculture expansion. • Poaching and Deforestation. • Human-Wildlife Conflict. • Exploitation of animals and plants.	06
4	Habitat Analysis and Population Assessment Techniques	• Standard Evaluation processes for habitat: HEP & HIS. • Population Assessment techniques (Wildlife Census): - Direct count: Block count, Transect methods, Point count, Visual encounter survey, Waterhole survey. - Indirect count: Pugmark, Camera trap, DNA fingerprinting, Call count, Track and sign, Pellet	06

		count. - Marking wildlife: Ringing, Tagging, Clipping, Colouring.	
5	Modern and Sustainable Wildlife Management	• Modern Wildlife management techniques: Bio-telemetry. • Management practices: Monitoring Wildlife Populations, Habitat Improvement, Hunting Regulations, Artificial Stocking, Disease Control, Management Funds, Captive breeding and propagation. • Sustainable Wildlife management: Eco-tourism / Wildlife tourism in forests. • Reasons for biodiversity formation, contribution to adaptive evolution. • Landraces of crop plants, conservation of genetic resources.	06

References:

1. Cunningham, W.P. & Cunningham, M.A. *Principles of Environmental Science*. McGraw-Hill.
2. Singh, J.S., Singh, S.P. & Gupta, S.R. (2006). *Ecology, Environment and Resource Conservation*. Anamaya Publications, New Delhi.
3. Odum, E.P. (1971). *Fundamentals of Ecology*. W.B. Saunders Company.
4. Hajra, P.K. & Mudgal, V. (1997). *Plant Diversity Hotspots in India*. Botanical Survey of India.
5. Krishnamoorthy, B. (2005). *Environmental Management*. Prentice-Hall of India Pvt. Ltd., New Delhi.

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Major Elective Practical

Course Code – EVS 312 MJPE

Course Title: Practicals Based on EVS 310 MJE

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

Objectives:

1. To develop skills in studying the flora and fauna of terrestrial ecosystems.
2. To train students in vegetation sampling and biomass estimation methods.
3. To understand diversity indices and threat assessment models.
4. To learn population assessment techniques for wildlife.
5. To introduce basic remote sensing and GIS applications in vegetation mapping.

Course Outcome:

Upon completion of this course, students will be able to:

1. Identify common flora and fauna of urban terrestrial ecosystems.
2. Estimate grassland biomass using the harvest method.
3. Calculate species diversity using Shannon and Simpson's indices.
4. Apply population assessment techniques for animals, plants, and birds.
5. Interpret aerial photographs and satellite imagery for vegetation mapping.
6. Explain eco-tourism activities and interspecies relationships.

List of Practicals (Total: 15 Practicals)

Sr. No.	Title of the Practical	No. of Practicals
1	Study of Flora (plants, trees, shrubs, herbs, grasses) of local terrestrial ecosystem	1
2	Study of Fauna (birds, insects, mammals, reptiles) of local terrestrial ecosystem	1
3	Estimation of Above Ground Biomass (AGB) and Below Ground Biomass (BGB) of grassland by harvest method	1
4	Estimation of Carbon stock in vegetation (using biomass to carbon conversion factor)	1
5	Study of various types of interspecific relationships (Competition, Predation, Mutualism, Parasitism) with field examples	1
6	Estimation of Chlorophyll content in leaves (by Arnon method or using SPAD meter)	1
7	Study of threat assessment model for an ecosystem (using field observation and scoring method)	1
8	Calculation of Species Diversity using Shannon-Wiener Diversity Index and Simpson's Diversity Index	1
9	Study of population assessment technique – Direct method (Line transect / Point count for birds or animals)	1
10	Study of population assessment technique – Indirect method (Pugmark tracking / Pellet count / Call count)	1
11	Identification of different groups of wild species using field guides (Flora: Trees, Herbs, Grasses; Fauna: Mammals, Birds, Reptiles, Butterflies)	1
12	Study of Eco-tourism activities – Visit to a nearby eco-tourism site / Wildlife Sanctuary / Nature trail (report writing)	1
13	Vegetation mapping and Land Use/Land Cover (LULC) interpretation using Google Earth / Satellite imageries	1

14	Use of GPS for field data collection – Plot marking, waypoint collection, and area measurement for vegetation study	1
15	Study of Quadrat and Transect methods for vegetation sampling – Density, Frequency, Abundance, and IVI (Importance Value Index) calculation	1

References:

1. Misra, R. (1968). Ecology Work Book. Oxford & IBH Publishing Co., New Delhi.
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3. Southwood, T.R.E. & Henderson, P.A. (2000). Ecological Methods (3rd ed.). Blackwell Science, Oxford.
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7. Krebs, C.J. (2016). Ecological Methodology (3rd ed.). Pearson Education.
8. FSI. (2023). India State of Forest Report – Volume II (Forest Carbon Stock). Forest Survey of India, Dehradun.
9. Champion, H.G. & Seth, S.K. (2020). A Revised Survey of the Forest Types of India. Natraj Publishers.

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Major Elective Practical

Course Code – EVS 313 MJPE

Course Title: Practicals Based on EVS 311 MJE

[No. of Credits:2 C] **[No. of Lectures: 30 L]**

Objectives:

1. To develop skills in the identification of wildlife species (flora and fauna).
2. To train students in wildlife habitat assessment and population estimation techniques.
3. To understand modern wildlife management tools (camera trap, bio-telemetry, pugmark tracking).
4. To learn wildlife census methods (direct and indirect counts).
5. To introduce wildlife tourism and conservation awareness.

Course Outcome:

Upon completion of this course, students will be able to:

1. Identify different groups of wild animals, birds, reptiles, amphibians, and insects.
2. Identify different groups of wild plants (trees, shrubs, herbs, grasses, aquatic plants).
3. Apply direct and indirect methods for wildlife population assessment.
4. Use camera traps, pugmark tracking, and call-count techniques for wildlife studies.
5. Analyse wildlife habitat using HEP and HIS methods.
6. Prepare field reports on eco-tourism and wildlife conservation.

List of Practicals (Total: 15 Practicals)

Sr. No.	Title of the Practical	No. of Practicals
1.	Identification of different groups of wild animals (Mammals of India – tiger, leopard, elephant, deer, wild boar, jackal, etc.)	1
2.	Identification of different groups of wild birds (Common birds of India – peacock, crow, eagle, kingfisher, pigeon, myna, etc.)	1
3.	Identification of different groups of reptiles (snakes, lizards, turtles, crocodiles) and amphibians (frogs, toads)	1
4.	Identification of different groups of insects (butterflies, beetles, dragonflies, grasshoppers, bees, ants)	1
5.	Identification of different groups of wild plants (Trees, Shrubs, Herbs, Grasses, Climbers)	1
6.	Study of aquatic wildlife (Freshwater – fish, turtles, frogs; Marine – corals, sea turtles, dolphins)	1
7.	Calculation of Species Diversity using Shannon-Wiener Diversity Index (H') for wildlife data	1
8.	Calculation of Species Diversity using Simpson's Diversity Index (D) for wildlife data	1
9.	Study of population assessment technique – Direct method (Line transect method for birds/animals)	1
10.	Study of population assessment technique – Direct method (Point count method for birds)	1
11.	Study of population assessment technique – Indirect method (Pugmark tracking and identification)	1
12.	Study of population assessment technique – Indirect method (Camera trap setup and interpretation)	1

13.	Study of population assessment technique – Indirect method (Pellet/Scat count and Call count method)	1
14.	Study of wildlife marking techniques (Ringing, Tagging, Clipping, Colouring – demonstration)	1
15.	Study of Eco-tourism / Wildlife tourism – Visit to a Wildlife Sanctuary / National Park / Nature trail (report writing and presentation)	1

References:

1. Prater, S.H. (2019). The Book of Indian Mammals (3rd ed.). Bombay Natural History Society / Oxford University Press.
2. Grimmett, R., Inskipp, C. & Inskipp, T. (2016). Birds of the Indian Subcontinent (2nd ed.). Helm Field Guides.
3. Sutherland, W.J. (2006). Ecological Census Techniques: A Handbook (2nd ed.). Cambridge University Press.
4. Krebs, C.J. (2016). Ecological Methodology (3rd ed.). Pearson Education.
5. Shannon, C.E. & Weaver, W. (1949). The Mathematical Theory of Communication. University of Illinois Press.
6. Simpson, E.H. (1949). Measurement of diversity. Nature, 163: 688.
7. Magurran, A.E. (2013). Measuring Biological Diversity (2nd ed.). Wiley-Blackwell.

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Vocational Skill Courses Theory

Course Code – EVS 321 VSC

Course Title: Environmental Legislation and Policy

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

Objectives:

1. To understand the basic concepts of law, policy, and environmental governance.
2. To study the constitutional provisions related to environment in India.
3. To learn about major environmental acts and legislations in India.
4. To understand the role of government institutions in environmental protection.
5. To study international environmental laws and agreements.

Course Outcome:

Upon completion of this course, students will be able to:

1. Explain the concept of environmental governance and its importance.
2. Describe constitutional provisions (Article 48A, Fundamental Rights and Duties) related to the environment.
3. Identify the roles of MoEFCC, CPCB, SPCB, and NGT.
4. Summarize major international agreements (Stockholm, Rio, Kyoto, Paris, Montreal Protocol).
5. Explain key environmental acts of India (Environment Protection Act, Water Act, Air Act, Wildlife Act, Forest Act).

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Introduction to Law and Policy	• Concept of law and policy. • Environmental governance – importance and elements. • Environmental ethics – introduction, concept, development.	06
2	Constitutional Provisions	• Article 48A: Protection and improvement of environment and safeguarding of forests and wildlife. • Fundamental Rights and Duties as per the Constitution of India. • Legal definitions: Environmental pollution, natural resource, biodiversity, forest, sustainable development.	06
3	Government Institutions	• Role of Ministry of Environment, Forests and Climate Change (MoEFCC). • Role of Central Pollution Control Board (CPCB). • Role of State Pollution Control Boards (SPCB). • Role of National Green Tribunal (NGT).	06
4	International Laws and Policy	• Stockholm Conference (1972). • United Nations Conference on Environment and Development (1992) – Rio Declaration, Agenda 21. • Montreal Protocol (1987). • Kyoto Protocol (1997). • Paris Summit (2015) – COP21. • Ramsar Convention.	06
5	Environmental Acts of India	• The Environment (Protection) Act, 1986. • The Forests (Conservation) Act, 1980. • The Wildlife (Protection) Act, 1972. • The Water (Prevention and Control of Pollution) Act,	06

		1974. • The Air (Prevention and Control of Pollution) Act, 1981. • Motor Vehicle Act, 1988. • The Public Liability Insurance Act, 1991. • Noise Pollution (Regulation and Control) Rules, 2000.	

References:

1. Abraham, C.M. (1999). Environmental Jurisprudence in India. Kluwer Law International.
2. Divan, S. & Rosencranz, A. (2002). Environmental Law and Policy in India (2nd ed.). Oxford University Press.
3. Leelakrishnan, P. (2016). Environmental Law in India (4th ed.). LexisNexis.
4. Doabia, T.S. (2017). Environmental and Pollution Laws in India (3rd ed.). LexisNexis.
5. Venkat, A. (2011). Environmental Law and Policy. PHI Learning Private Ltd.
6. Agarwal, V.K. (2005). Environmental Laws in India: Challenges for Enforcement. Bulletin of the National Institute of Ecology 15: 227-238.
7. Gupta, K.R. (2006). Environmental Legislation in India. Atlantic Publishers and Distributors.
8. Naseem, M. (2011). Environmental Law in India. Kluwer Law International.

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Field Project / Community Engagement Project

Course Code – FP/CEP 331 EVS

Course Title: Field Project and Report Writing

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

Objectives:

1. To develop skills in planning and executing an environmental field project.
2. To train students in data collection methods (sampling, observation, surveys).
3. To understand data analysis and interpretation techniques.
4. To learn scientific report writing and presentation skills.
5. To apply theoretical knowledge to real-world environmental problems.

Course Outcome:

Upon completion of this course, students will be able to:

1. Identify an environmental problem and formulate objectives for a field study.
2. Design an appropriate methodology for field data collection.
3. Collect, analyse, and interpret environmental data using suitable techniques.
4. Write a structured scientific report with introduction, methodology, results, discussion, and conclusion.
5. Present findings effectively using oral and visual presentation skills.
6. Develop solutions and recommendations for environmental issues studied.

Guidelines for Field Project:

The field project shall be undertaken by students in groups of 4 to 5 students each (individual projects are also permitted, as per the decision of the respective college). The total fieldwork duration shall be a minimum of 30 hours, spread over 4 to 6 weeks. The field project topic may be selected from any environmental issue related to water, soil, air, noise, biodiversity, waste management, climate change, or other relevant environmental themes. The study area shall be confined to the local area within a 10 to 15 km radius of the college, which may include a village, town, city, forest, lake, river, industrial area, or any other suitable site. The entire project shall be conducted under the guidance of a faculty supervisor appointed by the department.

Steps of Field Project:

The field project shall be carried out in a systematic step-by-step manner. The first step is topic selection, wherein students identify an environmental problem or research question. The second step is literature review, which involves studying previous research, reports, and background information related to the selected topic. The third step is formulation of objectives, where students develop 3 to 5 clear and specific objectives for the project. The fourth step is methodology, which includes designing a sampling plan, selecting data collection methods, and deciding analysis techniques. The fifth step is fieldwork, wherein students conduct field visits and collect samples or data for a minimum of 30 hours. The sixth step is data analysis, where the collected data is analyzed using appropriate statistical or qualitative methods. The seventh step is report writing, in which students prepare a structured scientific

report following the prescribed format. The eighth and final step is the presentation, during which students present their findings to a panel of examiners for 10 to 15 minutes.

Report Writing Format:

The field project report shall be structured in a scientific format, comprising the following sections in the following order.

1. The Title Page
2. The Certificate
3. The Acknowledgement
4. The Abstract
5. The Introduction
6. The Objectives section shall list 3 to 5 specific
7. Study Area (If Applicable)
8. The Methodology
9. The Results and Discussion
10. The Conclusion and Recommendations
11. The References
12. Appendices

Scheme of Evaluation:

Component	Marks
Field Project Report (Quality of content, analysis, presentation)	20
Viva Voce (Oral examination based on project)	10
Fieldwork Log / Journal (Hours, observations, daily records)	05
Presentation (PPT / Poster / Oral)	05
Total	40

References:

1. Day, R.A. & Gastel, B. (2016). How to Write and Publish a Scientific Paper (8th ed.). Cambridge University Press.
2. Swales, J.M. & Feak, C.B. (2012). Academic Writing for Graduate Students (3rd ed.). University of Michigan Press.
3. Booth, W.C., Colomb, G.G. & Williams, J.M. (2016). The Craft of Research (4th ed.). University of Chicago Press.
4. Kothari, C.R. (2004). Research Methodology: Methods and Techniques (2nd ed.). New Age International Publishers.
5. Sutherland, W.J. (2006). Ecological Census Techniques: A Handbook (2nd ed.). Cambridge University Press.

T.Y.B.Sc. Environmental Science (Semester-V)

Course Category: Minor Theory

Course Code – EVS 341 MN

Course Title: Environmental Biotechnology

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

Objectives:

1. To understand the introduction, scope, and applications of environmental biotechnology.
2. To study composting and vermicomposting technologies.
3. To learn about Genetically Modified Organisms (GMOs) and biosafety measures.
4. To understand agricultural biotechnology and biofertilizers.
5. To study the collection, enumeration, and ecological role of microbes.

Course Outcome:

Upon completion of this course, students will be able to:

1. Explain the importance and applications of environmental biotechnology.
2. Describe composting and vermicomposting processes.
3. Discuss the principles, advantages, and risks of GMOs and the Cartagena Protocol.
4. Identify types of biofertilizers and their role in sustainable agriculture.
5. Demonstrate methods for the collection, enumeration, and nutritional study of microbes.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Introduction to Environmental Biotechnology	• Introduction and meaning of Environmental Biotechnology. • Necessity and scope. • History and objectives. • Importance and applications.	06
2	Composting Technology	• Classification of composting methods. • Manufacturing process. • Formulation of compost. • Mode of action of composting technology. • Vermicomposting – process, advantages, and applications.	06
3	Genetically Modified Organisms (GMOs)	• Introduction to GMOs. • Principles and advantages. • Biosafety measures. • Examples of GMOs (Bt cotton, Golden Rice, etc.). • Risks to environment and human health. • Cartagena Protocol on Biosafety.	06
4	Agricultural Biotechnology and Biofertilizers	• Introduction to agricultural biotechnology. • Detection and diagnosis of plant diseases. • Micropropagation – principles and applications. • Biofertilizers – types (Rhizobium, Azotobacter, Azospirillum, Blue Green Algae, Mycorrhiza). • Role of biofertilizers in sustainable agriculture. • Waste utilization in agriculture.	06
5	Microbes in Environmental Biotechnology	• Collection and enumeration of microbes from environmental samples. • Ecological relationships of microbes in nature.	06

		• Nutritional requirements of microbes. • Nutrient media – types, preparation, and uses. • Isolation and culturing techniques.	

References:

1. Jogdand, S.N. (1995). Environmental Biotechnology. Himalaya Publishing House, Mumbai.
2. Fulekar, M.H. (2010). Environmental Biotechnology. Oxford & IBH Publishing Co.
3. Thakur, I.S. (2011). Environmental Biotechnology: Basic Concepts and Applications. I.K. International Pvt. Ltd.
4. Chatterji, A.K. (2011). Introduction to Environmental Biotechnology. PHI Learning Pvt. Ltd., New Delhi.
5. Srinivas, T. (2008). Environmental Biotechnology. New Age International Publishers, New Delhi.
6. Das, H.K. (2017). Textbook of Biotechnology. Wiley Publications, New Delhi.
7. Scragg, A. (2011). Environmental Biotechnology. Oxford University Press, New York.
8. Bhattacharyya, B.C. (2010). Environmental Biotechnology. Oxford University Press, New Delhi.
9. Jha, A. (2017). Environmental Biotechnology: Principles and Applications. Anmol Publication Pvt. Ltd., New Delhi.
10. Ramasamy, K., Kalaichelvan, G. & Nagamani, B. (1992). Working with Anaerobes: Methanogens. Fermentation Laboratory, TNAU, Coimbatore.
11. Gerhardt, P., Murray, R.G.E., Wood, W.A. & Krieg, N.R. (1994). Methods for General and Molecular Bacteriology. ASM Publications, Washington.
12. Crawford, R.L. & Crawford, D.L. (1996). Bioremediation – Principles and Applications. Cambridge University Press, London.

T.Y.B.Sc. Environmental Science (Semester-VI)
Course Category: Major Core Theory
Course Code – EVS 351 MJ
Course Title: Air and Noise Quality
[No. of Credits: 4 C] **[No. of Lectures: 60 L]**

Objectives:

1. To understand the composition of the atmosphere and the chemical reactions occurring in it.
2. To study the sources, types, and effects of air pollution.
3. To learn analytical methods for monitoring air pollutants.
4. To understand air pollution control equipment and techniques.
5. To study the basics of acoustics and noise specifications.
6. To understand the effects of noise on health and noise control measures.

Course Outcome:

Upon completion of this course, students will be able to:

1. Explain the composition of the atmosphere and factors influencing the pollutant mix.
2. Identify sources and types of air pollutants and their effects on health and the environment.
3. Describe sampling and analytical methods for SO_2, CO, NOx, and particulate matter.
4. Explain air pollution control equipment for particulate and gaseous pollutants.
5. Calculate Air Quality Index (AQI) and Air Pollution Tolerance Index (APTI).
6. Describe noise parameters, sound levels, and noise instrumentation.
7. Explain the effects of noise on health and various noise indices.
8. Describe noise control techniques and noise standards.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Atmosphere and its Nature	• Composition of Atmosphere – permanent and variable gases. • Chemical and photochemical reactions in the atmosphere. • Human activities and meteorology. • Factors influencing the pollutant mix in the atmosphere. • Transport of Pollution in Atmosphere. • Global Warming, Ozone Hole, El Niño, La Niña Phenomenon.	08
2	Air Pollution	• Air pollution – meaning and definition. • Sources and types of air pollutants (primary and secondary). • Major air pollutants – SO_2, NOx, CO, O_3, $PM_{2.5}$, PM_{10}, Pb, VOCs. • Types of air pollution – indoor air pollution, vehicular pollution, industrial pollution. • Status of Air pollution in India. • Effects of air pollution on plants, animals, humans, and materials.	12

		• Smog (photochemical and classical) and Acid rain. • Control of air pollution – preventive and control measures. • Emission Standards (Bharat Stage VI). • Air Quality Index (AQI) and Air Pollution Tolerance Index (APTI).	
3	Analytical Methods for Monitoring Air Pollutants	• Sampling methods for air pollutants – grab sampling, continuous sampling. • Stack sampling – principles and equipment. • Instrumentation and methods of analysis: - SO_2 – Modified West & Gaeke method. - CO – Non-dispersive infrared (NDIR) method. - NOx – Jacob & Hochheiser method. - Hydrogen Sulphide (H_2S) – Methylene blue method. - Hydrocarbons – Flame ionization detector (FID). - Methane – Gas chromatography. - Particulate Matter – Gravimetric method (High Volume Sampler, Fine Particulate Sampler).	10
4	Air Pollution Control	• Air pollution control – at source. • Equipment for control of air pollution – For Particulate Matter: - Settling chambers. - Fabric filters (Baghouses). - Scrubbers (Venturi, Spray tower). - Cyclones. - Electrostatic Precipitators (ESP). • Equipment for control of Gaseous pollutants: - Absorption. - Adsorption. - Scrubbers (chemical scrubbing).	12
5	Noise Pollution – Basics and Acoustics	• Basics of acoustics and specification of sound. • Sound power, sound intensity, and sound pressure levels. • Plane, point, and line sources; multiple sources. • Causes of noise – industrial, vehicular, construction, domestic, aviation. • Outdoor and indoor noise propagation. • Psycho-acoustics and noise criteria. • Noise instrumentation – Sound Level Meter (SLM) – components and working. • Noise monitoring procedure – sampling techniques, duration, frequency.	08
6	Noise Pollution – Effects, Indices and Control	• Effects of noise on health – hearing loss (temporary and permanent), cardiovascular effects, sleep disturbance, annoyance, stress, communication interference. • Annoyance rating schemes. • Special noise environments – Infra-sound, ultrasound, impulsive sound, sonic boom. • Noise indices – L_{10}, L_{50}, L_{90}, Leq (Equivalent Continuous Noise Level), Ldn (Day-Night Level), LNP (Noise Pollution Level). • Noise standards and limit values (CPCB, WHO, IS 9876). • Noise control techniques – source control, path control,	10

		receiver control. • Acoustic zoning and noise barriers. • Noise Pollution (Regulation and Control) Rules, 2000 (India).	

References:

1. Rao, C.S. (2007). Environmental Pollution Control Engineering (2nd ed.). New Age International Publishers, New Delhi.
2. Rao, M.N. & Rao, H.V.N. (2017). Air Pollution Control Engineering. McGraw-Hill Education.
3. Cunningham, W.P. & Cunningham, M.A. (2021). Principles of Environmental Science (10th ed.). McGraw-Hill.
4. Khopkar, S.M. (2020). Environmental Pollution Analysis (2nd ed.). New Age International Publishers.
5. Cunniff, P.E. (1987). Environmental Noise Pollution. McGraw Hill, New York.
6. Bies, D.A. & Hansen, C.H. (2017). Engineering Noise Control (5th ed.). CRC Press.
7. CPCB. (2021). Air Quality Monitoring and Analysis Guidelines. Central Pollution Control Board, New Delhi.
8. CPCB. (2023). National Ambient Air Quality Standards (NAAQS). Central Pollution Control Board, New Delhi.
9. WHO. (2021). WHO Global Air Quality Guidelines. World Health Organization, Geneva.
10. Wani, K.A. & Jangid, A. (2015). Air Pollution Tolerance Index of Plants. Journal of Environmental Science and Technology.
11. BIS. (2019). IS 9876:2019 – Noise Limits for Automobiles. Bureau of Indian Standards.
12. MoEFCC. (2000). Noise Pollution (Regulation and Control) Rules, 2000. Ministry of Environment, Forest and Climate Change, Government of India.

T.Y.B.Sc. Environmental Science (Semester-VI)

Course Category: Major Core Theory

Course Code – EVS 352 MJ

Course Title: Environmental Governance: EMS, EIA and ISO 14000

[No. of Credits: 4 C] **[No. of Lectures: 60 L]**

Objectives:

1. To understand the concept, importance, and elements of environmental governance.
2. To study the issues and challenges of environmental governance in India.
3. To learn about ISO 14000 standards and environmental management systems.
4. To understand the principles, methods, and process of Environmental Impact Assessment (EIA).
5. To study the basics of the Environmental Management System (EMS) and the Environmental Management Plan (EMP).
6. To analyze case studies of developmental projects and their environmental impacts.

Course Outcome:

Upon completion of this course, students will be able to:

1. Explain the concept, objectives, and attributes of environmental governance.
2. Describe the issues and challenges of environmental governance in India.
3. Summarise the ISO 14000 standards, implementation, and certification process.
4. Explain the EIA process, methods of data collection, and public participation.
5. Prepare an Environmental Management Plan (EMP) and understand environmental audit.
6. Analyse case studies of developmental projects and their impact on vegetation, wildlife, deforestation, and mining

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Environmental Governance	• Introduction, importance, objectives, and attributes of Governance. • Elements of governance: Institutional and structural, rules and regulation. • Environmental governance in India – issues and challenges.	12
2	ISO 14000 Standards	• Overview of ISO 14000 – Management system benefits and scopes. • Implementation and certification process. • ISO/207 TC function. • Environmental management and sustainability aspects.	12
3	Environmental Impact Assessment (EIA) – I	• Introduction, needs, and goals of EIA. • Advantages and disadvantages of EIA. • Life Cycle Assessment (LCA) – concept and applications. • Societal response and responsibilities – Public participation. • EIA Notification, 2006 (India).	12
4	Environmental Impact Assessment (EIA) – II	• Methods of data collection for EIA: - Network method. - Checklist method.	12

		- Matrix method. - Overlay & GIS method. - Cost – Benefit Analysis (CBA). • Concept of Environmental Audit – definition and types. • Benefits and objectives of environmental audit. • Onsite and offsite audit. • Report preparation.	
5	Environmental Management System (EMS) and Environmental Management Plan (EMP)	• Basics of EMS and EMP – elements and components. • Planning and selection of appropriate resources management. • Benefits of EMS and EMP system. • Integration of EMS with ISO 14000.	06
6	Case Studies	• Case studies based on developmental projects. • Assessment of impact of development activities on: - Vegetation and wildlife. - Deforestation and mining. • Indian case studies (e.g., Sardar Sarovar Dam, Posco Steel Plant, Vedanta Mining, Mumbai Coastal Road Project).	06

References:

1. Hempel, L.C. (1996). Environmental Governance: The Global Challenge. Island Press.
2. Rangarjan, M. (2007). Environmental Issues in India - A Reader. Pearson-Longman Publication.
3. Trivedy, R.K. (2004). Handbook of Environmental Law, Acts, Guidelines, Compliances, and Standards (Vol. I & II). BS Publications.
4. Louka, E. (2006). International Environmental Law, Fairness, Effectiveness and World Order. Cambridge University Press.
5. Najam, A., Papa, M. & Taiyab, N. (2006). Global Environmental Governance: A Reform Agenda. International Institute for Sustainable Development (IISD), Canada.
6. Curmally, A. (2002). Environmental Governance and Regulation in India. India Infrastructure Report.
7. Canter, R.L. (1996). Environmental Impact Assessment (2nd ed.). McGraw-Hill International Edition.
8. Rathi, A.K.A. (2016). Environmental Impact Assessment: Practical Guide for Professional Practices. Gujarat Akar Unlimited.
9. Asolekar, S.R. & Gopichandran, R. (2005). Preventive Environmental Management: An Indian Perspective. Centre for Environmental Education.
10. MoEFCC. (2006). EIA Notification, 2006. Ministry of Environment, Forest and Climate Change, Government of India.
11. ISO. (2015). ISO 14001:2015 – Environmental Management Systems – Requirements with guidance for use. International Organisation for Standardisation.
12. Morris, P. & Therivel, R. (2018). Methods of Environmental Impact Assessment (4th ed.). Routledge.

T.Y.B.Sc. Environmental Science (Semester-VI)

Course Category: Major Core Practical

Course Code – 3. EVS 353 MJP

Course Title: Practical Based on EVS351MJ and EVS352MJ

[No. of Credits: 4 C] **[No. of Lectures: 60 L]**

Objectives:

1. To develop skills in monitoring and analyzing air quality parameters.
2. To train students in noise level measurement and interpretation.
3. To understand the use of instruments like High Volume Sampler and Sound Level Meter.
4. To learn the EIA screening and scoping process through practical exercises.
5. To prepare environmental audit reports and EMP for mock projects.

Course Outcome:

Upon completion of this course, students will be able to:

1. Measure ambient air quality parameters (PM, SO_2, NOx) using standard methods.
2. Calculate Air Quality Index (AQI) and Air Pollution Tolerance Index (APTI).
3. Measure noise levels using Sound Level Meter and calculate noise indices (Leq, L_{10}, L_{90}).
4. Prepare a rapid EIA report for a mock developmental project.
5. Conduct a mock environmental audit and prepare an audit report.
6. Prepare an Environmental Management Plan (EMP) for a case study.

Sr. No.	Title of the Practical	No. of Practicals
1	Measurement of ambient air quality – determination of Particulate Matter (PM_{10} and $PM_{2.5}$) using High Volume Sampler / Fine Particulate Sampler	1
2	Determination of Sulphur Dioxide (SO_2) from ambient air samples (Modified West & Gaeke method)	1
3	Determination of Oxides of Nitrogen (NOx) from ambient air samples (Jacob & Hochheiser method)	1
4	Determination of Carbon Monoxide (CO) from ambient air (NDIR method / using CO monitor)	1
5	Calculation of Air Quality Index (AQI) from given pollutant concentration data ($PM_{2.5}$, PM_{10}, SO_2, NOx, CO, O_3)	1
6	Calculation of Air Pollution Tolerance Index (APTI) of selected plant species (using pH, ascorbic acid, total chlorophyll, relative water content)	1
7	Measurement of noise levels using Sound Level Meter (SLM) at different locations (silent zone, residential, commercial, industrial)	1
8	Calculation of Noise Indices – Leq (Equivalent Continuous Noise Level), L_{10}, L_{50}, L_{90} from noise data	1
9	Study of EIA Notification, 2006 – Screening, Scoping, and Categorization of projects (Category A and B)	1
10	Preparation of a Rapid EIA report for a mock developmental project (format and contents)	1
11	Study of EIA methods – Preparation of Checklist and Matrix method (Leopold Matrix) for a project	1
12	Study of EIA methods – Preparation of Network and Overlay / GIS method for a project	1
13	Preparation of an Environmental Management Plan (EMP) for a mock project (mitigation measures)	1

14	Conducting a mock Environmental Audit – Onsite and Offsite audit procedures	1
15	Preparation of Environmental Audit Report – Structure, contents, and presentation	1
16	Case Study analysis – Assessment of impact of a developmental project (mining / dam / highway / industrial estate) on environment	1

References:

1. CPCB. (2021). Air Quality Monitoring and Analysis Guidelines. Central Pollution Control Board, New Delhi.
2. CPCB. (2023). National Ambient Air Quality Standards (NAAQS). Central Pollution Control Board, New Delhi.
3. Khopkar, S.M. (2020). Environmental Pollution Analysis (2nd ed.). New Age International Publishers.
4. APHA. (2017). Standard Methods for Examination of Air and Noise. American Public Health Association.
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T.Y.B.Sc. Environmental Science (Semester-VI)

Course Category: Major Elective Theory

Course Code – EVS 360 MJE

Course Title: Aquatic Ecosystem and Management

[No. of Credits: C] **[No. of Lectures: L]**

Objectives:

1. To understand the basic concepts of limnology and aquatic environment.
2. To study the distribution, classification, and structure of major aquatic ecosystems.
3. To learn about freshwater ecology and its biotic communities.
4. To understand marine and estuarine ecology including mangroves and coral reefs.
5. To study methods of aquatic ecosystem management and conservation.

Course Outcome:

Upon completion of this course, students will be able to:

1. Explain the parameters, biota, and energy flow in aquatic ecosystems.
2. Describe the classification, stratification, and zonation of aquatic ecosystems.
3. Identify freshwater biota and understand lentic and lotic communities.
4. Explain marine biota, mangroves, coral reefs, and their ecological significance.
5. Apply remote sensing, GIS, and traditional methods for aquatic ecosystem management.
6. Suggest sustainable management and conservation strategies for aquatic resources.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Limnology	• Introduction to Limnology – the study of inland waters. • The Aquatic environment – physical, chemical, and biological parameters. • Aquatic Biota – producers, consumers, decomposers. • Energy flow in aquatic ecosystem – food chain, food web, trophic levels. • Major environmental factors and ecosystem processes. • Ramsar Convention and Ramsar sites in India.	06
2	Distribution of Major Aquatic Ecosystems	• Classification of aquatic ecosystems – freshwater, marine, estuarine. • Structure and patterns of aquatic ecosystems. • Types of interactions in aquatic communities. • Stratification and Zonation in lakes and oceans. • Impact of Climate change on aquatic ecosystems.	06
3	Freshwater Ecology	• The freshwater environment – types (lentic and lotic). • Limiting factors in freshwater ecosystems. • Ecological classification of freshwater organisms. • Freshwater biota (flora and fauna). • Lentic communities – lakes and ponds (littoral, limnetic, profundal zones). • Lotic communities – rivers, streams, springs. • Planktons – phytoplankton and zooplankton. • Biodiversity, negative and positive feedbacks, and resilience.	06
4	Marine and Estuarine Ecology	• The marine environment – characteristics and zones. • Marine biota (flora and fauna). • Zonation in the sea – intertidal, neritic, oceanic, benthic zones.	06

		• Study of planktons in marine ecosystems. • Communities in the marine environment. • Food production potential of marine ecosystems. • Mangrove Vegetation – types, distribution, ecological significance. • Coral reefs – types, formation, threats, and conservation. • Ecological significance of mangroves and coral reefs.	
5	Aquatic Ecosystem Management	• Methods of aquatic ecosystem management: - Remote sensing and GIS applications. - Eco-development programs. - Traditional methods of water conservation (e.g., stepwells, tanks, kunds). • Methods of aquatic sampling and data analysis – sampling approaches, species association. • Exploitation and consequences of wetlands. • Sustainable management of aquatic resources. • Role of Local Government and people in conservation. • Impact of Tourism and Eco-tourism on aquatic ecosystems. • Conservation and Sustainable use of India's aquatic resources. • Case studies (e.g., Loktak Lake, Chilika Lake, Vembanad Lake, Sundarbans).	06

References:

1. Groom, B. & Jenkins, M. (2000). Global Biodiversity: Earth's Living Resources in the 21st Century. World Conservation Press, Cambridge, UK.
2. Odum, E.P. & Barrett, G.W. (2017). Fundamentals of Ecology (5th ed.). Cengage Learning.
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5. Ananthakrishnan, T.N. (2006). Limnology. Oxford University Press.
6. Trivedy, R.K. (2010). Ecology of Aquatic Ecosystems. Environmental Publications.
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T.Y.B.Sc. Environmental Science (Semester-VI)

Course Category: Major Elective Theory

Course Code – EVS 361 MJE

Course Title: Nature Conservation

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

Objectives:

1. To understand the concept, objectives, and challenges of nature conservation.
2. To study in-situ conservation methods and protected areas.
3. To learn ex-situ conservation techniques and their applications.
4. To understand international and national efforts for nature conservation.
5. To study the role of NGOs and public awareness in conservation.

Course Outcome:

Upon completion of this course, students will be able to:

1. Explain the concept, objectives, and challenges of nature conservation.
2. Describe in-situ conservation methods – Biosphere reserves, National Parks, Wildlife Sanctuaries, Sacred groves.
3. Explain ex-situ conservation methods – Cryopreservation, Seed banks, Gene banks, Cultivation collections.
4. Identify the roles of IUCN, WWF, BNHS, MoEFCC, CPCB, and SPCB in conservation.
5. Discuss international protocols and conventions for nature conservation.
6. Explain the importance of state symbols and NGO role in conservation awareness.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	**Introduction to Nature Conservation**	• Introduction to Nature Conservation. • Concept of nature conservation. • Objectives of nature conservation – preservation, restoration, sustainable use. • Challenges in nature conservation – habitat loss, climate change, poaching, human-wildlife conflict.	**06**
2	**In-situ Conservation**	• Concept and principles of In-situ Conservation. • Types of in-situ conservation: - Biosphere reserves (structure – core, buffer, transition zones). - National Parks. - Wildlife Sanctuaries. - Biodiversity Hotspots. - Gene Sanctuaries. - Community Reserves. - Conservation Reserves. - Sacred Groves. • Challenges, merits, and demerits of in-situ conservation.	**06**
3	**Ex-situ Conservation**	• Concept and principles of Ex-situ Conservation. • Types of ex-situ conservation: - Cryopreservation (preservation at very low temperatures). - Seed banks (storage of seeds). - Field gene banks (living collections). - Cultivation collections (botanical gardens, zoos, aquariums). - Tissue culture and micropropagation. • Challenges, merits, and demerits of ex-situ conservation.	**06**
4	**International and**	• International efforts: - Role of IUCN (International Union for Conservation of Nature) –	**08**

	National Efforts for Conservation	Red List, protected area categories. - Role of WWF (World Wide Fund for Nature). - Introduction to Protocols and Conventions – CITES, Convention on Biological Diversity (CBD), Ramsar Convention, Bonn Convention. • National efforts: - BNHS (Bombay Natural History Society). - Conservation missions – Project Tiger, Project Elephant, Crocodile Conservation, Rhino Conservation, Reindeer Conservation, Whaling mission. - Administrative setup – MoEFCC, CPCB, SPCB, National Board for Wildlife (NBWL). - Role of NGOs in nature conservation.	
5	**Awareness and State Symbols**	• Awareness about conservation – need and methods. • State Symbols (Animal, Bird, Flower, Tree) of Maharashtra and other major states of India. • Role of NGOs in creating conservation awareness (e.g., WWF-India, BNHS, Greenpeace, Wildlife Trust of India). • Environmental education and public participation in conservation.	**04**

References:

1. Agrawal, K.C. (2009). Biodiversity: Concept, Conservation and Management. Concept Publishing Company Pvt. Ltd, New Delhi.
2. Ahluwalia, V.K. & Malhotra, S. (2008). Environmental Science. The Energy and Resources Institute (TERI).
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11. MoEFCC. (2023). Annual Report – Project Tiger and Project Elephant. Ministry of Environment, Forest and Climate Change, Government of India.
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T.Y.B.Sc. Environmental Science (Semester-VI)

Course Category: Major Elective Practical

Course Code – EVS 362 MJPE

Course Title: Practicals Based on EVS 360 MJE

[No. of Credits: C] **[No. of Lectures: L]**

Objectives:

1. To develop skills in sampling and analysis of aquatic ecosystems.
2. To train students in the identification of aquatic flora and fauna.
3. To understand the physicochemical parameters of water and their significance.
4. To study plankton diversity and its role as a bioindicator.
5. To learn GIS and remote sensing applications in aquatic ecosystem management.

Course Outcome:

Upon completion of this course, students will be able to:

7. Collect and preserve water samples from different aquatic ecosystems.
8. Identify freshwater and marine flora and fauna using field guides.
9. Analyze physico-chemical parameters of water samples.
10. Identify and quantify phytoplankton and zooplankton samples.
11. Calculate diversity indices for aquatic communities.
12. Use Google Earth / GIS for wetland mapping and analysis.

List of Practicals (Total: 15 Practicals)

Sr. No.	Title of the Practical	No. of Practicals
1	Study of aquatic ecosystem – Visit to a nearby lake / pond / river / wetland (observation and documentation)	1
2	Sampling of water from different aquatic ecosystems (lake, river, pond, marine, estuary) – techniques and preservation	1
3	Analysis of physico-chemical parameters of water – Temperature, pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS)	1
4	Estimation of Dissolved Oxygen (DO) and Free CO_2 in water samples (Winkler's method)	1
5	Determination of Alkalinity and Hardness of water samples	1
6	Determination of Nitrates (NO_3^-) and Phosphates (PO_4^{3-}) from water samples	1
7	Collection and identification of Freshwater Phytoplankton (Spirogyra, Chlamydomonas, Navicula, Oscillatoria, etc.)	1
8	Collection and identification of Freshwater Zooplankton (Daphnia, Cyclops, Rotifers, etc.)	1
9	Collection and identification of Marine Plankton (Diatoms, Dinoflagellates, Copepods, etc.)	1
10	Identification of Aquatic Macrophytes (Hydrilla, Eichhornia, Lemna, Typha, Nymphaea, etc.)	1
11	Identification of Aquatic Fauna (Fish, Frogs, Turtles, Snakes, Birds – Kingfisher, Crane, Duck, etc.)	1
12	Calculation of Species Diversity using Shannon-Wiener Index and Simpson's Diversity Index for aquatic communities	1
13	Study of Aquatic Food Chain and Food Web – Construction and analysis	1
14	Study of Ramsar Sites in India – Mapping and identification using Google Earth / GIS	1

15	Wetland mapping and land use/land cover (LULC) interpretation using satellite imageries (Landsat / Sentinel / Google Earth)	1

References:

1. APHA, AWWA, WEF. (2023). Standard Methods for the Examination of Water and Wastewater (24th ed.). American Public Health Association, Washington D.C.
2. Trivedy, R.K. & Goel, P.K. (2020). Chemical and Biological Methods for Water Pollution Studies. Environmental Publications.
3. Wetzel, R.G. & Likens, G.E. (2000). Limnological Analyses (3rd ed.). Springer.
4. Edmondson, W.T. (1992). Freshwater Biology. Wiley Publishing.
5. Ward, H.B. & Whipple, G.C. (2018). Freshwater Biology (2nd ed.). John Wiley & Sons.
6. Needham, J.G. & Needham, P.R. (2010). A Guide to the Study of Freshwater Biology. Holden-Day.
7. Pennak, R.W. (2017). Freshwater Invertebrates of the United States (4th ed.). John Wiley & Sons.
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9. MoEFCC. (2023). Ramsar Sites in India – A Complete Guide. Ministry of Environment, Forest and Climate Change, Government of India.
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T.Y.B.Sc. Environmental Science (Semester-VI)

Course Category: Major Elective Practical

Course Code – EVS 363 MJPE

Course Title: Practicals Based on EVS 361 MJE

[No. of Credits: C] **[No. of Lectures: L]**

Objectives:

1. To develop skills in identifying protected areas and conservation sites in India.
2. To train students in studying in-situ and ex-situ conservation methods.
3. To understand the role of IUCN Red List and CITES in species conservation.
4. To study the conservation status of Indian flora and fauna.
5. To learn about state symbols and their conservation significance.

Course Outcome:

Upon completion of this course, students will be able to:

1. Identify and map Biosphere Reserves, National Parks, and Wildlife Sanctuaries of India.
2. Describe the conservation status of species using IUCN Red List categories.
3. Identify CITES listed species and their appendices.
4. Study Sacred Groves and their role in biodiversity conservation.
5. Identify State Symbols (Animal, Bird, Flower, Tree) of different Indian states.
6. Prepare a project report on a conservation site or species.

Sr. No.	Title of the Practical	No. of Practicals
1	Bird watching and identification of common birds (Crow, Pigeon, Sparrow, Myna, Sunbird, Kingfisher, etc.) using field guide	1
2	Butterfly watching and identification of common butterflies (Cabbage White, Tiger Butterfly, Mormon, Grass Yellow, etc.)	1
3	Observation and identification of common trees in the college campus / local area (Banyan, Peepal, Neem, Mango, Gulmohar, etc.)	1
4	Observation and identification of common shrubs and herbs in the local area (Hibiscus, Lantana, Tulsi, Grass species, etc.)	1
5	Preparation of herbarium sheets – Collection, pressing, drying, mounting, and labeling of plant specimens	1
6	Study of leaf types, shapes, venation, and margins – Collection and mounting	1
7	Study of flower parts (Calyx, Corolla, Androecium, Gynoecium) – Dissection and observation	1
8	Study of seed dispersal mechanisms (Wind, Water, Animal, Explosive) – Collection and observation of different seeds	1
9	Preparation of a nature journal – Daily observations of plants, birds, insects, weather for one week	1
10	Study of a nearby sacred grove / park / garden – Documentation of flora and fauna (report writing with photographs)	1
11	Identification of common insects (Ant, Beetle, Grasshopper, Dragonfly, Ladybird, Mosquito, Butterfly) using hand lens	1
12	Soil and litter fauna study – Collection of ants, earthworms, millipedes, beetles from leaf litter using Tullgren funnel / hand sorting	1
13	Preparation of poster / chart on "Save Nature" / "Conserve Biodiversity" / "Stop Poaching" using simple art materials	1

14	Preparation of a simple bird feeder / nest using waste materials (plastic bottle / coconut shell / cardboard)	1
15	Field visit to a nearby garden / park / lake / forest / sacred grove – Report writing (location, observations, photographs, conservation message)	1

References:

1. Agrawal, K.C. (2009). Biodiversity: Concept, Conservation and Management. Concept Publishing Company Pvt. Ltd, New Delhi.
2. Primack, R.B. (2014). Essentials of Conservation Biology (6th ed.). Sinauer Associates.
3. Hunter, M.L. & Gibbs, J.P. (2017). Fundamentals of Conservation Biology (3rd ed.). Wiley-Blackwell.
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T.Y.B.Sc. Environmental Science (Semester-VI)

Course Category: Vocational Skill Course Theory

Course Code – EVS 371 VSC

Course Title: Remote Sensing and GIS

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

Objectives:

1. To understand the basic principles of Remote Sensing and its components.
2. To study the electromagnetic spectrum and its interaction with atmosphere.
3. To learn about satellites, sensors, and types of resolutions.
4. To understand aerial photography and its interpretation techniques.
5. To learn the basics of Geographic Information System (GIS) and its applications.

Course Outcome:

Upon completion of this course, students will be able to:

1. Explain the principles, components, and types of Remote Sensing.
2. Describe the electromagnetic spectrum and atmospheric interactions.
3. Identify different types of resolutions (spatial, spectral, radiometric, temporal).
4. Interpret aerial photographs using basic elements of photo interpretation.
5. Explain raster and vector data models in GIS.
6. Describe applications of Remote Sensing and GIS in environmental management.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Introduction to Remote Sensing	• Definition and principles of Remote Sensing. • Components of Remote Sensing – Energy source, target, sensor, processing, application. • Types of Remote Sensing – Active and Passive Remote Sensing. • Electromagnetic spectrum (Gamma rays to Radio waves). • Refraction, Reflectance, Emission, and Scattering. • Atmospheric windows.	08
2	Aerial Photography and Image Interpretation	• Aerial photography – definition and types (vertical, oblique). • Basic geometric characteristics of aerial photographs. • Scale, resolution, overlaps, flight planning. • Measurement of height on aerial photograph. • Principle of relative tonality. • Minimum mapping unit. • Photo interpretation elements for visual interpretation – tone, texture, pattern, shape, size, shadow, association.	08
3	Satellites and Sensors	• Types of satellites – Geostationary and Sun-synchronous. • Important Indian satellites – IRS, Resourcesat, Cartosat. • Important International satellites – Landsat, Sentinel, MODIS. • Sensors – Multispectral, Hyperspectral, Thermal, Radar. • Types of resolutions – Spatial, Spectral, Radiometric, Temporal.	06

4	Introduction to GIS	• Geographic Information System (GIS) – definition and components (Hardware, Software, Data, People, Methods). • Spatial and non-spatial data (Attribute data). • Raster and Vector data models – points, lines, polygons. • Database generation and database management system. • Land use / Land cover (LULC) mapping. • Overview of GIS software packages – QGIS, ArcGIS, Google Earth.	08
5	Applications of Remote Sensing and GIS	• Applications in geosciences – geology, geomorphology, soil mapping. • Water resource management – watershed mapping, groundwater potential. • Land use planning – urban sprawl, infrastructure planning. • Forest resources – forest cover mapping, deforestation monitoring. • Agriculture – crop monitoring, yield estimation. • Marine and atmospheric studies – sea surface temperature, cyclone tracking, air pollution monitoring. • Case studies – Flood mapping, drought assessment, forest fire monitoring.	06

References:

1. Lillesand, T.M., Kiefer, R.W. & Chipman, J.W. (2015). *Remote Sensing and Image Interpretation (7th ed.)*. John Wiley & Sons, New York.
2. Joseph, G. (2015). *Fundamentals of Remote Sensing (3rd ed.)*. Universities Press, Hyderabad.
3. Campbell, J.B. & Wynne, R.H. (2011). *Introduction to Remote Sensing (5th ed.)*. Guilford Press.
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T.Y.B.Sc. Environmental Science (Semester-VI)

Course Category: On Job Training

Course Code – OJT 381 EVS

Course Title: On-Job Training (OJT)

[No. of Credits: 4 C] **[No. of Lectures: 120 Hrs]**

Objectives:

1. To provide hands-on experience in real-world environmental work environments.
2. To apply theoretical knowledge gained during the course to practical situations.
3. To develop professional skills such as communication, teamwork, and problem-solving.
4. To understand the functioning of environmental organizations, industries, or government bodies.
5. To prepare students for employment in the environmental sector.

Course Outcome:

Upon completion of this course, students will be able to:

1. Work independently in an environmental organization / industry / NGO / government department.
2. Apply environmental monitoring, assessment, or management techniques in real-life situations.
3. Prepare a professional training report with objectives, methodology, observations, and conclusions.
4. Communicate effectively with professionals and stakeholders in the environmental field.
5. Identify career opportunities in the environmental sector.
13. Demonstrate professionalism, punctuality, and ethical behavior in the workplace.

Guidelines for On-Job Training:

The On-Job Training (OJT) shall be completed for a minimum of 120 hours, which is equivalent to 4 weeks or 1 month of training. The training can be undertaken as continuous full-time training or cumulative part-time training as per convenience. The timing of the training can be during the summer break (April-May) or as per the schedule decided by the respective college. Regarding placement, students shall find their own training place with guidance and assistance from the college. The training shall be supervised by two supervisors – an internal faculty mentor from the college and an external workplace supervisor from the host organization. Students must maintain a daily logbook recording all activities, tasks performed, and hours spent, and must submit a final training report after completion of the training. The final evaluation shall be based on the training report, daily logbook, oral presentation, and viva voce conducted by a panel of examiners.

Eligible Organizations / Workplaces for OJT:

Students may undertake On-Job Training at any of the following types of organizations related to environmental science:

- Government Bodies: CPCB, SPCB, MoEFCC, Forest Department, Municipal Corporation, Irrigation Department, Groundwater Survey and Development Agency (GSDA), and Pollution Control Board regional offices.
- NGOs: BNHS (Bombay Natural History Society), WWF-India, Greenpeace, Wildlife Trust of India, TERI (The Energy and Resources Institute), CSE (Centre for Science and Environment), and local environmental NGOs.
- Industries: Effluent Treatment Plants (ETP), Sewage Treatment Plants (STP), Common Effluent Treatment Plants (CETP), and Environmental Cells of industries such as Tata, Mahindra, Reliance, and L&T.
- Consultancies: Environmental Impact Assessment (EIA) consultancies, Environmental auditing firms, and Environmental laboratories.
- Research Institutes: NEERI (National Environmental Engineering Research Institute), IITs, NCL (National Chemical Laboratory), ARI (Agharkar Research Institute), Wildlife Institute of India, SAC-ISRO (Space Applications Centre), and NRSC (National Remote Sensing Centre).
- Wildlife and Biodiversity: National Parks, Wildlife Sanctuaries, Zoos, Rescue Centers, Botanical Gardens, and Seed Banks.
- Solid Waste Management: Landfill sites, Composting plants, Recycling units, Waste-to-energy plants, and Plastic recycling units.
- Water and Wastewater: Water treatment plants, Sewage treatment plants, and Water quality testing laboratories.
- Academic Institutions: Colleges and universities (assisting in research projects, laboratory work, and field work).

Steps of On-Job Training:

The On-Job Training shall be carried out in the following systematic steps:

- Step 1: Selection of Organization – Student identifies a suitable organization / industry / NGO / government department for training in consultation with the faculty mentor. The organization must be related to environmental science.
- Step 2: Approval – The faculty mentor and Head of Department approve the selected organization and training plan.
- Step 3: Joining and Induction – Student joins the organization, completes induction formalities, and understands workplace rules, safety protocols, and work culture.

- Step 4: Training Period – Student works for a minimum of 120 hours (4 weeks / 1 month) under the guidance of the workplace supervisor. Student performs assigned tasks, learns workplace skills, and maintains a daily logbook.
- Step 5: Daily Logbook Maintenance – Student records daily activities, observations, tasks performed, skills learned, and hours spent. The logbook is signed daily or weekly by the workplace supervisor.
- Step 6: Report Writing – After completion of training, student prepares a structured training report as per the prescribed format.
- Step 7: Presentation – Student presents the training experience and key learnings before a panel of examiners (10-15 minutes).
- Step 8: Evaluation – Final assessment based on report, logbook, presentation, and viva voce.

Training Report Format:

1 Title Page
2 Certificate
3 Acknowledgement
4 Abstract
5 Introduction
6 Objectives of Training
7 Training Activities (Daily Logs)
8 Results and Learnings
9 Conclusion
10 Recommendations
11 Photographs
12 Logbook Copy
13 Certificate of Completion

List of Documents to be submitted:

1. Training Report (bound copy)
2. Daily Logbook (original
3. Certificate of Completion from organization
4. Photographs (printed in report)
5. Presentation (PPT file)

References:

1. SPPU. (2020). CBCS Guidelines for On-Job Training (OJT). Savitribai Phule Pune University, Pune.

2. UGC. (2022). Guidelines for Internship / On-Job Training in Undergraduate Programs. University Grants Commission, New Delhi.
3. AICTE. (2021). Internship Guidelines for Students. All India Council for Technical Education, New Delhi.