

**ENVIRONMENTAL SCIENCE**  
**VII SEMESTER**  
**(For Research with Honours courses)**

**COURSE CODE: EVSR4722M**

**COURSE TYPE: MAJOR**

**COURSE TITLE: Research Methodology in Environmental Sciences**

**CREDITS: (4)**

**Course Objectives**

By the end of this course, students will:

1. Understand and apply methodological frameworks in environmental science investigations.
2. Develop field and laboratory research designs that address real-world environmental problems.
3. Integrate modern tools such as GIS, remote sensing, and molecular techniques into environmental studies.
4. Evaluate and select appropriate monitoring protocols for long-term and short-term studies.
5. Build the capacity to interpret environmental data for policy, conservation, and sustainable resource management.

**Learning Outcomes**

On successful completion, students will be able to:

1. Formulate environmental research questions and hypotheses grounded in scientific literature and field observations.
2. Conduct biodiversity, habitat, and environmental quality assessments using advanced field techniques.
3. Design and execute long-term environmental monitoring and tracer-based studies.
4. Apply molecular, mesocosm/microcosm, and modelling tools to environmental problem-solving.
5. Use GIS, remote sensing, and predictive models to support environmental planning and risk assessment.

**Unit I: Foundations of Environmental Research Methodology**

**16 hours**

1. Role of Methodology in Environmental Problem-Solving – Linking research design with environmental policy and management.
2. Framing Environmental Research Questions – Identifying gaps via literature mapping, global environmental databases, and observation.
3. Hypothesis Development – Translating ecological and environmental observations into testable predictions.
4. Selection of Research Approach – Comparative, experimental, observational, and modelling studies in environmental science.

**Unit II: Field-based Environmental Investigation Methods**

**16 hours**

1. Advanced Sampling Strategies – Stratified, cluster, and systematic sampling in heterogeneous ecosystems; seasonal and diurnal considerations.

2. Habitat and Biodiversity Assessment – Transect and quadrat methods, camera trapping, acoustic monitoring, and vegetation surveys.
3. Ecosystem Health Indicators – Macroinvertebrate indexing, vegetation cover analysis, phenological records.
4. Field-based Environmental Monitoring – Portable water, soil, and air sensors; in-situ calibration; real-time data logging.

**Unit III: Applied & Integrative Environmental Techniques** **16 hours**

1. Long-term Environmental Monitoring Protocols – Designing multi-year ecological datasets and integrating secondary data.
2. Environmental Tracer Techniques – Stable isotopes, fluorescent dyes and radioisotopes for hydrological and pollution studies, MoD Flow.
3. Mesocosm and Microcosm Experiments – Simulating environmental conditions to assess pollutant impacts and ecological processes.
4. Environmental Genomics & Molecular Tools – DNA barcoding, eDNA sampling, metagenomics for biodiversity and pollution studies.

**Unit IV: Technological & Modelling Approaches in Environmental Sciences** **16 hours**

1. Geographic Information Systems (GIS) – Spatial analysis, environmental mapping, habitat connectivity models.
2. Remote Sensing Applications – Multi-spectral, hyperspectral, and thermal imaging for vegetation, land use, and pollution mapping.
3. Climate and Ecosystem Modelling – Modelling habitat shifts, carbon sequestration, and climate change impacts.
4. Ecological Risk Assessment Frameworks – Hazard identification, exposure assessment, and consequence modelling for ecosystems.

**Bibliography**

1. Sutherland, W.J. (2006). *Ecological Census Techniques: A Handbook*. Cambridge University Press.
2. Bonham, C.D. (2013). *Measurements for Terrestrial Vegetation*. Wiley-Blackwell.
3. Mark, D.M. & Goodchild, M.F. (2020). *Geographic Information Systems and Science*. Wiley.
4. Anderson, R.K., & Brower, J.E. (2022). *Field and Laboratory Methods for General Ecology*. Waveland Press.
5. Yoccoz, N.G., Nichols, J.D., & Boulinier, T. (2001). Monitoring of Biological Diversity in Space and Time. *Trends in Ecology & Evolution*, 16(8), 446–453.
6. Gotelli, N.J., & Ellison, A.M. (2013). *A Primer of Ecological Statistics*. Sinauer Associates.
7. Jones, M., et al. (2012). *Environmental Monitoring: A Comprehensive Handbook*. Springer.
8. Hunter, M.L., Gibbs, J.P., & Sterling, E.J. (2014). *Problem-Solving in Conservation Biology and Wildlife Management*. Wiley-Blackwell.
9. Allaby, M. (2014). *Oxford Dictionary of Environment and Conservation*. Oxford University Press.
10. Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Synthesis*. Island Press.