

Course Code	Course Name	Credits
26BY508	PRINCIPLES OF ECOLOGY AND ECOTOXICOLOGY WITH AI APPLICATIONS	04

Course Objectives

- To introduce the fundamental principles of ecology and ecosystem structure.
- To explain biodiversity and environmental pollution concepts.
- To develop understanding of environmental conservation, energy resources, and sustainable development.
- To familiarize students with the applications of Artificial Intelligence in ecological monitoring, biodiversity conservation, and environmental management.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Explain fundamental ecological principles and ecosystem processes.
- Understand and evaluate biodiversity conservation strategies.
- Analyze environmental pollution, energy resources, and global environmental issues, along with appropriate control measures.
- Apply AI-based tools for ecosystem monitoring, species identification, and environmental data analysis.

Unit 1 - Introduction to Ecology (12 Hrs.)

Definition and subdivisions of ecology. Autecology: Population characteristics; genecology, ecological amplitude, ecads, ecotypes, ecospecies, and coenospecies; Synecology: Classification by Clements; analytical and synthetic characteristics of plant communities; AI-based vegetation analysis. Ecological Succession: Concept, causes, and various types, climax or stable communities; AI and remote sensing in predicting ecosystem change.

Unit 2 – Biosphere and Ecosystem (12 Hrs.)

Habitat, ecological niche, ecotone, and edge effect; AI in habitat mapping and species distribution modelling. Ecosystem Structure - Functions and nutrient (biogeochemical) cycles; Types of Ecosystems: Aquatic and terrestrial ecosystems with reference to productivity, biodiversity, trophic interactions, energy flow, and ecological pyramids. AI in ecosystem modelling and productivity analysis.

Unit 3 - Biodiversity and Its Conservation (12 Hrs.)

Definition and levels of biodiversity: genetic, species, and ecosystem diversity; alpha, beta, and gamma diversity. Endemic species, keystone species; AI Based Species Identification and Predicting Species Extinction. Red Data Book, Biodiversity hotspots; Principles of biodiversity conservation; in-situ and ex-situ conservation methods. AI in Biodiversity Monitoring- Softwares and Applications with Examples

Unit 4 – Eco-Toxicology and Environmental Pollution (12 Hrs.)

Definition and classification of environmental pollutions. AI in environmental monitoring and management. Water Pollution: Water quality parameters and standards, sources, impacts, control measures and wastewater treatment. Air Pollution: Air quality standards and AQI, sources, health hazards, and control measures. Noise Pollution: Sources, effects, permissible noise levels, and control measures. Radioactive Pollution: Causes, effects, and control measures.

Unit 5 - Conservation of Energy Resources and Environmental Issues (12 Hrs.)

Conservation of conventional and non-conventional energy resources. Alternative energy resources: wind, solar, and biomass energy. Global environmental issues and AI in Climate Change and Environmental Monitoring. Major environmental laws, and environmental human rights in independent India. Sustainable development and the UN Sustainable Development Goals (SDGs). Sustainable Development (SD) Programmes in India.

Reference Books:

1. Odum, E. P., and Barrett, G. W. (2005). Fundamentals of Ecology, 5th Edition. Brooks/Cole, Cengage Learning, Belmont, California, USA.
2. Begon, M., Townsend, C. R., and Harper, J. L. (2006). Ecology: From Individuals to Ecosystems, 4th Edition. Blackwell Publishing Ltd., Oxford, UK.
3. Sharma, P. D. (2017). Ecology and Environment, 13th Edition. Rastogi Publications, Meerut, India.
4. Krebs, C. J. (2014). Ecology: The Experimental Analysis of Distribution and Abundance, 6th Edition. Pearson Education Ltd., Harlow, England.
5. Ricklefs, R. E., and Relyea, R. (2014). The Economy of Nature, 7th Edition. W. H. Freeman and Company, New York, USA.
6. Newman, M. C. (2015). Fundamentals of Ecotoxicology: The Science of Pollution, 4th Edition. CRC Press, Taylor and Francis Group, Boca Raton, Florida, USA.
7. Goodfellow, I., Bengio, Y., and Courville, A. (2016). Deep Learning. MIT Press, Cambridge, Massachusetts, USA. (Useful for understanding AI applications in environmental monitoring and ecological modelling).