ENVIRONMENTAL SCIENCE
VII SEMESTER
(For Research with Honours courses)

COURSE CODE: EVSR2722M **COURSE TYPE: MAJOR**
COURSE TITLE: Ecological Modelling
CREDITS: 4

Course Objectives
The course aims to:

1. Introduce students to the theoretical foundations of ecological modelling and its applications in environmental sciences.
2. Develop understanding of population, community, and ecosystem-level models including mathematical representations.
3. Provide exposure to models for pollutant dispersion, ecosystem dynamics, and climate change.
4. Equip students with skills to apply modelling tools for environmental management, conservation, and sustainability.
5. Enable critical evaluation of ecological models with respect to their assumptions, limitations, and real-world applications.

Learning Outcomes
After successful completion of this course, students will be able to:

1. Explain fundamental principles of ecological modelling and the role of models in environmental research.
2. Formulate and analyze mathematical models of populations, communities, and ecosystems.
3. Apply models such as Lotka–Volterra predator–prey and Gaussian plume to ecological and environmental problems.
4. Use models for understanding nutrient cycling, species interactions, and pollutant dispersion.
5. Critically assess model validity, uncertainty, and applicability to environmental management.
6. Utilize basic software tools for ecological simulations and case study analysis.

Unit I: Basics of Ecological Modelling **16 hours**

1. Introduction to ecological models – scope, importance, applications
2. Types of models – conceptual, mathematical, deterministic vs stochastic
3. Model development process – assumptions, formulation, validation
4. System ecology concepts – energy flow, nutrient cycling, ecological networks

Unit II: Population and Community Models **16 hours**

1. Exponential and logistic growth models
2. Lotka–Volterra Models – predator–prey, competition, mutualism
3. Age- and stage-structured models – Leslie matrix, life tables
4. Metapopulation models – Levins model, extinction–colonization dynamics

Unit III: Ecosystem Monitoring Models **16 hours**

1. Nutrient and energy flow models – compartment models for biogeochemical cycles
2. Aquatic ecosystem models – Water Quality Eutrophication Model (WQEM)
3. Terrestrial ecosystem models-Integrated Terrestrial Ecosystem Model (iTEM)
4. Pollutant dispersion models – Gaussian plume model

Unit IV: Advanced Modelling and Applications **16 hours**

1. Climate and global change models – species distribution models (SDMs), ecological forecasting
2. Ecotoxicological and risk assessment models
3. Simulation approaches – Monte Carlo, agent-based modelling, cellular automata
4. Tools and case studies – STELLA, R, MATLAB, Ecopath with Ecosim, GIS & remote sensing integration

Bibliography

1. Jørgensen, S.E., & Fath, B.D. (2011). Fundamentals of Ecological Modelling. Elsevier.
2. Gotelli, N.J. (2008). A Primer of Ecology. Sinauer Associates.
3. Molles, M.C. (2016). Ecology: Concepts and Applications. McGraw Hill.
4. Hilborn, R., & Mangel, M. (1997). The Ecological Detective: Confronting Models with Data. Princeton University Press.
5. Odum, E.P. (2004). Fundamentals of Ecology. Cengage Learning.
6. Ambasht, R.S., & Ambasht, N.K. (2017). A Textbook of Plant Ecology. CBS Publishers.
7. Misra, R. (1968). Ecology Workbook. Oxford & IBH, New Delhi.
8. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut.
9. Shukla, R.S., & Chandel, P.S. (2015). Plant Ecology. S. Chand Publishing.
10. Singh, J.S., Singh, S.P., & Gupta, S.R. (2006). Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.
11. Kaushik, A., & Kaushik, C.P. (2019). Environmental Science and Engineering. New Age International, New Delhi.