DISCIPLINE SPECIFIC ELECTIVE (DSE-EVS-3): ENVIRONMENTAL MODELLING

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-3: ENVIRONMENTAL MODELLING	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into the concepts, methods, tools and application of environmental modelling
- Appreciate modelling approach with a clear understanding of its scope, limitations and complexity
- Improve knowledge of fate and transport of pollutants and important natural processes and events
- Empower with the application of modelling in ecosystem management via better environmental management, decision making and policy development

Learning outcomes

After the course, students will be able to:

- Choose the appropriate model for a given ecological question or environmental concern
- Overcome the common challenges of model building for improved predictability
- Evolve a better plan to implement and validate model outputs
- Apply models while keeping in view the strength and weaknesses of different model types
- Practice sustainability management, implement cleaner technologies, and argue in favour of environmental protection.

SYLLABUS OF DSE-EVS-3

Theory (02 Credits: 30 lectures)

UNIT – I Working with models (4 Weeks) (8 lectures)

Goals, objectives, scope and process of modelling in the environment. Modelling approach: deterministic, stochastic and physical. How to choose, construct and interpret statistical models, Statistical frameworks, Philosophy of statistical modeling, Fitting models to real-

world data, Techniques–from simple (distribution fitting) to complex (state-space modeling), Techniques for data manipulation and display. Uncertainties in model development: Design, analysis, documentation, and communication; Data availability and optimal modelling, Reliability of ecological models

UNIT – II Modelling in Science and Environment (5 Weeks) (12 lectures)

Science models: Visual models, Mathematical models, and Computer models. Model types: Conceptual, Mathematical, and Computational Models; Individual- or agent-based models, Unstructured population models, and Stage-structured matrix models, Single-, two-, and three-state variable models. Environmental models: Fate and transport models, Emissions and activities models, Exposure models, and Impact models; Models of common ecosystems (aquatic, terrestrial, and man-managed) for biodiversity conservation and ecosystem management; Model of the socio-ecological system.

UNIT – III Models for "out of balance" or environmental problems (5 Weeks) (10 lectures)

Acidification models in water pollution, Eutrophication models, Models of oxygen depletion, Fire and the spread of fire, Air pollution, Toxic substance pollution, Climate, weather and global warming, Environmental/ecological modeling for regulatory risk assessments and hazard predictions.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Test and practice different steps of model development
2. Validate the functioning of the model developed at 1
3. Apply the model to predict outcomes of different environmental scenarios
4. Formulate mathematical and computational models to visualize solar radiance on Earth
5. Develop model wind speed at a given area for establishing wind energy and power plant
6. Evaluate the given multiple leaf-layer model
7. Formulate, implement and evaluate the discrete model for population dynamics
8. Develop a model to predict predator-prey dynamics
9. Analyze competition between different species using an appropriate model
10. Model hydrological networks of the given area
11. Visualize digital elevation data for hydrological network analysis

12. Compare and contrast commonly used software for environmental and ecological modelling

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Beven, K., 2018. Environmental modelling: an uncertain future? CRC press.
- Essington, T.E., 2021. Introduction to Quantitative Ecology: Mathematical and Statistical Modelling for Beginners. Oxford University Press.
- Holzbecher, E., 2012. Environmental Modelling: Using MATLAB. Springer Science & Business Media.
- Jørgensen, S.E., 2009. Ecological Modelling: An Introduction. WIT press.
- Kelly, R.E., Drake, N.A. and Barr, S.L. eds., 2004. Spatial Modelling of the terrestrial environment. John Wiley & Sons.
- Sang, N. ed., 2020. Modelling Nature-Based Solutions: Integrating Computational and Participatory Scenario Modelling for Environmental Management and Planning. Cambridge University Press.
- Skidmore, A., 2017. Environmental Modelling with GIS and Remote Sensing. CRC Press.
- Wainwright, J. and Mulligan, M. eds., 2013. Environmental Modelling: Finding Simplicity in Complexity. John Wiley & Sons.

Suggestive readings

- Clark, J.S. and Gelfand, A.E. eds., 2006. Hierarchical modelling for the environmental sciences: statistical methods and applications. OUP Oxford.
- Emetere, M.E., 2019. Environmental Modeling Using Satellite Imaging and Dataset Re-processing. Springer International Publishing.
- Fort, H., 2020. Ecological Modelling and Ecophysics: Agricultural and Environmental Applications. IOP Publishing.
- Parnis, J.M. and Mackay, D., 2020. Multimedia Environmental Models: The Fugacity Approach. CRC Press.
- Soetaert, K. and Herman, P.M., 2009. A Practical Guide to Ecological Modelling: Using R as a Simulation Platform (Vol. 7, No. 7). New York: Springer.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.