Course title: Environmental Modeling			
Course code: NRE 171	**No. of credits:** 4	**L-T-P:** 42-14-0	**Learning hours:** 56
Pre-requisite course code and title (if any): NRE 131 Environmental Chemistry and Microbiology			
Department: Department of Energy and Environment			
Course coordinator:	**Course instructor:** Prof. Prateek Sharma		
Contact details:			
Course type: Elective	**Course offered in:** Semester 3		

Course Description

The environmental problems result from a complex interaction of physical, chemical and biological processes, involving land, water, air and energy resources that significantly affect human activities and attitudes. The complex and multidisciplinary nature of environmental problems requires that they are dealt in an objective and integrated manner. Quantitative tools provide the requisite objectivity in environmental decision-making. These tools help in investigating, understanding, representing the current and predicting the future state of environment and generating 'what-if' scenarios under alternative policy interventions. These are crucial for any integrated environmental assessment and management strategy. This course aims to provide introduction to the fundamental modeling concepts and their applications in simulating the pollutant fate and transport problems in the natural environmental systems.

Course objectives

1. Understand the idea, methodology and basic tools of environmental modeling
2. Understand the different modeling approaches, their scope and limitations
3. Understand the fate and transport of pollutants
4. Become aware of a wide range of applications of modelling in environmental management & decision making

Course content

SNo	Topic	L	T	P
1.	**Introduction** Environmental modelling: scope and problem definition, goals and objectives, definition; modelling approaches– deterministic, stochastic and the physical approach; applications of environmental models; the model building process	6	2	
2.	**Elementary concepts, laws, theories and processes** The building blocks: extensive and intensive properties, properties relevant to of environmental systems, the material balance approach; the transport processes–advection, diffusion, dispersion, gravitational settling, transport in porous media; the transformation processes–the non-reactive processes, the reactive processes; simulation of transport and transformation processes–introduction, the completely stirred tank reactor, plug flow reactor, mixed flow reactor models; the general material balance models.	12	4	
3.	**Environmental modelling - applications** Water quality modelling: surface water quality modelling – lakes and impoundments, rivers and streams, estuaries; ground water	24	8	

	pollution modelling. Air quality modelling: the box model, the Gaussian plume model point sources, line sources, area sources; special topics; Gaussian puff model			
	Total	**42**	**14**	

Evaluation criteria

- 2 Minor test 1: 20% each
- Tutorials: 20%
- Major test : 40%

Learning outcomes

1. develop models based on the mass-balance approach
2. predict the impact of the of external waste loading on different environmental matrices
3. predict and generate future conditions under various loading scenarios or management / intervention action alternatives

Pedagogical approach

Materials

Required text

1. Chapra S.C. (1997) *Surface Water-Quality Modelling*, McGraw-Hill International Edition.
2. Nirmalkhandan N. (2001) *Modeling Tools for Environmental Engineers and Scientists*, CRC Press, Boca Raton, Florida.
3. Schnelle K.B. and Dey P.R. (1999) *Atmospheric Dispersion Modelling Compliance Guide,* McGraw-Hill.
4. Thomann R.V. and Mueller J.A. (1987) *Principles of Surface Water Quality Modelling and Control*, Harper & Row, New York.
5. Turner D.B. (1994) *Workbook of Atmospheric Dispersion Estimates* 2nd ed., Ann Arbor, MI, Lewis Publishers.

Suggested readings

1. Benarie M.M. (1980) *Urban Air Pollution Modelling*, Cambridge, MA: The MIT Press.
2. Dunnivant F.M. and Anders E. (2006) *A Basic Introduction to Pollutant Fate and Transport*, John Wiley & Sons, Inc., New Jersey.
3. Ramaswami A., Milford J.B. and Small M.J. (2005) *Integrated Environmental Modelling*, John Wiley and Sons, Inc., New Jersey.
4. Schnoor J.L. (1996) *Environmental Modeling*, John Wiley & Sons, Inc., New York.
5. Zannetti P. (1990) *Air Pollution Modelling, Theories, Computational Methods and available Software,* Van Nostrand Reinhold, New York.

Case studies

Websites

Journals

1. Atmospheric Environment
2. Ecological Modelling
3. Environmental Modelling & Software
4. Environmental Science and Technology
5. Environmetrices

6. Journal of Environmental Engineering 7. Journal of Environmental Management 8. Science of the Total Environmental 9. Water Resources Research
Additional information (if any)
Student responsibilities Attendance, feedback, discipline, guest faculty etc