Course title: Water quality modelling and applications			
Course code: WSW 176	**No. of credits:** 4	**L-T-P distribution:** 42-0-14	**Learning hours:** 56
Pre-requisite course code and title (if any): Elementary calculus and matrix algebra			
Department: Department of Regional Water Studies			
Course coordinator(s): Dr. Sherly MA		**Course instructor(s):** Dr. Sherly MA	
Contact details: sherly.ma@terisas.ac.in			
Course type: Compulsory Core		**Course offered in:** Semester 2	

Course Description

The water quality 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 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 assessment and management strategy. This course aims to provide introduction to the fundamental modelling concepts and their applications in simulating the pollutant fate and transport problems in different water bodies.

Course objectives

- Understand the idea, methodology and basic tools of water quality modelling
- Understand the different modelling approaches, their scope and limitations
- Understand the fate and transport of pollutants in different water bodies
- Become mindful of a wide range of applications of modelling in water resources management & decision making

Course content

Module	Topic	L	T	P
1	**Introduction** The nature of water quality problem; waste load allocation principles; sources of pollution – point, non-point, continuous, intermittent, instantaneous; fundamental quantities; introduction to water quality modelling: scope, problem definition, goals, objectives and definition; historical perspective; modelling approaches – deterministic, stochastic and physical approach; the model building process.	6		4
2	**Elementary concepts, laws, theories and processes** Transport processes – advection, diffusion, dispersion, gravitational settling, transport in porous media; simulation of transport and transformation processes; completely mixed systems – completely stirred tank reactor model; incompletely mixed systems – plug flow reactor, mixed flow reactor models; the general material balance models.	10		6
3	**Surface water quality environments** Lakes and impoundments – physical and hydrologic characteristics, waste loadings, steady-state and time variable solutions, thermal stratification in lakes and reservoirs. Rivers and streams – classification, hydro-geometry, inflows, dispersion and mixing, stream equation, routing and water quality. Estuaries, bays and harbours – physical aspects, distribution of water quality, estuary equation, temporal aspects and vertical stratification. Eutrophication – basic mechanisms, concept of phosphorus loading, models for lakes, rivers and streams, control techniques. Dissolved oxygen analysis – principal components, kinetic relationships, carbon, nutrient and oxygen cycles, models for rivers and streams (Streeter-Phelps equation for point and non-point sources), tidal rivers and estuaries, lakes and reservoirs.	16		12
4	**Elements of ground water quality modelling** Groundwater occurrence and characteristics – subsurface distribution, general properties, geologic considerations, fluctuations in groundwater level, subsurface-surface water relations; Groundwater hydraulics – Darcy's law, hydrodynamic equations, flow and	10		6

	equipotential lines, flow nets, Dupuit's theory; flow to wells – steady and unsteady flow in confined and unconfined aquifers Contaminant transport modelling – transport mechanisms, contaminant transport equation. Saltwater intrusion problem, groundwater basin development, ground water remediation technologies.			
		42		**28**

Evaluation criteria

- **Minor test 1: 15%**
- **Minor test 2: 15%**
- **Tutorials: 20%**
- **Major test: 50%**

Learning outcomes

- develop models based on the mass-balance approach
- predict the impact of the of external waste loading on different water bodies
- predict and generate future conditions under various loading scenarios or management/intervention action alternatives

Pedagogical approach

The course will be delivered through class room lectures, discussion of case studies from original relevant research articles and hands on laboratory sessions on QUAL2k.

Materials

Textbooks

Chapra, S.C. (1997). Surface Water-Quality Modelling. McGraw-Hill International Edition.

Thomann, R.V. and Mueller, J.A. (1987). Principles of Surface Water Quality Modelling and Control, Harper & Row, New York.

Todd D.K. (1980) Groundwater Hydrology, John Wiley and Sons.

Suggested Readings

Dunnivant F.M. and Anders E. (2006) *A Basic Introduction to Pollutant Fate and Transport,* John Wiley & Sons, Inc., New Jersey.

Hadlock, C.R. (?). *Mathematical Modelling in the Environment*. The Mathematical Association of America.

Rastogi A.K. (2008) Numerical Groundwater Hydrology, Penram International Publishing Pvt. Ltd., Bombay.

Schnoor, J.L. (1996). *Environmental Modeling*. John Wiley & Sons, Inc., New York.

Journals

Ecological Modelling

Environmetrics

Environmental Modelling & Software

Environmental Science and Technology

Journal of environmental engineering

Journal of Hydrology

Risk Analysis

Water Research

Water Resources Research

Additional information (if any)

Student responsibilities

The students are expected to submit assignments in time and come prepared with readings when provided.

Course reviewers

1. Prof Shashi Mathur, Department of Civil Engineering, Indian Institute of Technology, Delhi.
2. Prof V.K. Minocha, Principal, Government College of Engineering, Jaffarpur.