Course Name:
Dynamic of Environmental Systems

Course Number:
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Credit:
3

Course Content (Outline):

- Introduction MATLAN and numerical analysis: Solutions of system of linear equations and ordinary differential equations, partial differential equations, curve fitting, interpolation, numerical integration, root finding, optimization.
- Review of Reaction Kinetics: Types of reactions; Rate of a reaction; Equilibrium versus non-equilibrium chemistry; Elementary versus non-elementary reactions; Order of a reaction: Modeling; Gibbs free energy; Activation energy, enthalpy and entropy; Rate equations for complicated reactions; Mass Balance Concept: Simple water-quality models. Residence Time. Response Time. General and Particular Solutions; Solutions for different loadings; Feed forward/ Feedback Systems: Matrix algebra: Eigenvalues and Eigenvectors. Batch reactors and CSTRs.
- Diffusion, Fick's Law; Distributed Systems (Steady State): Influence of boundary conditions; Distributed Systems (Time Variable): Characteristics of a differential equation: Spill models; Dye Dispersion studies and moments; Control Volume Approach: Steady State Solutions, matrix algorithms; Time Variable Solutions: Explicit versus Implicit schemes: Stability; Rivers & Streams; St. Venant equations; Waves; Longitudinal dispersion in natural streams; Estuaries; Lakes & Impoundments: Effects of bathymetry.
- Sediments: Simple solids budgets; Uncertainty analyses, Model calibration, and Monte Carlo analysis; Resuspension, Deposition, Settling.
- BOD & Oxygen Saturation: The DO sag, BOD5, Henry's law, Temperature effects; Gas Transfer & Oxygen Reaeration; Streeter-Phelps: Point and Distributed sources;
- Nitrogen: Modeling nitrification; Photosynthesis/Respiration;
- Pathogens: Sediment-water interactions;
- Nutrients and the Eutrophication Problem;
- Phosphorous Loading; Heat Budgets and temperature modeling; Thermal Stratification, Lake thermal regimes; effects of buoyancy, the thermocline; simple models of vertical transport.
- Microbe/Substrate Modeling: Bacterial growth; Monod kinetics; Plant growth and non-predatory losses; Prey-predator and nutrient/food- chain interactions; Nutrient/Food-chain Modeling; Equilibrium Chemistry; Coupling equilibrium chemistry with mass balance; pH Modeling; Toxic substance modeling; Mass transfer mechanisms: sorption and volatilization; Reaction mechanisms: Photolysis, hydrolysis and biodegradation.

Reference:

- "Surface water quality modeling", S.C. Chapra, Waveland Press, Long Grove, IL (2008).