EN345-Modeling and simulation of environmental systems.

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Lectures: Tuesdays 2:00 - 4:30 pm, Rocco bld, Conference room

Grading:
* Homework assignments: 30 %
* Midterm: 30 %
* Final: 40 %

EN345 is an undergraduate course for environmental engineering majors. The primary goal is to incorporate fundamental phenomena into mass balances to describe element cycles and the fate and transport of contaminants in environmental systems. This course will teach students to appreciate the advantages and limitations of models for managing environmental problems. The course will cover models of mass balance and reaction kinetics for completely mixed systems and incompletely mixed systems represented by systems of ordinary differential equations and reaction-diffusion-advection partially differential equations, respectively. Particular examples will be mostly focused on water-quality modeling, including fate and transport modeling of pollutants in rivers, estuaries, and lakes. This course will include a comprehensive treatment of mass balance models of oxygen, carbon, nitrogen and phosphorus in environmental systems incorporating abiotic and biotic transformation processes. Models of toxicant effects on natural populations will be also covered. The theoretical models will be presented in concert with real-life examples published in international journals. The models will be investigated by analytical and numerical methods (using Mathematica and other software).

Syllabus

1) Introduction to environmental modeling.
2) Mass balance in time and space. Derivation of reaction-advection-diffusion equations.
3) Mass balance for a well-mixed lake. Continuously stirred tank reactor (CSTR).
4) Different loading functions for CSTR. Nondimensionalisation and particular solutions.
5) Lakes in series. Feedforward systems of CSTRs.
6) Feedback systems of CSTRs. Steady state matrices for coupled reactors with first-order kinetics.
7) Spatially-distributed systems in one dimension. Steady-state theory.
8) Temporal dynamics of one-dimensional distributed systems.
9) Microbial kinetics.
10) Eutrophication, temperature and nutrients.
11) Carbon cycles and oxygen in aquatic systems.
12) Nitrogen cycle.
13) Phosphorus cycle.
14) Modeling toxicant and population dynamics.