Course Name:
Process Principles in Environmental Engineering

Course Number:
20604

Credit:
3

Course Description (Objectives):

The objective of this course is to understand fundamental processes responsible for mixing and mass transport in the environment, and introduce their implications for important applications in natural and engineered environmental systems.

Course Content (outline):

- Basic Concepts
  - Chemical concentration
  - Mass balance and control volume
  - Introduction to physical transport of chemicals
  - Introduction to biological transport
- Basic Environmental Chemistry
  - Collision theory
  - Gibbs free energy
  - Reaction types
  - Rate of a reaction
  - Reaction kinetics
  - Order of reactions
- Mixing and Mass Transport Processes
  - Diffusion
  - Fick's first Law
  - Fick's second Law
  - Random walk
  - Diffusion equation
  - Mechanical dispersion
  - Advection-Diffusion equation
  - Advection-Diffusion-Reaction equation
  - Peclet number
  - Approximated mixing time
- Mixing in Inland and Coastal Waters
  - Mixing in Rivers
  - Mixing in Reservoirs
  - Mixing in Estuaries
- Air–Water Exchange
  - Henry's Law
  - Gas transfer
  - Well mixed system
  - Slow system mixing
  - Whitman's two-film theory
  - Water-side and air-side control in the thin film model
  - Surface Renewal Model
- Sediment/Water Interface

    - Porosity
    - Stokes' Law
    - Settling
    - Solid budgets
    - Sediment Transport
- Fundamentals of Physical Water Treatment Processes
    - Adsorption processes
    - Filtering processes
    - Membrane processes
    - Partitioning and Separation
    - Diffusion and retardation in porous media
    - Chromatography
    - Coagulation and flocculation processes
- Filtration and Mass Transport in Porous Media
    - Classic capture mechanisms for collectors
    - Membrane operation processes
    - Ultrafiltration
    - Microfilter
    - Reverse Osmosis
    - Activated Carbon
- Chemical and Biological Processes
    - Acids and Bases
    - Acid-base reactions
    - Water dissociation constant
    - pH
    - Reduction-oxidation (Redox) chemistry
    - Oxidation of organic matter
    - Denitrification
    - Ecological redox sequence
    - Salt precipitation and dissolution
- Mass Transport Equation of *E. coli*
- Modeling the Transport of Coliphages

References:

1. "Surface water-quality modeling", Chapra, S. C., Waveland Press (Reissued), Long Grove, 2008.
2. "Transport Modeling for Environmental Engineers and Scientists", Clark, M.M., John Wiley & Sons, 2nd Ed., New York, 2009.
3. "Chemical Fate and Transport in the Environment", Hemond, H.F., and Fechner-Levy, E.J., Academic Press, 3rd Ed., London, 2015.
4. "Environmental Systems and Processes: Principles, Modeling, and Design", Weber, W.J., Jr., John Wiley & Sons, New York, 2000.
5. "Mixing in Inland and Coastal Waters", Fischer, H.B., List, E.J., Koh, R.C.Y., Imberger, J., Brooks, N.H., Academic Press, San Diego, 1979.

Course Notes:

1. Special Topics in Mixing and Transport Processes in the Environment, Scott A. Socolofsky and Gerhard H. Jirka (2005), Texas A&M University, webpage with chapter pdfs
2. Transport Processes in the Environment - MIT OpenCourseWare, Heidi Nepf.