**HWR 645 Stochastic Methods in Subsurface Hydrology**

Spring 2003
M & W 5:00-6:15 p.m.
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This course is to provide state-of-the-art knowledge of subsurface hydrology to quantitatively tackle issues related to scales and spatio-temporal variability of hydrological properties and processes in variably saturated geological media. Hydrological, geophysical, geochemical properties and processes of geological media are known to vary spatially and temporally at a multiplicity of scales and in multi-dimensions. Based on the classical hydrology concepts, scales of observations are often inconsistent with the scale of the tools for interpretation; scales of the properties estimated from hydro/geochem/geophyiscal tests rarely agree with others; and modeling grid scales are frequently incoherent with the sample scales. Many frightening questions arise: what are learning from the text books, what are you measuring, what are you estimating, and what are you predicting?

This stochastic method course examines these issues and provides strategies for resolving these inconsistencies. The course introduces quantitative methods for integrating geological, hydrological, geochemical, and geophysical data at various scales to enhance our characterization of geological media, and monitoring and forecasting processes in vadose zones and aquifers. Finally, the course offers methods to quantify uncertainties.

Topics include:

1. Stochastic representation of spatial variability of hydro/geophysical properties, concepts of CV, REV, ensemble and spatial averages.
2. Spectral theory for stochastic processes
3. Unconditional Estimators: unconditional effective parameter approaches
    - Monte Carlo Simulations
    - Spectral analytical approach
    - Numerical first-order approach
    - Methods for sensitivity analysis

4. Linear Conditional Estimators: conditional effective parameter approaches
    - Conditional estimates using hydrological or geophysical properties: Kriging
    - Conditional estimates using the properties and responses of geological systems: inverse modeling based on the least squares, cokriging.
        - Sequential conditioning–sequential kriging and cokriging.
        - Integration of different types of information (conductivity, head, concentration, arrival time, geophysical measurements).

5. Nonlinear Conditional Estimator

Successive Linear Estimator.
Applications to hydrological inversion in variably saturated media, hydraulic tomography, electrical resistivity tomography, hydrogeophysical joint inversion.