Lecture Number (~2 hrs)	Lecture Content
1	I. The soil as a multiphase, multi-scale system a. Liquid-solid and liquid-air interfaces i. Surface tension ii. Soil water potential 1. Matric potential 2. Osmotic potential 3. Gravitational potential 4. Total potential / Hydraulic Head 5. Basic flux laws iii. Soil freezing
2	a. Equilibrium conditions, mass-volume-potential relationships i. The moisture retention curve ii. The soil freezing curve
3	b. Bulk soil physical properties i. Representative elementary volume ii. Cumulative distribution functions iii. Introduction to spatial variability and spatial averages
4	I. Mass fluxes in soils a. Soil water flux i. Saturated flow and Darcy's Law 1. Saturated hydraulic conductivity ii. Unsaturated flow and the Darcy-Buckingham Flux Law (is it a law?) 1. Unsaturated hydraulic conductivity
5	iii. The continuity equation and conservation of mass 1. Derivation of the Richards equation iv. Steady and transient state soil water flux
6	v. Soil water flux in the field 1. Infiltration a. Modeling infiltration with the Richards equation i. Boundary conditions and initial conditions 1. Flux boundary conditions – precipitation limiting infiltration (unsaturated)
7	2. Ponded infiltration – potential (hydraulic head) boundary conditions – soil limiting infiltration a. The Philip equation and Sorptivity b. Multi-dimensional infiltration, matric flux potential and the "sorptive number" – α^*

7	2. Redistribution and Field Capacity a. Plant available water capacity (PAWC) 3. Evapotranspiration and the soil-plant-atmosphere continuum (SPAC) a. Permanent wilting point
8	b. Solute Flux i. Convection ii. Diffusion iii. Dispersion iv. Steady and transient state solute flux
9	v. The continuity equation and conservation of mass 1. The convection-dispersion equation (CDE) 2. Solution of the steady state CDE a. Boundary and initial conditions i. Flux and resident solution concentration b. Spike or pulse solute input boundary conditions c. Step input boundary conditions
10	vi. Attenuation processes 1. Adsorption 2. Production/decay
11	vii. Stochastic convective solute transport models (steady state) 1. The solute travel time distribution a. Relation to solute input boundary conditions b. Convolution
12	viii. Solute fluxes in the field 1. Coupled water and solute fluxes 2. Salinization of the root zone and the leaching fraction 3. Estimation of contaminant travel times
13	III. Electrical properties of soils and TDR a. Electrical Conductivity b. Dielectric Permittivity
14	c. Multiphase Dielectric Mixing Models i. Applications to calibration of TDR for soil water content measurement in unfrozen and partially frozen soils ii. Application for estimation of unfrozen water content in partially frozen soils and uncertainty of estimates d. Applications of TDR for measurement of soil water and solute fluxes