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| Number of hours | Lecture Content |
| 1.0 | Introduction* Basic soil physical properties and units
* Representative elementary volume (scales)
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| 2.0 | The solid phase* Soil texture and particle size distribution
* Cumulative distribution functions and the soil particle size distribution
* Specific surface
* Soil structure and aggregation
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| 2.0 | Mass and Energy Transport in Soils* Energy gradients/driving force in soils
* Conservation of mass and energy
* Continuity equation
* Transport flux laws
* Scale of transport processes; deterministic and stochastic processes/models
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| 8.0 | Soil Water – Equilibrium* What is equilibrium?
* Soil water potential (gravitational, matric, osmotic, pressure)
* Capillarity and matric potential
* The moisture retention curve and soil pore size distribution
* Relationship between soil particle size distribution, soil structure and soil pore-size distribution
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| Soil Water – Steady State Saturated and Unsaturated Flow* What is steady state?
* Poiseuille's law for steady state flow in a capillary tube
* Darcy’s law for steady sate flow in saturated soils
* Saturated hydraulic conductivity and relationship between saturated hydraulic conductivity and the soil pore size distribution
* The hydraulic conductivity curve and the soil pore size distribution/moisture retention curve
* The Darcy-Buckingham Flux Law for variably saturated soils
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| Soil Water – Transient Soil Water Flow * What is transient flow?
* Derivation of the Richards Equation
* Infiltration – a common transient soil water flow process
* Soil- and precipitation-limiting infiltration
* Redistribution and the field capacity concept
* Soil-plant-atmosphere continuum and permanent wilting point
* Plant-available water
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| 6.0 | Solute Transport – during steady state soil water flow* Solutes, conservative and non-conservative solutes (retardation factor – R)
* Soil water and aqueous solute velocity
* Breakthrough curves and concentration profiles – step and pulse solute inputs
* The solute travel time cumulative distribution function
* Mean travel time and mean travel depth
* Continuity equation and simple Solute Transport Equation
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| Solute Transport – Convection, diffusion, dispersion* Convective stochastic versus convective dispersive models of solute transport
* Stochastic stream tube models
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| 6.0 | Soil Aeration and Gas Transport* Gas concentrations
* Diffusion and convection
* Air permeability
* Gas transport equation
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| Soil Heat Transport and soil temperature regime* Soil temperature
* Soil thermal properties
* Heat transport by conduction: Steady state heat transport – Fourier’s law
* Transient heat transport – the heat equation
* Soil water flow under temperature gradients
* Coupled soil water and heat transport
* Soil freezing and thawing – relationship of the soil freezing curve and the moisture retention curve
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| 7.0 | Simulation of soil transport processes* Analytical solutions – boundary conditions, initial conditions
* Numerical methods
* uncertainty in soil transport parameters
* spatial variability in soil transport parameters – vertical and horizontal heterogeneity
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| Simulation of 1-D infiltration |
| Simulation of soil temperature |
| Simulation of solute transport |
| Total = 32 |  |