Self-check of material in the dynamics of water flow. You should be able to answer questions like those given below based on the class lectures and assigned reading

What is the definition of the Reynolds number for porous media flow?

What range of Reynolds number is applicable for laminar flow in soil (i.e., when Darcy's law applies)?

What is the difference between a homogeneous and heterogeneous soil?

When is the hydraulic conductivity isotropic?

When is the hydraulic conductivity anisotropic?

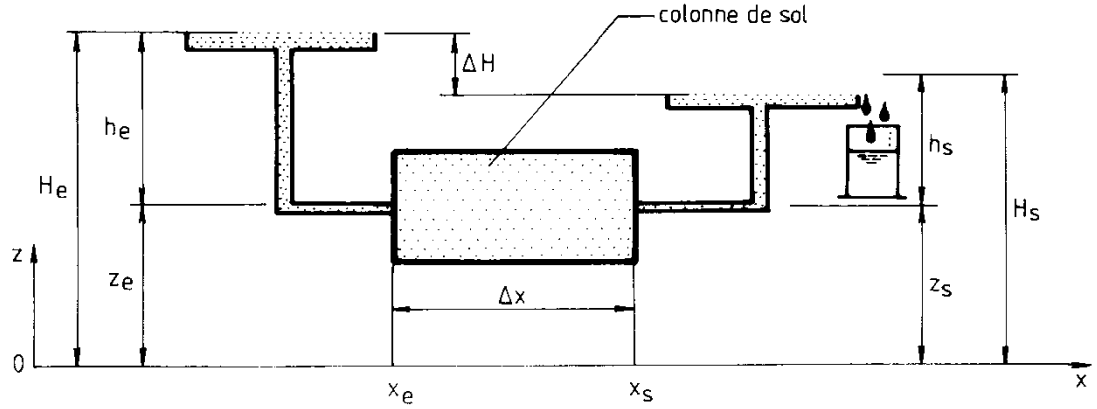
The hydraulic conductivity changes with temperature, why?

In what way are Darcy's law, Fourier's law and Fick's law similar?

What is the form of the conservation law that applies to flow in porous media?

For steady flow of water, only Darcy's law is needed to model the flow, why?

In the following figure, the water in the reservoirs is treated as being hydrostatic. Why is this a reasonable assumption?



Write Darcy's law for 1D horizontal flow.

Write Darcy's law for 1D vertical flow.

For steady flow, the Darcy flux is constant, why?

Darcy's law applies for both saturated and unsaturated flow. For unsaturated flow, the hydraulic conductivity changes rapidly with moisture content, θ, or pressure head, h (equivalently, suction Ψ = -h). What is the cause of this rapid change?

To model unsaturated flow, Richards' equation is used. Describe what information is needed to solve a flow problem using Richards' equation.

If the z axis points downwards, and $dH/dz > 0$, is the water moving upwards or downwards, why?

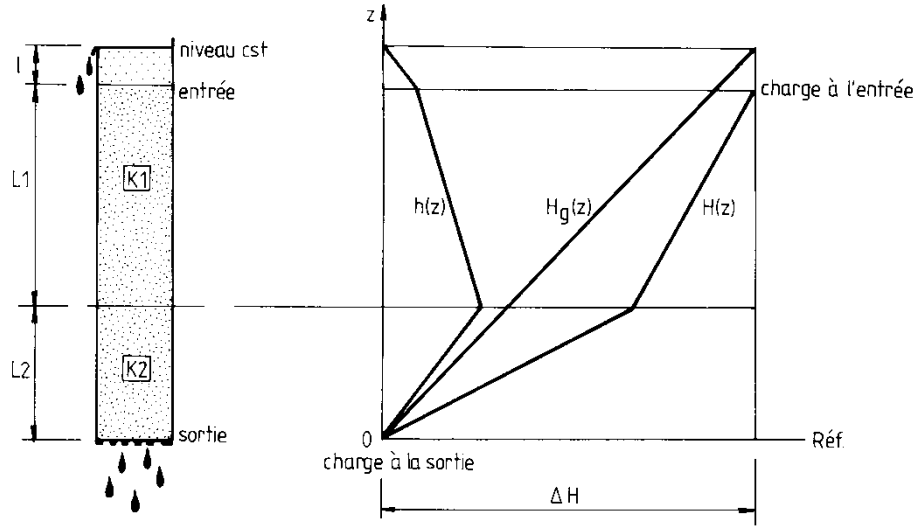
At a certain depth, z^*, in the soil, $dH/dz = 0$. If the evaporation rate at the surface is known, how can I calculate the change in moisture content between the soil surface and z^*?

How can I determine $h(\theta)$ in the laboratory?

What is c(h)?

A column of dry soil is placed in a container in a vertical orientation. Water flows upwards into the soil and eventually stops. You can measure the moisture content (θ) of the soil above the water surface, i.e., you measure θ(z). How can you use this measurement of θ(z) to determine θ(h), or, equivalently, h(θ)?

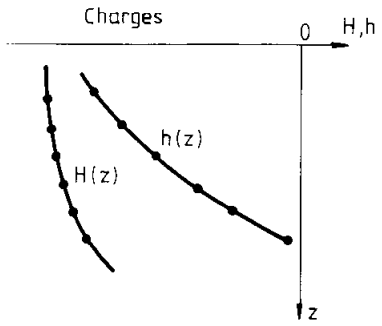
For the figure below (left side), derive Darcy's law accounting for the different hydraulic conductivities within the column. Also, explain the figure on the right side.



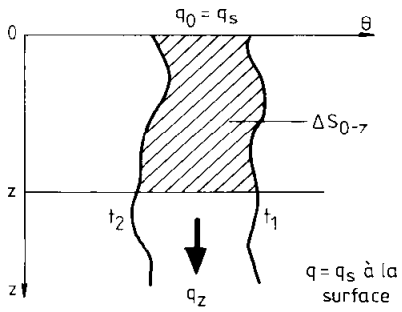
You want to model water movement in a swelling soil, is Richards' equation an appropriate model?

Write the 1D Richard's equation for the following cases:

(i) Vertical flow, z axis pointing downwards, h as the dependent variable (i.e., θ is not in the equation, so not solved for)
(ii) Vertical flow, z axis pointing downwards, θ as the dependent variable
(iii) Horizontal flow, h as the dependent variable
(iv) Horizontal flow, θ as the dependent variable



In the figure to the left, why is the curve for H to the left of the curve for h? In which direction is the water moving?



In the figure to the left, describe how to compute q_z?

Pg. 25 of the notes states:

> La surface du sol est alimentée à des flux correspondant à des régimes d'infiltration inférieurs à la saturation jusqu'à ce que l'écoulement soit permanent. A ce moment le gradient de succion tend généralement vers zéro et la conductivité hydraulique est égale au flux d'infiltration

Explain the second sentence.