SSC 107
HW 5
Date: Nov 4, 2002
Due Date: Nov 13, 2002

1) Assume that the cumulative depth of water (cm) infiltrates **vertically downward** into a long soil column is given by

$$I = 5t^{\frac{1}{2}} + 0.25\,t$$

where t is the time of infiltration in hours.

a) How much of water will infiltrate **vertically** into the soil column at t = 45 minutes?
b) How many minutes will it take for 5 cm of water to infiltrate **horizontally** into a similar soil with the same soil physical properties?
c) How many minutes will it take for 25 cm of water infiltrate **vertically upward** into this soil?
d) What is the infiltration rate at t = 30 minutes for the **horizontal** and **vertical** infiltration case?

2) A fine sandy loam soil with K of the wetted zone is 1.38 x 10^{-6} m/s is setup for horizontal infiltration. Given that θ_i = 0.1, θ_o = 0.45, h_o = 0 cm and h_i = -30cm. At t = 30 minutes, calculate:
a) the distance to wetting front (L)
b) cumulative infiltration (I)
c) infiltration rate (i)
d) Given that the Philip infiltration equation for horizontal infiltration I = $St^{1/2}$ Determine the constant S in the equation.
e) Express the infiltration rate (i) in term of t. Re-calculate the infiltration rate at t =30 minutes using this equation. Does the answer agree from part c?
f) Given that i = $(\theta_o-\theta_i)dL/dt$. Express the wetting front (L) in a function of t. Assuming θ_o and θ_i are constants
g) Re-calculate the wetting front L at t = 30 minutes using the equation obtained from part f. Does the answer agree from part a?

3) A 100 cm long vertical soil column has a steady state situation. The top of the soil column is open to atmosphere. A water table is maintained at the bottom of the soil column. The saturated hydraulic conductivity is 0.05 m/day, and the pressure head at 20 cm above the water table (z = 0.2 m) is –0.30 m. The air-entry value of the soil is -0.35m. Assume that the reference level is at the bottom of the soil column.

a) Compute the steady state evaporation rate.
b) Calculate the height of the saturated zone for this situation
c) Does this height remain constant if the evaporate rate is changed
d) Plot total head, gravity head, and matric head (of hydrostatic pressure) head through the soil column.

4) The diagram below shows total head profiles at two different times for a 1 m soil profile with a water table at 1 m depth. Initially, at time t_o, there is steady evaporation for which the total head gradient decreases with height. It then starts to rain and water infiltrates into the soil profile. The pressure head and total head after some time t_1 is indicated in this same diagram as well.

a) At time t_1, is there a water layer on top of the soil or anywhere else in the profile, and why?

b) Indicate the depths (points A, B, C, D and E) where there is upward, downward or no movement of water at time t_1. Why?

c) Is the profile t_1 at steady state? Explain why you think so.