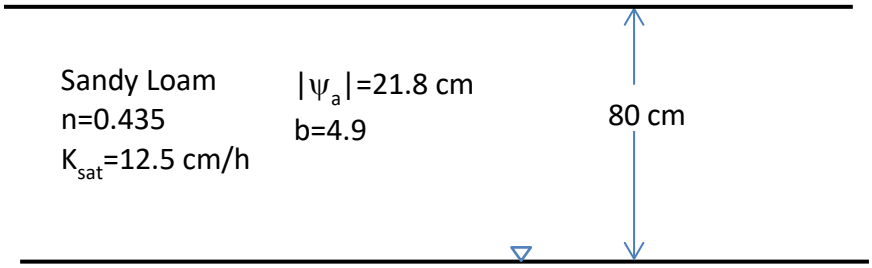
Utah State University
Department of Civil and Environmental Engineering
CEE 6400 Physical Hydrology

Midterm exam. Date: 10/21/2013
D.G. Tarboton Time: 75 min
90 Points

Open Book. Answer all questions. Please answer on separate sheets of paper. You may refer to the textbook, notes, solutions to homeworks and any other written or printed reference material that you have brought with you.
Calculator and Computer use. You may use a programmable calculator, laptop computer or equivalent calculating device (e.g. calculator functionality on a phone). You should limit use of the calculating device/computer to the performance of calculations or to looking up and reading material directly related to the class such as the online text or course material. You may use programs that you have written to evaluate quantities commonly used in this class (e.g. saturation vapor pressure). You may not send messages or use the internet to communicate in any way with anyone other than the instructor or moderator regarding solutions to these questions.

1. **Water in Soil.** Consider a sandy loam soil under hydrostatic conditions with water table located at a depth of 80 cm.



The parameters indicated are Clapp and Hornberger (1978) parameters from Table 1, page 4:18 of the Rainfall Runoff Processes workbook.

a. Plot the pressure head (matric potential) versus depth through the soil. [5]
b. Indicate the height of the top of the capillary fringe. [5]
c. Plot the water content versus depth through the soil. Indicate numerical values at the water table, top of capillary fringe, depth of 40 cm, and surface. [5]
d. Calculate the soil moisture deficit (cm). [For expediency you may use a reasonable numerical approximation.] [5]

Assume a rainstorm during which 6 cm falls steadily during 1 day.

e. Calculate the time to ponding. [5]
f. Calculate the depth of runoff generated. [5]

[30 points]

2. **Infiltration and Runoff Generation.** Consider the following storm

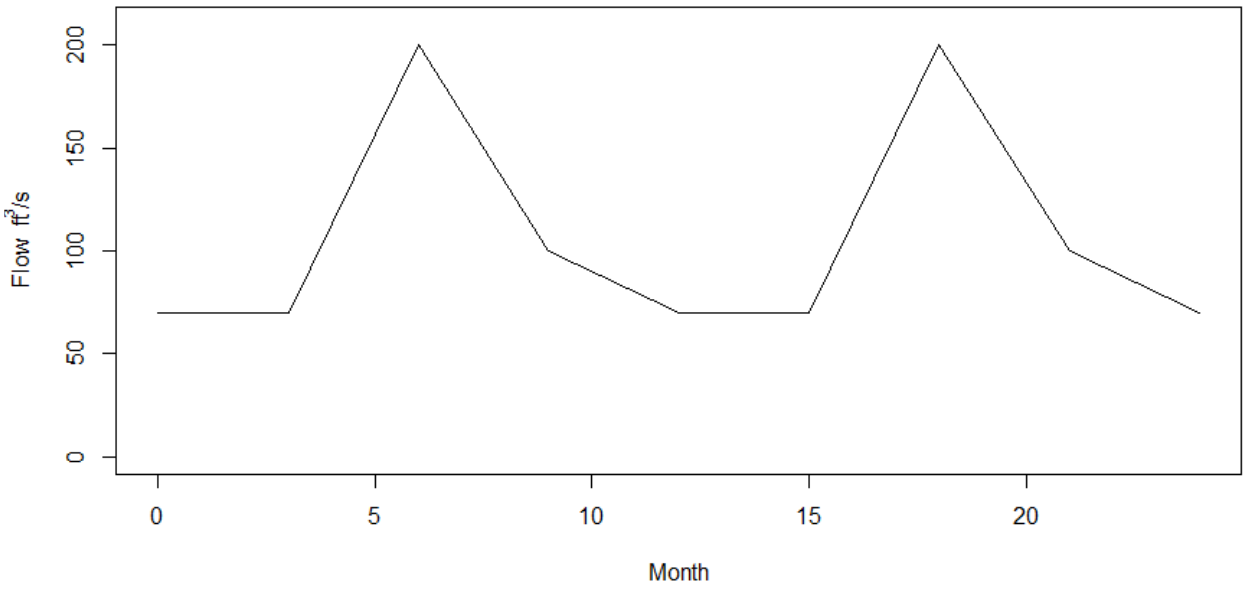
Time (h)	0-0.5	0.5-1
Rainfall Intensity (cm/h)	5	1

Horton's equation is applicable with f_o = 6 cm/h, f_1 = 1.06 cm/h and k=2.3 h^{-1}

a. Plot a graph of infiltration capacity as a function of infiltrated depth for this soil. [10]
b. What is the time that ponding first occurs in this storm. [10]
c. Determine the infiltration and runoff generated in each half hour increment. [10]

[30 points]

3. **Watershed Water Balance and Storage-Yield.** Consider a stream in which the seasonal cycle of monthly streamflow is as illustrated



Streamflow values in the graph are

Month	0	3	6	9	12	…
Streamflow	80	80	200	100	80	…

The watershed area is 100 mi^2. Average quarterly precipitation (snow and rain) totals are

Months	1-3	4-6	7-9	10-12
Precipitation (in)	20	15	5	10

a. Determine the mean annual flow in ft^3/s. [6]
b. Determine the storage (ft^3) required to support a firm yield of 100 ft^3/s. [8]
c. Estimate the mean annual evapotranspiration (in inches). [8]
d. Determine the runoff ratio for this watershed. [8]

[30 points]