CEE3430 Engineering Hydrology

Practice Exam (There are multiple practice questions here – A 110 min test will likely not have more than four questions)

1. Water Balance

   1.11. In a given year, a watershed with an area of 2500 km^2 received 130 cm of precipitation. The average rate of flow measured in a gage at the outlet of the watershed was 30 m^3/sec. Estimate the water losses due to the combined effects of evaporation, transpiration, and infiltration due to groundwater. How much runoff reached the river for the year (in cm)? What is the runoff coefficient?

2. Water Balance

   Following is some data I received that pertains to First Dam

   Design Volume = 85 acre-ft

   Surface Area = 430000 ft^2

   a) Calculate the average depth

   b) Given a discharge of 1500 ft^3/s in the Logan river calculate how long it would take for the dam to be filled from empty if no flow is released during the filling.

   On the basis of your results above comment on whether drawing First dam down in anticipation of a possible Spring Runoff flood due to snowmelt is a feasible flood mitigation strategy.

3. Evaporation

   At a weather station near a lake the following measurements have been reported to you:

   Air temperature: 18 ^oC

   Air pressure: 800 mb

   Dew point: 10 ^oC

   Relative humidity: 60%

   Vapor pressure: 32 mb

   Net Radiation: 300 cal cm^{-2} day^{-1}

   Wind speed: 2.5 m/s at a height of 2 m

   Water temperature: 23 ^oC

   a) Which of these measurements appears to be a discrepancy and why?

   b) Calculate the latent heat of vaporization.

   c) Calculate the evaporation using the Mass Transfer Method with a=0 and b=0.0118 cm day^{-1} m^{-1} s mb^{-1} in Equation 1-12 or 1-13

   d) Calculate the Bowen ratio and the sensible heat transfer

   e) Itemize the following terms of the energy balance at the surface of the lake

   Q_N Net radiation

   Q_h Sensible heat transfer

   Q_e Energy used for evaporation (latent heat transfer)

   Q_θ-Q_v Net of increase in energy stored in the lake and advected energy of inflow and outflow.

   Show the balance of these terms.

4. Hydrograph analysis

A watershed is approximately 22 square miles and has the following time-area relationship between its subbasins and travel time to the outlet

Time (hr)	Area (mi^2)
1	7
2	11
3	4

a) Given the following storm calculate the outflow hydrograph and report the peak flow (in ft^3/s) and runoff volume (in ft^3).

Time (hr)	Rainfall Excess (in/hr)
1	0.6
2	1.2

b) Determine the unit hydrograph for this area

c) Assume that development occurs in this watershed such that excess rainfall from the storm is increased to the following

Time (hr)	Rainfall Excess (in/hr)
1	1.0
2	1.7

Calculate the volume (in ft^3) of a detention basin required to hold the increased runoff

5. Frequency analysis

The demand on a city's water treatment and distribution system is rising to near system capacity because of a long period of hot, dry weather. Rainfall will avert a situation where demand exceeds system capacity. The time between rainfalls in this city at this time of year is described by an exponential distribution (Bedient page 198-199) with an average of five days.

a) Calculate the probability that there will be no rain for the next week (7 days).

b) Calculate the probability that there will be rain at least once in any week.

c) Calculate the probability that there will be two or more weeks (Sunday to Saturday) with no rain in a four week period.

6. Flood Routing

4.4. An inflow hydrograph is given for a reservoir that has a weir-spillway outflow structure. The flow through the spillway is governed by the equation

$$Q = 3.75\, Ly^{3/2} \text{ (cfs)},$$

where L is the length of the weir and y is the height of the water above the spillway crest. The storage in the reservoir is governed by

$$S = 300y \text{ (ac-ft)}.$$

Using Δt = 12 hr, L = 15 ft, and $S_0 = Q_0$ = O, route the inflow hydrograph through the reservoir using the storage indication method.

Time (hours)	Inflow (cfs)
0	0
12	40
24	125
36	10
0	0

7. Runoff generation

Consider a soil with the following properties pertaining to Philip's Infiltration Equation

Sorptivity, Sp (cm/h$^{0.5}$) 3.0

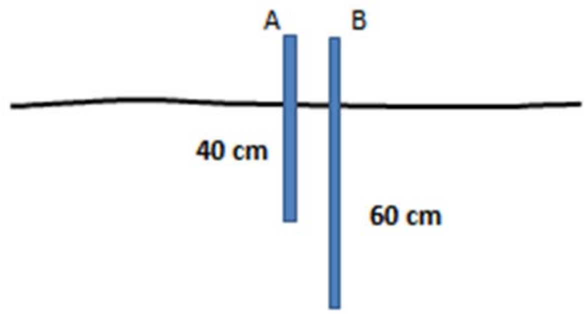
Conductivity, K_p (cm/h) 0.6

a) Given a precipitation rate of 3 cm/h calculate the cumulative infiltration at ponding and time to ponding.

b) For the following storm calculate the amount of runoff generated in each time step

Time (hours)	Rainfall rate (cm/h)
0-2	0.5
2-4	3

8. Consider the following experimental situation. A and B are vertical tensiometers that measure pore water pressure (tension) relative to atmospheric pressure at depths 40 and 60 cm below the ground. Following are pressure measurements recorded at A and B. Negative denotes capillary suction.
   A: -4500 Pa
   B: -2000 Pa



   a) Evaluate the pressure head (capillary suction) at A and B.
   b) Evaluate the total head at A and B using an arbitrary datum 1 m below the ground surface
   c) Indicate the direction of flow (downwards into the ground from B to A or upwards from B to A)

9. GroundWater

8.6. In a fully penetrating well, the equilibrium drawdown is 30 ft measured at r = 100 ft from the well, which pumps at a rate of 20 gpm. The aquifer is unconfined with K = 20 ft/day, and the saturated thickness is 100 ft. What is the steady-state drawdown at the well (r = 0.5 ft) for this aquifer?