**CE 3354 Engineering Hydrology**
**Exam 1**

1. For a watershed with a size of 120 $km^2$, the following data on precipitation $P$, evaporation $E$ and runoff $Q$ are recorded in watershed mm.

Table 1: Monthly Precipitation (P), Evapotranspiration (E), and Runoff (Q)

| **Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **P (mm)** | 250 | 205 | 165 | 50 | 5 | 0 | 0 | 5 | 10 | 55 | 65 | 190 |
| **E (mm)** | 5 | 25 | 30 | 50 | 80 | 100 | 150 | 70 | 60 | 20 | 10 | 5 |
| **Q (mm)** | 150 | 110 | 80 | 5 | 0 | 0 | 0 | 0 | 0 | 10 | 15 | 120 |

Determine:

a) The month (end) when the amount of water stored in the basin is the largest.

b) The month (end) when the amount of water stored in the basin is the smallest.

c) The difference (in $m^3$) in the amount of water stored in the basin between these two extremes.

d) The likely climate type (arid, humid temperate or humid tropical) one would expect to find this catchment.

2. A watershed with a catchment area of $1mi^2$ converts about 60-percent of precipitation into streamflow, the remainder is lost. The watershed response equation is

$$k\frac{dQ}{dt} + Q(t) = P(t) \cdot A \cdot C \tag{1}$$

where $Q(t)$ is the streamflow leaving the catchment, $P(t)$ is the precipitation entering the catchment, $A$ is the catchment area, $C$ is the precipitation to streamflow conversion fraction, and $k$ is the basin characteristic time constant.

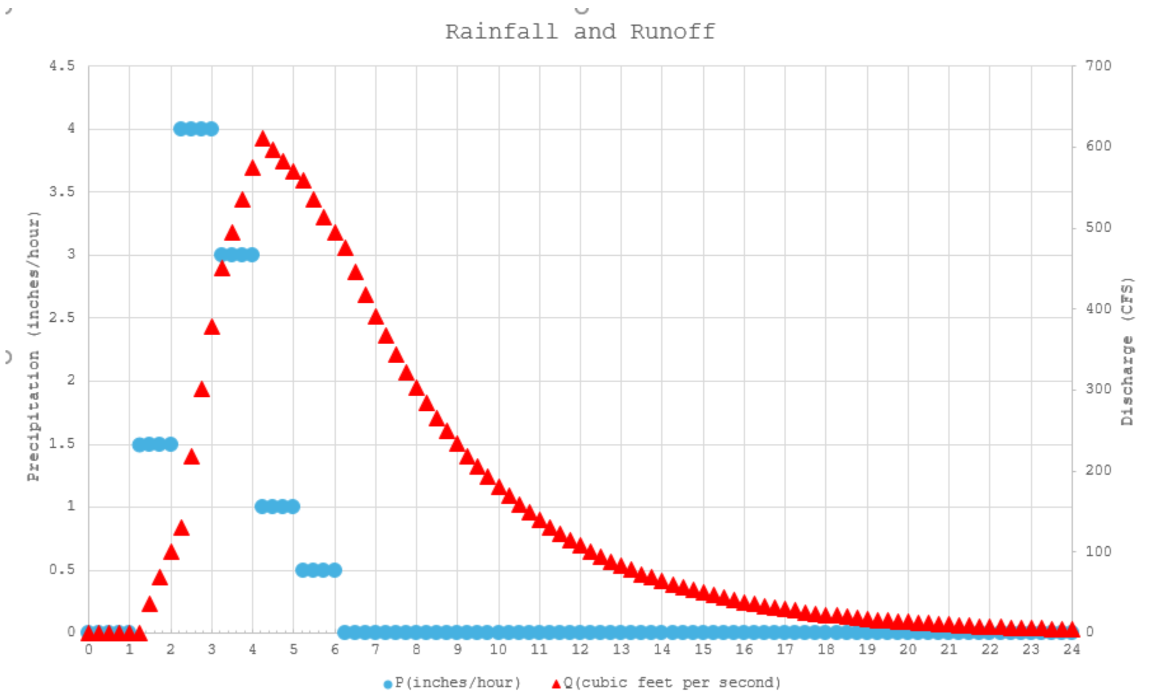


Figure 1: Rainfall-runoff plot for the catchment

Using the information in Figure 1 determine:

a) The maximum discharge rate in cubic feet per second.

b) The time when the maximum discharge occurs.

c) The value in hours of the of the basin time constant $k$.

d) The total volume in acre feet of precipitation entering the catchment (before any losses)

e) The total volume in acre feet of discharge leaving the catchment

3. Using an appropriate NRCS 24-hour rainfall distribution

   Determine:

   a) The cumulative rainfall depth (inches) for a 50-yr ARI storm in Lubbock, Texas.

   b) The rainfall intensity (inches/hour) for each half-hour increment of the storm.

   c) The maximum rainfall intensity (inches/hour) in any 30-minute interval.

4. The relation between infiltration capacity in mm/hour and the time (in hours) since the start of the experiment as measured with an infiltrometer is depicted in Figure 2.

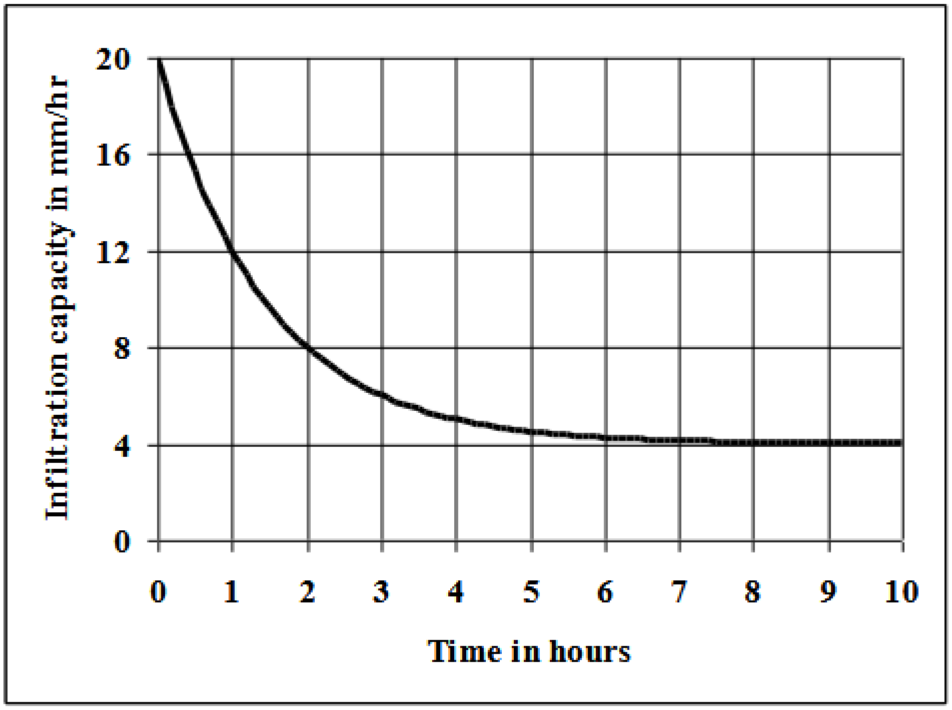


Figure 2: Infiltrometer data for some soil

The relationship is to be described with the Horton infiltration model

$$q(t) = f_c + (f_o - f_c)e^{-kt} \tag{2}$$

Determine:

a) The equilibrium infiltration rate, $f_c$, in mm/hr.

b) The initial (dry soil) infiltration rate, $f_o$, in mm/hr.

c) The soil constant $k$.

d) The total amount of water that will infiltrate into an initially dry soil during a rainstorm with a duration 60 minutes and a constant intensity of 20 mm/h.

e) The total amount of water that will infiltrate into an initially dry soil during a rainstorm with a duration 480 minutes and a constant intensity of 12 mm/h.