

Student Name: \_\_\_\_\_

FALL 2024

**CE 3354 Engineering Hydrology**  
**Exam 3, FALL 2024**

The exam is to be completed on Blackboard. The questions below are the same as on the Blackboard implementation.

1. What is a hydrograph (as used in this class)?
  - a) A record of rainfall rates (inches/hour) versus time.
  - b) A record of cumulative rainfall depth (inches) versus time.
  - c) A record of discharge rate (cubic feet/second) versus time.
  - d) A and B

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2. What is excess precipitation?
- a) The amount of precipitation that falls upon a watershed.
  - b) The amount of runoff that is produced from a watershed.
  - c) The equivalent depth of uniformly distributed precipitation.
  - d) A and B

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3. Hydrology is

- a) Study of the atmosphere, ocean, and surface waters
- b) The study of the occurrence, distribution, and movement of water above, on, and below the surface of the earth
- c) A study of the processes of evaporation, infiltration, and storage
- d) The study of the relationship between rainfall and runoff

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4. Rainfall behavior is expressed as a combination of
- a) depth or intensity, duration, and probability or frequency
  - b) intensity and probability or frequency
  - c) duration and probability or frequency
  - d) depth and duration

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5. An annual recurrence interval of 100-years is equivalent to an Annual Exceedance Probability (AEP) of what percent?
- a) 1-percent.
  - b) 10-percent.
  - c) 50-percent.
  - d) 100-percent.

6. What is a plotting position?
- a) The multiplicative inverse of relative frequency
  - b) An estimate of probability associated with an observation based on its magnitude relative to the arithmetic mean
  - c) An estimate of probability associated with an observation based on its position within a ranked sample set
  - d) Location in a chart of a data pair

7. What is a flood frequency curve?

- a) A plot of discharge and time
- b) A plot of estimated exceedance probability and discharge
- c) A plot of the frequency and discharge
- d) A plot of the discharge magnitude and the Weibull plotting position

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8. Average rainfall intensity is
- a) instantaneous rainfall rate
  - b) slope of the depth duration curve at a duration of one hour
  - c) the ratio of accumulated depth to duration
  - d) integral of the depth duration curve from 0 to 24 hours

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9. In the rational equation,  $Q = CIA$ , the intensity, I, is
- a) the ratio of depth to the time of concentration
  - b) the ratio of depth to watershed area
  - c) the ratio of depth to storm duration
  - d) the ratio of depth to watershed impervious cover

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10. The rational runoff coefficient for a 300 X 200-meter property with a slope of 3% is 0.35. The rainfall intensity is 116 mm/hr. The peak discharge from this property is anticipated to be about
- a) 2200  $\frac{m^3}{hr}$
  - b) 2400  $\frac{m^3}{hr}$
  - c) 3800  $\frac{m^3}{hr}$
  - d) 7000  $\frac{m^3}{hr}$

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11. A 3.2-inch storm is uniformly distributed over a 95 acre watershed. The NRCS Curve Number for the watershed is CN = 78. The anticipated watershed runoff is about

- a) 8.0 acre-feet
- b) 9.0 acre-feet
- c) 10.0 acre-feet
- d) 11.0 acre-feet

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12. A 3.5 acre drainage area receives a rainfall intensity of 0.5 in/hour; the peak runoff from the area is 500 gallons per minute. What is the runoff coefficient?

- (A) 0.11
- (B) 0.31
- (C) 0.64
- (D) 0.86

13. A residential lot of 0.37 acres contains a house that occupies 0.05 acres, and a driveway that covers 0.035 acres. The runoff coefficients are 0.50 for the undeveloped portions of the lot, 0.85 for the house, and 0.90 for the driveway. The peak discharge from the lot during a storm event with rainfall intensity of 0.5 inches per hour is

- (A)  $0.085 \text{ ft}^3/\text{sec}$
- (B)  $0.110 \text{ ft}^3/\text{sec}$
- (C)  $0.250 \text{ ft}^3/\text{sec}$
- (D)  $0.320 \text{ ft}^3/\text{sec}$

14. In an area with a composite runoff coefficient of 0.65, the surface runoff flows toward a street from the land on both sides. The watershed area extends to 100 ft on each side of the street centerline. The street has curb-and-gutter, and there is a curb inlet (or basin) on both sides of the street. The capacity of the curb inlet to pick up runoff from the gutter is 10 cfs (any more than this will just run past the opening). City policy is to design the street drainage system to accommodate a 6.8-in/hr rainfall. The distance (ft) between the inlets along the sheet should be most nearly:
- a) 230 feet
  - b) 490 feet
  - c) 640 feet
  - d) 980 feet

Figure 1 is a screen capture of a HEC-HMS model run.

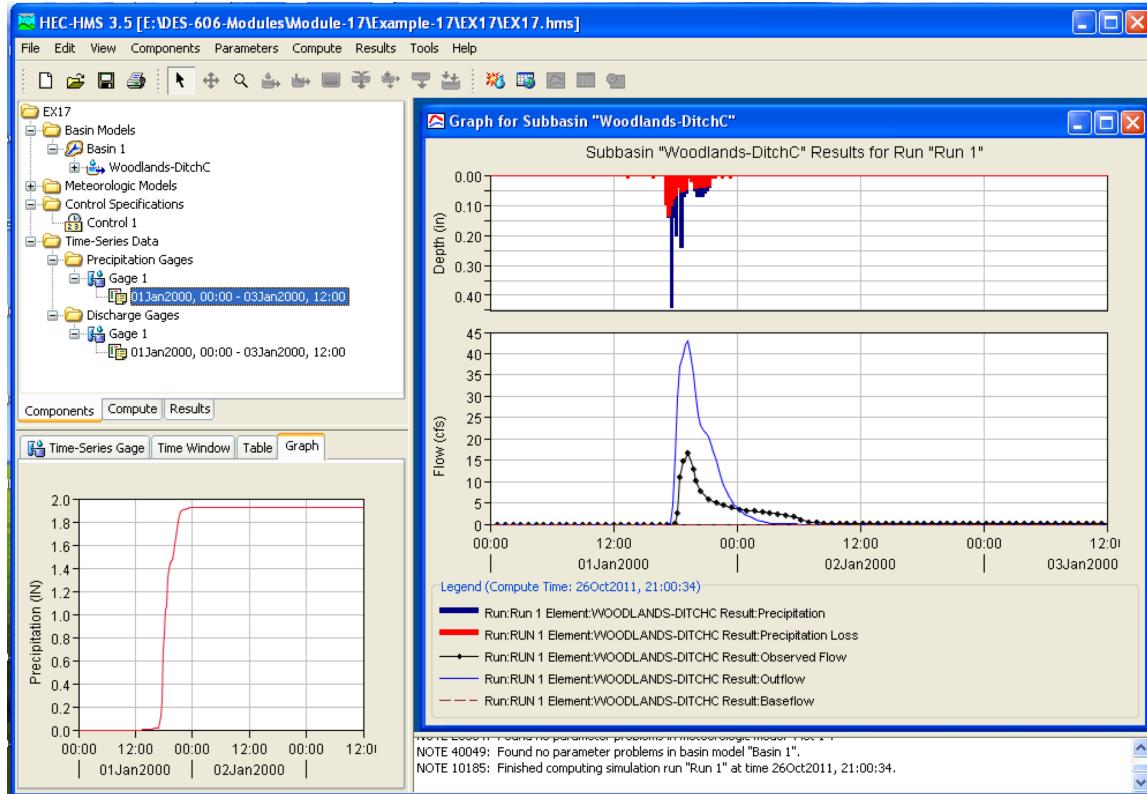


Figure 1: HEC-HMS Model Run for Woodlands-Ditch C sub-basin.

15. Which value below is the best estimate of the **COMPUTED** peak discharge for the Woodlands-DitchC sub-basin based upon Figure 1?
- 0.5 inches
  - 1.9 inches
  - 19 cubic feet per second
  - 44 cubic feet per second

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16. Which value below is the best estimate of the **OBSERVED** peak discharge for the Woodlands-DitchC sub-basin based upon Figure 1?

- a) 0.5 inches
- b) 1.9 inches
- c) 19 cubic feet per second
- d) 44 cubic feet per second

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17. Which value below is the best estimate of the total **RAW** input precipitation for the Woodlands-DitchC sub-basin based upon Figure 1?

- a) 0.5 inches
- b) 1.9 inches
- c) 19 cubic feet per second
- d) 44 cubic feet per second

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18. Which value below is the best estimate of the total **EXCESS** input precipitation for the Woodlands-DitchC sub-basin based upon Figure 1?

- a) 0.5 inches
- b) 1.9 inches
- c) 19 cubic feet per second
- d) 44 cubic feet per second

19. Figure 2 is a screen capture of a HEC-HMS model run. The model appears to have successfully run, but when the output graph is selected there is no hyetograph nor hydrograph displayed.

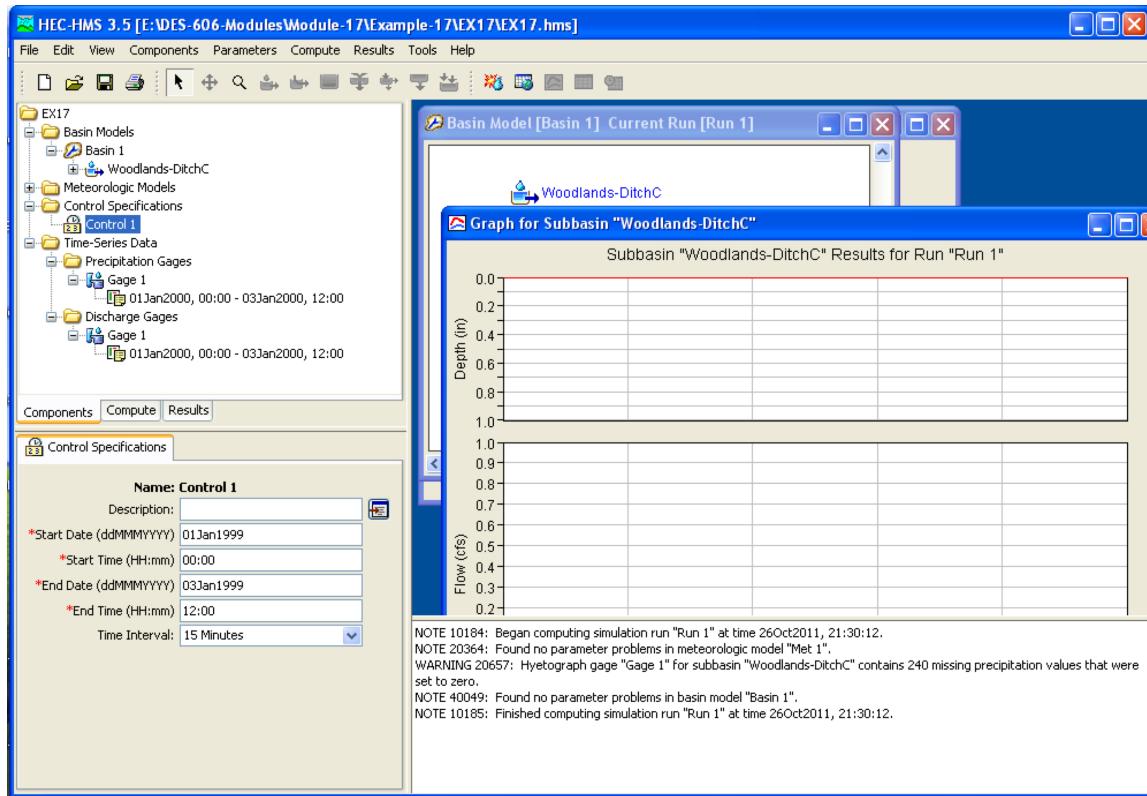


Figure 2: HEC-HMS Model Run for Woodlands-Ditch C sub-basin.

What is a likely explanation for the unanticipated output?

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Figure 3 is a schematic diagram of a creek that penetrates a 3-meter thick confined aquifer. During a long drought the flow in the creek **decreases** by 1.1 cubic meters per second between two gaging stations along the creek located 6 kilometers apart. On the west side of the creek the hydraulic head contours are parallel to the creek and the levels decrease moving **towards** from the creek at a rate of 0.0003 m/m. The head contours on the east side of the creek are also parallel to the creek and the levels decrease moving **away** from the creek at a rate of 0.0007 m/m.

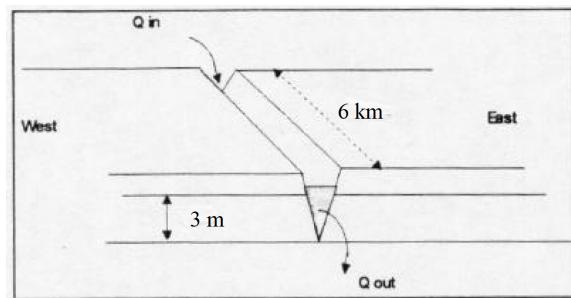


Figure 3: Dog Run Creek Schematic

20. Figure 4 is a representative sketch of a water balance where the term  $R_{in}$  represents the recharge from the stream into the aquifer.

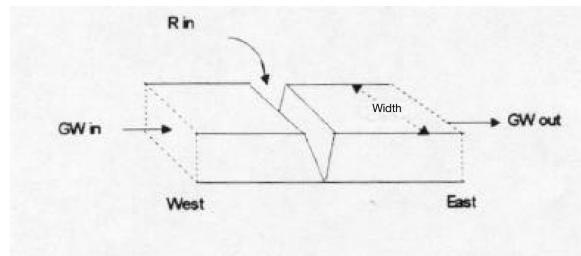


Figure 4: Dog Run Water Balance

Which expression best represents the water balance for the **aquifer** in the vicinity of the creek?

- a)  $Q_{WEST} - R_{RIVER} - Q_{EAST} = 0$
- b)  $Q_{WEST} + R_{RIVER} - Q_{EAST} = 0$
- c)  $Q_{EAST} - R_{RIVER} = Q_{EAST}$
- d)  $R_{RIVER} + Q_{WEST} = Q_{WEST}$

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21. Which value using Darcy's Law and the water balance is the best estimate the hydraulic conductivity of the aquifer in Figures 3 and 4?

a)  $0.105 \frac{m}{sec}$

b)  $0.153 \frac{m}{sec}$

c)  $0.250 \frac{m}{sec}$

d)  $0.302 \frac{m}{sec}$

22. During a drought period the following declines in the water table were recorded in an unconfined aquifer.

Table 1: Water Table Declines

Area	Size (mi <sup>2</sup> )	Decline (ft)
A	14	2.75
B	7	3.56
C	28	5.42
D	33	7.78

The total volume of water removed from storage in this aquifer during the time period was  $5.7385 \times 10^4$  acre-feet. Which value below is the best estimate the specific yield of this aquifer, for the data provided?

- a) 0.09
- b) 0.10
- c) 0.15
- d) 0.20

23. Three wells monitor an aquifer as shown in Figure 5. The head in each well is listed in table 2 below.

Table 2: Monitoring Well Locations and Head

Area	Size (mi <sup>2</sup> )	Decline (ft)	
Well ID	X	Y	Head
#1	10	90	93.2
#2	20	5	88
#3	90	95	90

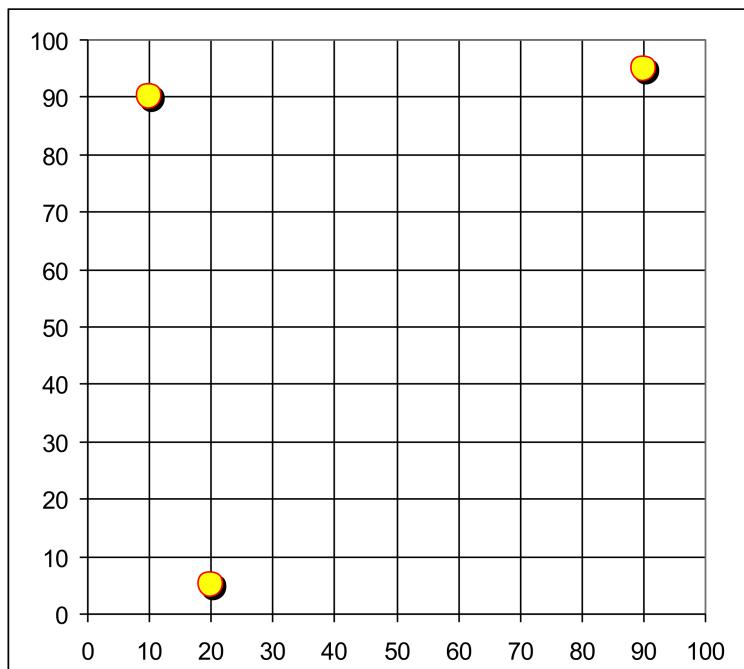


Figure 5: Map of well locations for Table 2

Which value(s) below best represent the magnitude and direction of the hydraulic gradient in this aquifer.

- a)  $\frac{\Delta h}{\Delta L} \approx 0.084$ ; NW to SE
- b)  $\frac{\Delta h}{\Delta L} \approx 0.384$ ; NW to SE
- c)  $\frac{\Delta h}{\Delta L} \approx 0.084$ ; NE to SW
- d)  $\frac{\Delta h}{\Delta L} \approx 0.384$ ; NW to SE

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24. An unconfined aquifer is 300 feet deep, and has a hydraulic conductivity of 0.5 feet per day. A one-foot diameter well is drilled into the aquifer and pumped at a rate of 50 gallons per minute. The well's radius of influence is 1000 feet. After pumping has continued long enough for equilibrium to be established, the depth of water in the well is
- a) 190 feet
  - b) 220 feet
  - c) 240 feet
  - d) 270 feet

25. Figure 6 depicts a concrete dam that impounds water as shown. The standing water depth is 1.5 meters. The soil layer under the reservoir is underlain by a highly porous sand layer. The sand layer at the bottom of the soil profile has horizontal drainage

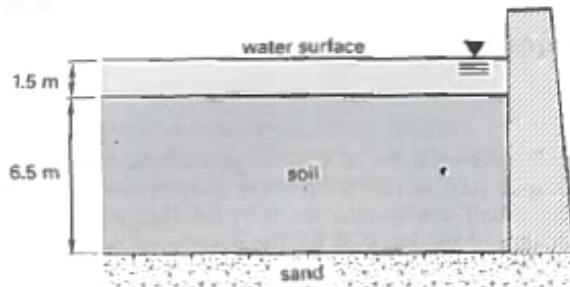


Figure 6: Debris trap (dam) with 6.5 meters of sediment above a sand layer

and zero pore pressure. The water level of the reservoir is constant. The total surface area of the reservoir pool is  $1000 \text{ m}^2$ , and the hydraulic conductivity of the soil layer is  $4.7 \times 10^{-6} \text{ mm/sec}$ . The loss from seepage through the soil layer per year is

- (A) 1.1 cubic meters
- (B) 2.8 cubic meters
- (C) 34 cubic meters
- (D) 180 cubic meters