CVEN 339 – Water Resources Engineering
Summer Semester 2012
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Final Exam

Open-book, Open-notes (8 pages, front & back, not including answer sheet; 18 questions)

Questions 1 to 12 are written in the format of the F.E. Exam Morning Section and should require on average 2 minutes per question to complete. Each question is worth 4 points. ***Clearly* write the letter corresponding to the best answer in the blank provided on the answer sheet.**

1. Which of the following statements about evapotranspiration are true?

   I. Evapotranspiration is typically quantified as a depth.
   II. For a given watershed and period of time, evapotranspiration tends to be inversely related to streamflow leaving the watershed.
   III. Evapotranspiration involves a phase change of water from vapor to liquid.
   IV. Evapotranspiration is the sum of evaporation and transpiration.

   (A) I and III only
   (B) II, III, and IV only
   (C) I, II, and IV only
   (D) I, II, III, and IV

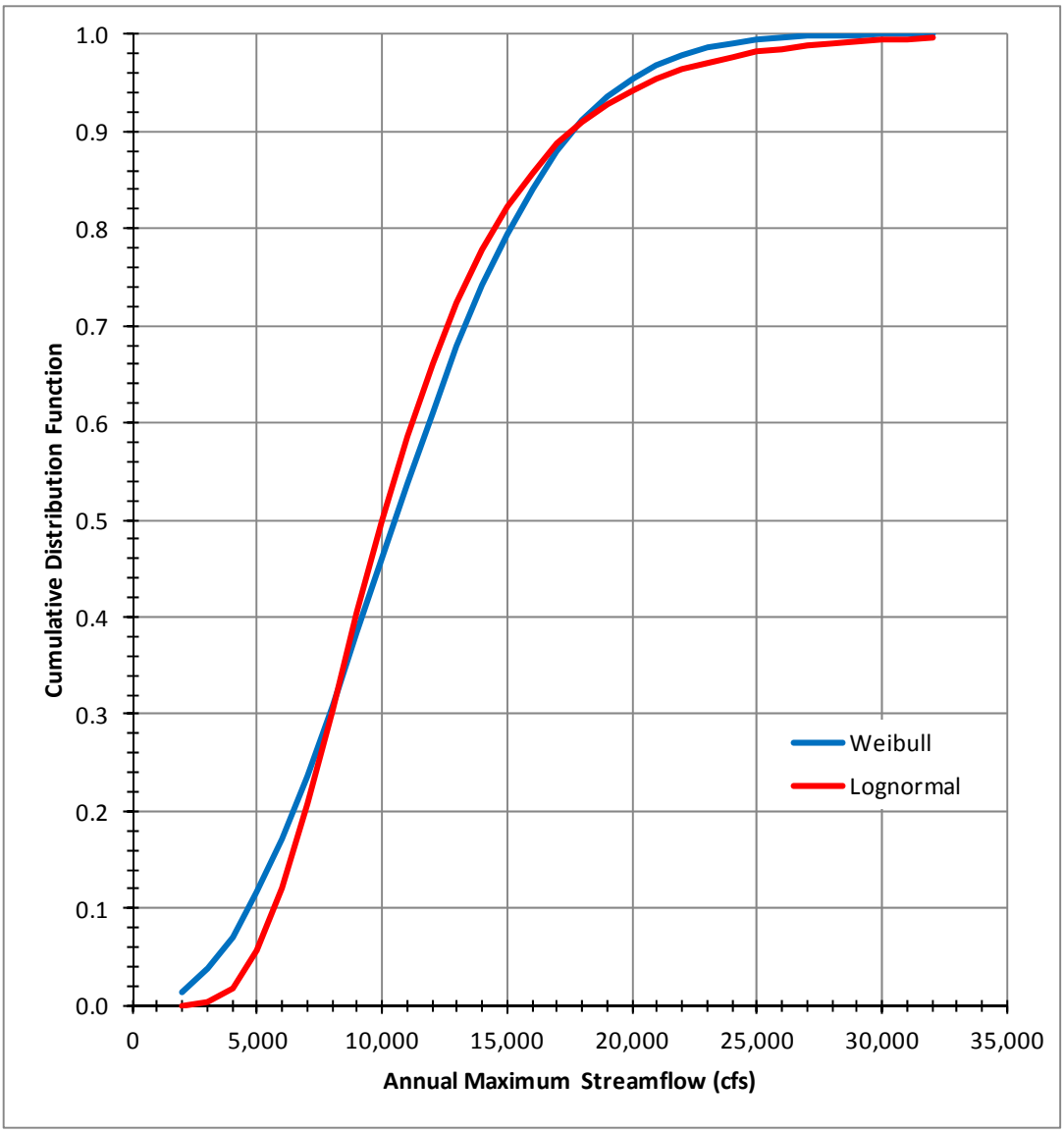
2. A trapezoidal open channel has experiences a change in slope that causes a transition from subcritical to supercritical flow. In the subcritical section, flow depth is 1.7 m, and flow velocity is 0.18 m/s. If the channel cross-section does not change, flow depth in the supercritical section is 0.4 m, and there is no loss of specific energy, the flow velocity in the supercritical section is most nearly (m):

   (A) 0.77
   (B) 5.05
   (C) 9.15
   (D) 25.7

3. A triangular swale (open channel) has Manning's roughness coefficient 0.028, 4H:1V sideslopes, and longitudinal bed slope 0.016. If the flow in the swale 38.7 ft^3/sec, what is the depth of flow (ft)?

   (A) 1.37
   (B) 1.59
   (C) 2.98
   (D) 5.75

Questions 4 and 5 refer to the figure below:



4. The figure above presents results of statistical analysis of annual maximum streamflow at a specific streamgage. If the Weibull distribution is used, the magnitude of the 25 year flood (cfs) at this location is most nearly:

   (A) 14,000
   (B) 7,000
   (C) 3,000
   (D) 20,000

5. Which of the following statements regarding the figure above are true?

   I. The magnitude of the 100 year flood will be higher if the Lognormal distribution is used for its estimation rather than the Weibull distribution.
   II. For any flood with return period greater than 5 years, the Lognormal distribution will estimate greater magnitude than the Weibull distribution.
   III. An engineering design will be essentially the same regardless of which of the two frequency distributions is used.

   (A) I only
   (B) III only
   (C) II and III only
   (D) I, II, and III

6. A watershed has NRCS curve number equal to 62. If a rain event with 0.50 inches of precipitation occurs on this watershed, the runoff generated will be most nearly (inches):

   (A) 0.00
   (B) 0.31
   (C) 0.10
   (D) 0.50

7. A tracer flows in the groundwater between 2 wells in an unconfined aquifer. The wells are 30 m apart. The ground elevation at well 1 is 250.0 m, and the water table is at a depth of 43.2 m below the surface there. Well 2 has ground elevation 262.7 m and water table depth of 57.1 m. If it takes 294 days for the tracer to flow between the wells, and the wells lie directly along the aquifer's hydraulic gradient, what is the saturated hydraulic conductivity of the aquifer (m/day)?

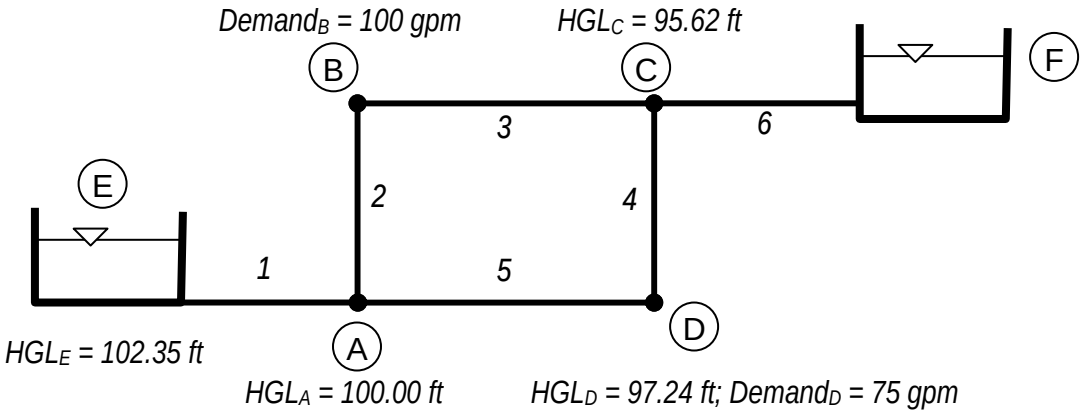
   (A) 0.102
   (B) 0.220
   (C) 0.241
   (D) 2.55

8. Which of the following statements regarding culverts are true?

   I. Increasing tailwater elevation will decrease discharge for inlet controlled conditions.
   II. For the case of submerged inlet and outlet, the longitudinal slope of the culvert pipe does not affect flowrate.
   III. Mitering a culvert inlet will increase flowrate for outlet controlled conditions.

   (A) I only
   (B) II and III only
   (C) I and III only
   (D) I, II, and III

9. A simple pipe network is diagrammed below, and some basic data is provided about elements in the network.



Which of the following statements can be proven to be true?

I. Pipe 5 has flow from Node A to Node D.
II. Pipe 6 has flow from Node F to Node C.
III. The value of HGL at Node F is less than HGL at Node E.
IV. Either Pipe 2 has flow from Node A to Node B, or Pipe 3 has flow from Node C to Node B, but both conditions cannot occur simultaneously.
V. Pipe 3 has flow from Node C to Node B.

(A) I only
(B) I and IV only
(C) I, II, and III only
(D) II and V only

10. A rectangular open channel has bottom width of 2.5 ft. What will be the flow depth (ft) in the channel if volumetric flowrate is 3.2 ft^3/sec and Froude number is 1.72?

(A) 0.48
(B) 0.13
(C) 0.38
(D) 0.26

11. In the year 2012 a river experiences a 25 year flood. What is the probability that another 25 year flood will occur in the year 2013 at the same location on this river?

(A) 0.25
(B) 0.0016
(C) 0.04
(D) 0

Tables "C-1" and "C-2" below are taken from the *Unified Stormwater Design Guidelines* of the Cities of Bryan and College Station, TX. Refer to these tables for question 12.

Table C-1
Equations for Calculating Rainfall Intensities

Reference Section V, Paragraph B1-a, page 2 of 8)

Storm Frequency	Intensity (i) (inches per hour)
2-Year	$65/(t_c + 8.0)^{0.806}$
5-Year	$76/(t_c + 8.5)^{0.785}$
10-Year	$80/(t_c + 8.5)^{0.763}$
25-Year	$89/(t_c + 8.5)^{0.754}$
50-Year	$98/(t_c + 8.5)^{0.745}$
100-Year	$96/(t_c + 8.0)^{0.730}$

Source: TxDOT Hydraulic Manual, 1986.

Note: $[t_c]$ = min

Table C-2
Runoff Coefficients (c) By Land Use Type

Reference Section V, Paragraph B1-a, page 2 of 8.

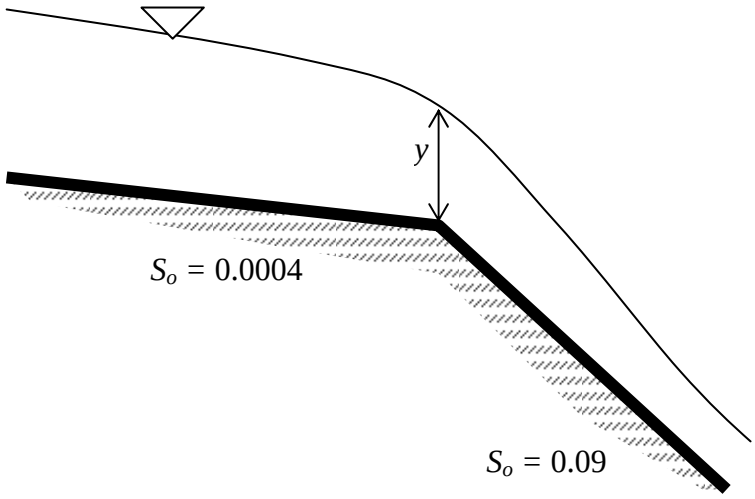
Land Use Description	Slope	Range of Values	
		From	To
Park and Open Space	Flat (0 to 2%)	0.25	0.41
	Average (2 to 7%)	0.33	0.49
	Steep (>7%)	0.73	0.53
Single Family Residential			
Lot size 5,000 to 7,000 sq. ft.	Flat (0 to 2%)	0.50	0.69
	Average (2 to 7%)	0.54	0.74
	Steep (>7%)	0.56	0.76
Lot size 7,000 to 10000 sq. ft.	Flat (0 to 2%)	0.44	0.62
	Average (2 to 7%)	0.49	0.68
	Steep (>7%)	0.52	0.71
Lot size 10,000 to 20,000 sq. ft.	Flat (0 to 2%)	0.38	0.56
	Average (2 to 7%)	0.44	0.63
	Steep (>7%)	0.47	0.66
Estate Lots (> 20,000 sq. ft.)	Flat (0 to 2%)	0.32	0.48
	Average (2 to 7%)	0.38	0.56
	Steep (>7%)	0.42	0.60
Multiple Family Residential			
Low Density (3 stories or less)	All	0.65	0.74
Medium Density (6 stories or less)	All	0.68	0.76
High Density (more than 6 stories)	All	0.71	0.80
Commercial			
Limited & General Office Sites	All	0.75	0.84
Shopping Center Sites	All	0.79	0.88
Neighborhood Business Districts	All	0.79	0.88

12. A culvert will be placed at the outlet of a 5 acre catchment fully occupied by low density multiple family residential buildings. The catchment time of concentration is approximately 5 minutes. The the culvert is to be designed to convey flow for a 25 year storm. If the engineer wishes to design for the most conservative case within the above design guidelines, the culvert design flow (cfs) is most nearly:

(A) 65.1
(B) 40.6
(C) 46.3
(D) 57.2

Questions 13 to 18 are written in the format of the F.E. Exam Afternoon Section and should require on average 4 minutes per question to complete. Each question is worth 8 points. ***Clearly* write the letter corresponding to the best answer in the blank provided.**

13. A rectangular open channel includes a change in slope as shown in the figure below. The channel has width 10.4 m and Manning's roughness coefficient 0.015. If the dimension *y* is 1.50 m, what will be the flow depth (m) far downstream of the change in slope?



(A) 0.71
(B) 0.49
(C) 2.86
(D) 1.43

14. Three monitoring wells have been drilled into an unconfined aquifer. The coordinates and piezometric head at each well are:

    Well 1: (300 m, 250 m), head = 142.2 m
    Well 2: (100 m, -50 m), head = 143.1 m
    Well 3: (550 m, 475 m), head = 155.0 m

    The aquifer's saturated hydraulic conductivity is 0.32 m/day. The average velocity and direction of flow in this aquifer is:

    (A) 0.052 m/day, 34.6° north of due west
    (B) 0.052 m/day, 34.6° south of due east
    (C) 0.251 m/day, 34.6° north of due west
    (D) 0.251 m/day, 34.6° south of due east

15. A pumping station includes a single pump that has the pump characteristic curve defined below:

    Head (ft) = $70 - 0.002\ Q^2 - 0.2\ Q$ (Q in gpm)

    The pipe network has a static head of 30 ft. The friction loss is defined by the following equation:

    Friction loss (ft) = $0.008\ Q^2$ (Q in gpm)

    The flow rate (gpm) delivered by the pump in operation is most nearly:

    (A) 74.3
    (B) 34.4
    (C) 62.3
    (D) 54.0

16. The 1 hr unit hydrograph for a watershed is given below. If a storm of duration 2 hrs and 2.9 in runoff depth falls on this watershed, the peak of the runoff hydrograph resulting from the storm is most nearly:

Time (hrs)	1 hr Unit Hydrograph (cfs/in)
0	0
0.5	72
1	135
1.5	142
2	95
2.5	24
3	0

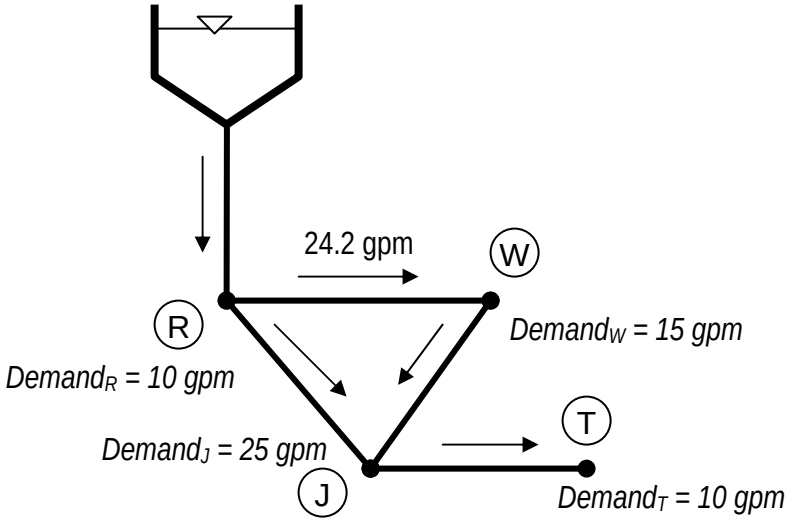
    (A) 206 cfs
    (B) 334 cfs
    (C) 412 cfs
    (D) 896 cfs

17. A pipe network is shown in the drawing below. Demands are indicated for all nodes, flow directions are indicated for all pipes, and flow magnitude is indicated for one pipe. All nodes are at elevation 0 ft except the fixed-grade node, which has a free water surface at elevation 135 ft. The friction loss for each pipe is defined by the following equation:

Friction loss (ft) = 0.0059 Q^2 (gpm) for 2 gpm < Q < 500 gpm

What is the pressure at node T?

(A) 6820 psi
(B) -53.2 psi
(C) 58.5 psi
(D) 47.3 psi



18. The 1 hr unit hydrograph given below was calculated from the rainfall-streamflow data for a 25 year flood. Which of the following statements can be shown to be true with the given data?

Time (hrs)	1 hr Unit Hydrograph (cfs/in)
0	0
1	1300
2	850
3	120
4	0

I. If the unit hydrograph had been calculated from data for the 100 year flood, its peak would be greater than 1300 cfs/in.
II. The watershed's peak runoff flow for the 5 year flood would be less than 1300.
III. The unit hydrograph has a 4% probability of being applicable in any given year.

(A) III only
(B) I and III
(C) I, II, and III
(D) None of the above