CE3620: Water Resources Engineering
Practice Final Exam

These are questions which are representative of things you may see on the final exam. Please note that you are also strongly advised to look at the sample problems posted for Exams I and II, as well as Exams I and II themselves, and be sure that you understand the homework problems assigned throughout the semester. THE EXAM WILL BE CUMULATIVE!

On the actual exam, remember to show all calculations to ensure that you receive as much partial credit as possible. If short on time, you may also summarize the solution procedure for partial credit (if correct and reasonably well explained). If you feel that not enough information is given, then assume something, clearly state your assumption(s), and proceed to solve the problem.

You will be given 2 hours to complete the exam. The exam will be closed book, but you may bring TWO crib sheets. Each sheet is to be an 8.5” x 11” sheet of paper. Each sheet can be two sided, but must contain handwritten material!! You will also be provided with the formula sheet at the end of this document.

Problem 1

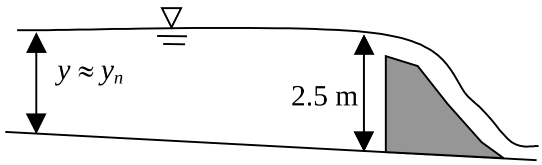
Given: A highway bridge is designed to just pass a discharge with an annual exceedance probability of 0.020 without overtopping the roadway.

Find: Compute the probability that the bridge will be overtopped at least once during the next 10 years.

Answer: 0.183

Problem 2

Given: A stream bed has a rectangular cross section 5 meters wide and a slope of .0002 m/m. The flow rate in the stream is 8.75 m^3/s. A dam is built across the stream, causing the water surface to rise to 2.5 meters just upstream of the dam, as shown below. Assume n = .015.



Find: **(a)** Find the normal depth, y_n, corresponding to this flow rate and channel geometry.

Ans. $y_n = 1.8$ m

(b) Find the critical depth, y_c.

Ans. $y_c = 0.678$ m

(c) Identify the water surface profile upstream of the dam. Explain your answer for full credit.

Ans. M1 profile.

(d) Briefly explain (or list the steps) how you would compute the water surface profile (depth vs. distance along the channel).

Ans. Discuss steps of Direct-Step method.

Problem 3

Given: An *upstream hydrograph* is shown below in Figure 1.

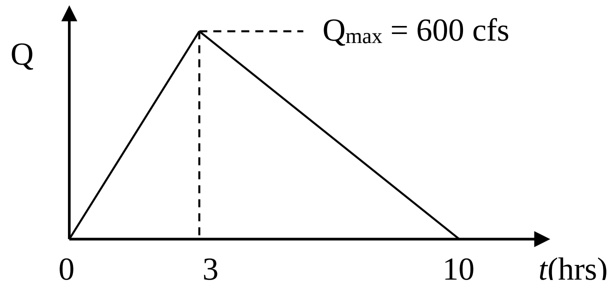


Figure 1. Upstream (inflow) hydrograph.

Find: Route the *upstream hydrograph* to a location downstream using the Muskingum method with K = 0.4 hr, X = 0.2, and Δt = 0.5 hr. Assume that the initial flow downstream is zero. You only need to compute the **first three** ordinates of the downstream hydrograph (from time 0 to $3\Delta t$).

Answer:

Time (hrs)	Inflow (cfs)	Outflow (cfs)
0	0	0
0.5	100	29.8
1.0	200	121.2
1.5	300	220.1

Problem 4

Given: The outflow rate (cfs) and storage (cfs-hr) for an emergency spillway of a certain reservoir are linearly related by $O = S/3$, where the number 3 has units of hours.

Find: Use storage-outflow relationship $O = S/3$ and the continuity equation

$$S_{t+1} + \frac{O_{t+1}\Delta t}{2} = \frac{(I_t + I_{t+1})\Delta t}{2} + S_t - \frac{O_t \Delta t}{2}$$

to determine the peak outflow rate from the reservoir for the following event:

Time (hr)	I (cfs)	S (cfs-hr)	O (cfs)
0	0	0	0
2	400		
4	600		
6	200		
8	0		

Answer: Peak outflow is 350 cfs.

Time (hr)	I (cfs)	S (cfs-hr)	O (cfs)
0	0	0	0
2	400	**300**	**100**
4	600	**900**	**300**
6	200	**1050**	**350**
8	0	**675**	**225**

Problem 5

Given: A 400-acre watershed is to be developed into an industrial district with an estimated NRCS Curve Number of 90. The distance from the watershed divide to the outlet is 3800 ft, and the average watershed slope is 75 ft/mile (0.0142 ft/ft).

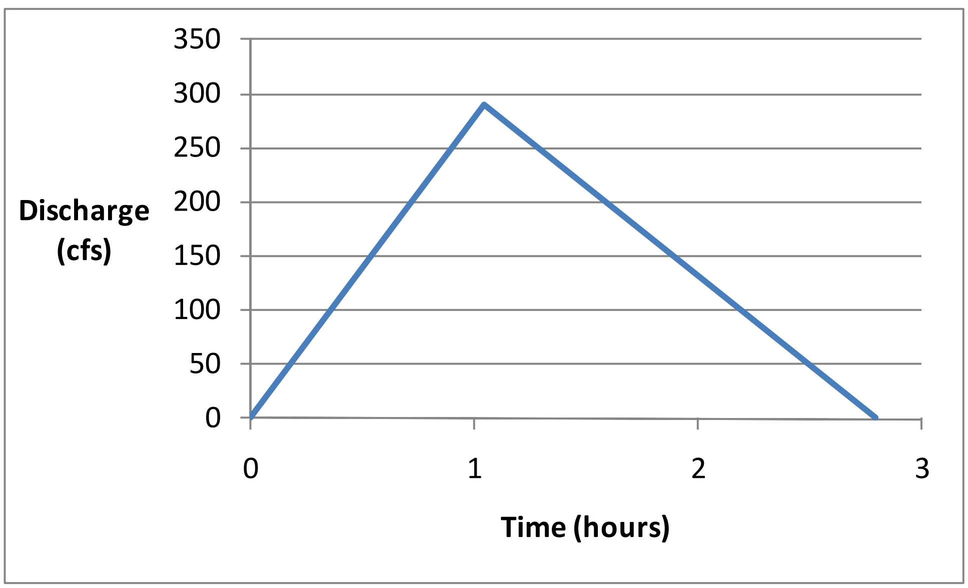
Find: **(a)** Compute the hourly runoff depth from a 2-hour, 4-inch rainfall event assuming the rainfall occurs at a uniform rate (2 in/hr for 2 hrs).

Ans.

Time (hrs)	ΔV_R (in)
0	0
1	1.09
2	1.83

(b) Compute basin lag time t_L (hours), time to peak T_P, and the peak unit hydrograph discharge Q_P (ft^3/s), and sketch the *1-hr* NRCS triangular unit hydrograph for the watershed.

Ans. t_L = 0.545 hrs; T_P = 1.045 hrs; Q_P = 289.5 cfs; T_B = 2.79 hrs



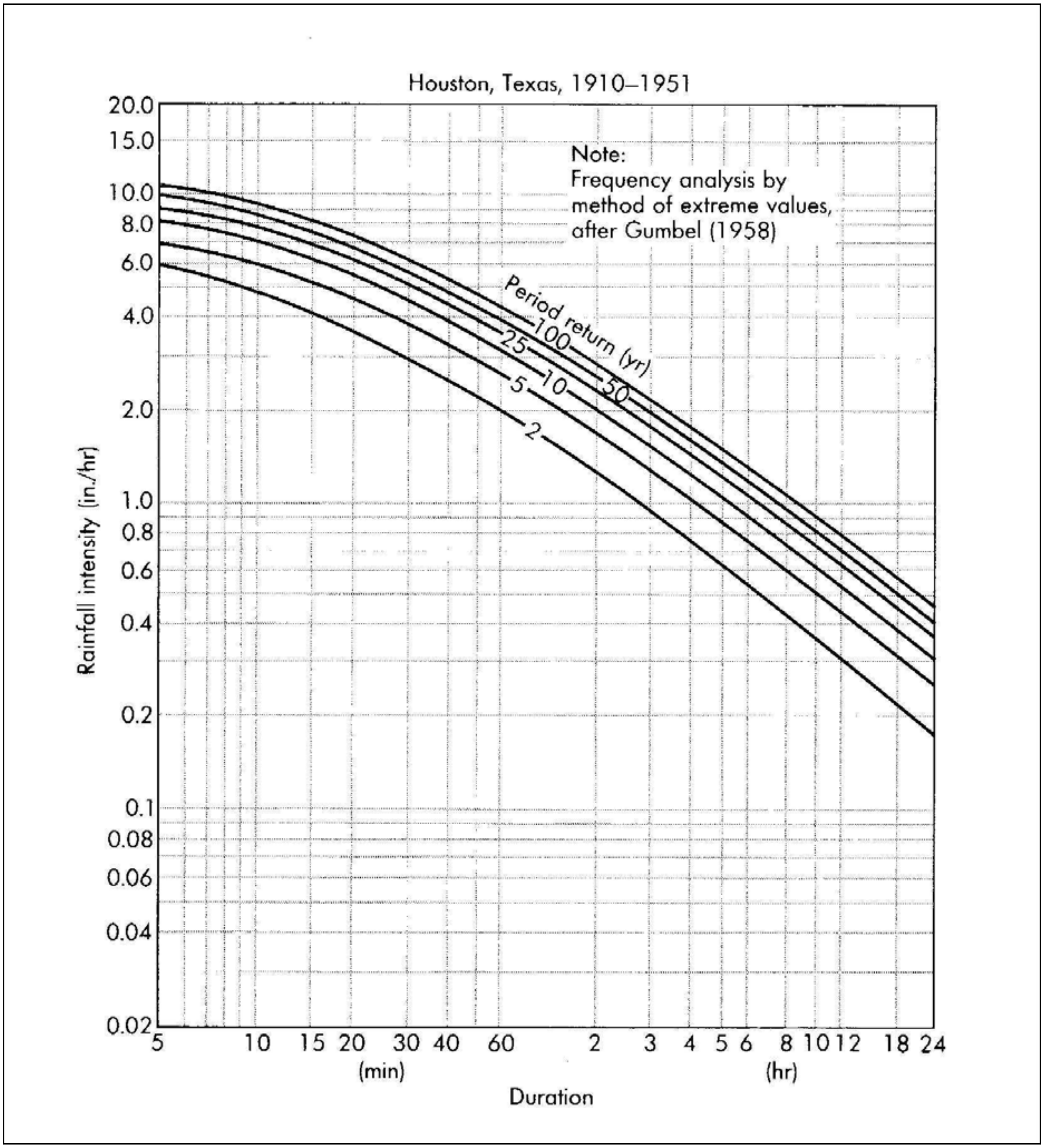
(c) Estimate the peak discharge (ft^3/s) from the 4-inch rainfall event assuming that the rainfall occurs uniformly over a 2-hour period (2.0 in/hr). Use a 1-hour time interval for your calculations.

Ans.

Time	UH Flow	Excess Precipitation (in)		Runoff
(hrs)	(cfs)	1.09	1.82	(cfs)
0	0	0		0
1	277.0	301.9	0	301.9
2	130.8	142.5	504.2	**646.7**
3	0	0	238.0	238.0
4	0	0	0	0

(d) Based on the attached rainfall intensity-duration-frequency curve, what is the return period of this 2-hour storm?

Ans. T = 10 years


Houston, Texas, 1910–1951
Note:
Frequency analysis by
method of extreme values,
after Gumbel (1958)
Period return (yr)
100
50
25
10
5
2
Rainfall intensity (in./hr)
20.0
15.0
10.0
8.0
6.0
4.0
2.0
1.0
0.8
0.6
0.4
0.2
0.1
0.08
0.06
0.04
0.02
5
10
15
20
30
40
60
(min)
2
3
4
5
6
8
10
12
18
24
(hr)
Duration

EQUATIONS AND CONVERSION FACTORS

$\sum F_x = \beta\rho Q(V_2 - V_1)$

$\frac{P_1}{\gamma} + z_1 + \frac{\alpha V_1^2}{2g} + E_p = \frac{P_2}{\gamma} + z_2 + \frac{\alpha V_2^2}{2g} + H_L + H_M$

$Q = N_p A\sqrt{\frac{2gH_L}{K_{en} + K_f + 1}}$

$Q = N_p A_e C_o \sqrt{2g(H - D/2)}$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$Q = VA$

$y_1 + z_1 + \frac{V_1^2}{2g} = y_2 + z_2 + \frac{V_2^2}{2g} + H_L$

$Q = \frac{C_m}{n} AR^{2/3} S_o^{1/2}$

$Fr = \frac{V}{\sqrt{gD}}$

$\frac{dE}{dy} = 1 - \frac{Q^2}{gA^3}\frac{dA}{dy}$

$\frac{dy}{dx} = \frac{S_o - S_f}{1 - Fr^2}$

$y_2 = \frac{y_1}{2}\left(-1 + \sqrt{1 + 8Fr_1^2}\right)$

$P_{water} = \gamma Q E_p$

$P_{shaft} = P_{water}/\eta$

$H_L = f\,\frac{L}{D}\frac{V^2}{2g}$

$H_M = K\frac{V^2}{2g}$

$H_L = \frac{n^2 V^2 L}{C_m^2 R^{4/3}}$

$A = y(B + SSy)$

$P = B + 2y\sqrt{1 + SS^2}$

$T = B + 2ySS$

$A = By$

$P = B + 2y$

$D = A/T$

$R = A/P$

$Q = CiA$

$i = \frac{a}{(t + b)^c}$

$T_P = D/2 + t_L$

$T_B = 5T_p$

$T_B = 2.667T_p$

$Q_P = 484A/T_P$

$Q_P = 2.08A/T_P$

$t_L = \frac{l^{0.8}(1000 - 9CN)^{0.7}}{1900CN^{0.7}Y^{0.5}}$

$t_L = \frac{l^{0.8}(2540 - 22.86CN)^{0.7}}{1410CN^{0.7}Y^{0.5}}$

$t_C = \frac{5}{3}t_L$

$V_R = \frac{(P - 0.2S)^2}{P + 0.8S}$

$S = \frac{2540}{CN} - 25.4$

$S = \frac{1000}{CN} - 10$

$I_A = 0.2S$

$R = 1 - (1 - P)^N$

$T = 1/P$

$S = K[XI + (1 - X)O]$

$O_{t+1} = C_1 I_{t+1} + C_2 I_t + C_3 O_t$

$\frac{dS}{dt} = I - O$

$C_1 = \frac{0.5\Delta t - KX}{K - KX + 0.5\Delta t}$

$C_2 = \frac{0.5\Delta t + KX}{K - KX + 0.5\Delta t}$

$C_3 = \frac{K - KX - 0.5\Delta t}{K - KX + 0.5\Delta t}$

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1 mile = 5280 ft

1 inch = 2.54 cm

1 ft^3 = 7.48 gallons

1 acre = 43,560 ft^2

1 mi^2 = 640 acres

g = 32.2 ft/s^2 = 9.81 m/s^2

γ = 62.4 lb/ft^3 = 9.79 kN/m^3