

**FINAL EXAM-CVG 3120 (HYDROLOGY)**

Professor: Seidou Ousmane

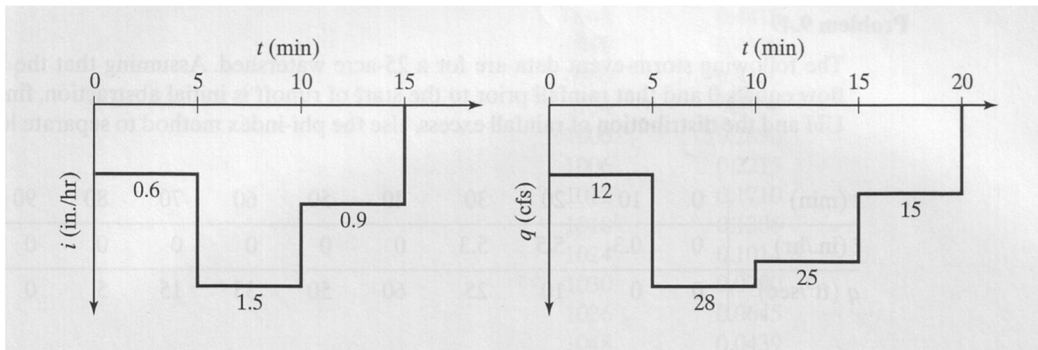
Wednesday, December 21<sup>th</sup>, 2015, 14h-17h

Duration: 3h

Closed book exam-Formula sheet allowed.

**PROBLEM 1 (10 pts)**

Compute the direct-runoff hydrograph for the following rainfall excess and UH.



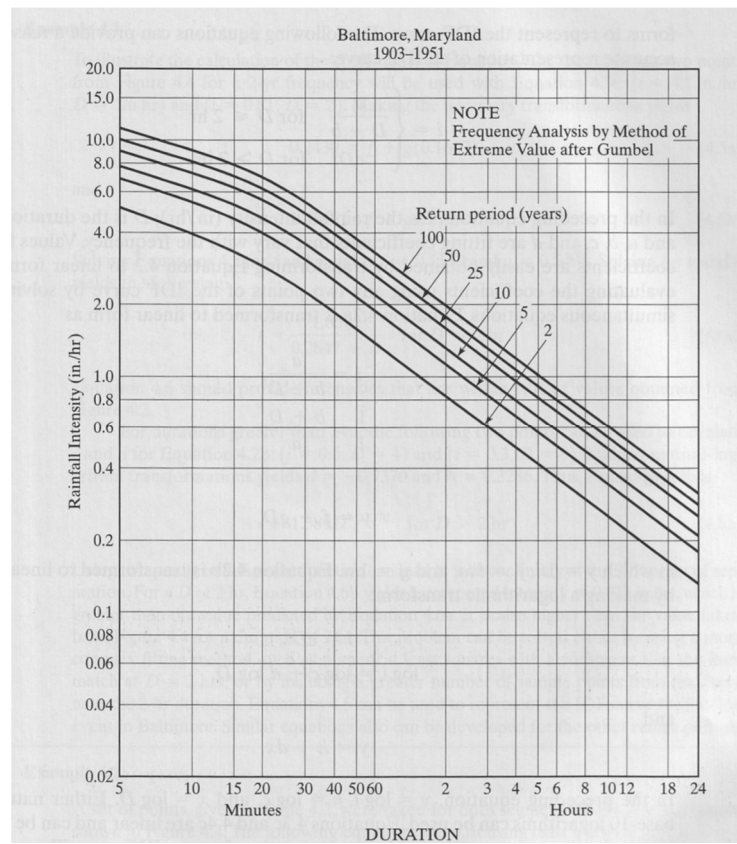
Time (min)	UH (cfs)
5	12
10	28
15	25
20	15

Time (min)	$0.6 \cdot UH \cdot 5/60$	$1.5 \cdot UH \cdot 5/60$	$0.9 \cdot UH \cdot 5/60$	DRO=sum
5	0.6			0.6
10	1.4	1.5		2.9
15	1.25	3.5	0.9	5.65
20	0.75	3.125	2.1	5.975
25	0	1.875	1.875	3.75
30	0	0	1.125	1.125
35	0	0	0	0

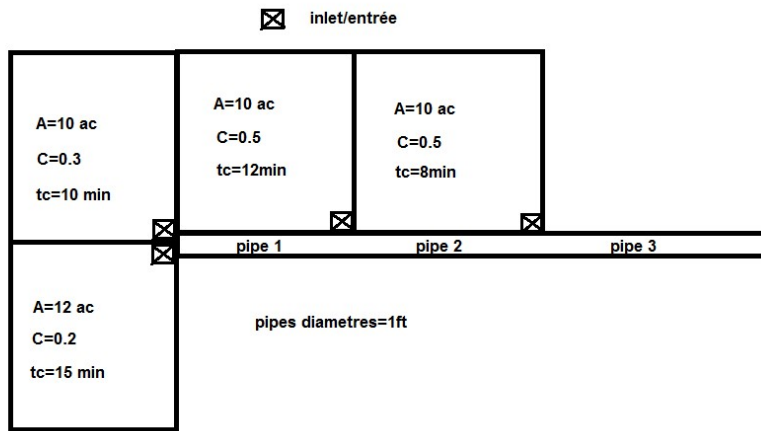
**PROBLEM 2 (20 pts)**

From the IDF curve shown below, determine the missing values of intensity, depth, duration, or return period for the following table:

Intensity (in./hr)	Depth (in.)	Duration (hr)	Return period (yr)	
	2	4	<b>2</b>	<b>100</b>
<b>0.2</b>		4.8	24	<b>8</b>
<b>0.58</b>		<b>3.48</b>	6	75
<b>6.987951807</b>		0.58	0.083	<b>18</b>
	0.3	<b>3.6</b>	12	<b>5</b>



For the following watershed schematic shown, find the peak discharge (using the Rational Method) into each inlet and the required discharge capacity for each pipe segment. Use a 50-yr return period and the above IDF curve.

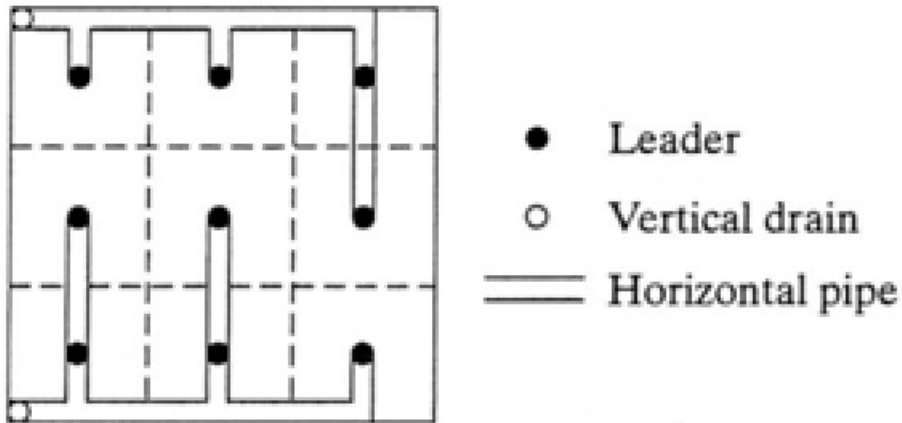


Inlet 1		Inlet 2		Inlet 3		Inlet 4	
A (acres)	10	A (acres)	12	A (acres)	10	A (acres)	10
tc (min)	10	tc (min)	15	tc (min)	12	tc (min)	8
I (in/h)	8	I (in/h)	7	I (in/h)	6.5	I (in/h)	8.5
C	0.3	C	0.2	C	0.5	C	0.5
Q(cfs)	24	Q(cfs)	16.8	Q(cfs)	32.5	Q(cfs)	42.5

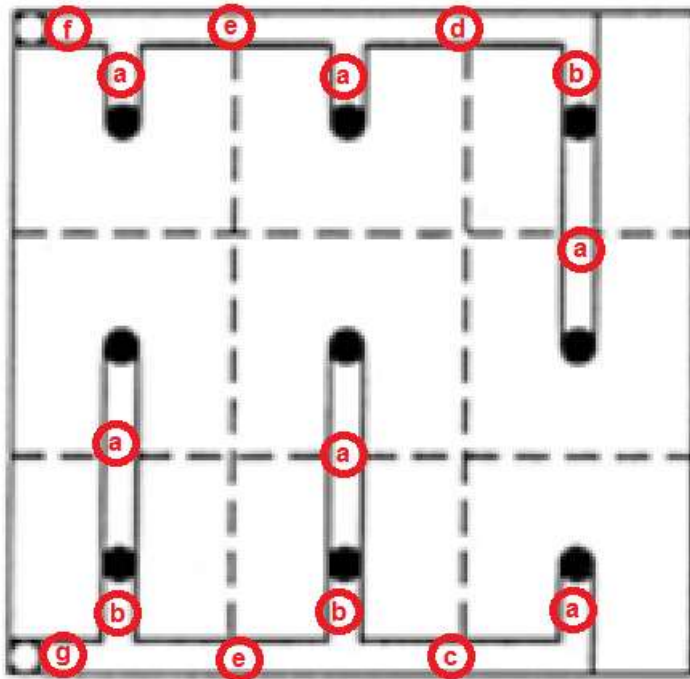
Pipe 1		Pipe 2		Pipe 3	
A=A1+A2	22	A=A1+A2+A3	32	A=A1+A2+A3+A4	42
tc=max(10,15)	15	tc=max(tc1+tpipe1, tc2+tpipe2, tc3)	15.03	tc=max(tc1+tpipe1+tpipe2, tc2+tpipe1+tpipe2, tc3+tpipe2, tc4)	15.0525 836
I	7	I	7	I	7
$C=(C1A1+C2A2)/(C1+C2)$	0.24545 4545	$C=(C1A1+C2A2+C3A3)/(A1+A2+A3)$	0.325	$C=(C1A1+C2A2+C3A3+C4A4)/(A1+A2+A3+A4)$	0.36666 667
Q(cfs)	37.8	Q(cfs)	72.8	Q(cfs)	107.8
Area (ft <sup>2</sup> )	0.785	Area (ft <sup>2</sup> )	0.785	Area (ft <sup>2</sup> )	0.785
Velocity=Q/A (ft/s)	48.1528 6624	Velocity=Q/A (ft/s)	92.7388 535	Velocity=Q/A (ft/s)	137.324 841
Travel time=100/V/60 (min)	0.03461 1993	Travel time=100/V/60 (min)	0.01797 161	Travel time=100/V/60 (min)	0.01213 667

**PROBLEM 3 (15 pts)**

Design a roof drainage system for a square building with a roof area of 180,000 ft<sup>2</sup>. Local drainage policy requires control of the 25yr, 10-min rainfall (use the IDF curve provided in problem 2). Use a slope of 0.125 in./ft for horizontal drains located in the interior of the roof and a slope of 0.5 in./ft for those along the perimeter of the roof. Assume two vertical drains from the roof to the ground level.



**SOLUTION**



- a) horizontal drain in the interior, drains one square**
- b) horizontal drain in the interior, drains two squares**
- c) horizontal drain in the perimeter, drains one square**
- d) horizontal drain in the perimeter, drains two squares**
- e) horizontal drain in the perimeter, drains three squares**
- f) horizontal drain in the perimeter, drains five squares**
- g) horizontal drain in the perimeter, drains four squares**
- h) vertical drain, drains five squares**
- i) vertical drain, drains four squares**

Area of one square= $180000/9$ (ft <sup>2</sup> )	20000
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Intensity (in/h)	7
Discharge (cfs/s)	3.2
Discharge( gal/min)	1454.4

Description	Nb squarres	Discharge (gal/min)	Slope (in/ft)	Diameter (in)
<b><u>a) horizontal drain in the interior, drains one squarre</u></b>	1	1454.4	0.125	12.2
<b><u>b) horizontal drain in the interior, drains two squarres</u></b>	2	2908.9	0.125	15.8
<b><u>c) horizontal drain in the perimeter, drains one squarre</u></b>	1	1454.4	0.5	9.4
<b><u>d) horizontal drain in the perimeter, drains two squarres</u></b>	2	2908.9	0.5	12.2
<b><u>e) horizontal drain in the perimeter, drains three squarres</u></b>	3	4363.3	0.5	14.2
<b><u>f) horizontal drain in the perimeter, drains five squarres</u></b>	5	7272.2	0.5	17.2
<b><u>g) horizontal drain in the perimeter, drains four squarres</u></b>	4	5817.8	0.5	15.9
<b><u>h) vertical drain, drains five squarres</u></b>	5	7272.2	N/A	17.1
<b><u>i) vertical drain, drains four squarres</u></b>	4	5817.8	N/A	15.8

**PROBLEM 4 (15 pts)**

A 1 -hour unit hydrograph is given by a rectangle whose base is 8 hours and height is 0.125cm/hour. Construct an S-hydrograph using this UH, and derive the 2-hours, 3 hours and 4 hours unit hydrograph.

S-hydrograph

Time (h)	UH	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	UH (lagged)	SH=sum
1	0.125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.125
2	0.125	0.125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25
3	0.125	0.125	0.125	0	0	0	0	0	0	0	0	0	0	0	0	0	0.375
4	0.125	0.125	0.125	0.125	0	0	0	0	0	0	0	0	0	0	0	0	0.5
5	0.125	0.125	0.125	0.125	0.125	0	0	0	0	0	0	0	0	0	0	0	0.625
6	0.125	0.125	0.125	0.125	0.125	0.125	0	0	0	0	0	0	0	0	0	0	0.75
7	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0	0	0	0	0	0	0	0	0	0.875
8	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0	0	0	0	0	0	0	0	1
9	0	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0	0	0	0	0	0	0	1
10	0	0	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0	0	0	0	0	0	1

11	0	0	0	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0	0	0	0	0	1
12	0	0	0	0	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0	0	0	0	1
13	0	0	0	0	0	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0	0	0	1
14	0	0	0	0	0	0	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0	0	1
15	0	0	0	0	0	0	0	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0	1
16	0	0	0	0	0	0	0	0	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	1

**2 hours, 3 hours and 4 hours UH**

Time (h)	SH	SH (lagged 2h)	Difference	2h-UH=0.5*difference
1	0.125		0.125	0.0625
2	0.25		0.25	0.125
3	0.375	0.125	0.25	0.125
4	0.5	0.25	0.25	0.125
5	0.625	0.375	0.25	0.125
6	0.75	0.5	0.25	0.125
7	0.875	0.625	0.25	0.125
8	1	0.75	0.25	0.125
9	1	0.875	0.125	0.0625
10	1	1	0	0
11	1	1	0	0
12	1	1	0	0
13	1	1	0	0
14	1	1	0	0
15	1	1	0	0
16	1	1	0	0

Time (h)	SH	SH (lagged 3h)	Difference	3h-UH=difference/3
1	0.125		0.125	0.04166667
2	0.25		0.25	0.08333333
3	0.375		0.375	0.125
4	0.5	0.125	0.375	0.125
5	0.625	0.25	0.375	0.125
6	0.75	0.375	0.375	0.125
7	0.875	0.5	0.375	0.125
8	1	0.625	0.375	0.125
9	1	0.75	0.25	0.08333333
10	1	0.875	0.125	0.04166667
11	1	1	0	0
12	1	1	0	0
13	1	1	0	0

14	1	1	0	0
15	1	1	0	0
16	1	1	0	0

Time (h)	SH	SH (lagged 4h)	Difference	4h-UH=difference/4
1	0.125		0.125	0.03125
2	0.25		0.25	0.0625
3	0.375		0.375	0.09375
4	0.5		0.5	0.125
5	0.625	0.125	0.5	0.125
6	0.75	0.25	0.5	0.125
7	0.875	0.375	0.5	0.125
8	1	0.5	0.5	0.125
9	1	0.625	0.375	0.09375
10	1	0.75	0.25	0.0625
11	1	0.875	0.125	0.03125
12	1	1	0	0
13	1	1	0	0
14	1	1	0	0
15	1	1	0	0
16	1	1	0	0

**PROBLEM 5 (20 pts)**

The following hydrograph (ft<sup>3</sup>/sec) was measured at the upstream section of a river with the data recorded on a 0.4-hr time increment. Route the hydrograph using the Convex Method through two reaches that have the following characteristics: reach 1 (length = 7,200 ft, velocity = 2.5 ft/sec) and reach 2 (length = 6,480 ft, velocity = 1.8 ft/sec). The upstream hydrograph ordinates are: (0, 210, 530, 840, 920, 870, 610, 380, 190, 80, 40, 20). Assume that the initial discharge at the downstream sections is 0. **Do not route the entire hydrograph: The three first discharge values at the end of the second reach are sufficient.**

**PROBLEM 6 (20 pts)**

An underground storage tank with rectangular sections (length = 100 ft, width = 70 ft., height = 50 ft) is used for temporary control of storm runoff. Determine the stage storage-discharge relationship assuming outflow from the tank is controlled by an orifice at the base of the tank. The rectangular orifice has a length of 3 ft and a height of 0.5 ft. The loss coefficient is 0.6. Start routing the following hydrograph through the reservoir (**Do not route the entire hydrograph: The three first discharge values of the routed hydrograph are sufficient.**).

<b>TIME (h)</b>	<b>DISCHARGE (ft<sup>3</sup>/S)</b>	<b>TIME(h)</b>	<b>DISCHARGE (ft<sup>3</sup>/s)</b>
6:00 A.M.	30	1 :00 P.M.	430
7:00	30	2:00	400
8:00	60	3:00	300
9:00	120	4:00	240
10:00	240	5:00	180
11 :00	420	6:00	30
12 : 0 0	4 5 0		