

Université d'Ottawa

Faculté de génie

Département de

Génie Civil



uOttawa

L'Université canadienne
Canada's university**FINAL EXAM-CVG 3120 (HYDROLOGY)**

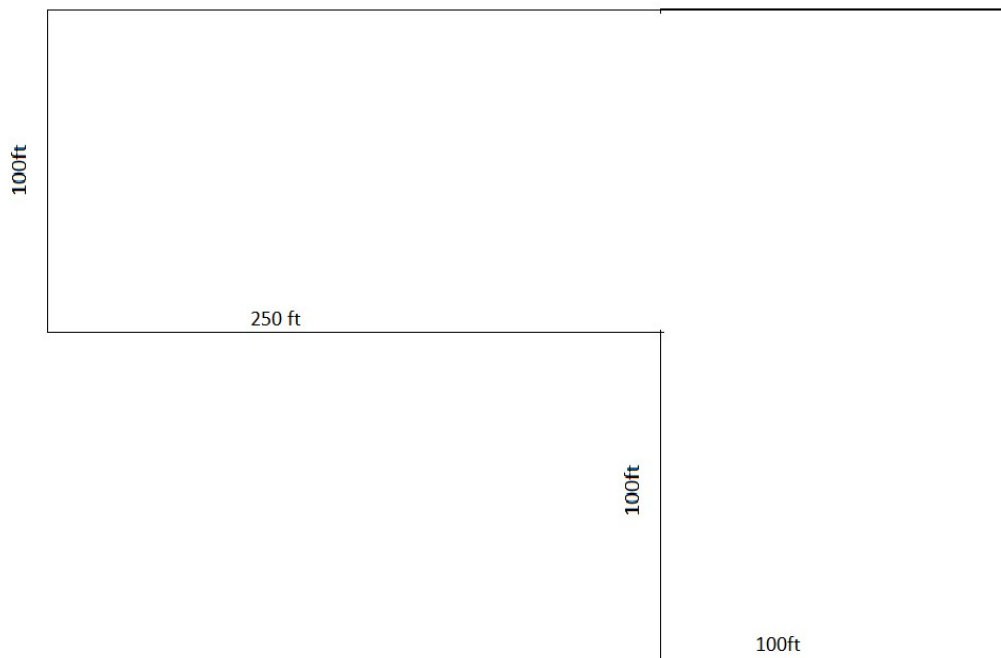
Professor: Seidou Ousmane

Wednesday, December 14, 2016, 19:00 – 22:00, 125 University (GYM) C/D

- **Duration: 3h**
- **Closed book test (formula sheet allowed).**

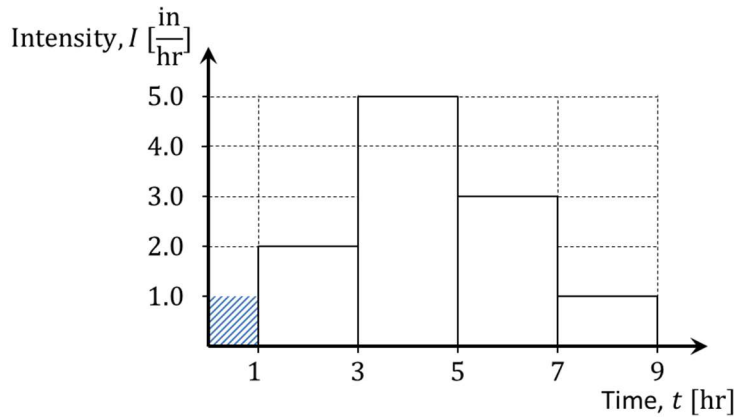
Question 1 [15 Marks]

Design and size a roof-drainage system for the commercial building shown below (i.e. choose the positions of the drains and find their sizes). Local drainage policy requires control of the 50-yr, 0.1-hr storm event (use the IDF curve given at the end of the exam). Use a slope of 0.25 in/ft for all horizontal drains. Do not forget that it is recommended to have at least a drain per 10000ft²



Question 2. [25 Marks]

The depth of runoff for a watershed was recorded as 7.6 in after the rainfall event presented on the figure below. The shaded part of the hyetograph represents the initial abstraction



1. Determine the Φ index (one decimal precision) for a watershed using the rainfall hyetograph shown below. Clearly show the Φ index on the rainfall hyetograph (you may sketch it on your booklet if you wish). **[10 Marks]**
2. The **2h** unit hydrograph is given in the table below. Calculate the direct runoff hydrograph at the outlet of the watershed. **[15 Marks]**

Time (h)	2h-HU (ft ³ /s)
0	0
1	100
2	100
3	0

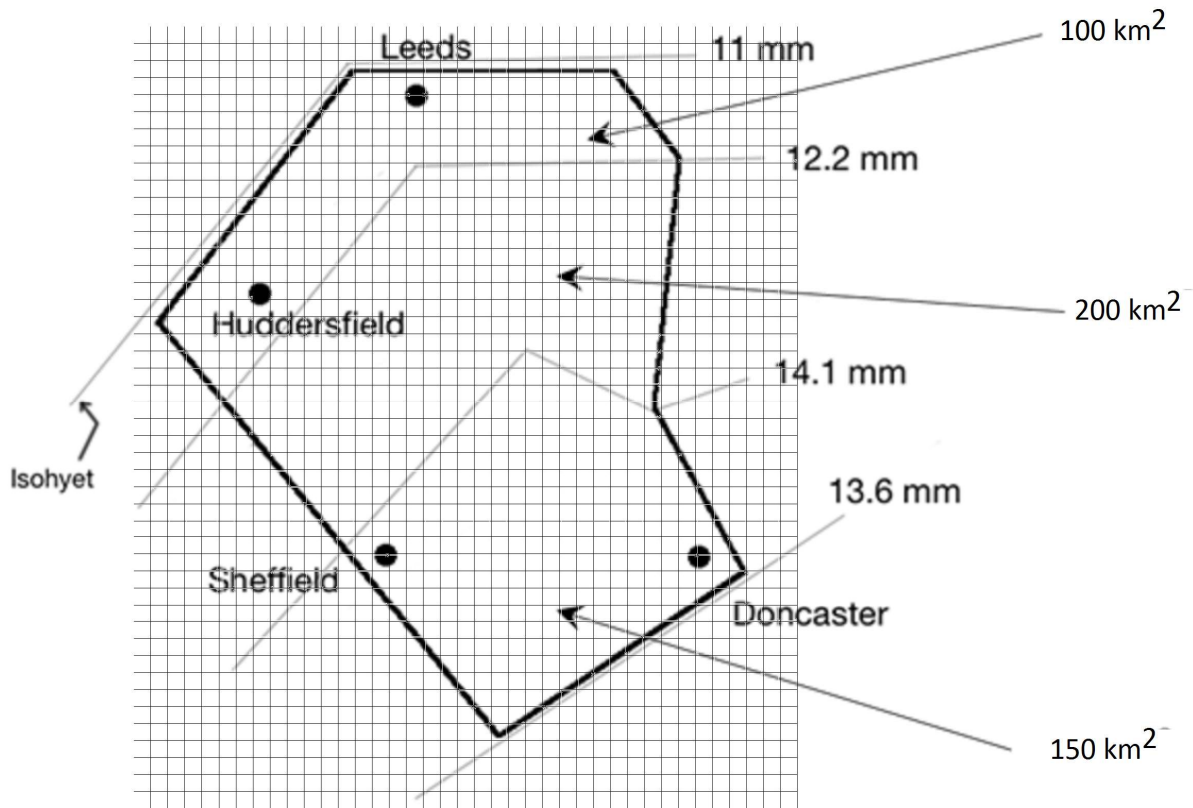
Question 3. [20 Marks]

For the following watershed

- a) Find the missing precipitation for Doncaster using the Normal Ratio Method. **[5 Marks]**
- b) Find the missing precipitation for Doncaster using the Inverse Distance Method. **[5 Marks]**
- c) Find the areal precipitation of the watershed using the Thiessen Polygons Method (use only Leeds, Huddersfield and Sheffield) **[5 Marks]**
- d) Find the areal precipitation of the watershed using the Isohyetal Method. **[5 Marks]**

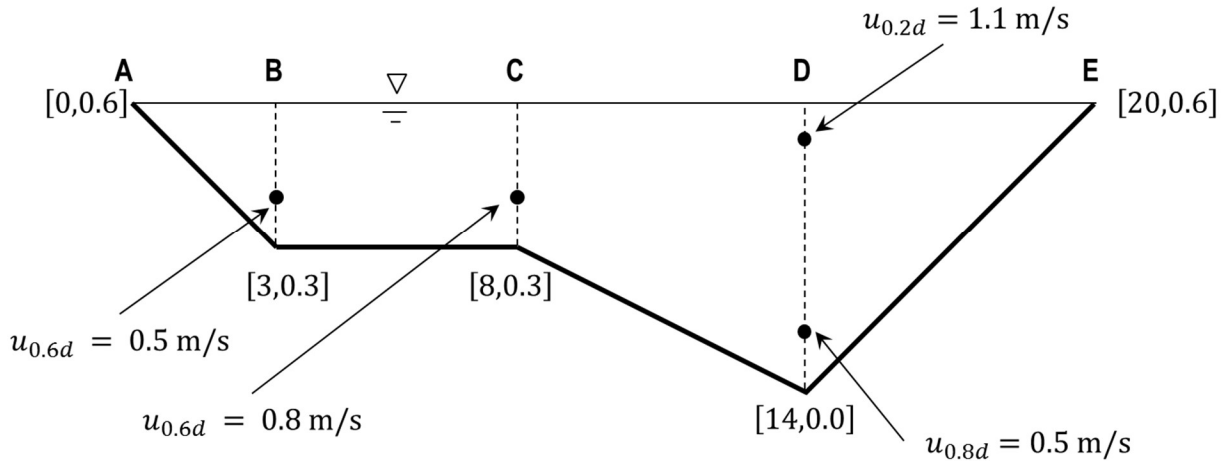
Location	Average annual rainfall (mm)	Total storm rainfall (mm)
Leeds	600	11.2

Huddersfield	720	12.0
Sheffield	650	14.3
Doncaster	603	



Question 4. [10 Marks]

1. For the cross-section below, determine the discharge. The coordinates in the figure are $[y, z]$ coordinates in metres. **[8 Marks]**
2. Assuming the cross-section is constant throughout the river reach, determine the Manning's roughness if the bed slope is 0.03. **[2 Marks]**



Question 5. [10 Marks]

The following hydrograph has been measured for a watershed:

Time [min]	Inflow [cfs]
0	0
10	60
20	100
30	60
40	50
50	40
60	30
70	20
80	10
90	5
100	0

a) A reservoir to control the flood has been designed at the outlet of this watershed. The Storage-Indication curve relationship was determined using a time-step of 10 minutes for this reservoir as:

$$Q = 0.00001 \left(\frac{2S}{\Delta t} + Q \right)^3 - 0.003 \left(\frac{2S}{\Delta t} + Q \right)^2 + 0.4298 \left(\frac{2S}{\Delta t} + Q \right)$$

where, Q has units [cfs] and S has units [ft^3]. Consider the initial storage and outflow equal to zero.

1. Route the hydrograph in the above table shown until the outflow hydrograph start decreasing. Show the calculations for all the values obtained. **[6 Marks]**
2. What impact the reservoir has on the peak flow? **[2 Marks]**
3. What impact the reservoir has on time to peak? **[2 Marks]**

Question 6 (20 pts)

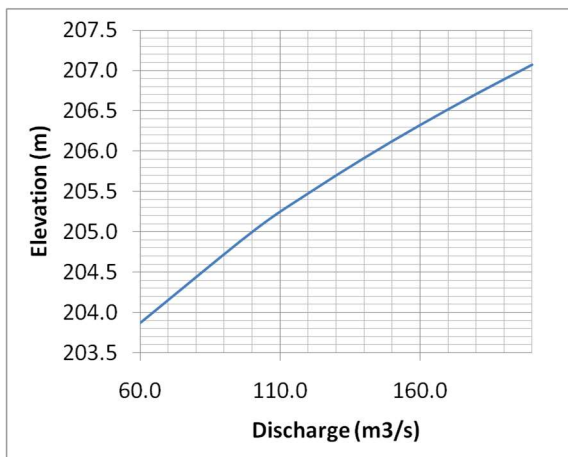
The Muskingum routing parameters for a river reach are the following:

- $x=0.15$
- $k=6500$

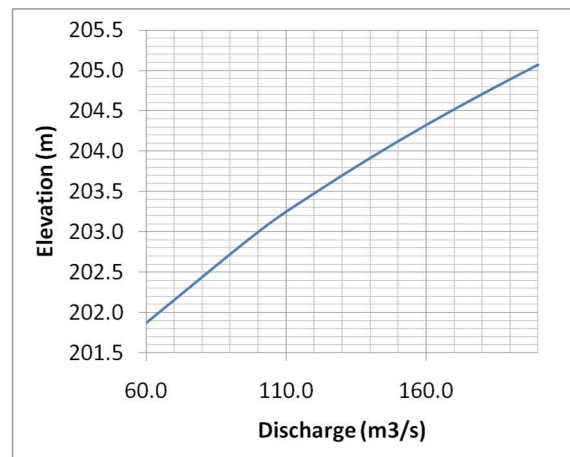
The water elevations measured at the upstream end of the reach are given below:

Time (hours)	0	1	2	3	4	5
Elevation (m)	205	205.5	205.9	205.9	205.5	205

The stage discharge relationships at the upstream and downstream ends of the river are given on the figures below:



Upstream end



Downstream end

1. Calculate the upstream hydrograph. **[4 Marks]**

2. Route the upstream hydrograph using the Muskingum routing method. Only four iterations are required. Assume the initial discharge is the same at both ends of the reach. **[12 Marks]**
3. Calculate the downstream levels for the four first time steps. **[4 Marks]**

