UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Sciences

BSc Environmental Health

MAIN EXAMINATION PAPER DECEMBER2014

TITLE OF PAPER	:	HYDROLOGY
COURSE CODE	:	EHM 318
DURATION	:	2 HOURS
MARKS	:	100
INSTRUCTIONS	:	THERE ARE FIVE QUESTIONS IN THIS EXAM
	:	ANSWER ANY FOUR OF THE FIVE QUESTIONS
	:	EACH QUESTION CARRIES 25 MARKS
	:	NO PAPER SHOULD BE BROUGHT INTO OR OUT OF THE EXAMINATION ROOM

QUESTION ONE (25 Marks)

1A. Define the following terms: i) Detention storage ii) Surface detention iii) Bank storage iv) antecedent precipitation .....[4 Marks]

1B. Indicate how and in what way each of the following factors affect the rate of runoff from a given catchment: i) Drainage density ii) Direction of storm iii) Size of the catchment iv) shape of the catchment v) Speed and direction of wind.....[4 Marks]

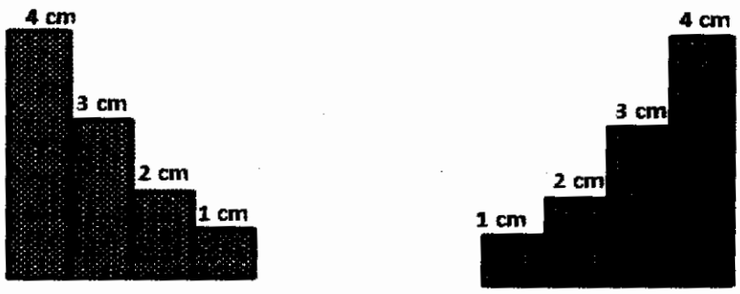
1C. Describe in detail the principles underlying the movement of air by convection.
..... [4 Marks]

1D. There is a region of the atmosphere where the temperature may exceed 500^0C and yet a person existing in this part of the atmosphere may feel extremely cold. Which part of the atmosphere is this? Explain the discrepancy stated in terms of high temperature and yet feeling very cold.....[4 Marks]

1E. Figure Q1 below shows two storm (rainfall) hyetographs that occurred in the same basin at different times. The rainfall amount is the same in both cases except that in the case of A it started raining heavily early while in the case of (ii) the highest rainfall came later. Indicate :

I. Whether the peak (maximum) runoff will be the same for the two storms. Support your answer with reason. .....[5 marks]

II. Whether the total runoff will be the same for the two storms. Support your answer with reason. .....[4 marks]



(i) Figure Q1 (ii)

QUESTION TWO (25 Marks)

A double mass curve analysis made between a certain rain fall gauging station X and 10 other neighboring stations produced the lines shown in Figure Q2.1 below. It was discovered that there was a change in slope at point B.

2A. Describe the change that happened at station X and the possible causes for such change. .....[10 marks]

2B. The monthly rain fall recorded at station X during the times corresponding to points A and B were respectively 4 cm and 10 cm respectively. Determine the adjusted rain fall values for the two points according to the information derived from the double mass curve. .....[15 marks]

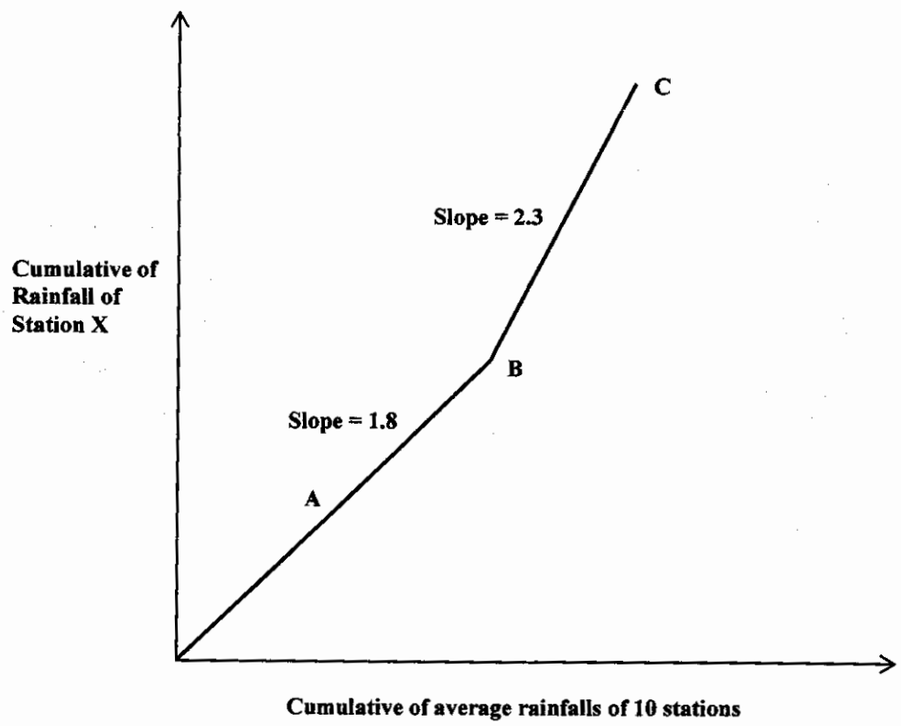


Figure Q2.1

QUESTION 3 (25 Marks) (Each question below carries five marks).

For the catchment area show in Figure Q 3.1 below:

3A. Determine the time of concentration of flow for each of the sub-catchments I, II, III and IV

3B. Determine the design duration of rainfall for the given catchment that gives maximum runoff

3C. Determine the design intensity of rainfall that gives maximum runoff. State what will happen if the intensity of rain is i) greater than and ii) less than the design intensity.

3D. Determine the 20 years return period runoff. The characteristics of the catchment are provided in the table below.

3E. Determine the maximum runoff if the intensity of rain is half of the design intensity.

The time of concentration can be calculated using the overland flow equation given as:

$$t_c = 0.02L^{0.8}S^{-0.4}$$

Where t_c is the time of concentration in minutes, L is the length in meters and S is the slope in m/m.

The intensity of rain can be calculated using the following IDF curve equation:

$$I = \frac{80\,T^{0.2}}{(t+12)^{0.5}}$$

Where I is the rainfall intensity in cm/hr, T is the return period in years and t is the time of travel (time of concentration) of rain in minutes.

Sub-Catchment	Area (km^2)	Length (km)	Slope (%)	Runoff coefficient (c)
I	3	2	1%	0.5
II	4	1.7	1.5%	0.45
III	4.5	1.5	2%	0.4
IV	1.5	1.2	2.4%	0.35

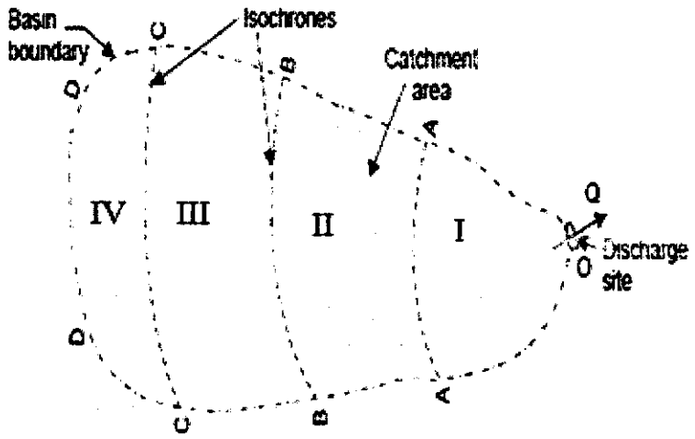


Figure Q3.1

QUESTION FOUR (25 Marks)

The runoff record for a certain river is shown in the table below: The rainfall hyetograph is also shown in Figure 4.1. The rate of infiltration is 1.2 cm/hr.

4A. Determine the total surface runoff in m^3/sec .....[5 marks]

4B. Estimate the total area in m^2 from which the runoff was generated .....[5 marks]

4C. State the effective duration of the rain .....[5 marks]

4D. Determine the coordinates ofthe unit hydrograph ....[10 marks]

Time Hr	Base flow m^3/sec	Runoff m^3/sec
0	2.83	2.83
1	2.83	2.83
2	2.83	8.50
3	2.83	19.82
4	2.83	28.32
5	2.83	22.65
6	2.83	16.99
7	2.83	11.33
8	2.83	8.50
9	2.83	5.66
10	2.83	2.83
11	2.83	2.83

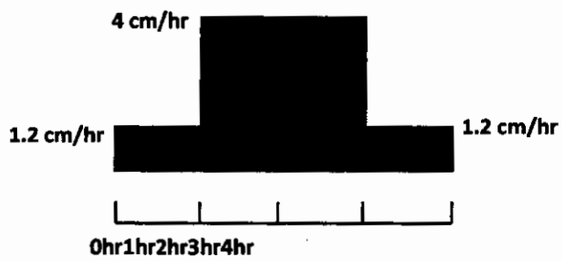


Figure 4.1

QUESTION FIVE (25 Marks)

A well penetrating a confined aquifer is pumped at auniform rate of 3000 m^3/day. Drawdowns during the pumping period are measured in an observation well 100 m away. Observations for t and s are listed in the table below. Using the Theis method:

5A. Determine the transmissibility T of the aquifer .....[12 Marks]

5B. The storage coefficient S of the aquifer .....[13 marks]

Time (min)	Drawdown (m)	r^2/t (m^2/min)
0	0	∞
2	0.45	2160
6	0.72	720
8	0.795	540
10	0.855	432
14	0.945	308
24	1.08	180
30	1.14	144
60	1.35	72
120	1.5	36
180	1.605	24
240	1.68	18

Equations for determining parameters of unsteady flow:

$$\text{Transmissibility,} \quad T = \frac{2.303Q}{4\pi\Delta S}$$

$$\text{Storage coefficient, } S = \frac{2.246\, Tt_0}{r^2}$$