

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

**BSc Environmental Health**

**MAIN EXAMINATION PAPER DECEMBER 2013**

**TITLE OF PAPER** : HYDROLOGY

**COURSE CODE** : EHS:545

**DURATION** : 2 HOURS

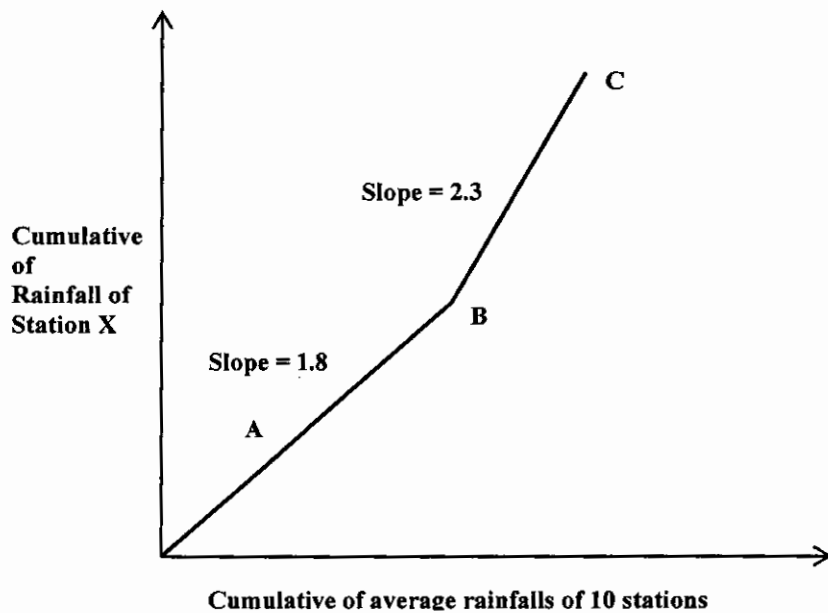
**MARKS** : 100

**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

EHS 545 , EHM 318  
DECEMBER 2013

**QUESTION ONE (25 Marks)**

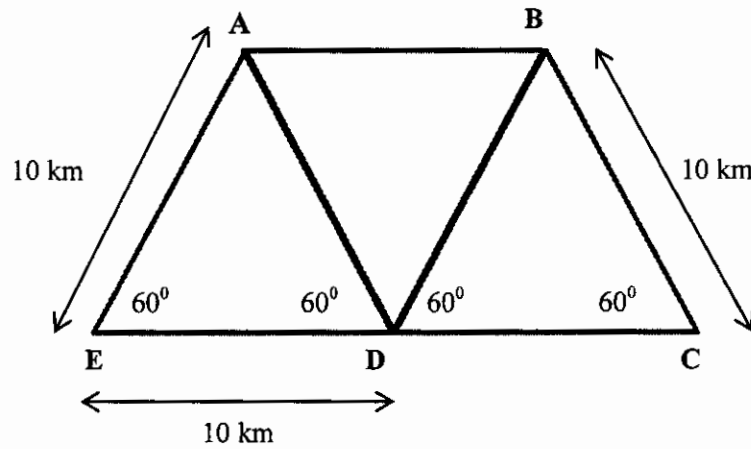
- 1A.** Describe the following processes for the formation of rain drops: i) the Bergeron process  
ii) Growth by accretion iii) growth by aggregation. ....[4 Marks]
- 1B.** Describe the following mechanisms of precipitation formation i) convective ii) cyclonic iii)  
orographic. ....[4 Marks]
- 1C.** Explain with the help of a sketch the techniques for the separation of base flow from the  
total runoff in order to obtain the direct runoff hydrograph. ....[4 Marks]
- 1D.** Define i) adiabatic and i) adiathermic processes. Give an example of condensation and  
rain formation through each of the processes. ....[4 Marks]
- 1E.** A double mass curve analysis made between a certain rain fall gauging station X and 10  
other neighboring stations produced the lines shown in the figure Q1 below. It was  
discovered that there was a change in slope at point B. 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. ....[ 9 Marks]



**Figure Q1**

**QUESTION TWO (25 Marks)**

The catchment area enclosed by ABCDE shown in Figure Q2 below has five rain gauge stations located at the vertices A, B, C, D and E. The monthly average rain fall for each station is given in table below. In addition the rain fall recorded for the particular month of November are given except that the full record of rain fall was missing at station B for this month due to inoperation of the gauge for about a week.



**Figure Q2**

- i) Estimate the missing record at station B for the month of November.....[ 10 Marks]
- ii) Estimate the monthly average areal rain fall for the entire region.....[15 Marks]

Station	A	B	C	D	E
Monthly average rainfall (cm)	10	17	12	14	8
Rain fall for November (cm)	28	Missing	33	37	23

**QUESTION 3 (25 Marks)**

A class A pan is maintained near a small lake to determine the daily evaporation. The level in the pan is observed at the end of every day. Water is added if the level falls near 17 cm. For each day the difference in height level is calculated between the current and previous day and the precipitation value is from the current day. Determine the daily lake evaporation if the pan coefficient is 0.70.

Day	Rainfall (cm)	Water level (cm)
1	0.00	20.00 (top full level)
2	0.58	19.80
3	1.40	19.68
4	0.13	19.63
5	0.03	19.40
6	0.00	18.95
7	0.05	18.58
8	0.03	18.30
9	0.00	18.13
10	0.00	17.98
11	0.00	17.00 (lowest level reached and refilled to top full level)
12	0.03	19.78
13	0.00	19.65
14	0.05	19.50

**QUESTION FOUR (25 Marks)**

The table below shows the rainfall data recorded together with the stream runoff at a gauging station for a storm in a particular day. The basin area is 10 km<sup>2</sup>.

4A. Derive the unit hydrograph of 1.5 hr. duration. ....[20 marks ]

4B. Determine the runoff coefficient and the percentage of infiltration. ....[5 marks ]

Time (min)	Rainfall (cm)	Runoff m <sup>3</sup> /sec
0	0.0	0
15	1.0	0.49
30	3.6	59.57
45	4.8	110.215
60	5.8	129.08
75	6.4	137.025
90	6.6	134.05
105		127.12
120		110.215
135		78.435
150		45.675
165		23.835
180		10.92
195		5.845
210		3.465
225		1.995
240		1.19
255		0.7
270		0.385
285		0.21
300		0

**QUESTION FIVE (25 Marks)**

- 5A.** Define the following terms: i) Specific yield ii) Confined aquifer iii) Anisotropic aquifer iv) Vadose zone. ....[ 5 Marks]
- 5B.** In a certain alluvial basin of  $150 \text{ km}^2$ ,  $120 \text{ Mm}^3$  of ground water was pumped in a year and the ground water table dropped by about 7 m during the year.
- i. Assuming no replenishment, estimate the specific yield of the aquifer...[ 5 Marks]
  - ii. If the specific retention is 15 %, what is the porosity of the soil?.....[ 5 Marks]
- 5C.** A fully penetrating well discharges 50 liters/second of water from an unconfined aquifer. The original water table depth recorded was 20 meters. After a long time period the drawdown was recorded as 2 meters in an observation well located 100 meters away and 0.5 meters in an observation well located 500 meters away. Determine the hydraulic conductivity of the aquifer in m/day. .... [10 marks ]