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

BACHELOR OF SCIENCE IN ENVIRONMENTAL MANAGEMENT AND WATER RESOURCES

MAIN EXAMINATION PAPER 2016

TITLE OF PAPER	:	HYDROLOGY
COURSE CODE	:	EHM 318
DURATION	:	2 HOURS
MARKS	:	100

INSTRUCTIONS

: READ THE QUESTIONS & INSTRUCTIONS CAREFULLY

: ANSWER **ANY FOUR** QUESTIONS

: EACH QUESTION **CARRIES 25** MARKS.

: WRITE NEATLY & CLEARLY

: NO PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM.

: BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY THE INVIGILATOR.

QUESTION ONE(5 Marks each)

The Isohyetal lines are drawn for the catchment area given in Figure Q1-1 below. Table Q1 below gives the areas that each of the regions labeled from I and VI and shown in Figure Q1-1 represents. Determine the average areal precipitation of this catchment using the Isohyetal method.

Table Q1; Area belonging to rainfall regions labeled from I to VI in Figure Q1-1

Zone	*Area (km^2)*
I	56
II	192
III	420
IV	244
V	44
VI	58
Area of basin	= 1014 km^2

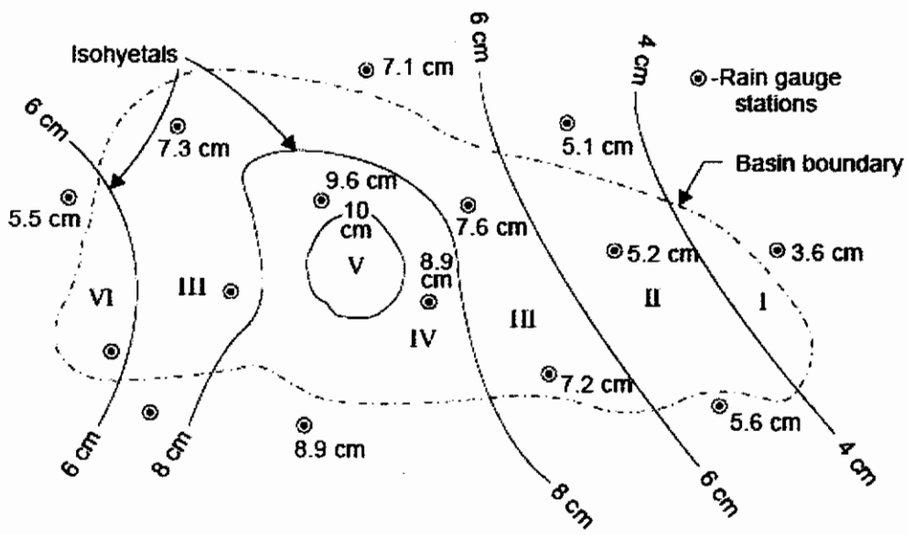

Figure Q1-1: Isohytal lines drawn for a given catchment area

QUESTION TWO(25 Marks)

The catchment area shown in Figure Q2-1 below drains into two rivers A and B. Draw the boundaries of the catchment areas for each of the rivers. After drawing the boundaries, detach this paper page and include it in your answer sheet. Mark distribution will be 12 and ½ marks for each of the boundaries drawn for rivers A and B.

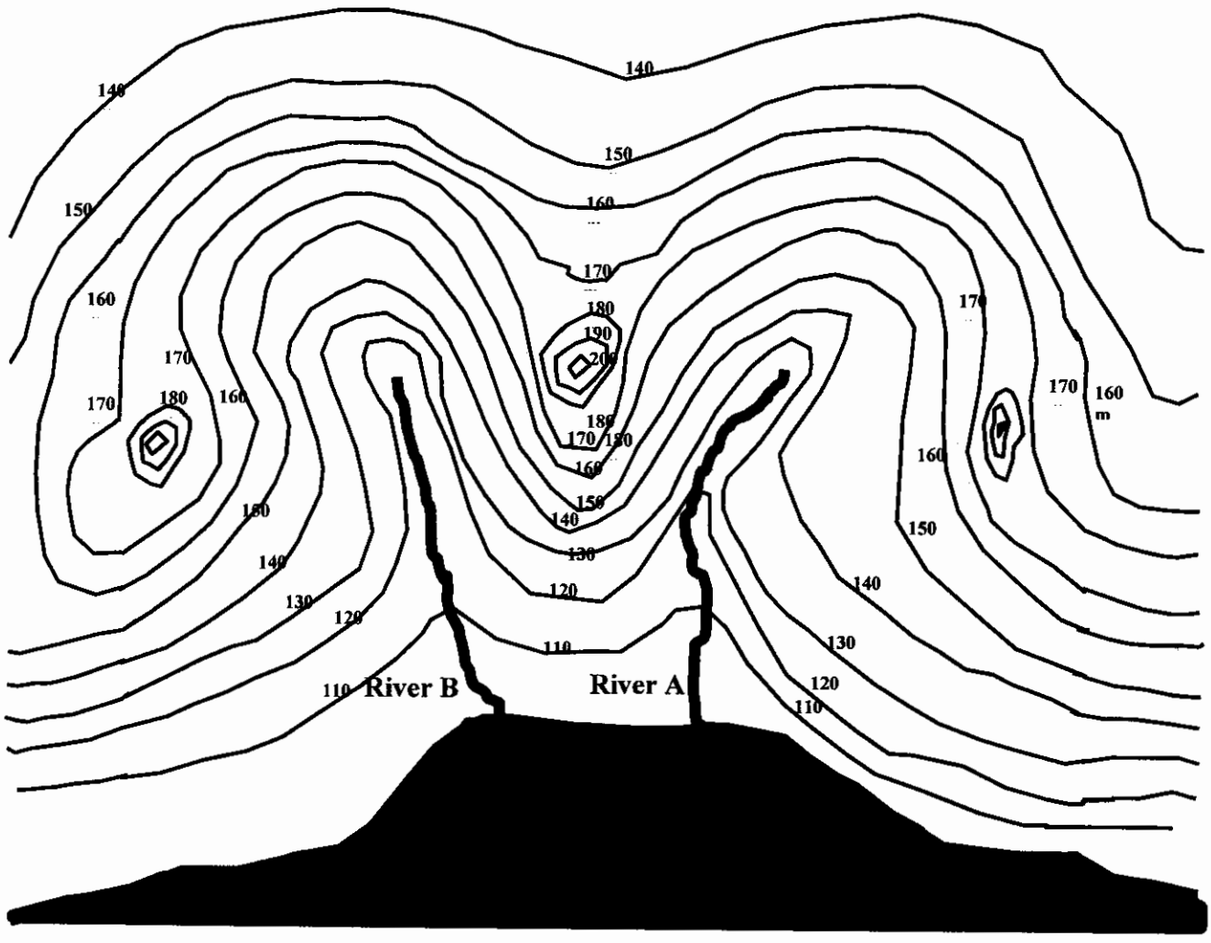

Fig Q2-1: Contour lines shown at 10 m intervals for a given catchment

QUESTION THREE (5 Marks each)

3A. Define each of the following terms: (1 marks each)

i. Lapse rate

ii. Temperature inversion

iii. Troposphere

iv. Mid-latitudes

v. Albedo

3B. In the Northern Hemisphere, why are summers warmer than winters even though the earth is actually closer to the sun in January?What weather conditions are best suited for the formation of a cold night and a strong radiation inversion?

3C. Write the equation for the computation of net radiation. Assuming that the albedo of the earth to be 0.4 and 35% of the incoming short wave solar radiation that impinges on earth is reradiated back in the form of long wave radiation, make an estimate of the net radiation as percent of the incoming radiation for i) night conditions , ii) day light clear sky conditions and ii) cloudy day

3D. Describe the weather patterns of a Monsoon climate

3E. Describe the different alternative mechanism by which rainfall drop growth occurs

QUESTION FOUR(25 Marks)

Given below are the stream flows from a catchment area of 20 km^2 due to a storm of 1 hour duration. Find the surface runoff hydrograph ordinates from an effective rainfall (net rain) of 6 cm and duration of 1 hour. Assume a constant base flow of 15 m^3/sec

Time (hour)	Stream flow (m^3/sec)
0	15
1	25
2	50
3	55
4	48
5	35
6	30
7	27
8	24
9	20
10	15

QUESTION FIVE(25 marks)

5A. [12 marks]

In a certain alluvial basin of 100 Million m^3 of ground water storage, water was pumped in a year and the water table dropped by 5 m during the year. Assume no replenishment, estimate the specific yield of the aquifer. If the specific retention is 12 %, what is the porosity of the soil?

5B. [13 marks]

A fully penetrating well of diameter 0.3 m is located in an unconfined aquifer of saturated depth 45 m. If the drawdown in the well is 15 m for the discharge of 1200 m^3/day and the radius of influence is 300 m, compute the hydraulic conductivity.

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B.Sc. DEGREE IN ENVIRONMENTAL MANAGEMENT AND WATER RESOURCES

MAIN EXAMINATION PAPER 2017

TITLE OF PAPER	:	WATER DISTRIBUTION AND SEWERAGE SYSTEMS
COURSE CODE	:	EHM 320
DURATION	:	2 HOURS
MARKS	:	100
INSTRUCTIONS	:	READ THE QUESTIONS & INSTRUCTIONS CAREFULLY
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QUESTION ONE

1A. Compare the advantages of providing a single overhead water tank in for a house and that of two tanks (one over the ground and the other over the roof)

.....[5 marks]

1B. Compare the advantages of direct pumping of water to a distribution system with that of pumping first to an elevated service reservoir from which water will flow to the distribution system by gravity. .....[5 Marks]

1C. Evaluate the benefits of providing i) ductile iron pipes and ii) PVC pipes for distribution systems. .....[5 Marks]

1D. Explain the correlation method for the detection of leaks in water distribution systems. .....[5 Marks]

1E. List the technical provisions for improvement of reliability in distribution systems.

.....[5 marks]

QUESTION TWO

The branched network shown in Figure Q2-1 below distributes water from a spring water to demand nodes B, C and D. The pipe lengths, elevations and nodal demands are shown in the figure. Assume that there is a leakage of 5 % of the nodal demands to be added to each of the nodal demands at B, C and D. A minimum pressure of 10 meters is required at each nodal demand point. Using the head loss table provided below, determine:

i. The diameters of pipes AB, BC and CD .....[13 marks]

ii. The nodal pressures at nodes B, C and D .....[12 marks]

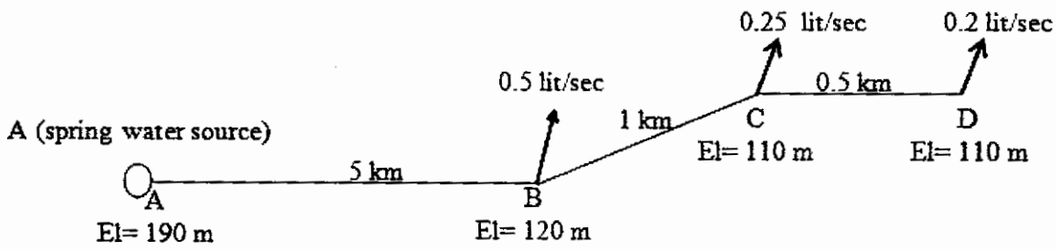


Figure Q2-1: Gravity fed water distribution branched network

Head loss in m/km for GI pipes

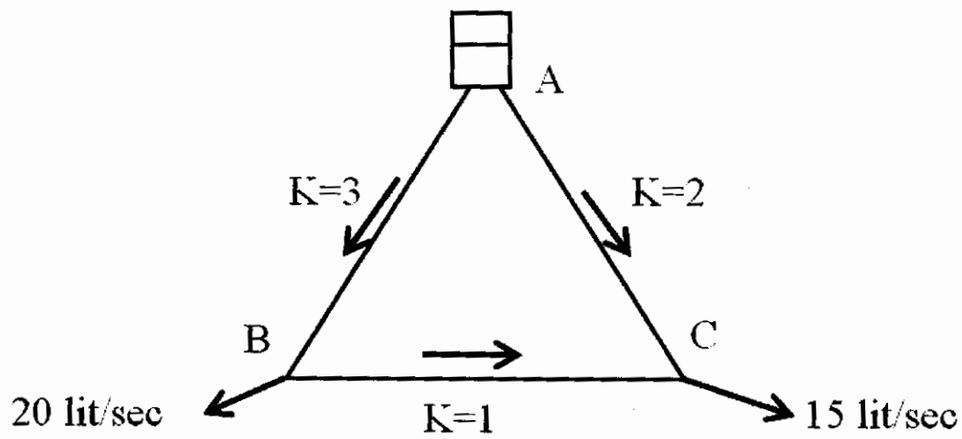
Flow (lit/sec)	Diameter (mm)									
	13	19	25	31	38	50	63	75	100	150
0.05	36.00	5.67	1.49	0.52	0.19	0.051	0.017	0.007	0.002	0.000
0.06	50.45	7.95	2.09	0.73	0.27	0.071	0.023	0.010	0.002	0.000
0.07	67.10	10.57	2.78	0.97	0.36	0.09	0.031	0.013	0.003	0.000
0.08	85.90	13.53	3.56	1.25	0.46	0.12	0.039	0.017	0.004	0.001
0.09	106.81	16.83	4.42	1.55	0.58	0.15	0.049	0.021	0.005	0.001
0.1	129.80	20.45	5.37	1.88	0.70	0.18	0.060	0.026	0.006	0.001
0.11	154.82	24.39	6.41	2.25	0.83	0.22	0.071	0.030	0.007	0.001
0.12	181.86	28.65	7.53	2.64	0.98	0.26	0.084	0.036	0.009	0.001
0.13	210.89	33.22	8.73	3.06	1.14	0.30	0.10	0.041	0.010	0.001
0.14		38.10	10.01	3.51	1.30	0.34	0.11	0.048	0.012	0.002
0.15		43.29	11.38	3.99	1.48	0.39	0.13	0.054	0.013	0.002
0.16		48.78	12.82	4.50	1.67	0.44	0.14	0.061	0.015	0.002
0.18		60.66	15.94	5.59	2.07	0.55	0.18	0.076	0.019	0.003
0.2		73.71	19.37	6.79	2.52	0.66	0.21	0.092	0.023	0.003
0.25		111.38	29.27	10.27	3.81	1.00	0.32	0.14	0.034	0.005
0.3			41.01	14.38	5.34	1.40	0.46	0.19	0.048	0.007
0.35			54.54	19.13	7.10	1.87	0.61	0.26	0.064	0.009
0.4			69.82	24.49	9.09	2.39	0.77	0.33	0.082	0.011
0.45			86.82	30.46	11.30	2.97	0.96	0.41	0.10	0.014
0.5			105.51	37.01	13.73	3.61	1.17	0.50	0.12	0.017
0.55			125.85	44.15	16.38	4.30	1.40	0.60	0.15	0.020
0.6			147.83	51.86	19.24	5.06	1.64	0.70	0.17	0.024
0.65				60.13	22.31	5.86	1.90	0.81	0.20	0.028
0.7				68.97	25.59	6.72	2.18	0.93	0.23	0.032
0.75				78.36	29.07	7.64	2.48	1.06	0.26	0.036
0.8				88.30	32.76	8.61	2.79	1.19	0.29	0.041
0.85				98.78	36.65	9.63	3.12	1.34	0.33	0.046
0.9				109.79	40.73	10.70	3.47	1.49	0.37	0.051
0.95				121.34	45.02	11.83	3.84	1.64	0.40	0.056
1				133.42	49.50	13.01	4.22	1.81	0.44	0.062
1.1				159.15	59.05	15.52	5.03	2.15	0.53	0.074
1.2				186.95	69.36	18.22	5.91	2.53	0.62	0.087
1.3					80.43	21.13	6.86	2.93	0.72	0.10
1.4					92.25	24.24	7.87	3.36	0.83	0.12
1.5					104.81	27.54	8.94	3.82	0.94	0.13
1.6					118.10	31.03	10.07	4.31	1.06	0.15

QUESTION THREE

The pipe system shown below has the source water from A (Reservoir) supplying water to demand nodes B and C. The head loss can be calculated using the relationship:

$$h_L = K Q^2$$

Where K is the pipe resistance whose values are shown in the figure and Q is the flow rate in the pipes in lit/sec. Using Hardy Cross method of pipe network analysis, determine the flows in pipes AB, AC and BC.



Mark allocation:

- Description of formula (5%)
- Steps followed in solving the problem (15 %)
- Numerical answers (5%)

QUESTION FOUR

4A. Compare separate sewer systems with that of combined sewer systems in terms of their suitability for collection of waste water from cities. . .....[5 Marks]

4B. A waste water collection sewer system has to cross a valley that is show Figure Q4-1 below. Describe with the help of a sketch a suitable structure that will make this transition possible. .....[5 Marks]

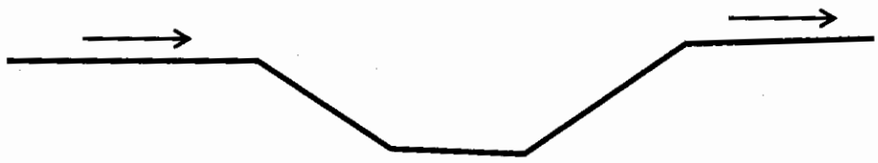


Figure Q4-1: Sewer system crossing a valley

4C. List five methods of inspection of sewer pipes. .....[5 marks]

4D. Describe possible methods that can be applied for cleaning sewer systems.

.....[5 marks]

4E. Describe methods that can be employed to remove and control odors in sewer systems. .....[5 marks]

QUESTION FIVE

In an area with a ground slope of 0.0025, a sanitary sewer of diameter 300 mm is required to carry a peak flow of 0.75 m^3/min. The Manning's n of the sewer pipe is equal to 0.013. Using the discharge equation given in Eq. Q5-1 and the partial flow graph provided in Figure Q5-1 below:

A. Determine if the available slope for the given diameter will achieve self-cleansing velocity of greater than or equal to 0.65 m/sec at the specified flow.

.....[20 Marks]

B. Suggest what should be done in the event this self-cleansing velocity is not achieved.

....[5 Marks]

$$Q = \left(\frac{0.312}{n}\right) * D^{\frac{8}{3}} * S^{1/2} \qquad \text{.....(Eq. Q5-1)}$$

Where Q = sewer flow in m^3/sec

D = Sewer pipe diameter in meters

n = Manning's coefficient = 0.013

S = Slope of sewer pipe (m/m).

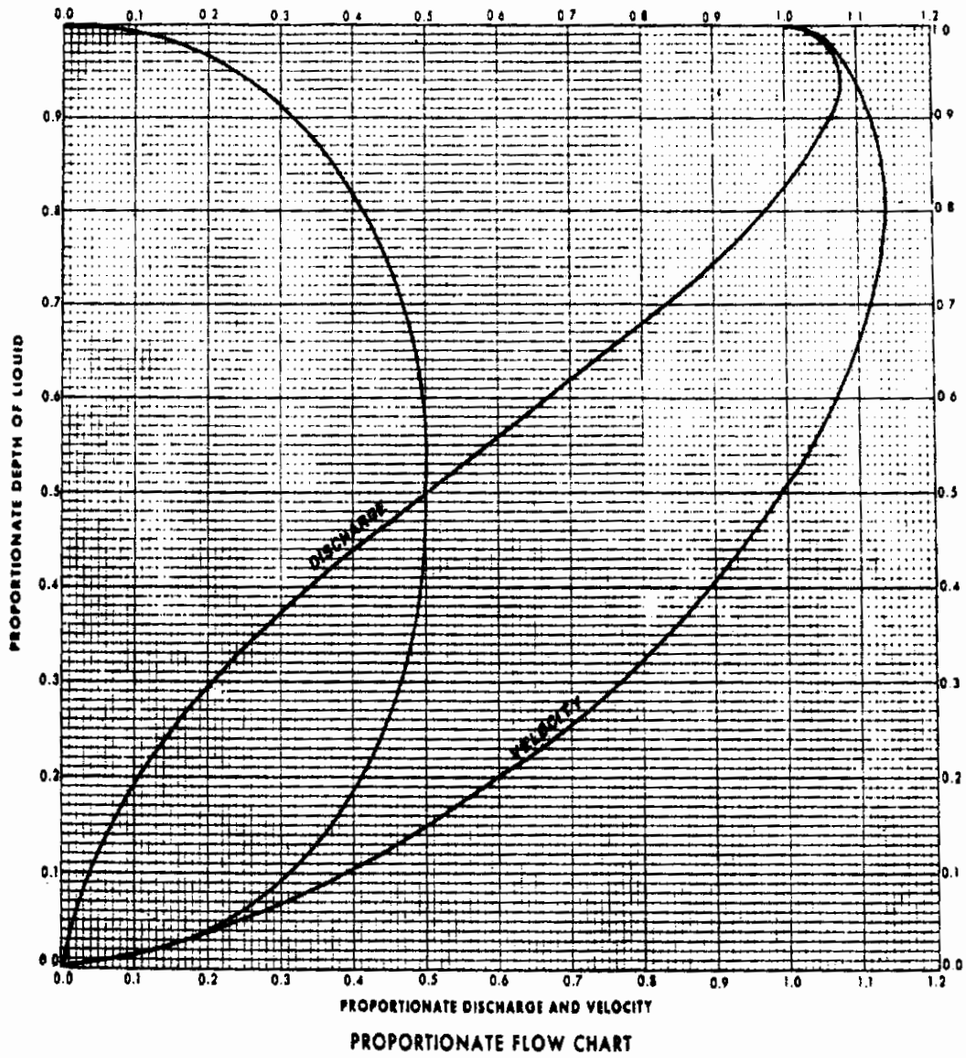


Figure Q5-1: Partial flow graph for Sewer flow calculation