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

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
	:	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

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]

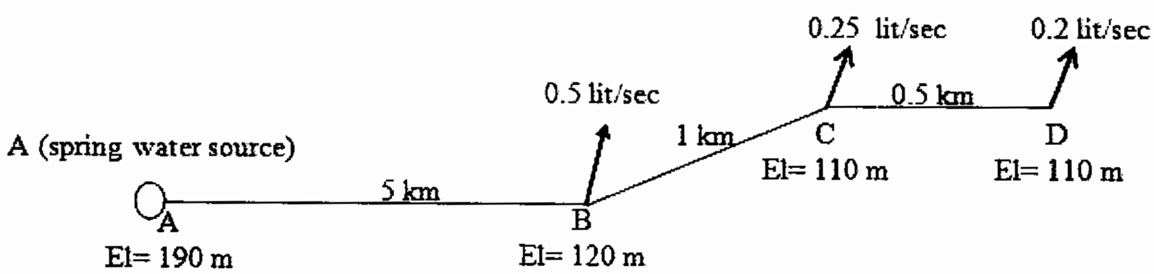


Figure Q2-1: Gravity fed water distribution branched network

Head loss in m/km for GI pipes

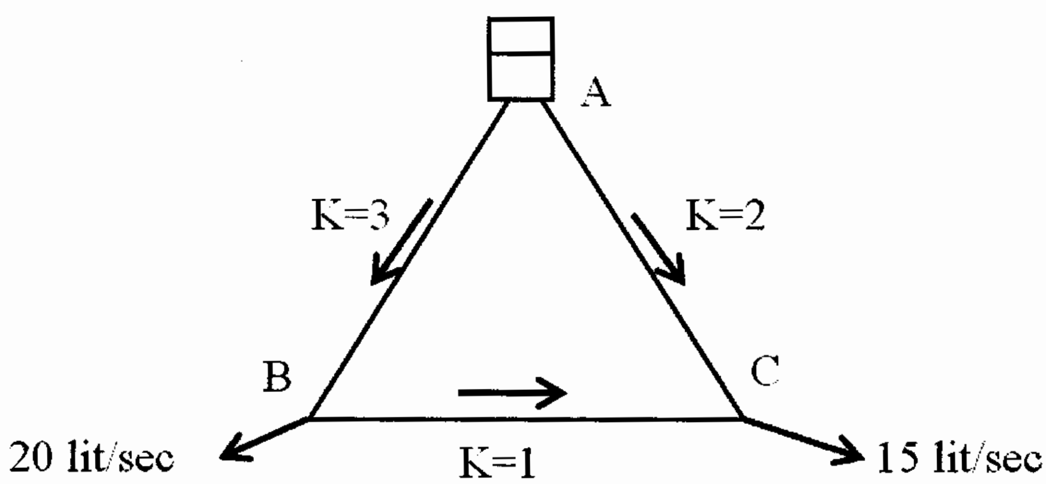
Flow (lit/sec)	Diameter (mm)									
	13	19	25	31	38	50	63	75	100	150
0.05	36.00	5.67	1.49	0.52	0.19	0.051	0.017	0.007	0.002	0.000
0.06	50.45	7.95	2.09	0.73	0.27	0.071	0.023	0.010	0.002	0.000
0.07	67.10	10.57	2.78	0.97	0.36	0.09	0.031	0.013	0.003	0.000
0.08	85.90	13.53	3.56	1.25	0.46	0.12	0.039	0.017	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).

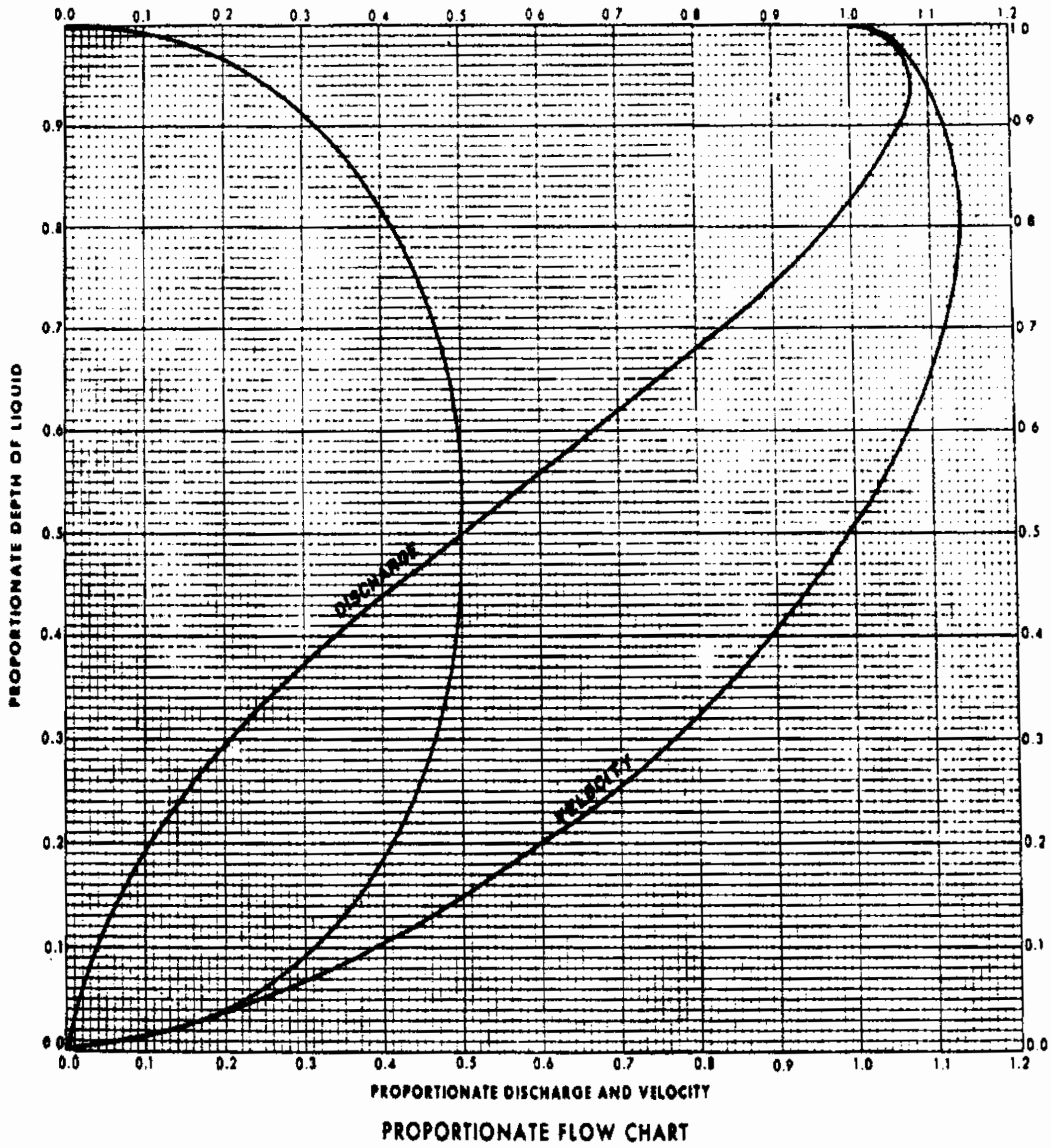


Figure Q5-1: Partial flow graph for Sewer flow calculation