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

DEGREE IN ENVIRONMENTAL MANAGEMENT AND WATER RESOURCES

FINAL EXAMINATION PAPER 2016

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.

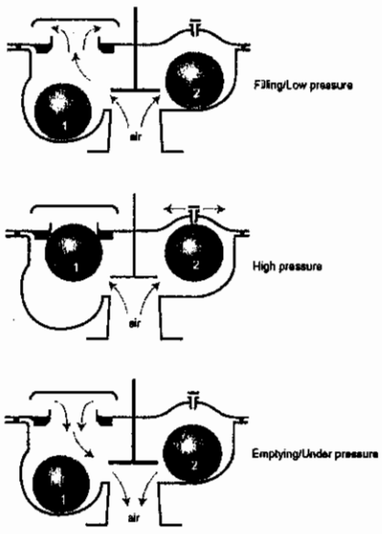
QUESTION ONE

1A. State the names of the fittings: Type A and Type B shown in the figure below and explain the function and importance of such fittings. .....[5 Marks]

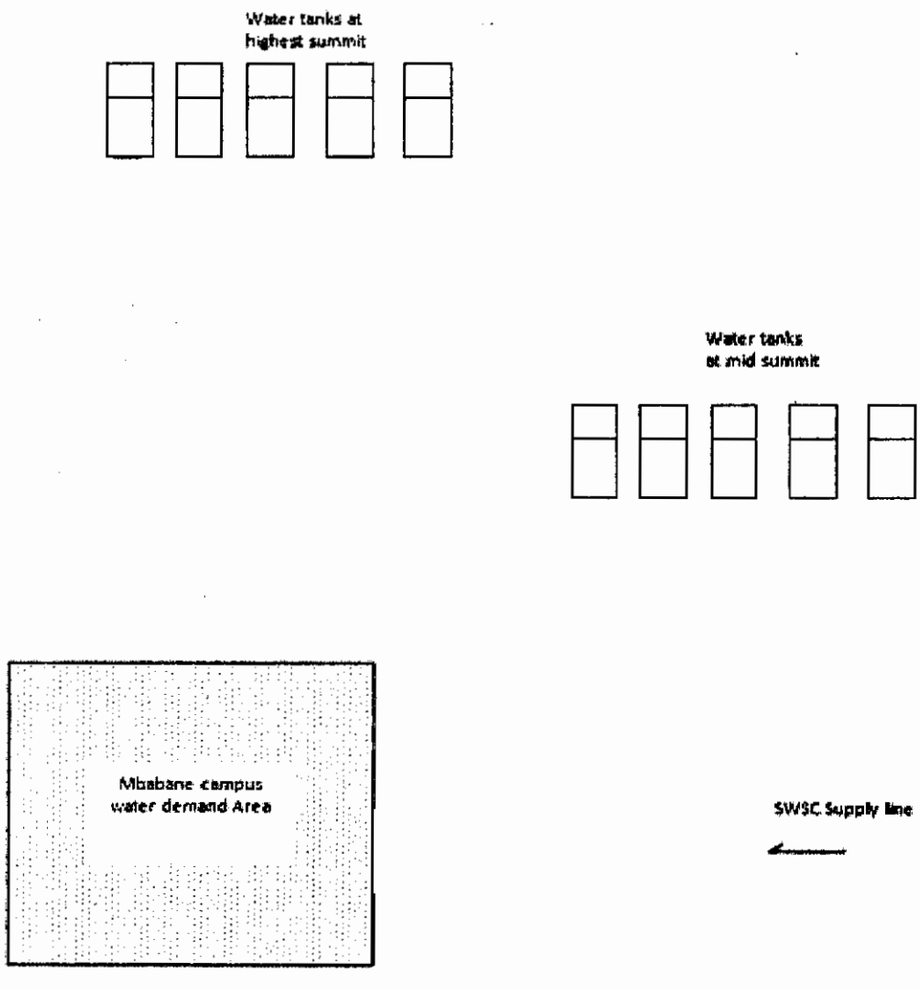
Type A

Type B

1B. Describe the principle of operation of air valves shown below. .....[5 Marks]



1C. For the UNISWA Faculty of Health Sciences campus backup water supply layout shown below, draw the appropriate pipe lines and indicate on the drawing appropriate fitting materials. .....[15 Marks]



QUESTION TWO

The branched network shown below distributes water from the source A which is a spring source to demand nodes C,D, E and F. The nodal demands are shown in the figure. Assume that there is a leakage of 20% of the nodal demands to be added to each of the nodal demands. Using the head loss table provided below,

i. Determine the appropriate diameters of pipes AB, BC, CD, BE and EF .....[15 marks]

ii. Determine the pressures at B, C, D E and F .....[10 marks]

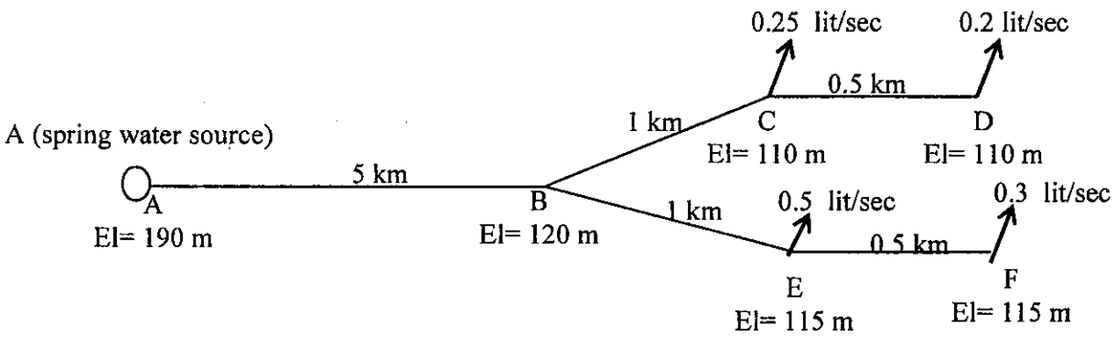


Table 11.2: Friction Head Loss in meters per 100 meters Galvanized Iron (GI) Pipes

Q	Pipe Sizes (mm)									
Lps	13	19	25	31	38	50	63	75	100	150
.06	6.00	0.82	0.20							
.07	8.00	1.00	0.26							
.08	10.00	1.30	0.34							
.09	12.60	1.64	0.44	0.15						
.10	15.20	2.12	0.52	0.18						
.11	18.20	2.36	0.62	0.22						
.12	21.40	3.00	0.72	0.26						
.14		4.00	0.96	0.34	0.13					
.15		4.20	1.10	0.36	0.15					
.16		5.00	1.24	0.44	0.16					
.18		6.20	1.54	0.54	0.202					
.20		7.60	1.88	0.64	0.262	0.70				
.25		11.60	2.84	0.96	0.400	0.10				
.30			4.00	1.34	0.46	0.14				
.40			6.80	2.30	0.94	0.24				
.50			10.20	3.48	1.42	0.36	0.12			
.60			14.40	4.80	2.00	0.50	0.17	0.70		
.70				6.40	2.66	0.66	0.22	0.9		
.80				8.20	3.40	0.84	0.28	0.11		
1.00				12.60	5.20	1.28	0.42	0.17		
1.20				17.60	7.20	1.78	0.60	0.248		
1.40					8.80	2.40	0.80	0.330		
1.50					9.80	2.70	0.88	0.374		
1.60					11.00	3.04	1.02	0.422	0.104	
1.80					14.70	3.76	1.28	0.524	0.129	
2.00					16.80	4.60	1.54	0.640	0.157	
2.50						7.00	2.40	0.96	0.238	
3.00						9.90	3.30	1.30	0.332	
3.50						13.90	4.58	1.80	0.452	
4.00						18.40	6.00	2.40	0.568	

QUESTION THREE

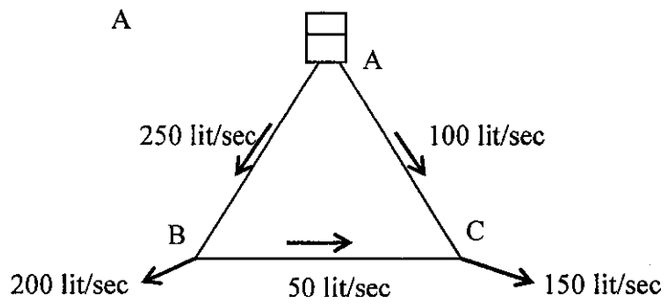
3A. List the long term measures for the elimination of microbial growths in distribution systems. .....[5 Marks]

3B. The table below shows structure of water consumption according to the IWA classification. Fill in the blanks designated with letters A to N with the appropriate classification flows. .....[10 Marks]

<table>
<tr><td rowspan="2">Authorised consumption</td><td rowspan="2">A</td><td>E</td><td rowspan="2">Revenue water</td></tr>
<tr><td>F</td></tr>
<tr><td rowspan="2">B</td><td>G</td><td rowspan="7">Non-Revenue water</td></tr>
<tr><td>H</td></tr>
<tr><td rowspan="3">Water Losses (UFW)</td><td rowspan="2">C</td><td>J</td></tr>
<tr><td>K</td></tr>
<tr><td rowspan="3">D</td><td>L</td></tr>
<tr><td>M</td></tr>
<tr><td>N</td></tr>
</table>

3C. The pipe system shown below has the source water from A (Reservoir) supplying water to demand nodes B and C. Assume that the probability that two or more pipes fail at the same time is low.

a. Calculate the nodal reliabilities at B and C .....[6 Marks]
b. Calculate also the overall system reliability. .....[4 Marks]



QUESTION FOUR

4A. Describe briefly what aspects you would look in the preliminary reconnaissance survey for the design of sewer system for a given city. .....[5 Marks]

4B. Discuss the importance of the following pieces information to be acquired for the design of a sewerage system for a given city:

i. Ordnance survey maps of 1:50,000 to 1:100,000 scale as well as maps at scales of 1:10,000 to 1:25,000.
ii. Rainfall intensity and temperature data
iii. Population statistics
iv. Geology, trial holes and borings. .....[5 Marks]

4C. Compare and contrast the following sewer pipe materials in terms of their suitability, condition of operation, jointing, etc.

i) Vitrified clay ii) Concrete pipe iii) iv) PVC pipe v) ductile iron pipe.[5 Marks]

4D. i) How do you compare the bedding requirement of smaller sewer pipe compared to larger size sewer pipe?

ii) State what will happen to a sewer pipe that is laid on unfavorable soil conditions such as wet clays and organic soils. State also the bedding requirements. .....[5 Marks]

4E. Describe with the help of a sketch the process of crown corrosion of sewers. [5 Marks]

QUESTION FIVE

The minimum slope required to achieve self-cleansing velocity has been suggested as 0.0019 m/m for a sewer pipe diameter of 300 mm. In an area with a ground slope of 0.0019 a sanitary sewer is required to carry a flow of 0.06 m^3/min. Using the discharge equation given in Eq. Q5-1 and the partial flow graph provided in Figure Q5-1 below:

A. Determine if the suggested slope for the given diameter will achieve self-cleansing velocity of greater than or equal to 0.6 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]

$$Q = \left(\frac{0.312}{n}\right) * D^{\frac{8}{3}} * S^{1/2}$$

.....*(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).

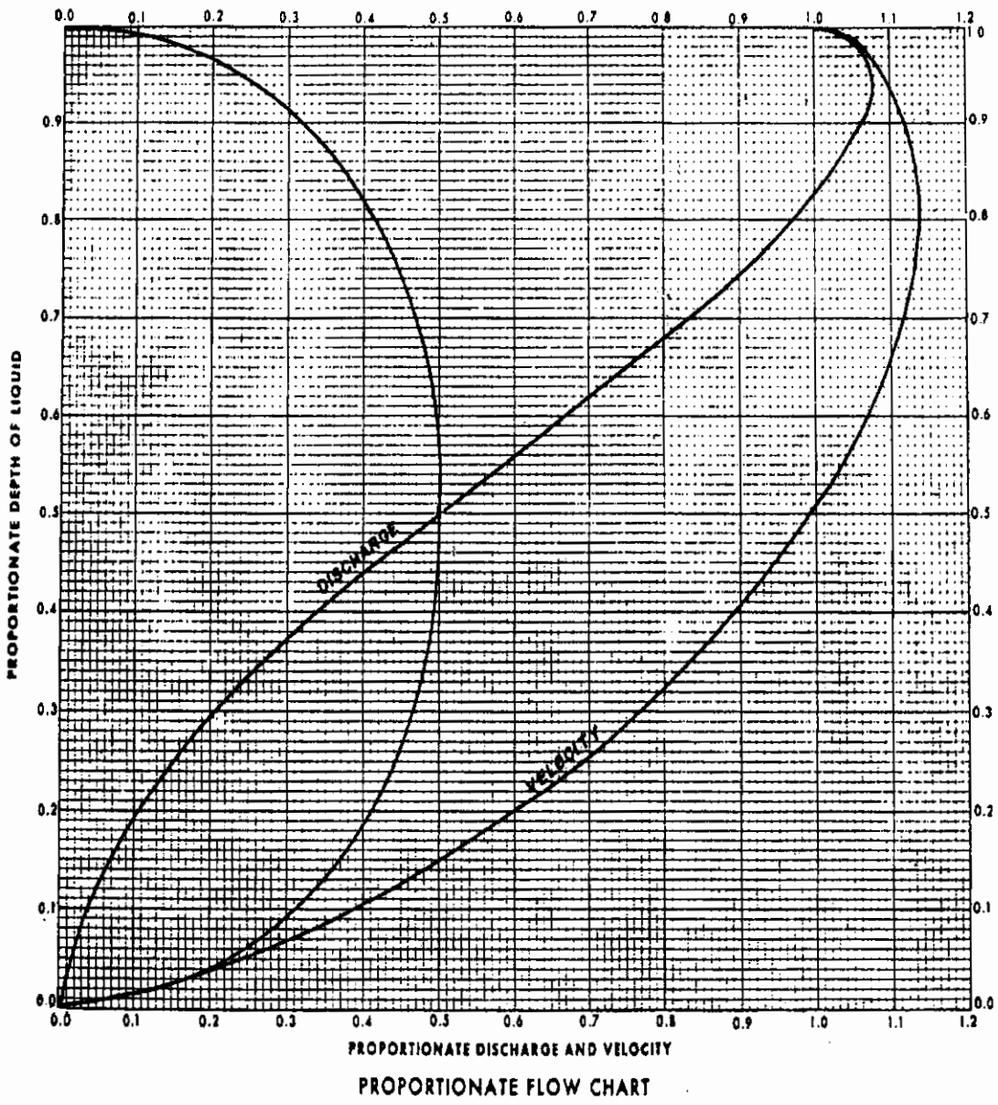


Figure Q5-1: Partial flow graph for Sewer flow calculation