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

DEGREE IN ENVIRONMENTAL MANAGEMENT AND WATER RESOURCES

MAIN EXAMINATION PAPER 2018

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 (25 marks)

A 450 mm diameter siphon pipeline shown in Figure Q1-1 below discharges water from a large reservoir.

1A. Determine the height Z_c that will allow a discharge of 1 m^3/sec through the exit point C ..... (13 marks)

1B. Determine the absolute pressure in KN/m^2 at the summit point B. Take atmospheric pressure as 1 Bar (10^5 N/ m^2). ....(12 marks)

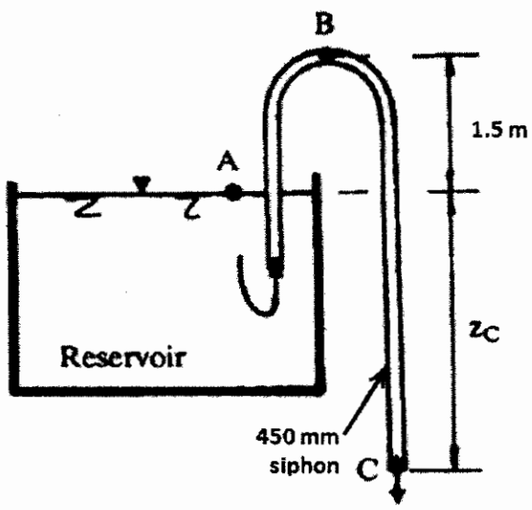


Figure Q1-1

QUESTION TWO (25 marks)

2A. State the advantage and disadvantage of installing a two tank storage system at household level compared to a single elevated storage tank? .....[5 Marks]

2B. What is the importance/purpose of creating pressure zones in distribution systems? ..... [5 marks]

2C. Discuss a suitable design provision of service reservoir with respect to each of the following service requirements:

i. Excluding surface contamination
ii. Cleaning
iii. Overflow control
iv. Monitoring
v. Water quality ..... [5 Marks]

2D. Match items in B against items from A. Note that items from A can have more than one matches from B and vice versa. .....[10 Marks]

A	B
A1. Hydrants	B1. Stronger, more flexible and thinner walls,
A2 Concrete pipes	B2. Oldest pipe material but declined with time
A3 Gate valves	B3. Used to prevent reservoir overflows
A4 Ductile iron pipe	B4. Can also be used for pipe cleaning, leakage control, flushing streets, etc.
A5 Float valves	B5. Not suitable for flow regulation
A6 Steel pipes	B6. Rigid, mainly used for sewerage
A7 Cast iron pipes	B7. Cement lining to prevent corrosion
	B8. Alloy of carbon, silicon and iron
	B9. Not suitable where frequent valve operation is required

QUESTION THREE (5 marks for each question below)

3A. Define the following terms in connection with pipe laying

i) shoring ..... (2 marks)

ii) shielding .....(1 mark)

iii) surround ..... (1 mark)

iv) Infill .....(1 mark)

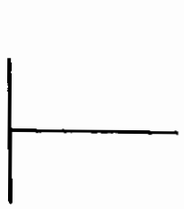
3B. Discuss the provisions that are required during pipe laying for each of the following conditions:

i. Avoiding of point loads at joints
ii. Cover depth requirements
iii. Pipe laying in water logged soils

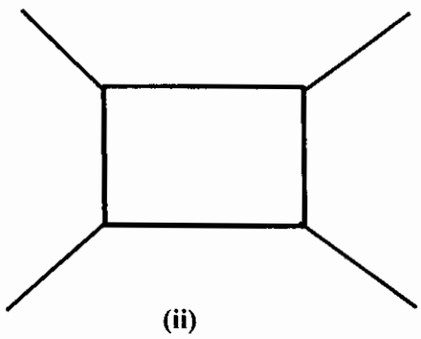
3C. Describe with the help of a diagram the determination of the operating point of a pump used for pump selection.

3D. List the long-term measure that can be used to eliminate growth of animals in distribution systems.

3E. For each of the network junctions shown below, suggest (with the help of a diagram) ways of improving the reliability.



(i)



(ii)

QUESTION FOUR (5 marks each question)

4A. Describe the following sewer systems:

i. Vacuum sewerage .....[1.5 Marks]

ii. Pressurized sewerage .....[1.5 Marks]

iii. Small bore sewerage. .....[2 Marks]

4B. Describe the factors that can lead to

i. Sanitary sewer overflows. .....[1.5 Marks]

ii. Combined sewer overflows. .....[1.5 Marks]

iii. Indicate the steps needed to minimize these overflows. .. [2 Marks]

4C. What are the factors that should be explored in the geotechnical investigation for the design and construction of sewer systems? .....[5 Marks]

4D. Match the items in B against the items in A. .....[5 Marks]

Item A	Item B
A1: Curved sewers	B1: Consider private ownership of land
A2: Manholes	B2: Maintenance hole provision
A3: Aggressive soil	B3: Economic/practical justification
A4: Design depth of flow	B4: Illegal/inappropriate
A5: Location of pumping stations	B5: Allow for free air ventilation
A6: Width of trench	B6: Cathodic protection
A7: Dead end mains	B7: Provision for venting

4E. Describe the factors that should be taken into account in the layout of sewer systems. .....[5 Marks]

QUESTION FIVE (25 marks)

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 m/m a sanitary sewer is required to carry a flow of 0.06 m^3/min. Using the Manning's discharge formula given in Eq. Q5-1 and the partial flow graph provided in Figure Q5-1 below:

5A. 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]

5B. Suggest what should be done in the event this self-cleansing velocity is not achieved. ....[5 Marks]

Manning's formula for discharge:

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

.....*(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 the sewer line

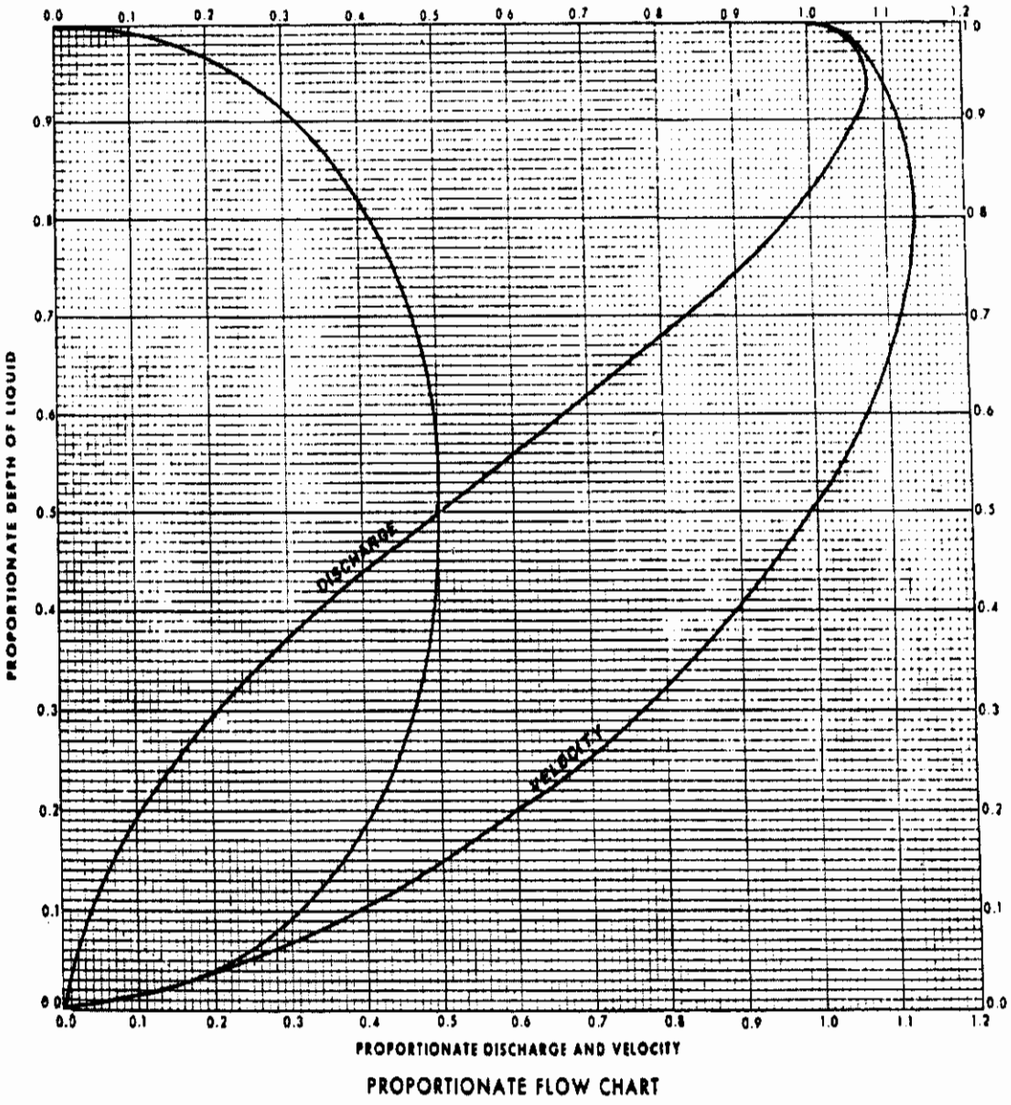


Figure Q5-1: Partial flow graph for Sewer flow calculation