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

DEGREE IN ENVIRONMENTAL MANAGEMENT AND WATER RESOURCES

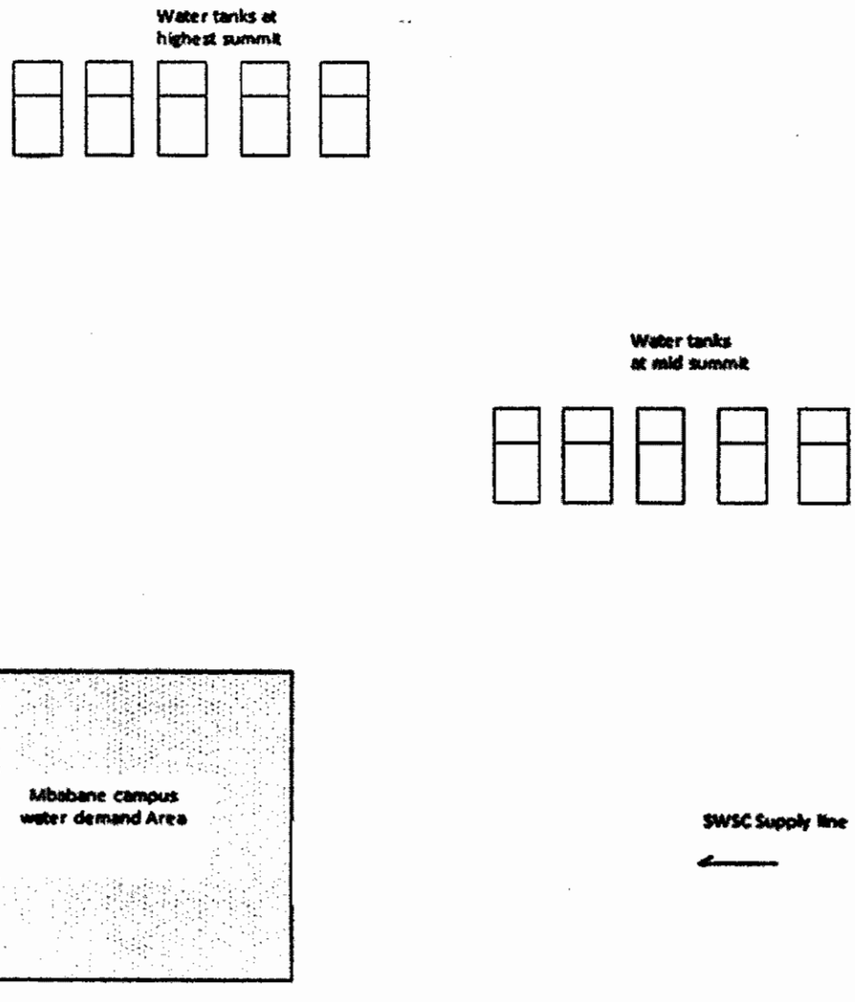
**MAIN EXAMINATION PAPER DECEMBER 2018**

| | | |
|---|---|---|
| TITLE OF PAPER | : | WATER DISTRIBUTION AND SEWERAGE |
| COURSE CODE | : | EHS 451 |
| 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)

For the UNESWA, Faculty of Health Sciences campus backup water supply layout shown below, draw the appropriate pipe lines and indicate on the drawing appropriate fitting materials. Work your answer on this paper; write your ID number on the top. Detach the paper after working the answer and include it in your answer sheet.



**QUESTION TWO** ( 25 marks and 5 marks for each question)

**2A.** State the advantage and disadvantage of installing a two tank storage system at household level compared to a single elevated storage tank.

**2B.** What is the importance/purpose of creating pressure zones in distribution systems?

**2C.** 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

**2D.** Evaluate the benefits of providing i) ductile iron pipes and ii) PVC pipes for distribution systems.

**2E.** Describe the methods used for the development of a well.

**QUESTION THREE** ( 25 marks total. Five marks for each of questions 3A, 3B and 3C. Question 3D is allotted 10 marks)

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

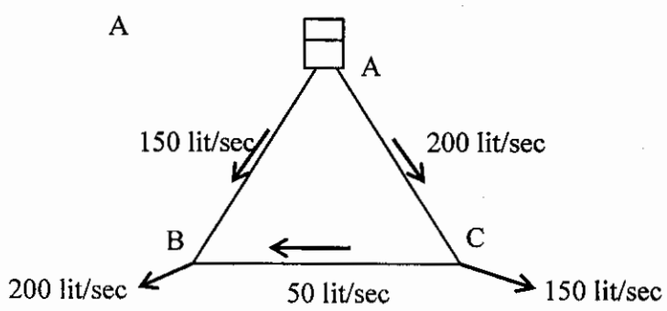
i. Avoiding of point loads at joints
ii. Cover depth requirements
iii. Pipe laying in water logged soils

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

**3C.** Describe with the help of a diagram the principle of operation of air valves.

**3D.** 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.

i. Calculate the nodal reliabilities at B and C .....[ 5 Marks ]
ii. Calculate also the overall system reliability. .....[ 5 Marks ]



**QUESTION FOUR** ( 25 marks total and 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.** Match the items in B against the items in A.

| Item A | Item B |
|---|---|
| Curved sewers | Consider private ownership of land |
| Manholes | Maintenance hole provision |
| Aggressive soil | Economic/practical justification |
| Design depth of flow | Illegal/inappropriate |
| Location of pumping stations | Allow for free air ventilation |
| Width of trench | Cathodic protection |
| Dead end mains | Provision for venting |

**4C.** Compare separate sewer systems with that of combined sewer systems in terms of their suitability for collection of waste water from cities.

**4D.** Describe methods that can be employed to remove and control odors in sewer systems.

**4E.** Describe with the help of a sketch the process of crown corrosion of sewers.

**QUESTION FIVE** ( 25 marks and marks are indicated for each question)

The minimum slope required to achieve self-cleansing velocity has been suggested as 2.2% for a sewer pipe diameter of 250 mm. Manning's roughness coefficient n can be taken as n = 0.013. In an area with a ground slope of 2.2% a sanitary sewer is required to carry a flow of 0.5 $m^3$/min. Using the discharge equation 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 were 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).

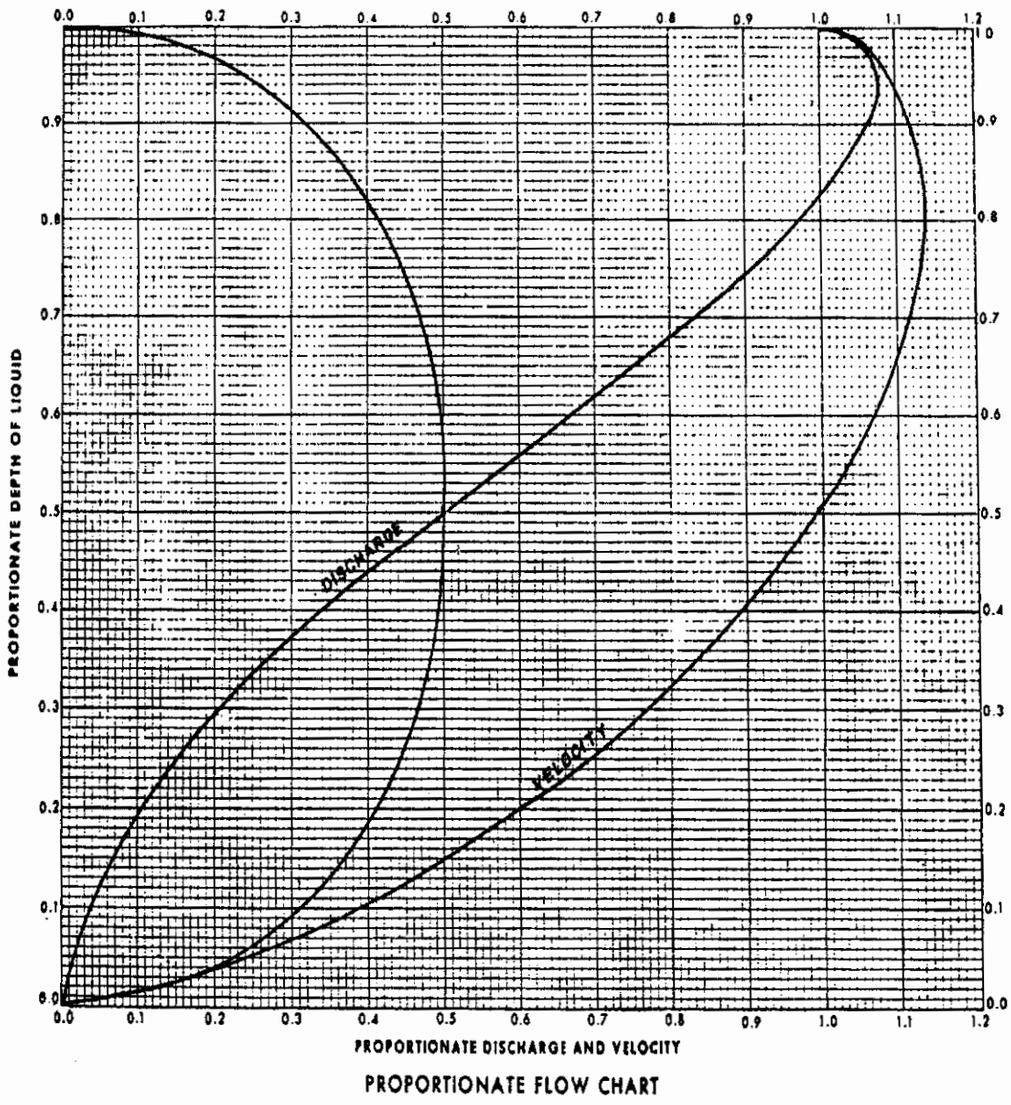



Figure Q5-1: Partial flow graph for Sewer flow calculation