UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEGREE IN ENVIRONMENTAL HEALTH SCIENCES

(FINAL EXAMINATION)

TITLE OF PAPER : **WATER DRAINAGE AND SEWARAGE**

COURSE CODE : **EHS 587**

TIME : **2HOURS**

TOTAL MARKS : **100**

INSTRUCTIONS:

- **ANSWER ANY FOUR QUESTIONS**
- **QUESTION 1 (I) IS MULTIPLE CHOICE**
- **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
- **NO FORM OF PAPER SHOULD BE BROUGHT IN OR OUT OF THE EXAMINATION ROOM**
- **BEGIN THE ANSWER TO EACH QUESTION IN A SEPARATE SHEET OF PAPER.**

DO NO OPEN THIS EXAMINATION PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR.

QUESTION 1

Multiple choice: Write true or false against each letter corresponding to the following statements as they apply to water drainage and sewerage.

a) The discharge of drainage water also affects the quality of the receiving water into which it flows.

b) Sewers are designed to be laid at a gradient which ensures that peak flows carry away any solids deposited during periods of low flow.

c) Storm sewers are usually designed to have sufficient capacity so that they do not run full when conveying the computed surface water.

d) Pipe network analysis involves the determination of the pipe flows rates and pressure heads which do not satisfy the continuity and energy equations.

e) Waste water sewers are designed such that the mean velocity should not exceed a self cleansing velocity of 0.61 m/s.

f) The "critical tractive force" theory and the "maximum permissible velocity" concept are commonly used in the design of erodible channels for stability.

g) The tractive force is the force exerted by the water on the perimeter of the channel.

h) Waste water sewers are designed using a general flow at six times the dry weather flow.

i) The pipe capacity of a drain is checked at least twice the dry weather flow.

j) In steady uniform flow the motivating and drag forces are exactly balanced.

(20 Marks)

If a 250 mm sewer is placed on a slope of 0.010, what is the full quantity and velocity for (i) n = 0.013, and (ii) n = 0.015?

(5 Marks)

QUESTION 2

a) Compute the diameter of the outfall sewer required to drain storm from the watershed described in figure 3, which gives the lengths of lines, drainage areas, and inlet times. Assume the following: a rainfall coefficient of 0.30 for the entire area, the five-year frequency curve from figure 4, and a following full velocity of 0.75 m/s in the sewer.

(5 marks)

b) The measured of flow in a 1200 mm concrete storm sewer on a grade of 0.0015 m/m is 740. What is the calculated quantity and velocity of flow?

(5 marks)

c) A 450 mm sewer pipe, n = 0.013, is placed on a slope of 0.0025. At what depth of flow does the velocity of low equal 0.60 m/s?

(5 marks)

QUESTION 3

Describe drainage in poor countries under the following headings:

(a) Town planning implications

(8 marks)

(b) Technical aspects

(12 marks)

© Institutional aspects

(5 marks)

QUESTION 4

(a) Design a branch within a storm sewer network which has a length of 100m, a bed slope of 1 in 150 and roughness size of 0.15mm which receives the storm run off form 3.5 hectors of impermeable surface using the Rational (Lloyd-Davies) Method. In designing the upstream pipes the maximum 'time of concentration' at the head of the pipe has been found to be 6-2minutes. The relationship between rainfall intensity and average storm duration is tabulated below.

Storm duration (mm)	2.0	3.0	4.0	5.0	6.0	7.0	8.0
Average rainfall intensity (mm/hr)	94.0	82.7	73.8	70.0	61.4	57.2	53.5

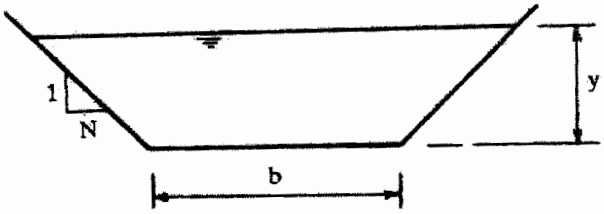
Note: The (Rational Lloyd-Davies) Method gives the peak discharge (Q_p) from the urbanized catchment in the form.

$$Q_p = \frac{1}{360} A_p i \ (m^3/s)$$

Where A_p = impermeable area (hectors)
i = average rainfall intensity (mm/h) during the storm)

(18 marks)

(b) A trapezoidal irrigation channel excavated in silty sand having a critical force on the horizontal of 2.4 N/m^2 and an angle of friction 30^0 is to be designed to convey a discharge of 10 m^3/s on the bed slope of 1:10 000. The side slopes will be 1(vertically): 2 (horizontally). n = 0.02. Determine the channel dimensions such that the mean velocity does not exceed 0.6m/s when conveying the discharge of 10 m^3/s.



QUESTION 5

Describe the design of the following:

a) A Storm sewer system;

(11 marks)

b) A sanitary sewer system

(8 marks)

c) Small-bore sewers

(6 marks)