



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT BUILDING AND CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BSC IN CIVIL ENGINEERING

ECE 2313: PUBLIC HEALTH ENGINEERING II

END OF SEMESTER EXAMINATION

SERIES: APRIL 2016

TIME: 2 HOURS

DATE: 13 May 2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, Drawing Instruments, Scientific calculator, examination pass and student ID

This paper consists of five questions. Attempt question ONE (Compulsory) and any other TWO questions.

ANSWER **THREE** QUESTIONS. **QUESTION 1 IS COMPULSORY**

QUESTION 1:

- State the importance of studying the characteristics of sewage. **(3 Marks)**
- What are the physical, chemical and biological characteristics of sewage? **(4 Marks)**
- Biochemical Oxygen Demand (BOD) is a very important parameter in wastewater treatment processes design and control. It is the amount of oxygen required by microorganisms to oxidize the biodegradable organic matter in wastewater. Briefly describe how to perform a BOD test clearly stating how to calculate the value of BOD from the test results. **(7 Marks)**

- d. Assuming the rate of de-oxygenation (oxygen uptake) is directly proportional to the amount of organic matter remaining in the wastewater, show that:

$$\text{BOD remaining, } L_t = L_0 e^{-k't}$$

Where:

L_0 = Initial ultimate BOD in mg/l

L_t = BOD remaining at any time, t

K' = de-oxygenation constant in d^{-1}

t = time in days

(8 Marks)

- e. The BOD of sewage incubated for two days at 30°C has been found to be 150 mg/l. what is the 5-day BOD at 20°C? Assume the reaction rate constant, $K = 0.1 d^{-1}$ at 20°C. **(8 Marks)**

QUESTION 2:

- a. Draw a typical bacterial growth curve and describe briefly the various growth phases. **(5 Marks)**

- b. Describe briefly the following terms as applied in biological wastewater treatment:

- i. Biodegradable organic matter
- ii. Inorganic matter
- iii. Nitrification
- iv. 1st stage BOD
- v. 2nd stage BOD

(5 Marks)

- c. Discuss the factors which affect the environment of microorganisms for effective biological wastewater treatment. **(5 Marks)**

- d. A sanitary engineer will always be interested in the microorganisms which are necessary in the biological treatment processes of wastewater. Name three such microorganisms. **(3 Marks)**

(3 Marks)

- e. There are a number of ways of classifying microorganisms in wastewater treatment. Give a general classification of microorganisms based on their survival temperature range. **(2 Marks)**

QUESTION 3:

- a. Describe the anaerobic digestion process in sewage treatment stating clearly the end products. Use neat sketches and chemical reactions where necessary to support your answer. **(5 Marks)**
- b. Design anaerobic pond to treat sewage from a housing estate with a total population of 30,000 people. The water consumption is 100 litres per capita per day and the influent BOD₅ is 500 mg/l. Take retention time to be five days and make all the other necessary assumptions. **(9 Marks)**
- c. Outline the design procedure used for facultative ponds. What is their major purpose in a waste stabilization pond system? **(6 Marks)**

QUESTION 4:

- a. Describe the principles of the following design parameters for sanitary sewers:
 - i. Velocity
 - ii. Slope
 - iii. Capacity**(6 Marks)**
- b. Calculate the velocity of flow in a circular sewer of diameter 150cm laid in a slope of 1 in 750 while flowing full. The sewer is made of cast iron with a Manning's coefficient of roughness, $\eta = 0.013$. Also determine the flow, Q in the sewer. **(6Marks)**
- c. Determine the discharge in a 30 cm circular sewer with a Manning's coefficient of roughness, $\eta = 0.013$, slope, $i = 0.004$ and depth of flow equal to 7.5 cm. Use both the nomogram based on Manning's formula for circular sewers ($\eta = 0.013$) and partial flow diagram provided. **(8 Marks)**

QUESTION 5:

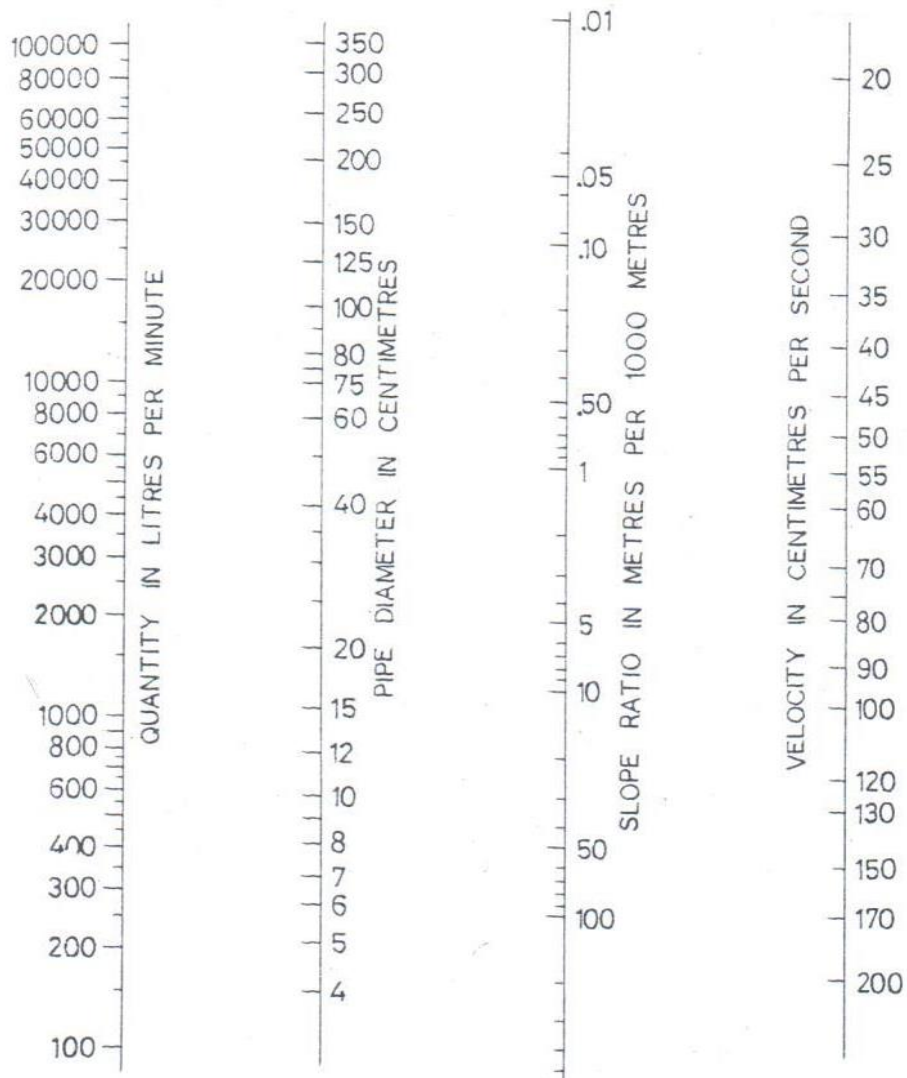
- a. List and briefly describe at least five factors that are considered in the selection of a sewage treatment process. **(5 Marks)**
- b. Explain the purpose of the following units in sewage treatment:
 - i. Skimming tank
 - ii. Grit chamber
 - iii. Sedimentation tank

(6 Marks)

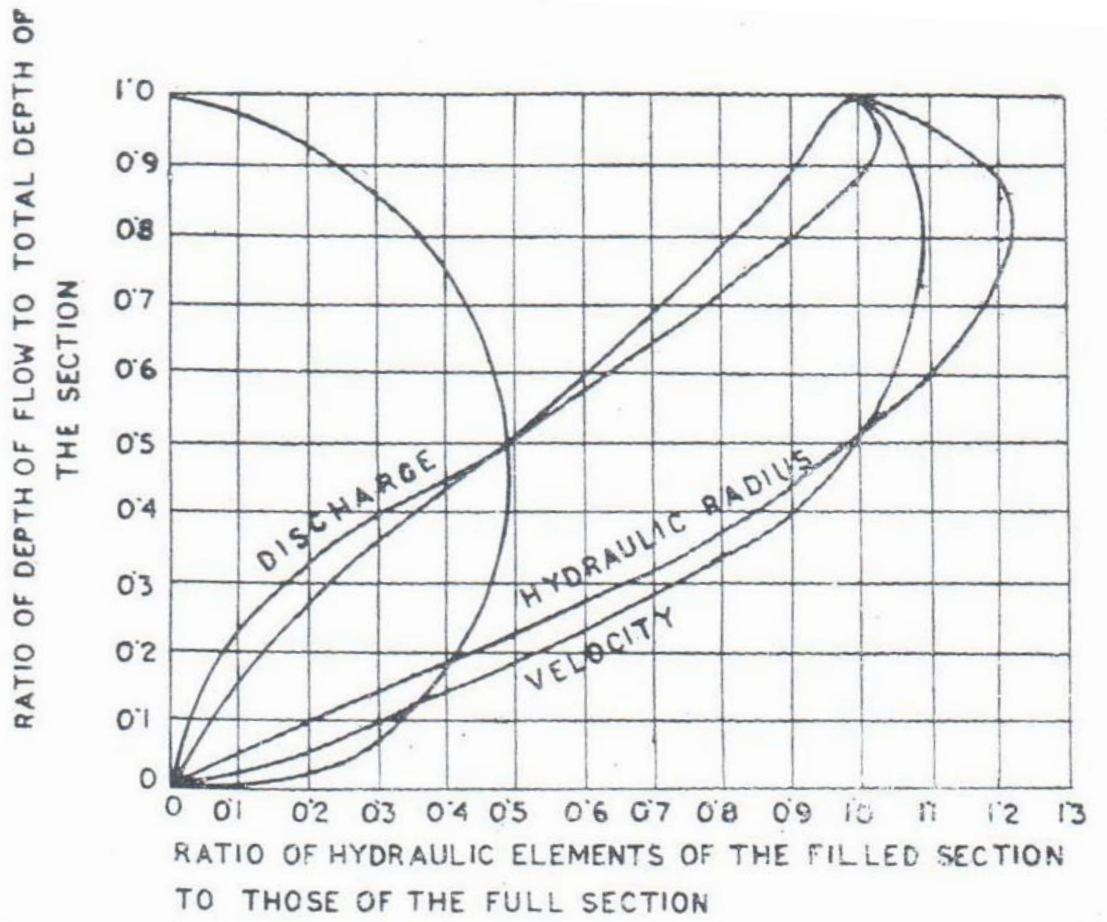
c. Differentiate between plain sedimentation and coagulation/flocculation sedimentation.

(2 Marks)

d. The expected average sewage flow per capita in a small town is 120 l/h/d. Design a sedimentation tank for sewage treatment for the town with a projected ultimate population of 300,000 people. The recommended depth is 3.0 metres. Assume a detention time of 3 hours and a design flow of 180% of the average flow. (7 Marks)



Nomogram based on Manning's formula for circular pipes (for $n=0.013$) running full



Partial flow diagram