MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 310: PUBLIC HEALTH ENGINEERING II

DATE: **TIME:**

INSTRUCTIONS

(i) QUESTION ONE IS COMPULSORY

(ii) ATTEMPT ANY OTHER TWO QUESTIONS

(iii) REASONABLE ASSUMPTIONS SHOULD BE MADE WHERE NECESSARY

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Discuss in your own words what is meant by an indicator organism. Which group of organisms are used as indicator organisms and why? List three groups of pathogenic organisms that may be found in water and wastewater. (5 marks)

b) Describe the purpose of physical, chemical, and biological characterization of wastewater in the overall scheme of wastewater treatment. (3 marks)

c) A five-day BOD test is performed on an " unseeded" primary effluent wastewater sample. 10 ml of primary effluent are added to each 300 ml BOD bottle, to which dilution water is added. A total of four BOD bottles are used in this particular test. The average DO concentration of the diluted wastewater samples at the beginning and end of the BOD test is 9.2 mg/L and 4.3 mg/L, respectively. Calculate the BOD of the primary effluent (10 marks)

d) The following test results were obtained on an influent sample to an industrial wastewater treatment plant. All solid analyses were performed using a sample volume of 50 ml. Determine the concentration of (10 marks)
a) total solids
b) total volatile solids
c) total suspended solids
d) volatile suspended solids
e) total dissolved solids. (10 marks)

Tare weight of evaporating dish =	54.6423 g
Weight of evaporating dish plus residue after evaporation @ 105°C =	54.7148 g
Weight of evaporating dish plus residue after ignition @ 550°C =	54.6818 g
Tare weight of Whatman glass fiber filter =	1.5434 g
Weight of Whatman glass fiber filter and residue after drying @ 105°C =	1.5625 g
Weight of Whatman glass fiber filter and residue after ignition @ 550°C =	1.5531 g

e) Discuss the importance of wastewater flow characterization in wastewater treatment (2 marks)

QUESTION TWO (20 MARKS)

a) What is the Public Health importance of the following parameters in wastewater? (10 marks)

- Nitrates
- Phosphorous
- Lead
- Biochemical Oxygen Demand
- Temperature

b) Estimate the wastewater generation from the water demand for a city of 200,000 people. Assume the annual average consumption rate is 0.171 m^3 per capita per day and use the flow ratios given in Table 1 for estimating the following flow rates in million litres per day (MLD):
i) Average daily demand and hence average wastewater generated.
ii) Peak daily demand and hence peak daily wastewater generated.
iii) Peak hourly demand and hence peak hourly wastewater generated. (10 marks)

Table 1: Flow Ratios with respect to Average Daily Demand.

Flow	Range	Average
Peak daily demand : average daily demand	1.5:1 to 3.5:1	2.0:1
Peak hourly demand : average daily demand	2:1 to 7.0:1	4.5:1
Minimum hourly demand : average daily demand	0.25: to 0.5:1	NA

QUESTION THREE (20 MARKS)

a) State and discuss five methods of collection and conveyance of wastewater (10 marks)

b) Discuss the factors that necessitate the construction of household and small-scale wastewater treatment systems. Give five examples of these systems (10 marks)

QUESTION FOUR (20 MARKS)

a) Calculate the five -day and seven-day BOD for a sample of treated wastewater assuming a BOD rate constant, $k=0.10days^{-1}$ and an ultimate BOD of $3.5x10^{-4}kg/L$. Finally calculate the percent of ultimate BOD exerted at 5 days and 7 days respectively (10 marks)

b) Using the maximum permissible velocity method, design a sanitary gravity sewer of concrete (n=0.013), circular cross-section flowing half full and which must carry sewage at a uniform rate of flow of $2m^3/s$. The choice of your design velocity should ensure that there is no deposition and sewer corrosion is minimal. Allow for a freeboard and show how you arrive at the freeboard allowed for (10 marks)

QUESTION FIVE (20 MARKS)

a) Using fig 5 below discuss the relationship between BOD exerted and BOD remaining (5 marks)

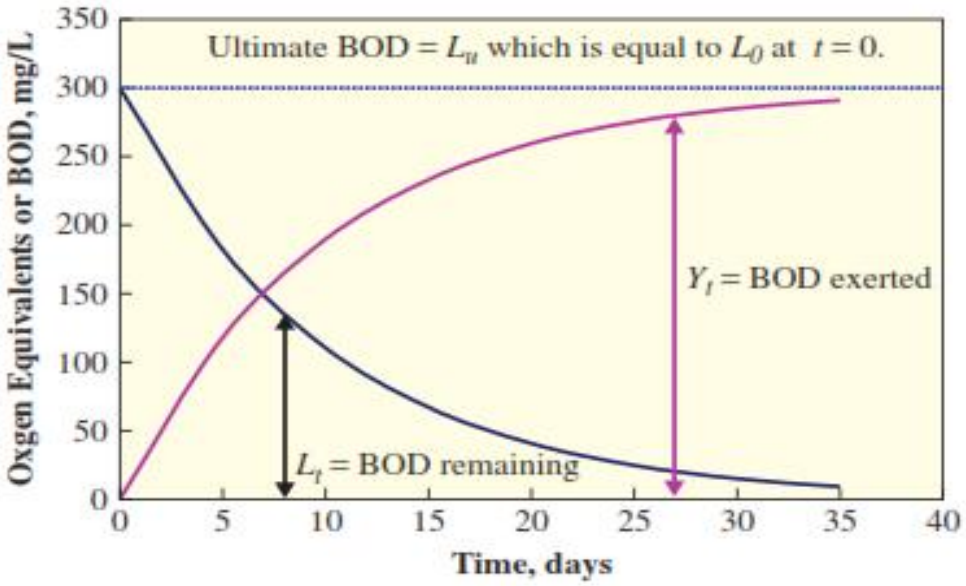

Fig Q5

b) With the aid of a diagram describe the treatment process in septic tanks. What are some of the operation procedures that must be observed? (10 marks)

c) Estimate the size of a septic tank for a picnic park which hosts 500 residents on average daily. Assume that the anticipated flow is 150L/day per capita and HRT of 24hrs (5 marks)