

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering



Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: CVX6345 Environmental Engineering
Academic Year	: 2022/2024
Date	: 9 th January 2024
Time	: 0930-1230hrs
Duration	: 03 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **SIX (06)** questions on **Four (04)** pages.
3. Answer **ANY FIVE** questions
4. Answer for each question should commence from a new page.
5. Necessary additional information is provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

Question 1

Metal contamination is one of the significant global environmental concern, leading to harm not just individual organisms but also to entire ecosystems worldwide.

- List six other major global environmental issues with their major impacts. (6 Marks)
- Discuss the potential consequences of metal pollution (6 Marks)
- Typically, higher trophic levels shows high susceptibility to metal pollution. Justify this statement. (8 Marks)

Question 2

Energy in an ecosystem moves in one direction, starting from the sun or non-living sources to plants, then to various consumers. Higher-level consumers have less energy available compared to lower-level ones.

- Explain what autotrophs are and provide examples. (6 Marks)
- Explain heterotrophs and give examples of various types (6 Marks)
- Discuss why higher trophic levels have less energy available compared to lower trophic levels (8 Marks)

Question 3

- Figure 3.1 illustrates various growth phases of microorganisms. Provide a brief explanation of each growth phase shown in the figure. (5 Marks)

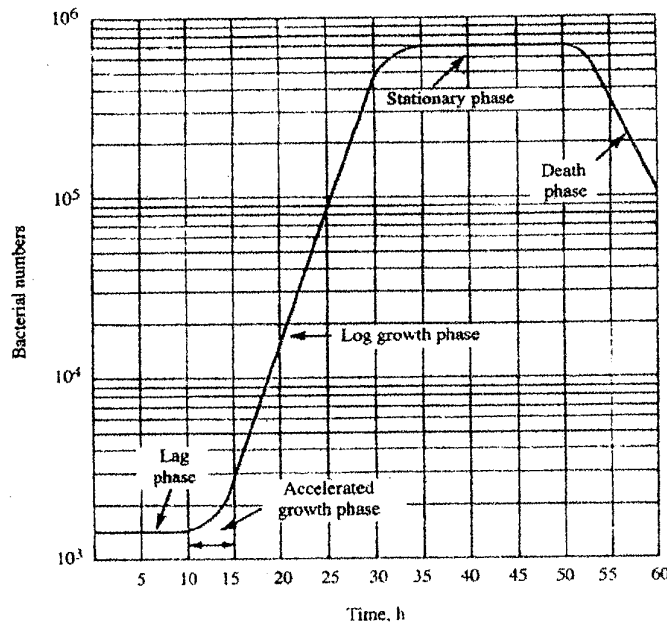


Figure 3.1

(b) An activated sludge treatment system receives an inflow containing 100mg/L of BOD₅ at a flow rate of 0.1 m³/s. The system aims to decrease the BOD₅ to 10% of the influent's BOD₅ concentration. Using the information given below;

- Estimate the mean cell residence (SRT) time in the activated sludge system (4 Marks)
- Calculate the hydraulic retention time for the aeration tank (4 Marks)
- Determine the volume of the aeration tank (7 Marks)

Assumptions:

- Steady state prevails in the system
- Mixed Liquored Volatile Suspended Solid (MLVSS) in the aeration tank 2000 mg/L
- Growth constants: $K_s = 100 \text{ mg/L BOD}_5$; $\mu_m = 2.5 \text{ d}^{-1}$; $k_d = 0.05 \text{ d}^{-1}$;

$$S = \frac{K_s(1+k_d\theta_c)}{\theta_c(\mu_m - k_d) - 1} \quad (1)$$

$$X = \frac{\theta_c(Y)(S_0 - S)}{t_0(1+k_d\theta_c)} \quad (2)$$

Q = Wastewater flow rate into the aeration tank, m³/d

X = MLVSS concentration in the aeration tank, mg/L

S = Soluble BOD₅ in the aeration tank and effluent, mg/L

S₀ = Soluble BOD₅ in the influent, mg/L

θ_c = Mean cell residence time, d

V = Volume of the aeration tank, m³

K_s = Half velocity constant

μ_m = Maximum growth rate constant, d⁻¹

k_d = Decay rate of microorganisms, d⁻¹

Y = Yield coefficient, mg/mg

t₀ = Hydraulic retention time, h

Question 4

- Explain briefly the adverse effects of noise pollution on both the environment and human health. (4 Marks)
- Briefly explain the concept of root mean square pressure which used in noise measurement (4 Marks)
- Using the definition of sound pressure level, derive the equation utilized to estimate the average sound pressure level when combining multiple sound pressure levels. (8 marks)

$$\overline{L_p} = 20 \log \left[\frac{1}{N} \sum_{j=1}^N 10^{\frac{L_j}{20}} \right]$$

Where;

$\overline{L_p}$: Average sound pressure level(dB) with a reference level of 20μPa

L_j : jth sound pressure level, (dB) with a reference level of 20 μPa

N: Number of sound pressure levels

- d) Multiple appliances are operating simultaneously within a house, resulting in the following sound levels at a study table. Determine the average sound pressure level experienced at the study table due to these sounds. (4 Marks)

Washing machine: 72dB

Blender; 76 dB

Television: 68 dB

Question 5

- a) Provide a concise explanation of how air pollution harms both humans and the environment. (6 Marks)
- b) If one mole of an ideal gas pollutant occupies a volume of 22.414L at 0°C and 101.325 kPa, develop an equation to determine the volume (V_p) of an ideal gas (with mass M_p) at temperature T_2 and pressure P_2 , given its Granular Molecular Weight (GMW). The ideal gas equation can be utilized for this calculation. (10 Marks)
- c) Determine the ideal gas concentration provided in question 5(b) in parts per million (ppm). Also, derive an expression for this gas concentration in ppm utilizing the terms introduced in the previous question, taking into account the volume of the gas container as V_a . (4 Marks)

Question 6

- a) Briefly explain the procedure of coarse screening in water treatment process. (5 Marks)
- b) With the aid of an appropriate sketch briefly explain the use of Void Space Ratio (VSR) in designing of coarse screens. (5 Marks)

- c) An initial design for a coarse screen is needed to accommodate an approach flow velocity of 0.4 m/s. Evaluate whether the given set of data is suitable for this design requirement..

Bar spacing: 75 mm

Bar thickness: 15 mm

Maximum allowable head loss: 150 mm

Angle of slope from the vertical is 30°

Design flow rate: 0.4 m³/s

$$\text{Head loss through screen (h)} = \frac{V_b^2 - V_a^2}{2g} \times \frac{1}{0.7}$$

V_b : Velocity through screen

V_a : Approach velocity

g : Gravitational acceleration

(10 Marks)