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

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX6345 Environmental Engineering**
Academic Year	: 2023/2024
Date	: 8th February 2025
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

The science of ecology is essential to understand and mitigate the environmental pollution in the Globe.

a) Explain the science of ecology and why it is essential to mitigate environmental pollution. (6 Marks)

b) Describe the hierarchy of ecology and its components. (6 Marks)

c) Describe the population characteristics and how it interpret the ecology of a system. (8 Marks)

Question 2

Understanding the level of organization is essential to define a ecosystem.

a) Explain the level of organization in the living world and its significance in understanding the ecosystem. (6 Marks)

b) Describe the difference between an ecosystem, a biome and a biosphere. (6 Marks)

c) Explain, the reasons behind the occurrence of eutrophication and cyanotoxins in water bodies. (8 Marks)

Question 3

Use **Table 3.1**, **Table 3.2** and **Table 3.3** to answer this question.

A rural village presently have a population of 500residents. Furthermore, tabulated entities are present within the village which are fed from the same water treatment plant.

Table 3.1: Sources of Non-domestic use

Non Domestic Use	Number	Detail
Hospitals (per bed)	1	45 beds
Hostels (per bed)	1	30 beds
Boarding schools (per resident)	1	250 residents
Restaurants (per seat)	5	25 seat per restaurant
Bus/Railway stations (per user)	1	175 user per day
Day schools (per pupil)	1	40 pupils
Offices (per person)	3	20 persons per office
Factories (per person)	1	300 workers
Cinemas (per seat)	1	150 seats per day

a) If a rural population of 500 has an annual population growth rate is 1.5%, determine the population of this village in 30 years using exponential model. You can use the following equation. (5 marks)

$P_n = p(1 + r)^n$

P_n : Population at n^{th} year
p : Base population
n : number of years
r : growth rate (%)

b) Determine the water demand for domestic use for this village in 30 years.
(5 Marks)

c) Determine the institutional demand for the village in 30 years. Please justify your selection of consumption rates.
(5 Marks)

d) Determine the industrial demand of the village in 30 years.
(5 Marks)

e) If the loss due to None Revenue Water (NRW) is 25% and the losses at the treatment plant is 10% calculate the total raw water demand.
(5 Marks)

Question 4

a) Briefly explain the difference between Slow Sand Filters and Rapid Sand Filters.
(4 Marks)

b) Design a slow sand filter to treat $1800m^3\ day^{-1}$ at a filtration rate of $0.15mh^{-1}$. You are expected to decide dimensions of the filter.

Design parameters

- Maximum allowable surface area for SSF = 200 m^2
- Select appropriate heights for under drain, sand bed and assume a hydraulic head of 1.5 m

(6 Marks)

c) Design a rapid gravity filter to treat $1800m^3\ day^{-1}$ at a filtration rate of $8m\ h^{-1}$. You are expected to decide dimensions of the filter.

Design parameters

- Select appropriate heights for under drain, sand bed and assume a hydraulic head of 1.5 m (6 Marks)

d) Compare the volumes of two filter designed under part (b) and Part (c), and discuss one advantage and disadvantage of both type of filters. (4 Marks)

Question 5

a) Briefly explain the three steps involved in controlling gaseous pollutants from stationary sources (6 Marks)

b) Describe the following listed methods used in air pollution control with special emphasis on scientific mechanisms in each method (4 Marks)

- Adsorption
- Combustion

c) Explain the following listed methods used in mitigating particulate pollutants describing scientific principles involved in these methods (6 marks)

- Cyclones
- Bag filters
- Venturi Scrubbers

d) Controlling air pollution created by mobile sources, is essential to maintain good air quality. Describe following listed methods use to control air pollutants from mobile sources (4 Marks)

- Fuel Tank Evaporation losses
- Engine exhausts

Question 6

a) Briefly discuss the steps in each degree of treatment in wastewater treatment listed below. You may use a flow diagram to answer the question.

- Pretreatment
- Primary treatment
- Secondary treatment
- Tertiary treatment

(4 Marks)

b) Briefly discuss the purpose of flow equalization in wastewater treatment used in many wastewater treatment plant in the world. (4 Marks)

c) Design an equalization basin for the following cyclic flow pattern. Provide a 25 percent excess capacity for equipment, unexpected flow variations, and solids accumulation. Evaluate the impact of equalization on the mass loading of BOD_5. (12 Marks)

Table 6.1 :

Time, h	Flow, m^3/s	BOD_5, mg/L	Time, h	Flow, m^3/s	BOD_5, mg/l
0000	0.0481	110	1200	0.0718	160
0100	0.0359	81	1300	0.0744	150
0200	0.0226	53	1400	0.0750	140
0300	0.0187	35	1500	0.0781	135
0400	0.0187	32	1600	0.0806	130
0500	0.0198	40	1700	0.0843	120
0600	0.0226	66	1800	0.0854	125
0700	0.0359	92	1900	0.0806	150
0800	0.0509	125	2000	0.0781	200
0900	0.0631	140	2100	0.0670	215
1000	0.0670	150	2200	0.0583	170
1100	0.0682	155	2300	0.0526	130

Table 3.2: Per capita Water Demand

Community	House connection (L/per capita day)
Medium rural(1000 to 1500)	120
Large rural (1500 to 5000)	140
Small urban (5000 to 10000)	185
Medium urban (10000 to 20000)	185
Large urban (over 20000)	Needed to be separately assessed

Table 3.3: Per capita consumption for non-domestic consumption

Non Domestic Use	Liters/per capita/Day
Hospitals (per bed)	220-300
Hostels (per bed)	180-700
Boarding schools (per resident)	90-140
Restaurants (per seat)	60-90
Bus/Railway stations (per user)	15-20
Day schools (per pupil)	15-30
Offices (per person)	25-40
Factories (per person)	20-30
Cinemas (per seat)	10-15