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	**: CEX4234/CVX4534/CVX4348 - Water & Wastewater Engineering**
Academic Year	: 2019/2020
Date	: 19th January 2021
Time	: 1330-1630hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Five (5)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts / codes / equations are provided in last page
6. This is a Closed Book Test **(CBT).**
7. Answers should be in clear handwriting.
8. Do not use red colour pen.

Question 1

(a) (i) The consumption of water in public use can be divided mainly into six classes. List them.

(ii) Water is leaking from a roadside public water post (tap) at a rate of one drop per second and each drop contains 0.15 mL of water. Calculate how much water (in liters) will be lost during one year.

(iii) Assuming the cost of water per cubic meter is Rs. 25, estimate the non-revenue per year due to a leaking faucet.

[06 marks]

(b) The municipal council of a town wants to design its water distribution network. The census records of the area are follows. The city anticipates constant rate of growth.

Year	Population	Increase in population	Rate of growth per decade
1990	5400		
2000	7300	1900	.....
2010	8700	2400	.....
2020	11300	2600	.....

(i) According to the geometrical increase method, if the present population is given as 'P' and the rate of growth per decade is 'r' write the expression for the population after 'n' decades.

(ii) Estimate the growth/decade and the geometric mean (r).

(iii) Assuming that the future growth follows the same geometric mean for the periosd of 1990 -2020, calculate the population in 2040.

[08 marks]

(c) Selecting a good water source as well as placing a surface water intake is important.

(i) Write four factors that should consider when selecting a location for surface water intake.

(ii) List type of river intakes.

(iii) If the water level is highly fluctuating in a river, which intake would be mostly appropriate. Explain what changes to be done in construction for drawing water to the intake well in such cases.

[06 marks]

Question 2

(a) Water to be stored temporarily after the treatment and supplied to the consumers through the distribution network.

(i) What requirements to be considered when designing a distribution reservoir.

(ii) briefly explain the need of distribution reservoirs for water distribution network.

(iii) There are four different systems of distribution reservoirs. Write advantageous of each and clearly illustrate using a diagram.

[08 marks]

(b) (i) A small housing scheme of 80 houses is being planned. Assume a reasonable rate for the average residential consumption and estimate the average daily water production to be supplied by the Water Board.

(ii) If the number of houses increases to 120, and the use of low-flush valves would reduce the water consumption by 18%, what would be the water production to be supplied by the Water Board.

[06 marks]

(c) (i) Water treatment includes many operations. Draw a treatment unit flow diagram for reservoir supply. Indicate each unit operation clearly.

(ii) During hot seasons, the reservoir is affected by blue-green algae. The disruption algae may release toxins to water. List three actions that helps to reduce algae in the intake well.

[06 marks]

Question 3

(a) Aeration and gas stripping are normally the first treatment step of production of drinking water.

(i) How aeration improves water quality. Explain briefly.

(ii) What is meant by 'trough depth' of a cascade aerator?

(iii) If the fall height of a cascade aerator is 0.5m, what would be the trey depth.

(iv) Estimate a fall time and the aeration period if the cascade aerator is having five trays.

[08 marks]

(b) During coagulation flocculation process, coagulants are added to aid in floc formation.

(i) The dosage of coagulants is depended on several factors, list those factors.

(ii) Why Aluminum sulphate (Alum) is commonly used as coagulant in Sri Lanka.

(iii) A water treatment system uses 16mg/L dosage of alum as the coagulant. If the system treats 1800m^3/day, estimate the amount of Alum crystals required to purchase for a month.

(iv) Estimate the capacity of a flocculation basin of a water treatment system if the water retention time is 600 sec.

[09 marks]

(c) Estimate the chlorine requirement per day that is needed to disinfect a total volume of 1800 m^3/d water, if the chlorine dosage is 0.8 mg/L in the above treatment plant.

[03 marks]

Question 4

(a) Sedimentation tanks are important to settle discrete particles in water. In ideal sedimentation basin there are four zones can be identified. Draw a schematic diagram of either horizontal flow or vertical flow clarifier and indicate the above mentioned four zones clearly.

[05 marks]

(b) In a water treatment system, two rectangular settling basins are proposed. Each settling basin is with dimensions of 10 m long, 5 m wide, and 3.5 m deep, and used to settle 1800 m^3 of water per day, following alum coagulation. The effluent channels have a total weir length of 30 m. Calculate the detention time, overflow rate and weir loading.

[08 marks]

(c) (i) A proposed filtration unit of the above water treatment plant indicates that 12 m/h will be acceptable to treat 1,800 m^3/d. The surface configuration of the filtration unit is 6 m × 8 m. Calculate the number of filter units will be required, if one additional back up unit is needed.

(ii) When clogged, the above filters are supposed to be backwashed with a rate of 48 $m^3/hr/m^2$ for 10 minutes. What is the quantity of clean water required to backwash?

[07 marks]

Question 5

(a) (i) If an organic pollutant is mixed with a stream, explain how regeneration of the Dissolved Oxygen would occur in the downstream of the river. Using a sketch explain the behavior of self-assimilation capacity of a river.

(ii) How to estimate a pollutant load in a river using river flow rate (Q) m^3/s and pollution concentration (C) mg/L.

[06 marks]

(b) (i) An urban canal in a city continuously carries treated wastewater to a perrenial river. The *minimum* flow in the river is 50 m^3/s and the flow rate of the urban canal is 1.7 m^3/s. If the maximum acceptable level of a certain pollutant in the perennial river is 45 mg/L, and the recorded maximum concentration of this pollutant in upstream above the mixing point is 5 mg/l, what is the maximum concentration of the pollutant (in mg/L) that can be safely released from the wastewater treatment plant to the urban canal.

(ii) List assumptions made for solving this problem?

(iii) Estimate the pollutant load in the downstream of the perennial river.

[08 marks]

(iv) A cheese processing factory produces about 100,000 Kg of cheese products and releases 1500mg/L of BOD with an average of 12000 L/day of wastewater. Compute BOD equivalent population and Hydraulic equivalent population of the diary wastewater discharge. Assume Hydraulic and BOD equivalents based on average sanitary wastewater are 190 Lpcd and 40 gBOD per person per day.

[06 marks]

Question 6

(a) A grit chamber has a wastewater depth of 0.9m. A 0.2 mm sand particle settles at a rate of 0.2cm/s. Compute the time required for settling and the effective length of the grit chamber assuming the horizontal velocity of wastewater is 0.3 m/s.

[05 marks]

(b) A circular settling tank is with the diameter of 20 m, and the wastewater flow rate is 10MLD.if the wastewater depth is 2.5 m. The weir length is the circumference of the outlet chamber of the circular tank. Estimate,

(i) Surface loading rate

(ii) Volume of the tank

(iii) Detention time

(iv) Weir loading rate.

[09 marks]

(c) (i) What is the necessity of skimming tank?

(ii) A 10,000 m^3/day wastewater flow of a hotel consists of 220 mg/L of oil and grease. If the detention time is 5 min, determine,

- tank volume
- surface area and
- the depth of the tank.

State your assumptions.

[06 marks]

Question 7

(a) Activated sludge aerated tank operating parameters are as follows:

Flow = 400m³/day

Incoming BOD_5 after primary settling = 300 mg/L

MLSS = 4000 mg/L

A treatment system must be designed that will produce an effluent BOD of 30mg/L. (90% of removal). Determine,

(i) the volume of the tank

(ii) F/M ratio

(iii) aeration time.

[09 marks]

(b) What would be the oxygen requirement per day, if the sludge age is 10 days? The O_2 requirement per day is given as:

$1.47\ Q\ (S_0\text{-}S) - 1.42V(X/\theta_c)$ with usual notations. ***[04 marks]***

(c) (i) What is the objective of sludge stabilization? List the methods available for sludge stabilization?

(ii) List the low-cost wastewater treatment options. How effective such treatment for a country like SriLanka. Discuss briefly.

(iii) With the COVID-19 pandemic situation, how safe the insitu wastewater treatment systems? Discuss briefly.

[07 marks]

Supplementary

$$r_u = -\frac{\mu_m S X_{avg}}{K_s + S}$$

$$\frac{F}{M} = \frac{QS_0}{VX}$$