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

039

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX4348**
Academic Year	: 2021/2022
Date	: 20th February 2023
Time	: 0930-1230hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Six (6)** 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 an Closed Book Test **(CBT).**
7. Answers should be in clear handwriting.
8. Do not use red colour pen.

Question 1

(a) Since population is always a relevant factor in estimating future water use, it is necessary to predict, in some manner, what the population will be.

i) List any three methods of estimating the future population of a city. What are their relative merits?

ii) A community has experienced the growth in population and water use shown. Estimate the populationand total daily water demand in 2048 if the per capita demand is180lpcd .

Year	1978	1988	1998	2008	2018
Population	5467	6789	8902	11678	13657
Average daily flow, m^3	2270	2720	3630	4970	6600

[10 marks]

(b) (i)What are the advantages and disadvantageous of intermittent water supply systems over continuous systems?

(ii) It is also recorded that the considerable amount is account for Non revenue water (NRW). What are the causes for NRW? [04 marks]

(c) List six factors which affects the water demand of a city and explain three of them breifly. [06 marks]

Question 2.

(a) Water, whether it is drawn from surface or ground water supplies, must be conveyed to community and distributed to the users.

i) Explain the importance of chemical and bacteriological analysis of water used for domestic purposes.

ii) What are the methods available for conveyance of water from the source to the water treatment plant?

iii) Elevated storage tanks are important in a water supply system and they are located at selected points. Discuss the advantages of having elevated water tanks at specifiedlocations. [10 marks]

(b) A sedimentation basin is to be designed to remove 100% of all particles with a settling velocity of 0.25mm/s. For a flow of $8m^3$/min,

i) Determine the appropriate dimensions for a rectangular basin in which the length is five times the width. The detention time is 2.5 hrs.

ii) Estimatr the total weir length required if the overflow rate is 228m^3/m/day.

[07 marks]

(c) (i) What are the various methods commonly used to remove color, odour and taste from the water? Describe any method in detail. [03 marks]

Question 3.

(a) A rapid sand filter is to produce a maximum flow of 23,000 m^3/day. The nominal filtration rate is 120m/day and is not to exceed 180m/day with one filter being backwashed nor 240m/day with one filter being backwashed and one filter out of service. Determine the number of units required and the individual filter area. How much water is required to wash one filter if the backwash rate is 1m/min and the duration is 10min?

[08 marks]

(b) A water treatment plant processes 30,000 m3/day of water. The water is treated by coagulation /flocculation and then by sedimentation. The requirement of Ferrous Sulfate is estimated as 28 mg/l of water.

(i) Coagulation and flocculation processes are considered essential in the removal of colloidal particles. Why?

(ii) The monthly requirement of Ferrous Sulfate in Kg

[04 marks]

(c) What are the types of river water intakes available for extracting water for water treatment works?

(d) Fe and Mn in drinking water can be seen commonly in Sri Lanka.

(i) What are the problems caused by Fe and Mn if the water is used for domestic purposes.

(ii) Explain briefly the most suitable method to remove the above constituents to improve the drinking water quality?

[06 marks]

Question 4.

(a) A grit chamber to remove sand particles (density = 2650 kg/m^3) with a mean diameter of 0.18 mm. Assume the sand is spherical and the temperature of the wastewater is 25ºC. The wastewater flow is 10,000 m^3/d. A velocity of 0.3 m/s will be automatically maintained, and the depth must be 1.5 times the width at maximum flow.

$$v_s = \frac{g(\rho_s - \rho)}{18\mu}$$ Viscosity of water =1.0 x10^2 cm^2/sec

i) Calculate the settling velocity of sand particles.
ii) What is the cross sectional area of the grit chamber?
iii) Determine the detention time and the length required for a particle to fall the entire tank depth.
iv) What are the dimensions of the grit chamber?

[08 marks]

(b) (i) Explain the importance of 'self cleansing velocity' in the design of wastewater carrying pipes?

(ii) A residential community has an estimated ultimate population density of 15,000 /km^2 and an area of 120,000 m^2. The average wastewater flow is presently 300 liters per capita per day. Estimate the maximum sewage flow rate to be expected from this area. Also compute the size of the sewer main to carry the sewage flow. List the assumption you have made.

[08 marks]

(c) (i) What is meant by "assimilative capacity of streams"? What factors affecting assimilative capacity of a stream?

[04 marks]

Question 5.

(a) (i) A community discharges a wastewater flow of 150m3/day through as out fall to a river. The minimum flow in the stream is 10m3/day, the maximum stream temperature is 28ºC. At this condition, the stream BOD5 concentration is 9mg/l and the pollutant at the outfall is 400mg/l above the sewage outfall. Determine the effluent BOD5 from the sewage treatment plant.

(ii) In the above question, if the reaction rate constant is 0.1/day. What would be the ultimate BOD_5 of waste? Also compute the five day BOD at the temperature 30ºC.

[$k=k_{20}\vartheta^{(T-20)}$; $BOD_5 = Lo\,(1- e^{-kt})$; $\vartheta = 1.047$]

[10 marks]

(b) (i) Explain the necessity of providing manhole in sewer line.

(ii) Why explosions occur in the sewer lines and how they can be prevented?

[05 marks]

(c) Secondary treatment is usually biological treatment where microorganisms are employed for removal of organic matters.

(i) What are the treatment methods involving in secondary treatment? List them.

[05 marks]

Question 6.

(a) Calculate the maximum radius of the clarifier (settling tank) for which a single peripheral weir surface will provide adequate length. Assume surface overflow rate SOR=36m/day and weir overflow rate WOR=400 m^2/day.

[06 marks]

(b) Sludge production in a "typical" plant treating domestic wastewater amounts to about 100g.day per capita of which 70 % is volatile. The sludge is commonly 95% water. Calculate the volatile solids loading and the volume per capita in a digester with a detention time of 20 days.

[08 marks]

(c) (i) Proper handling of sludge is very important in wastewater treatment plant. What is the importance of sludge management? Explain briefly.

(ii) Sludge digestion can be done aerobically as well as anaerobically. What are the advantageous of anaerobic digestion process over aerobic system?

[06 marks]

Question 7.

(a) A wastewater treatment plant employs a completely mixed activated sludge system. Following information are given:

Per capita water demand of the area: 200 l/day
Population equivalent: 60,000
Influent BOD: 350 mg/l
Influent suspended solids: 340 mg/l
Required effluent BOD: 20 mg/l
SS in the effluent: 52 mg/l
MLSS in aeration basin: 3000 mg/l
The hydraulic retention time:5 hrs

(i) Estimate the volume of the aeration basin
(ii) Food to microorganism ratio
(iii) BOD and SS removal efficiency

[08 marks]

(b)Two activated sludge aerated tanks are operated in series. Each tank has following dimensions: 6 m wide by 18 m long by 3.5 m effective liquid depth. Operating parameters of the systems are as follows.

Flow =0.0796m3/s
Soluble BOD5 after primary settling =130 mg/L
MLSS= 2900 mg/L

i) Determine the volume of the tank F/M ratio and the aeration time.
ii) If the effluent BOD is 15mg/l, what would be the oxygen requirement per day, if the sludge age is 10 days? O_2 required per day is given as $1.47\ Q\ (S_0\text{-}S) - 1.42V(x/\theta_c)$ with usual notations.

[08 marks]

(c) (i) Explain briefly about the consequences which can be expected if effluents from hospital wastewater are used for irrigation purposes.

(ii) State the requirements to be fulfilled to use a sea outfall to discharge the wastewater to a sea.

[04 marks]

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