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

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| Study Programme | : Bachelor of Technology Honours in Engineering |
| Name of the Examination | : Final Examination |
| **Course Code and Title** | **: CVX4534/CEX4234** |
| | **Water Supply and Sewerage Engineering** |
| Academic Year | : 2018/19 |
| Date | : 31st January 2019 |
| Time | : 0930-1230hrs |

**General Instructions**

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Four (4)** 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 are provided.
6. This is Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

***Question 1.***

**(a)** (i) Why protected water supply is needed? Explain briefly. [02 marks]

(ii) List three water borne diseases that cause due to pathogens in water. [02 marks]

**(b)** (i) How aquifers are formed?Illustrate different aquifers using a neat sketch. [04 marks]

(ii) The ground water sources may be of three types. List them. [02 marks]

(iii) Differentiate between shallow wells and deep wells. Which water (Shallow well water or Deep well water) is usually hard? Why? [03 marks]

**(c)** (i) What is meant by 'wholesome water' and 'potable' water? [03 marks]

(ii) In some areas water gives objectionable taste and their laundry becomes tarnish during washing. What would be the cause of these taste of water? What are the suggestions that would overcome such situations? [04 marks]

***Question 2.***

**(a)** (i) Population forecasting is important when planning a water supply project. Why? [02 marks]

(ii) A rural city is planning to provide water supply from a irrigation tank nearby. The census records provide the following data.

| Year | 1987 | 1997 | 2007 | 2017 |
|---|---|---|---|---|
| Population | 5220 | 7600 | 9345 | 12251 |

Estimate the population using the incremental increase method. The method is given as $P_n = P_1 + (nX) + \frac{n(n+1)Y}{2}$ with usual notations. [05 marks]

**(b)** (i) The demand for water varies from town to town. 'Quality of water' and 'sewerage system' are two factors affecting the rate of demand. How do they affect the water demand in a city? Explain briefly. [04 marks]

(ii) How a city waterworks supplies a quantity of water required for fire-fighting needs. Explain briefly. [02 marks]

**(c)** DadugamOyais the sourcefor Raddolugama water works, provide water through river intake situated 2 km away from the plant.

(i) What factors govern the location of a river intake structure? [02 marks]

(ii) How does it maintain the abstraction in dry period. [02 marks]

(iii) What are the methods available for conveying water to the treatment plant? Discuss its merits and demerits. [03 marks]

***Question 3.***

**(a)** (i) A dry zone reservoir is used for water supply. During hot climatic conditions, it covers with green algae. List the temporary actions that can to overcome out with this problem. [03 marks]

(ii) Suggest three permanent solutions to overcome algae in water supply works. [03 marks]

**(b)** Two sedimentation tanks are operated in parallel. The combined flow to the two tanks is 0.1000 $m^3/s$. The depth of each tank is 2 m and each has a detention time of 4 h.

(i) Estimate the surface area of each tank, [03 marks]

(ii) What is the overflow rate of each tank in$m^3/d \cdot m^2$? [03 marks]

**(c)** (i) Why flocculation and coagulation processes are needed in water treatment of surface water? [02 marks]

(ii) Why it is needed to use coagulant aids such as clay or polymer in coagulation process? [03 marks]

(iii) A water flow of 0.1000 $m^3/s$ needed 18mg/L of alum for coagulation process. Estimate the alum requirement in Kg per day. [03 marks]

***Question 4.***

**(a)** (i) List two advantages of P.V.C. pipes over steel pipes for water supply. [02 marks]

(ii) What is meant by 'tuberculation'. Describe how this affects water supply. [03 marks]

(iii) How are water mains with internal deposits in the pipe wall are rehabilitated? [03 marks]

**(b)** (i) What are the joints that can be used for cast iron pipes. List them. [02 marks]

(ii) In low lying service areas, many leakages and linebreakages can be seen. What would be the reason for such occurring? [02 marks]

(iii) How do you overcome such situations when laying pipe lines. Explain briefly. [02 marks]

**(c)** (i) Differentiate distribution storage and equalization storage? [02 marks]

(ii) A town with 45,000 people require average 210lpcd. If the equalizing storage is 15%from the daily average demand and for a fire flow of 40 l/s for a 3 h duration is required, compute capacity of distribution storage tank. [04 marks]

***Question 5.***

**(a)** Chlorination is important unit processes in water treatment systems.

(i) What do you understand by break point chlorination? [01 marks]

(ii) What are the Chlorine reactions in water? [02 marks]

(iii) Why Ozone is considering as a better disinfectant than chlorine. List three factors. [02 marks]

**(b)** (i) Why COD values are always higher than the BOD value. [01 marks]

(ii) What is the difference between 3day BOD and 5day BOD. [02 marks]

(iii) Why the BOD measures at 20ºC? [02 marks]

(iv) Five day BOD at 20ºC is giving the importance? If 5day 20ºC of a sample is 240mg/l, what will be ultimate BOD and the BOD at 28 ºC? Assume $K_{20}$ = 0.1/day

$[k=k_{20}\vartheta^{(T-20)};\ BOD_5 = Lo\,(1-e^{-kt});\ \vartheta = 1.047]$ [06 marks]

**(c)** A milk processing factory discharges its wastewater to the nearby river with an average flow of 0.2$m^3$/s with $BOD_5$ concentration of 1300 mg/L. The river has a freshwater flow is 8$m^3$/s and the BOD concentration is estimated as 5mg/L. Estimate the pollutant concentration at the point of discharge assuming the complete mixing. [04 marks]

***Question 6.***

**(a)** (i) Discuss the factors on which the storm water flow depends on. [02 marks]

(ii) Storm sewers convey runoff from precipitation plus what kinds of wastes? In regions with intense of thunderstorm weather, how may heavy runoff be conveyed? If a storm sewer overflows during rainstorm, was the sewer improperly sized (designed)? [03 marks]

**(b)** A developed town is with the area of 3$km^2$. The percentage covers and the runoffcharacteristics are given below.

40% Lawns: 0.2

10% Roofs: 0.85

2% Streets: 0.70

8% Playgrounds: 0.230 - 0.35

35% Suburban areas: 0.35 - 0.40

5% Commercial areas: 0.70 - 0.95

Rain fall related data for a given area are as follows:

Time of concentration = 40 minutes

Rate of rain fall = 70/(T+12) cm/minute

(i) Calculate the storm water runoff. runoff in cubic meters per second. (Rational formula with usual notations is given as Q=0.278CIA in SI units. [06 marks]

(ii) Calculate the capacity of the storm water carrying pipe assuming the velocity 0.9 m/s when flowing full. [04 marks]

**(c)** (i) Explain the necessity of providing a manhole on a sewer line. [02 marks]

(ii) What is the requirement of drop manhole. Where it locates ? [03 marks]

***Question 7.***

**(a)** If the flow of a 0.4380 $m^3/s$ activated sludge plant havingF/M ratio is 0.200 mg/mg per day, the influent$BOD_5$ after primary settling is 150 mg/L, and the MLVSS is 2,200 mg/L,

(i) What is thevolume of the aeration tank? [03 marks]

(ii) If the operator of the plant described in Problem Q7(i) reduces wasting and allowsthe MLVSS to rise to 3,000 mg/L, what is the new F/M ratio? [03 marks]

(iii) Estimate the hydraulic retention time. [03 marks]

**(b)** (i) Aeration is the most important unit operation in the activated sludge process. How aeration helps the activated sludge process? [02 marks]

(ii) It is proposed to design Q 7 (a)an activated sludge plant to reduce the concentrations of settled $BOD_5$ from to 15mg/l. If the system is to operate at F/M of 0.2/day and maintain 2200mg/l concentrations of MLVSS in the aeration tank computevolume oxygen required per day if the mean cell residence time is 10 days.
[The oxygen required/day $=1.47Q(S_o-S)-1.42V(x/\theta_c)$ with usual notations]
[04 marks]

**(c)** (i) Before discharge, sludge is sludge is required to be stabilized before final disposal. Why? [01 marks]

(ii) List the main factors that affect aerobic sludge digestion. [02 marks]

(iii) List sludge dewatering methods [02 marks]