THE OPEN UNIVERSITY OF SRI LANKA
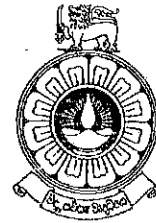Department of Civil Engineering
Diploma in Technology - Level 4

CEX 4234 - WATER SUPPLY AND SEWERAGE ENGINEERING

FINAL EXAMINATION – 2016/2017

Time Allowed: Three Hours | *Index No.*

Date: 18th of November 2017 | Time: 0930 - 1230

Answer any **FIVE** questions. All questions carry equal marks.

Question 1.

(a) (i) What factors influences for determining the water demand for a water supply project?
[03 marks]

(ii) What are the factors that must be considered in deciding on a supply source?[01 mark]

(iii)Once the water drawn from the supply must be conveyed to the treatment plant or to the distributed system. What are the methods available for conveyance of water from the source? List them. [02 marks]

(b) A rural city is planning to have a water supply project using ground water as the sole water source. The census data of a rural city is given as follows.

Year	1985	1995	2005	2015
Population	10025	12532	16756	201423

(i) Estimate the population of the city for which a water supply scheme is to be designed if the designed period is 30 years, considering the rate of growth of population of the city is 2%. [06 marks]

(ii) If the per capita demand is 200 L/day, compute the design flow for the treatment plant.
[03 marks]

(c) (i) What is meant by 'potable water'? [02 marks]

(ii) If you are given a sample of water from a community water supply system, what are the aspects you would look for before deciding on whether it is safe for drinking.

[03 marks]

Question 2.

(a) (i)List three types of aquifers and differentiate those using a clear sketch. [03 marks]
(ii)How do you determine the 'capacity of a well' (open well)? [03 marks]

(b) A well is 0.2m in diameter and pumps formed an unconfined aquifer 30 m deep at an equilibrium (steady-state) rate of 1000 m^3/d. two observation wells are located at distances 50m and 100m from the well and they have been drawn down by 0.3m and 0.2m, respectively.

(i)What are the coefficient of permeability : [05 marks]

(ii)Estimate drawdown at the well? [04 marks]

(c) (i) Broadly classify the 'surface water intakes' [01 marks]

(ii) Write a brief description on one of those. Draw a sketch of the selected category of intake to support your answer. [04 marks]

Question 3.

(a) (i) List the tests that can be carried out at the laboratory of the water treatment plants to test the raw/treated water quality for drinking water. [02 marks]

(ii) A water treatment plant purifies 2 million m^3/day and computed that 28mg/L of alum for coagulation process during rainy season. Estimate the monthly requirement of alum for removing turbidity of raw water. [03 marks]

(b) (i) Aeration is generally recommended specially for when the source is groundwater. List the purpose of having aerators in a water supply system. [03 marks]

(ii)Find the exposure of water in gravity aerators falling through a distance 4m, in three descents. The elapse time is given as $t=\sqrt{2nh/g}$ [04 marks]

(c) Design a rectangular sedimentation tank to treat 2.4 million raw water per day. Assume the retention time is 3 hrs and depth of the sedimentation tank is 3.5 including 0.5 m free board.

(i) Dimensions of sedimentation tank [04 marks]

(ii) Overflow rate [04 marks]

Question 4.

(a) A rectangular sedimentation basin will have a design flow of 3800 m^3/d of raw water using a 2:1 length /width ratio, an overflow rate of 0.00024 m/s and detention time of the basin is 3 hours.

(i) What will the dimensions of the basin be? [03 marks]

(ii) Calculate the weir length [01 mark]

(iii)What will be the weir loading? [03 marks]

(b) (i)What is meant by 'break point chlorination'? How do it useful in disinfection process? [02 marks]

(ii) If the chlorine demand is 1.2mg/L and the design flow is 0.25m³/s what would be the chlorine usage per day in this treatment plant. Also compute the approximate chlorine usage per year. [03 marks]

(iii) What is the necessity of maintaining 'residual chlorine' in treated water?[02 marks]

(iv) List the consequences, if the dosage of chlorine is higher than the requirement? [02 marks]

(c) A rapid filtration unit in a treatment plant is to be constructed to process 100,000 m³/day. It was estimated that filtration rate of 20m/h will be acceptable. Estimate the number of filter units that would be required assuming that approximate surface configuration of a filter unit is 7mx10m. Allow one unit out of service for backwashing. [04 marks]

Question 5.

(a) (i) What is the purpose of having a distribution reservoir? Briefly explain. [03 marks]

(ii) What is the need of 'equalizing storage" for a city water supply system?[02 marks]

(b) (i) Why the measurement of BOD and COD of wastewater is important? [01 marks]

(ii) Self-purification capacity is important for a balance healthy ecosystem of a stream. What are the controlling factors of 'self-purification capacity' of a stream. [03 marks]

(iii) A milk processing factory discharges 0.2 m³/s wastewater into nearby stream. The five-day BOD of the wastewater is 1200 mg/L considering that the average stream flow is eight times higher than the factory discharge. If the BOD concentration of the river is 5mg/L calculate the five-day BOD concentration of the stream at the immediate downstream. If the stipulated five-day BOD is given as 30mg/L, write whether the said disposal method is fulfilled the legal requirements? [06 marks]

(c) A laboratory test was conducted to determine BOD of a wastewater sample. 15 mL of sample was incubated using a 300 mL standard BOD bottle. If the initial dissolved oxygen concentration of 8.2 mg/L and the sample was kept at 20°C for five days to determine the BOD. If the 5 day dissolved oxygen concentration had dropped to 4.1 mg/L;

(i) What is the 5-day BOD of the wastewater? [03 marks]

(ii) If the reaction rate constants 0.20/day, what would be the ultimate BOD of waste? [BOD$_5$ = L$_o$ (1- e^{-kt})] [02 marks]

Question 6.

(a) (i) Why the screens are important in preliminary wastewater treatment system? Where it is located? [02 marks]

(ii) What are the methods available for velocity control? Explain briefly. [02 marks]

(iii) What is skimming tank and where is it employed? [02 marks]

(b) **(i)** What is meant by 'recirculation' in wastewater treatment systems? Explain with the help of a sketch if necessary. [02 marks]

(ii) Calculate the diameter and depth of a circular sedimentation basin for a design flow of 2800m³/d and the recirculation is 1000 m³/d, based on an overflow rate of 0.00024m/s and a detention time of 3 hr. [06 marks]

(c) **(i)** Differentiate drywells and wet wells? [02 marks]

(ii) In the combined sewer line, a pneumatic ejector is used for lifting sewage from 10m below lift station. If the air volume is given by $V = \dfrac{Q(H+10.3)}{12.2}$ m³/min, what would be the required air quantity for the ejector? [04 marks]

Question 7.

(a) It is proposed to design an activated sludge plant to treat 5000m³/day flow if domestic wastewater to reduce the concentrations of settled BOD_5 from 400mg/l to 20mg/l. If the system is to operate at F/M of 0.2/day and maintain 2500mg/l concentrations of MLSS in the aeration tank by recycling 2200m³/day flow of activated sludge from the secondary settling tank, compute:

(i) The volume of the aeration tank. [03 marks]

(ii) Hydraulic retention time. [03 marks]

(iii) Oxygen required per day if the mean cell residence time is 10 days. [03 marks]

[The oxygen required/day $= 1.47Q(S_o - S) - 1.42V\left(\dfrac{x}{\theta_c}\right)$ and $F/M = \dfrac{Q.BOD}{V.MLSS}$ with usual notations]

(b) **(i)** List the methods available for sludge thickening? [02 marks]

(ii) Why sludge is required to be stabilized before final disposal? [02 marks]

(iii) List the main factors that affect anaerobic sludge digestion. [02 marks]

(iv) How do you reuse the treated wastewater? Provide two examples. [02 marks]

(c) Drain fields are used to discharge effluents in such systems. A rural community produce a wastewater flow of 40m³/day. Assuming the depth of a trench, calculate the drain length of a drain field. Percolation rate of a soil is given as 20liters/m²/day and dimensions of drain field are given by the equation $L = \dfrac{NQ}{2DI}$ with usual notations.

[03 marks]

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