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

CEX 4234- WATER SUPPLY AND SEWERAGE ENGINEERING

FINAL EXAMINATION - 2012/2013

Time Allowed: Three Hours *Index No.* ☐☐☐☐

Date: 01st of August, 2013 **Time: 0930 - 1230**

Answer any FIVE questions. All questions carry equal marks.

Question 1.

(a) (i) What is a perched aquifer? [02 marks]
(ii) Using a neat sketch, explain briefly how a perched aquifer is formed. [02 marks]
(iii) What methods are available to obtain water from perched aquifers? [01 mark]

(b) (i) How do local climatic conditions and individual water meters affect the water demand? [02 marks]
(ii) Hirigal Ella stream is the only water source identified to supply water for a village at a mountainous region. The water supply is intended to serve 60 houses with an average household size of 5. Consider a design period of 30 years. Population growth rates for three consecutive years are given as 0.09, 0.085 and 0.10. Estimate the geometric mean and design water demand after three decades, considering per capita water demand as120 liters/day. [06 marks]

(c) Raddolugama water treatment plant, which abstracts water from Dadugam Oya, has the river intake situated 2 km away from the plant.
(i) What factors govern the location of such an intake structure located on this meandering river? [03 marks]
(ii) How is the water conveyed to the treatment plant? [01 marks]
(iii) What are the disadvantageous of open channels and masonry aqueducts used to convey water to treatment plants? [03 marks]

Question 2.

(a) (i) Why coagulation and flocculation is needed in surface water treatment? [02 marks]
(ii) Name two trivalent metallic salts used as coagulants. [01 mark]
(iii) What is the jar test and its significance in coagulation operation in water treatment? [02 marks]

(b) (i) List the types of flocculators employed in water treatment plants. [01 marks]

(ii) A water treatment plant has been designed to process 25,000 m^3 of water per day. The rapid mixing tank will blend 35 mg/l alum with the flow and is to have a detention time of 2 min. Determine the quantity (kilogram per day) of alum added and the dimensions of the three flocculation tanks. [07 marks]

c) A water treatment system must be able to deliver $60x10^6$ liters per day of water to a city of 150,000 people.
(i) Estimate the surface area of three settling basins that are 3 m depth with 2 hour detention periods. [05 marks]
(ii) Discuss utilization and disposal options for water treatment sludge collected in the settling tanks following flocculation basins. [02 marks]

Question 3.

(a) A filter unit is to be constructed to process 25,000 m^3/d. Pilot plant analysis on mixed media indicates that a filtration rate of 15 m/h will be acceptable. Assuming a surface configuration of approximately 5 × 8 m, how many filter units will be required? [08 marks]

(b) Chlorine is widely used as a disinfectant in Sri Lanka. The break point chlorination curve prepared for a disinfection process is shown in Figure Q3.

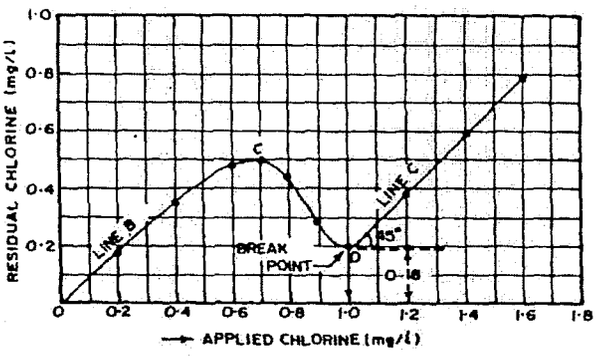

Figure Q3. Illustration for the Problem Q3(b)

(i) What would be the recommended chlorine dose? Explain your answer. [01 marks]
(ii) What is an alternative method to determine the residual chlorine at the laboratory? [02 marks]
(iii) Estimate the chlorine requirement per day that is needed to disinfect a total volume of 25,000 m^3/d water in the above treatment plant. [03 marks]

(c) Hardness in water causes many problems for users, both domestic as well as industrial.
(i) Differentiate between temporary and permanent hardness. [02 marks]
(ii) What are the methods available to remove hardness in water intended to be used for industrial purposes? [01 mark]
(iii) What is meant by 'regenerating of a softener' plant? What compound or compounds can be used for regenerating process in softener plants? [03 marks]

Question 4.

(a) (i) In water distribution systems 'gridiron' arrangement of pipes is preferred as a layout than that has many 'dead-end' branches. Explain the reasons briefly. [03 marks]
(ii) List most appropriate types of joints that can be used in cast iron, PVC, RCP, and steel pipes, respectively. [02 marks]
(iii) Special attention should be paid when laying pipes in low-lying service areas, mainly to prevent leaks and water main breaks. Why does this happen and how do you overcome this situation? [04 marks]

(b) (i) What are the basic functions of a distribution storage tank other than providing equalization storage? [02 marks]
(ii) A town has a population of 32,000 people with an average per capita water demand of 200 l/d. Assuming that the need for equalizing storage is 20 percent of the average daily demand and that storage for a fire flow of 60 l/s for a 4 h duration is required, compute the required volume of a distribution storage tank for the town. [04 marks]

(c) Many water mains suffer the effects of a gradual and persistent buildup as solid deposits on the inside wall of the pipe, which is called 'tuberculation'.
(i) Describe how these deposits buildup and how 'tuberculation' affects water supply. [03 marks]
(ii) How are water mains with internal deposits in the pipe wall are rehabilitated? [02 marks]

Question 5.

(a) (i) What is meant by 'self-cleansing velocity' and why is it necessary to maintain such a velocity at least once a day in a sewer? [04 marks]
(ii) A main combined sewer is to be designed to serve an area of 12 km^2 with a population density of 250 liters/capita/day. The maximum flow is 100% in excess of average together with the rainfall equivalent of 15 mm in 24 hrs, all of which are runoff. Determine the total flow for the combined sewer. Taking the maximum velocity of flow as 3 mm/sec, determine the size of the circular sewer. [06 marks]

(b) (i) What is the use of 'inlets' in storm water sewers? [02 marks]
(ii) Differentiate clearly between curb inlet and a gutter inlet. [02 marks]

(c) (i) What are the factors to be considered when selecting a material to construct sewer pipes? [02 marks]
(ii) How does 'crown corrosion' occur in sewer carrying pipes that are made of concrete, and explain how these concerete pipes can be protected against crown corrosion? [04 marks]

Question 6.

(a) (i) Dissolved oxygen (DO) is one of the most important constituents for biodegradation in any aquatic system. What are the two mechanisms that replenish oxygen in natural water systems? [01 marks]

(ii) The BOD_5 of a water sample obtained from natural water has been measured as 150 mg/l at 20°C. What proportion of ultimate BOD remains unoxidised after 20 days? [$BOD_5 = Lo\ (1 - e^{-kt})$; $K_{20} = 0.23$/day] [04 marks]

(b) Aeration is the most important unit operation in the activated sludge process.

(i) How aeration helps the activated sludge process? [03 marks]

(ii) What are the methods available for aeration in an activated sludge process? [02 marks]

(c) An aeration system with a hydraulic retention time of 2.5 hour receives a flow of 750 m^3/d at a BOD of 150 mg/l. The suspended solids concentration in the aeration tank is 4,000 mg/l. The effluent BOD is 20 mg/l and effluent suspended solid concentration is 30 mg/l. Calculate,

(i) The volume of the aeration tank [02 marks]

(ii) F/M ratio (food to microorganisms) [03 marks]

(iii) Percentage efficiency of BOD and SS removal for this system. [02 marks]

(iv) What would be the oxygen requirement per day, if the sludge age is 8 days. O_2 required per day = $1.47\ Q\ (S_0 - S) - 1.42 V(x/\theta_c)$ with usual notations. [03 marks]

Question 7.

(a) Dwellers in rural areas and suburban towns in Sri Lanka generally use septic tanks for sewage disposal.

(i) What are the advantages and disadvantages of using septic tanks? [02 marks]

(ii) Estimate the size of the septic tank and the drain field to treat wastewater flow of 2 m^3/day. State the assumptions that you make (The trench length is given by NQ/2DI with usual notations. i=10 litres/ m^2/day) [04 marks]

(iii) A drain field does not function properly for areas with a high water table. What alternatives do you suggest for such a situation? [02 marks]

(b) (i) Explain why dewatering of sludge is important? [01 marks]

(ii) Explain the method of dewatering the sludge on sludge drying beds. [02 marks]

(iii) Estimate the per capita area of drying bed that is needed for digested sludge from an activated sludge plant serving 200,000 people. Assume that the total solids remaining in the digested sludge (combined primary and activated) is 57 g/capita/day and solids loading per year is 365 kg/m^2. [05 marks]

(c) (i) If untreated wastewater is disposed through a sea outfall, what would be the consequences that can occur? [02 marks]

(ii) Suggest methods that can be adopted to minimize coastal pollution due to such wastewater disposal. [02 marks]

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