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

CEX 4234 - WATER SUPPLY AND SEWERAGE ENGINEERING

FINAL EXAMINATION - 2015/2016

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

Date: 26th of November, 2016 **Time: 0930 - 1230**

Answer any FIVE questions. All questions carry equal marks.

Question 1.

(a) (i) List the factors that govern the selection of a water source. [02 marks]
(ii) The key parameters to calculate the water demand include, the 'average daily rate of water consumption' and, the 'peak rate of water demand'. Discuss briefly why is it important to estimate the average daily water consumption, highlighting two reasons. [04 marks]

(b) (i)To estimate the future water need of a city, the population forecasting is done based on 2010 and 2015 census data. Explain how reliable this poplation estimate would be? [03 marks]
(ii) A small housing scheme of 50 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. [02 marks]
(iii) If the number of houses increases to 83, 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. [03 marks]

(c) (i)What is meant by 'Non-Revenue Water' or NRW? Briefly explain what causes Non-Revenue Water. [02 marks]
(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 millilitres of water. Calculate how much water (in liters) will be lost during one year. [02 marks]
(iii) Assuming the cost of water per cubic meter is Rs. 25, estimate the non-revenue per year due to a leaking faucet. [02 marks]

Question 2.

(a) (i)What is meant by 'base flow of a perennial stream' ? [02 marks]

(ii) A well with a 0.25 m diameter fully penetrates an unconfined aquifer that is 20 m thick. The well has a discharge of 0.015 m^2/s and a drawdown of 8 m. If the flow is steady and the permeability is 1.5 x 10^{-4} m/s, what is the height of the piezometric surface above the confining layer at a site 80 m away from the well. [07 marks]

(b) (i) List the methods available for locating and accessing groundwater sources. [03 marks]

(ii)If a water supply authority has decided to use groundwater as the water source, what unit processes would be recommended to afford minimum treatment? [02 marks]

(c) (i)Unlike groundwater intakes, surface water intakes are broadly categorized based on their special features. Describe those categories, highlighting such special features. [03 marks]

(ii)Dissolved gases in the water supply is a common problem in many water supply systems. Explain three methods that can be used to remove dissolved gases from water. [03 marks]

Question 3.

(a) (i) Any impounded water reservoir should be free of vegetation and preventive measures for comtrolomg vegetation infestations are important. What can be used to control algal growth in water storage impoundments? [03 marks]

(ii) Describe three basic approaches that can be used in the removal of odours in water. Explain each with the aid of sketches. [03 marks]

(b) (i) Describe the meaning of 'detention time' and the 'overflow rate' with reference to sedimentation unit process. [03 marks]

(ii)Determine the surface area of a settling tank for a new water treatment plant with a design flow of 0.5 m^3/s and a design overflow rate of 16 $m^3/day.m^2$. Find the depth of the clarifier and the detention time. Assume a minimum of two tanks being provided and the length:width ratio for settling is 5:1. [06 marks]

(c) (i) Adding a coagulant aid is the general practice in coagulation and flocculation treatment process. How does a coagulant and the coagulant aid result in coagulation? [02 marks]

(ii) What are the common coagulant aids used in water treatment? [01 mark]

(iii) Under what circumstances are lime and/or soda ash added to water during the coagulation process? [02 marks]

Question 4.

(a) Two proposed rectangular settling basins, each having dimensions of 9 m long, 4.5 m wide, and 3 m deep, is used to settle 1500 m^3 of water per day, following alum coagulation. The effluent channels have a total weir length of 18 m. Calculate the detention time, overflow rate and weir loading. [06 marks]

(b) (i)A proposed filtration unit of a water treatment plant indicates that 12 m/h will be acceptable to treat 5,000 m^3/d. If the surface configuration of the filtration unit is 8 m × 10 m, how many filter units will be required for this treatment plant? Allow one additional back up unit to be used when a filtration unit is out of service for backwashing. [04 marks]

(ii) When clogged, the above 10 m × 20 m 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? [04 marks]

(c) Suppose that it is necessary to recommend a series of laboratory tests to be run on a small drinking water treatment plant in a developing country. The plant consists of coagulation and flocculation, sedimentation, rapid sand filtration unit processes and disinfection using Chlorination. List the tests to be done and the frequency. [06 marks]

Question 5.

(a) A community requires water at a maximum flow of 50 million L/d during 10 h on a peak day beginning at 8 a.m. to 6 p.m. During the 10 h, it needs 10 million L/d. During the entire 24 h period, the water treatment plant is able to provide a constant flow of 25 million L/d that is pumped into the distribution system. Estimate the size of the elevated storage tank to meet the peak water demand. [06 marks]

(b) (i) Briefly explain why it is important to consider the position and the elevation of distribution reservoirs when planning a water supply system. [02 marks]

(ii) Why are pressure reducing valves not recommended, especially at low level mains in water distribution systems.? What do you recommend instead of using pressure reducing valves? [02 marks]

(c) (i) Define the 'time of concentration'. [01 marks]

(ii)How peak discharge is estimated when the values for 'duration of rainfall' and the 'time of concentration' are same? [02 marks]

(ii) What is the peak discharge from a land area of a school for a 5-year storm? The land area encompasses a 0.2 km^2 plot. Assume the time of concentration of the grounds is 55 minutes. The composition of the area is as follows:

Table Q5 (c):

Characterization of surface	Area (m^2) %	Runoff coefficient
Parking lot – Asphalt cover	20	0.85
Building	15	0.75
Lawns, heavy soil		
2% slope	40	0.17
6% slope	25	0.20

[07 marks]

Question 6.

(a) (i) List the most important pollutant affecting water quality in rivers and explain how it affects water quality of the river. [03 marks]

(iii) 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 graph explain the behavior of self-assimilation capacity of a river. [03 marks]

(b) (i)The BOD of a wastewater sample is estimated to be 180 mg/L. What is the volume of undiluted sample that should be added to a 300-mL bottle? Also, what is the sample size used for and the dilution factor for this volume? Assume that 4 mg/L can be consumed in the BOD bottle. [06 marks]

(ii) Assuming the rate constant is 0.18/d, find the ultimate BOD of the wastewater of the above wastewater sample at 20°C. [03 marks]

(c) A city situated on a large river continuously disposes treated wastewater to the river. The *minimum* flow in the river is 150 m^3/s and the discharge rate of the treatment plant is 10 m^3/s. If the maximum acceptable level of a certain pollutant is 15 mg/L in the downstream of the river, and the recorded maximum concentration of this pollutant in upstream 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. [05 marks]

Question 7.

(a) (i)Two activated sludge aerated tanks are operated in series. Each tank has the following dimensions:

7.0 m wide, 30 m long, 4.3 m effective liquid depth.

The plant operating parameters are as follows:

Flow = 0.0796 m^3/s

Soluble BOD_5 after primary settling = 130 mg/L

MLSS = 2100 mg/L

MLSS =1.4 (MLVSS)

Determine the volume of the tank, F/M ratio and the aeration time. [06 marks]

(ii) If the effluent BOD is 15 mg/l, what would be the oxygen requirement per day, if the sludge age is 15 days? The O_2 requirement per day is given as:

$$1.47\ Q\ (S_0-S) - 1.42V(x/\theta_c)$$

with usual notations. [02 marks]

(b) (i) Compare the positive and negative effects of disinfection of wastewater effluents which are supposed to be discharged into inland surface water [04 marks]

(ii)Explain briefly about the consequences which can be expected if an effluent from a hospital wastewater treatment plant is used for irrigation purposes. [03 marks]

(c) (i) What is the objective of sludge stabilization? [01 marks]

(ii)What are the methods available for sludge stabilization? [02 marks]

(iii)What could be the ultimate goal of the stabilized sludge? [02 marks]

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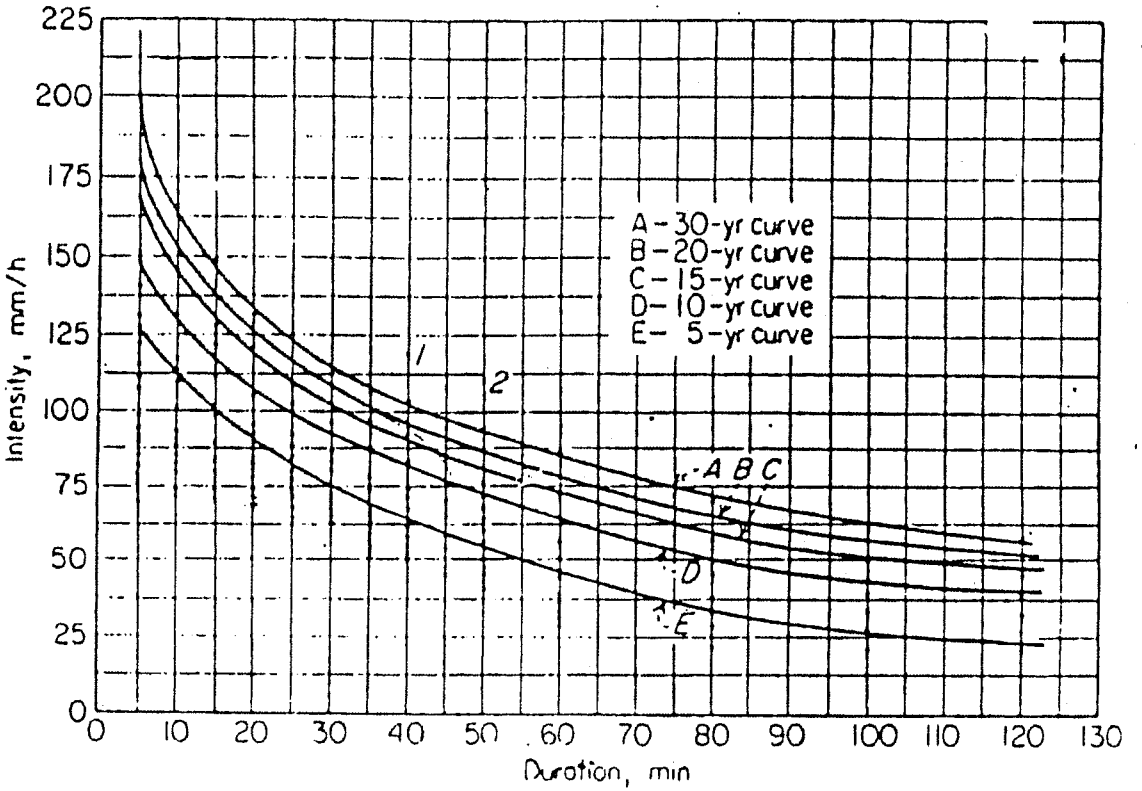

RAINFALL CURVES
DERIVED FROM STORM
RECORDS

FIG. Q5 - RAINFALL CURVES - DERIVED FROM STORM RECORDS