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

CEX 4234 - WATER SUPPLY AND SEWERAGE ENGINEERING

FINAL EXAMINATION   - 2014/2015

Time Allowed: Three Hours	*Index No.*

Date: 27th of August, 2015   **Time: 0930 - 1230**

Answer any FIVE questions. All questions carry equal marks.

Question 1.

(a) (i) Design period and population forecast are important for a water supply project. Why? Explain briefly.   [03 marks]

(ii) The average per capita water consumption in Sri Lankan cities varies widely. List five factors that directly influence for such variation.   [03 marks]

(b) The census data of a rural city in Northern Province is given in the following table.
(i) Compute the geometric rate of growth of population of the city.   [02 marks]
(ii) Estimate the population of the town in 2044 using the most appropriate method.
                                                                                                                                [04 marks]
(iii) Give reasons for selecting the particular computation technique for furcating population.
                                                                                                                                [02 marks]

Year	1974	1984	1994	2004	2014
Population	2234	5025	8016	16024	32365

(c) (i)Assuming the per capita demand of the above city is 200 L/day compute the design flow of the treatment plant after 3 decades. Provide 5% additional capacity for the design flow for unforeseen changes.   [03 marks]
(ii) If the industrial requirement in 2044 is $50000m^3$ compute the total water requirement in 2044.   [03 marks]

Question 2.

(a)   Groundwater aquifers are the largest available freshwater source of the earth.
(i) Differentiate between confined aquifer and unconfined aquifer.   [03 marks]
(ii)How groundwater withdraw for a public water supply systems   [02 marks]

(b) (i) What is meant by safe yield for a groundwater basin? [03 marks]

(ii) A pumping test was carried conducted in an unconfined aquifer using a test well penetrating to the underlying impervious stratum. Two observation well were located at distance of 20 and 120 m from the main well. Before starting, the static water levels in all three wells were 15.0 m above the underlying impervious stratum. Upon reaching equilibrium conditions after several hours of pumping the test well at a steady state of 35 L/s, the water level drawdown were measured as 3.04 m and 0.80 m in the observation wells at distances of 20 m and 120 m, respectively. Compute the field coefficient of permeability.

[07 marks]

(c) (i) Why it says that the groundwater needs less treatment when compares to the surface water? Explain briefly. [02 mark]

(ii) If the industrial requirement in 2044 is 50000m^3 compute the total water requirement in 2044. [03 marks]

Question 3.

(a) (i) List the four categories of water quality for drinking water. [02 marks]

(ii) Explain how to conduct a jar test to obtain an optimum coagulation dosage.

[03 marks]

(iii) A water treatment plant receiving 0.15m^3/s needs 12mg/L of alum for coagulation process. Estimate the weekly requirement of alum for removing turbidity of raw water.

[03 marks]

(b) (i) What is the volume required for a flocculation basin that is to be used to treat 0.15m^3/s of the water if the detention time is 10 seconds. [03 marks]

(ii) Suppose a parallel flocculation basins are to be used to treat a water flow of 0.15m^3/s. If the design detention time is 20 minutes, what is the volume of each tank? [04 marks]

(c) (i) What are the disposal options for water treatment sludge collected in the settling tanks following flocculation basin. [02 marks]

(ii) A new water treatment plant is being designed for Katharagama. The climate is dry and land is readily available at a reasonable cost. What methods of sludge dewatering would be most appropriate? Explain your reasoning. [03 marks]

Question 4.

(a) A proposed treatment plant consists of a rectangular sedimentation basin to treat 1.2 m^3/d of raw water with an L:B ratio of 3:1. If the detention time of the basin is 3 hours and weir loading is 125m^3/d/m^2 calculate

(i) Volume and depth of the sedimentation basin [03 marks]

(ii) Weir length [02 marks]

(b) (i)Short-circuiting is a greater concern in disinfection systems when 99.99% removal is the goal than when 90% removal is the goal. Explain why short-circuiting is more problematic when greater removal is sought. [03 marks]

(ii) In the Sri Lanka, Chlorine is preferred as a disinfectant over ozone because it has a residual. Why is the preference of a residual important? [02 marks]

(iii) There is a potential of producing THM as a byproduct when Chlorine use as the disinfectant. Under what conditions THM could be produces? [02 marks]

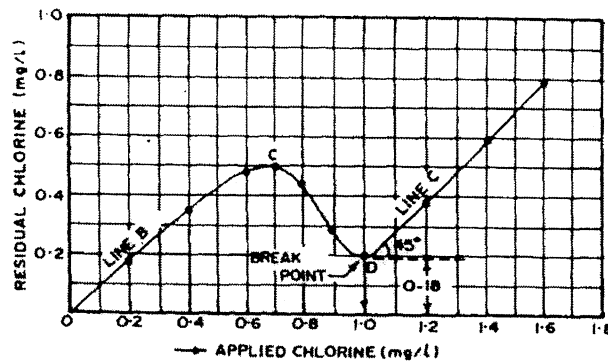**(c)** The break point chlorination curve prepared for a disinfection process is shown in Figure Q4.

Figure Q4. Illustration for the Problem Q4(c)

(i) If the design flow is 0.15m^3/s what would be the chlorine usage per day in this treatment plant. Also compute the approximate chlorine usage per month. [03 marks]

(ii) Differentiate free chlorine and combined chlorine in water treatment. [02 marks]

(iii) An adequate chlorine concentration for disinfection is often achieved prior to the chlorine "breakpoint." Why then is the breakpoint concentration used rather than a lesser concentration? [03 marks]

Question 5.

(a) (i) What is the main difference between rapid sand filter and slow sand filter? In what occasions are they used? Explain briefly. [02 marks]

(ii)Explain how a slow sand filter is cleaned when clogged. [02 marks]

(iii) A rural community needs to construct a slow sand filter for purifying water obtained from a small irrigation tank. Assuming a reasonable slow sand filtration rate compute the surface area of the slow sand filter? Assume that the population of the community is 75 and the per capita demand is 120 L/d [04 marks]

(b) (i)Generally distribution reservoirs are elevated type. What are the advantages of having elevated reservoirs? [02 marks]

(ii) Why PVC are popular in water distribution mains. Provide your views highlighting the merits of using PVC pipes. [02 marks]

(ii) List the majour components of a house water service connection. [01 marks]

(c) PQRS (shown in **Fig Q5**) is the water network of a proposed city. Find the equivalent length of 200mm diameter pipe for a triangular network. Use Hazen William formula or diagram if necessary. You are free to select any triangular network PQR or PRS for the computation. [07 marks]
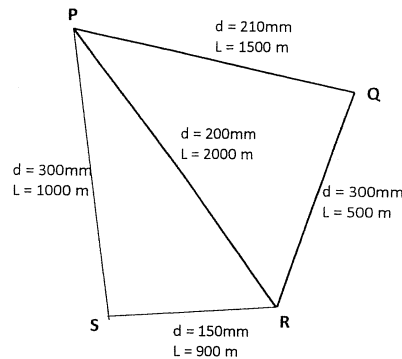

Figure Q5. Illustration for the Problem Q5(c)

Question 6.

(a) (i) Differentiate ordinary manholes and special manholes giving examples. [02 marks]

(ii)Explain the usage of curb inlets and gutter inlets. [01 mark]

(iii)What is catch basin? Explain the importance of having a catch basin in a sewer system. [02 marks]

(iv) How are lateral sewer ventilated? Explain briefly. [02 marks]

(b) If the BOD_5 of a municipal wastewater is 213 mg/L and the ultimate BOD is 318.4 mg/L What is the rate constant (base e)? Assume the temperature is 20°C. [03 marks]

(ii) A wastewater sample is being analyzed to determine its BOD content. The sample diluted in order to perform the test: 290 mL of distilled water are added to 5 mL of sample to fill the 300 mL BOD bottle. The bottle has an initial dissolved oxygen concentration of 7.7 mg/L. After incubating 5 days, the dissolved oxygen concentration is 4.1 mg/L.

(i) What is the 5-day BOD of the wastewater? [02 marks]

(ii) The deoxygenation rate constant, k_1, is 0.18 day^{-1}. What is the ultimate BOD of the wastewater? [03 marks]

(c) (i)What is meant by self purification capacity of a stream and its controlling factors? [01 marks]

(iii) A milk factory discharges 0.3 m³/s treated water into a river. The BOD of the wastewater is 350 mg/L considering that the average river flow of the river is eight times higher than the discharge. If the BOD concentration of the river is 30mg/L compute the BOD concentration in the river at the immediate downstream.

[04 marks]

Question 7.

(a) (i) Explain the difference between point source and nonpoint source of pollution.

[01 mark]

(ii) List the two nutrients of primary concern with respect to a receiving body of water.

[01 mark]

(iii) What problems are arisen when polluted water discharge in to the coastal waters? List three of them.

[02 marks]

(b) (i) The concentration of mixed-liquor suspended solids (MLSS) is often taken as the concentration of active biomass. List two shortcomings to the assumption that X = MLSS?

[02 marks]

(ii) A municipal wastewater treated by an activated sludge reactor under the following condition. Determine food to biomass ratio (F/M) of the system and the BOD removal efficiency.

Flow =15000m³/day
Influent BOD =230 mg/L
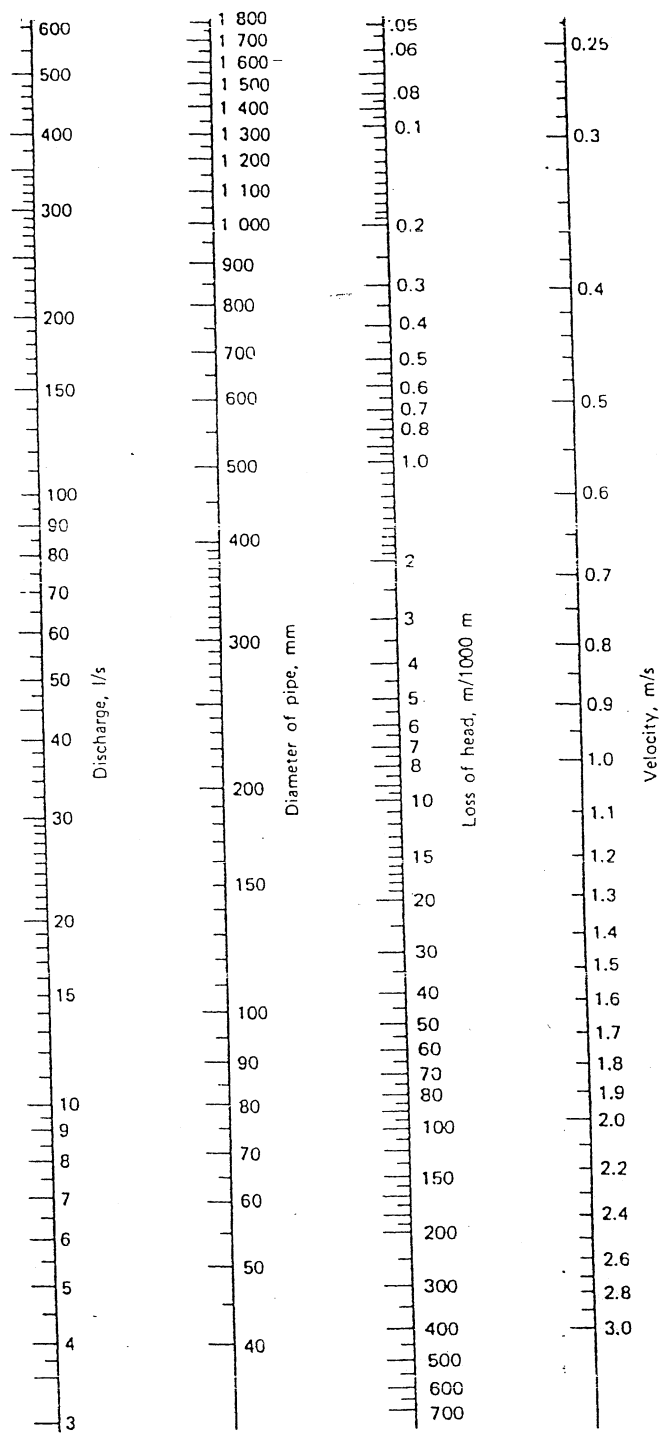Effluent BOD= 10 mg/L
Retention time= 4 hours
MLVSS= 3000 mg/L

[06 marks]

(c) (i) Why sludge digestion is important in wastewater treatment. Briefly explain.

[02 marks]

(ii) Design a sludge digester for a town with a population of 100000, given that volume of the fresh sludge and digested sludge are 2.1m³/day/1000persons and 8m³/day/1000persons. Assume that the digester period =30 days at 28°C.

[06 marks]

--------XXXXX---------

Discharge, l/s

600
500
400
300

200

150

100
90
80
70
60
50

40

30

20

15

10
9
8
7
6
5
4
3

Diameter of pipe, mm

1 800
1 700
1 600
1 500
1 400
1 300
1 200
1 100
1 000

900
800

700

600

500

400

300

200

150

100
90
80
70
60
50

40

Loss of head, m/1000 m

.05
.06
.08
0.1

0.2

0.3
0.4
0.5
0.6
0.7
0.8
1.0

2

3
4
5
6
7
8
10

15

20

30

40
50
60
70
80
100

150

200

300

400
500
600
700

Velocity, m/s

0.25

0.3

0.4

0.5

0.6

0.7

0.8

0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.2
2.4
2.6
2.8
3.0

Nomograph for Hazen Williams Formula, based on $C = 100$.