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

## CEX 4234- WATER SUPPLY AND SEWERAGE ENGINEERING

### FINAL EXAMINATION    - 2013/2014

Time Allowed:  Three Hours                          *Index No.*

Date:  14<sup>th</sup> of August, 2014                           Time: 0930 - 1230

**Answer any <u>FIVE</u> questions. All questions carry equal marks.**

## Question 1.

(a) (i) What is an aquifer?                                                        [01 mark]
    (ii) Using a neat sketch, explain confined aquifer and unconfined aquifer.   [03 marks]
    (iii) What is the difference of a water table well and an artesian well?      [02 marks]

(b) An unconfined aquifer is 10 m thick and is being pumped so that one observation well placed at a distance shows a drawdown of 0.5m. On the opposite side of the extraction well is another observation well 100 m from the extraction well and this well shows a drawdown of 0.3m. Assume the coefficient of permeability is 50m/day.
    (i) What is the discharge of the extraction well?                            [06 marks]
    (ii) Suppose the well at 100 m from the extraction well is now pumped. Show with a sketch what this will do with the drawdown.                                        [02 marks]

(c) (i) What is the broad classification of surface water intakes? Explain the main features of those intakes.                                                               [04marks]
    (ii) A design of water transmission line depends on several factors. List four of them.
                                                                                 [02 marks]

## Question 2.

(a) (i) The average per capita water consumption of city caries due to number of factors. Consider the city where you live and list five main factors which directly affect for the per capita demand of your city.                                                    [04 marks]

    (ii) Suppose census data of your city is given in the following table. Estimate the geometric rate of growth of population calculate the population of the town in 2041.

$[P_n = P(1+r)^n]$

[05 marks]

| Year | 1981 | 1991 | 2001 | 2011 |
|------|------|------|------|------|
| Population | 30711 | 45346 | 68523 | 84694 |

**(b)** (ii) What do you understand by the term 'fluctuation' in water demand per day?

[02 marks]

(iii) What is an intermittent system of water supply? [01 marks]

(iii) Non revenue water (NRW) or non accounting water is a serious issue for any water supplier. What components that list under NRW? [02 marks]

**(c)** A residential development of 350 houses is being planned. Assume the National norms for the average daily household consumption apply, and that each house has four residents. Estimate the additional average daily water production in L/d that will have to be supplied by the city. If the water consumption reduces by 14% due to rainwater harvesting what would be the total design demand? [06 marks]

## Question 3.

**(a)** (i) What is the meaning of the terms "coagulation", "floc" and "flocculation"? Are they the same when we consider water treatment? [04 marks]

(ii) How does a coagulant aid result in coagulation? List the four basic types of coagulant aids. [03 marks]

(iii) How does stirring help the process of flocculation? Explain briefly. [02 marks]

**(b)** (i) A water treatment plant receiving 8 million L/d needs 14mg/L of alum for coagulation process. Estimate the weekly requirement of alum for removing turbidity of raw water. [02 marks]

(ii) The sedimentation tank of the above treatment plant has diameter of 20m and an average water depth of 3m for settling particles. Calculate the retention time and over flow rate of the sedimentation basin? Estimate the linear meters of weir. [05 marks]

**(c)** (i) Filtration in very important process in meeting turbidity limits. What is the filtration rate or 8m by 6m filter if it receives 8 million L/d? [02 marks]

(ii) How much backwash water is required to clean a 8m by 6m filter? [02 marks]

## Question 4.

**(a)** (i) What is meant by "residual chlorine" in treated water? [01 mark]

(ii) Why is residual chlorine maintained in treated water? [01 mark]

(iii) What value of residual chlorine would you expect in Tap water, Well water and Rain water? [02 marks]

**(b)** (i) Selection of pipe sizes is important for water distribution systems. Why? Explain briefly. [02 marks]

(ii) Plastic pipes (PVC) are commonly used in Sri Lanka for water distribution systems. What are the main advantageous of using plastic pipes? [02 marks]

(iii) Find the leakage of a pipeline of 225 mm, 500 m section to maintain the required pressure 1000 kPa. The pipe sections are 5m long between joints. Does it exceed allowable leakage given as 15 L/h. Allowable leakage is given in following formula with usual notation? [04 marks]

$$Q_L = \frac{N \times D \times P^{1/2}}{C}$$

Where $Q_L$ = Allowable leakage

N – Number of joints in length of main tested

D = pipe diameter (mm)

P = Test pressure

C = 32600

**(c)** Find the equivalent length of 25cm diameter pipe for the network shown in Fig **Q4**. Use Hazen William formula or diagram if necessary. [08 marks]
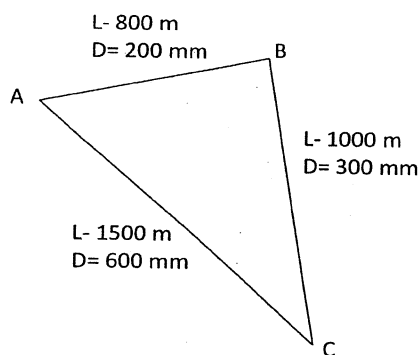


L- 800 m
D= 200 mm

L- 1000 m
D= 300 mm

L- 1500 m
D= 600 mm

**Figure Q4. Illustration for the Problem Q4(c)**

**Question 5.**

(a) (i)Briefly explain the use and operation of gate valve, butterfly valve and check valve in water distribution systems. [03 marks]

(ii)Standard pressure-operated flush valves are installed in a newly constructed building, for its water closets. When flushing, these valves deliver 130 l/min. If the delivered water costs Rs 40 per cubic meter, what is the monthly cost of not repairing a broken valve that flushes continuously? [04 marks]

(b) (i) What is the primary reason for installing manholes spaced along a sewer line?
[01 mark]

(ii) What factors dictate their placement? [02 marks]

(iii) Where are drop manholes used and why? [02 marks]

(c) (i) A discharge from a sewage treatment plant enters a stream at a flow rate of $3m^3/d$. The BOD of the discharge is 50mg/L. How many Kgs of BOD are entering the stream per day [03 marks]

(ii) If you have two BOD bottles full of lake water and keep one in dark and the other in day light, which one would have a higher DO after a few days? Why? [02 marks]

(iii) Suppose the ultimate BOD of the lake water sample is 570mg/L. Calculate the 5 day BOD at 20°C. Assume $K_{20} = 0.22/day$ ; $BOD_5 = Lo (1- e^{-kt})$ [03 marks]

**Question 6.**

(a) (i)Explain the difference between point source and nonpoint source of pollution.
[02 marks]

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

(iii)A battery factory discharges 0.126 $m^3/s$ treated water into a river. The heavy metal (Pb) of the wastewater is 250 µg/L. The stream average flow is 1.7$m^3/s$. Upstream of the wastewater outfall; the Pb concentration is 1.2 µg/L. Calculate the Pb concentration in the river after mixing. [04 marks]

(b) (i) What is the purpose of recirculation in a trickling filter plant and how does it differ from return sludge in an activated sludge plant? [03 marks]

(ii)If the F/M ratio a 0.4380 $m^3/s$ activated sludge plant is 0.2 mg/mg. d, the influent $BOD_5$ after primary settling is 150mg/Land the MLVSS is 2200 mg/L, what is the volume of the aeration tank? [04 marks]

(c) A conventional treatment plant receives 90L/s with an average BOD of 250mg/L. The aeration basin is 3000m$^3$. The MLSS is 2800mg/L and effluent SS is 25mg/L. The waste activated sludge is 2m$^3$/s from the recycle line. The SS of the recycle flow is 9000 mg/L.

(i) What is the F/M ratio? [03 marks]

(ii) What is the mean cell residence time (MCRT) [03 marks]

## Question 7.

(a) (i) What is the difference between oxidation pond and oxidation ditch? [02 marks]

(ii) An oxidation pond having s surface area of 90,000m$^3$ is loaded with a waste flow of 500m$^3$/day containing 180Kg of BOD$_5$. The operating depth is from 0.8 to1.6 m. Determine the loading rate and detention time of the oxidation pond. [06 marks]

(b) An anaerobic digester produces 13m$^3$/day of sludge with a suspended solids concentration of 8 percent. What volume of sludge must they discharge of each year if their sand drying beds yield a solid concentration of 35 percent? [05 marks]

(c) (i) Explain briefly three basic approaches to land treatment of wastewater. [03 marks]

(iii) Compare the positive and negative effects of disinfection of wastewater effluents. [02 marks]

(iv) What are the consequences can be expected if effluents from hospital wastewater are used for irrigation purposes. Explain briefly. [02 marks]
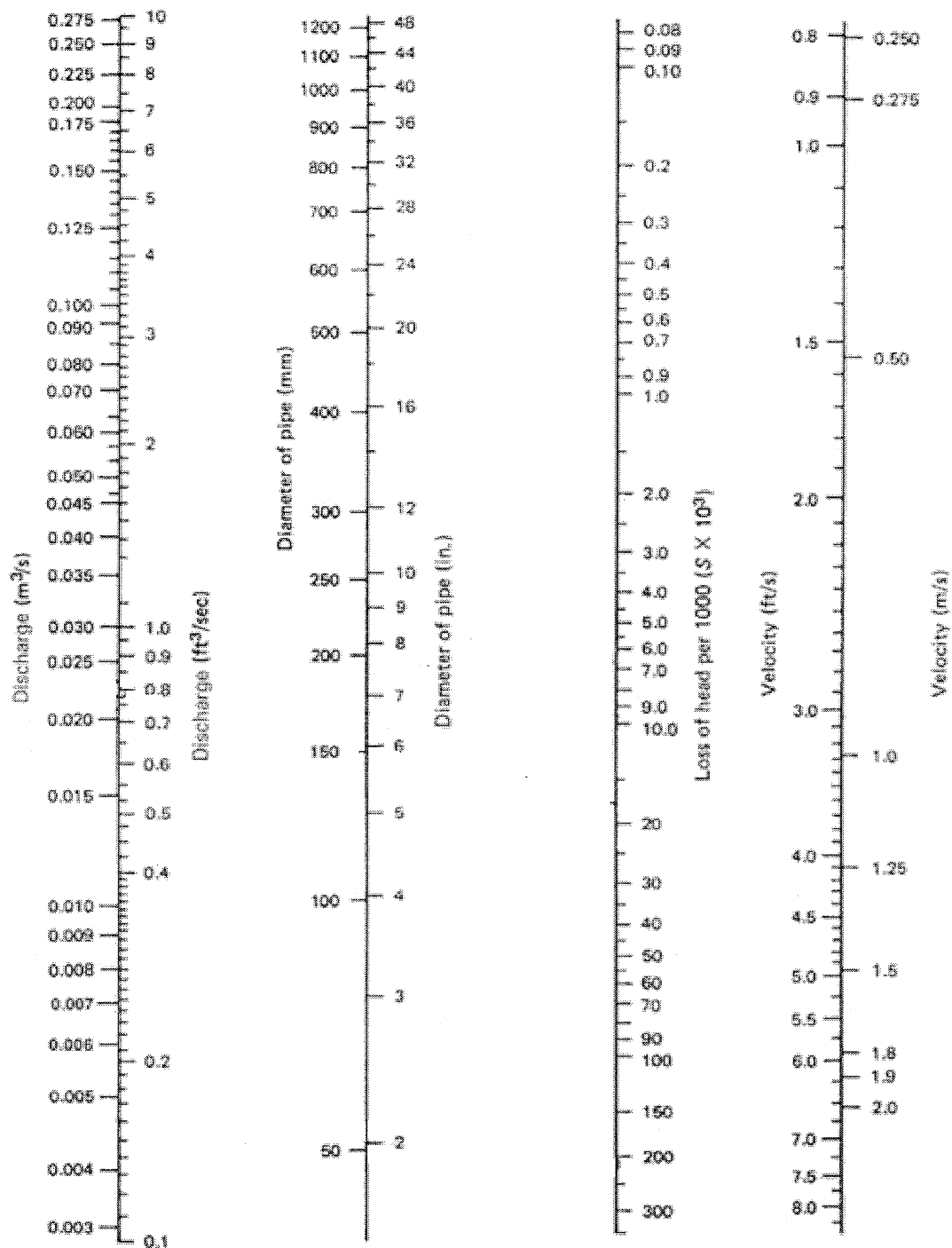
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Title of Data: Hazen- Williams Nomograph



Nomogram based on the Hazen-Williams equation, for $C = 100$.

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