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

CEX 4234- WATER SUPPLY AND SEWERAGE ENGINEERING

FINAL EXAMINATION - 2010/2011

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

Date: 10th March, 2011 **Time: 0930 - 1230**

Answer any FIVE questions. All questions carry equal marks.

Question 1.

(a) Surface runoff forms the surface sources for water supply, while. the water in the zone of saturation called as 'groundwater'

(i) What are the main types of surface water sources and groundwater sources available for water supply? [02 marks]

(ii) What factors are affecting in selection of water source for a public water supply? [02 marks]

(iii) A well of 0.6 m diameter is driven in an aquifer having unconfined flow. The water level when it is not pumped is 30m above the impervious layer. When water is pumped at 150m^3/hr, the level of water below the original level in the observation well at a distance of 15m is 3m and another well at a distance of 30m is 1m. Calculate the drawdown at the pumping well. [06 marks]

(b) Though no water in earth is 100% pure, drinking water should be wholesome or potable. What are the properties that would expect from wholesome water? Explain briefly. [03 marks]

(c) (i) What are the various factors which directly after the per capita demand of a town. [02 marks]

(ii) A local authority (LA) needs to expand their city water supply to serve till year 2040. The city considers as a growing semi urban city. Determine the future population of the city using the most appropriate method using following data.

Year	1970	1980	1990	2000	2010
Population (thousands)	40.2	44.5	60.4	75.4	88.5

[05 marks]

Question 2.

(a) Aeration is not a must, but use to improve drinking water quality in water treatment systems.

(i) How can aeration improve drinking water quality? Describe briefly. [03 marks]

(ii) List the types of aerators available to aerate water? [02 marks]

(b) A rectangular sedimentation tank to be designed for a flow of 3.28MLD, with an L:B ratio of 2:1. The overflow rate is 0.023 cm/s and the detention time is 3.5h. If the weir loading is $120 m^3/d/m^2$ calculate,

(i) Surface loading rate [02 marks]

(ii) Depth of the tank [02 marks]

(iii) Weir length [03 marks]

(c) A grit chamber is employed to remove sand particles (density = 2650 kg/m^3) with a mean diameter of 0.12 mm. A velocity of 0.30 m/s will be automatically maintained, when the wastewater flow is 5,000 m^3/d. The depth of the grit chamber must be 1.5 times the width at maximum flow. (The settling velocity is given as $v_s = \frac{g(\rho_s - \rho)d^2}{18\mu}$ with usual notations.) Assuming the sand is spherical and the temperature of the wastewater is 25°C and viscosity of water is 1.0×10^2 cm^2/sec, estimate,

(i) Settling velocity of sand particles. [02 marks]

(ii) Cross sectional area of the grit chamber [02 marks]

(iii) The detention time of the grit chamber. [02 marks]

(iv) Length required for a particle to fall the entire tank depth. [02 marks]

Question 3.

(a) A rectangular sedimentation tank to be designed for a flow of 3.28MLD, with an L:B ratio of 2:1. The overflow rate is 0.023 cm/s and the detention time is 3.5h. If the weir loading is $120 m^3/d/m^2$ calculate,

(i) Surface loading rate [02 marks]

(ii) Depth of the tank [02 marks]

(iii) Weir length [02 marks]

(b) (i) What are the objects of disinfection of water? [01 marks]

(ii) Select two of followings and explain briefly. [03 marks]

Pre chlorination, Plain chlorination,
Super chlorination, Post chlorination,
Breakpoint chlorination

(iii) It is required to treat 5ML/day of water with 0.3mg/l of chlorine. If the disinfection is in the form of CaO that contains 30% of available chlorine, how many kg of CaO are required per week to treat the daily flow of water? [03 marks]

(c) Sand filters separate suspended matter from water by passing it through porous medium.

(i) What is the purpose of an underdrain (under pipeline) of a filter? [02 marks]

(ii) Design a rapid sand filter to treat 10ML/day, allowing 0.5% of filtered water for backwashing. If 0.5 hour per day is used for backwashing, determine the total filter area and number of units to be employed. It is given that the each bed area should be less than $50m^2$. [05 marks]

Question 4.

(a) (i) The selection of pipe material and pipe design depends on various factors. List them. [02 marks]

(ii) List the joints that can be used for cast-iron pipes. [01 marks]

(iii) What factors induce corrosion of water supply mains? How do you control the corrosion on pipe materials? [04 marks]

(b) (i) Describe the various layouts or distribution network in a water supply system and state their advantage and disadvantages. [02 marks]

(ii) Why water meters are important in house connections? Explain briefly. [02 marks]

(iii) Explain the different types of valves used in water distribution system with their specific purposes. [02 marks]

(c) ABC is part of proposed water distribution system for a city. Determine the theoretical diameter of a single 1500m long equivalent pipe from A to C, which is shown in figure Q4 (c). (Hazen William Constant; C=100 for the pipe material) [07 marks]

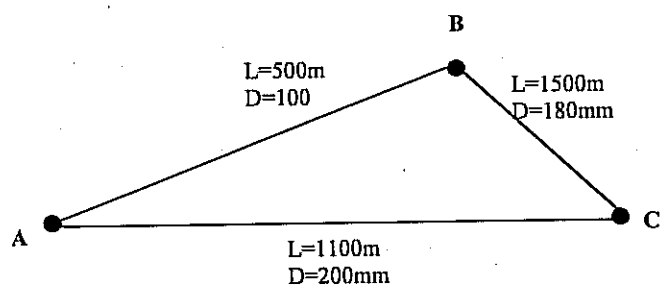

Figure Q4. Illustration for Problem Q4 (c)

Question 5.

(a) (i)Why is storm water control an important aspect of wastewater technology? [02 marks]

(ii) Briefly describe the factors which increase the storm runoff. [03 marks]

(b) (i) Suppose you work in a Local authority and you have been asked to design a storm drainage system for Officer's quarters of Hambantota National Centre. The following characteristics of the proposed scheme are given.

The total catchment area is 3 ha and it can be divided into two parts A_1 and A_2 depending on the classification. Runoff coefficient for each type of surface and slope for each sewer reach are given.

Catchment		Type of surface	% of total area	Runoff coefficient
Type	Area (ha)			
A1	1.2	Roof	50%	0.94
		Pavement	15%	0.90
		Roads	35%	0.65
A2	1.8	Gravel Roads	20%	0.38
		Garden	80%	0.12

Assuming the maximum rainfall intensity is 2.5 cm/hr, calculate the design flow and the required pipe diameter for each reach by using the rational method. (Rational formula with usual notations is given as Q=0.278CIA in SI units). [06 marks]

(ii) The OUSL needs to combine the storm water flow with the wastewater flow and send total combined flow to the nearby wastewater treatment plant using a combined sewer section with 280mm of diameter. What would be the total wastewater flow that can send to the treatment plant? Assume the self cleansing velocity is 0.6m/s, when flowing full. [05 marks]

(c) (i) Write a short note on 'ordinary manhole' explaining its spacing between manholes and available shapes and sizes. [03 marks]

(ii) List other special manholes available in sewerage systems? [01 marks]

Question 6.

(a) (i) Why 'population equivalent' is important when treat industrial wastewater in common treatment plant? [01 marks]

(ii) If the standard per capita Suspended solids are given 100g, find the population equivalents of a combined serving 200,000 liters daily of industrial wastewater containing 1500 mg/l of suspended solids. [04 marks]

(b) A wastewater disposal stream of a factory wastewater treatment system has been diverted into a river with flow of $10m^3/s$, which fed for a city water supply. The pollutant concentration of the wastewater flow is 320mg/l and the flow is $0.3m^3/s$.

(i) If the river water flows with 2mg/l of pollutant concentration, what will be the pollutant concentration at the point of mixing? [04 marks]

(ii) Explain the difference between dilution process, if the wastewater effluents are disposed into a stream water and sea water. Also list the factors affecting in self purification in both circumstances. [04 marks]

(c) (i) Differentiate clearly between BOD and COD. [02 marks]

(ii) The BOD_5 of a wastewater has been measured as 600mg/l at 20°C. What is the ultimate BOD of the sample? Assume $K_{20} = 0.23$/day

$[k=k_{20}\theta^{(T-20)};\ BOD_5 = Lo\ (1-e^{-kt});\ \theta = 1.047]$ [03 marks]

(iii) What proportion of ultimate BOD remains unoxidised after 5 days? [02 marks]

Question 7.

(a) (i) What do you mean by back siphonage and how do you prevent it? [02 marks]
(ii) What are'S-type' and 'P-type' water closet? What is the difference of them and how do you fix them in to a building sanitary system? Explain briefly. [03 marks]

(b) (i) What are skimming tank? Why are they provided in wastewater treatment plants? [03 marks]

(ii) It is proposed to design an activated sludge plant to treat 5MLD flow of domestic wastewater to reduce the concentration of settled BOD_5 from 300 mg/l to 22mg/l. Compute the volume of the aeration tank and hydraulic retention time if the system is to operate at F/M of $0.3d^{-1}$ and maintaining 2800mg/l concentrations of MLVSS in the aeration tank by recycling 2000 m^3/d flow of activated sludge from the secondary settling tank. [05 marks]

(iii) If the solids retention time is 10 days, what would be the excess sludge production per day? Also estimate the oxygen requirement per day. [03 marks]
O_2 required per day = $1.47\ Q\ (S_0\text{-}S) - 1.42V(x/\theta_c)$ with usual notations.

(c) What is the process of sludge digestion? Describe briefly the uses and biological process for aerobic and anaerobic digestion. [04 marks]

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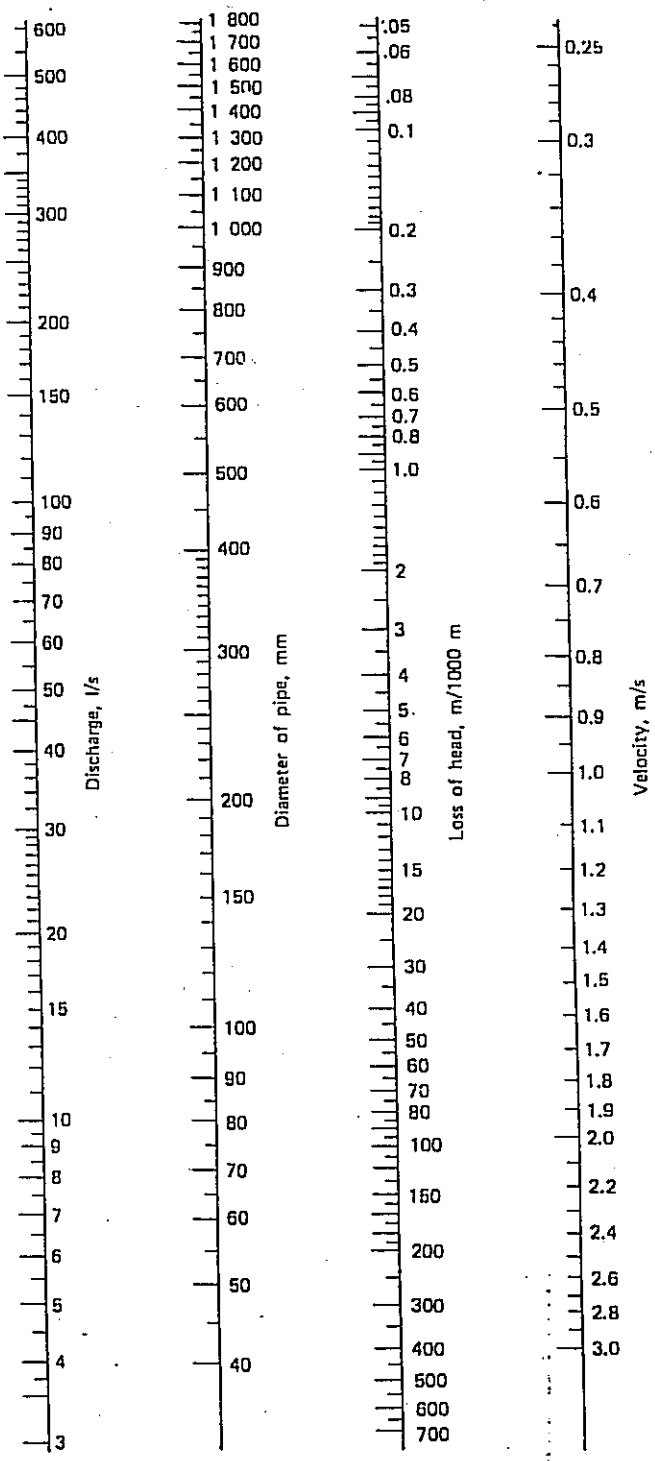

Nomograph for Hazen Williams Formula, based on $C = 100$.