00056

THE OPEN UNIVERSITY OF SRI LANKA
Department of Civil Engineering
Bachelor of Technology (Civil) - Level 6

CEX 6233 – ENVIRONMENTAL ENGINEERING

FINAL EXAMINATION - 2011/2012

Time Allowed: Three hours **Index No.** | | | | |

Date: 04th March, 2012 Time : 0930 - 1230

Answer any FIVE questions. All questions carry equal marks.

1) The central wastewater treatment plant at the Seethawaka Industrial Estate treats approximately 10,000 m^3/day .

a) Identify, using a neat diagram, the different components of the plant. Indicate the material flows between the different components in your diagram.

b) Explain briefly the function of each of the components identified in your diagram.

c) Explain the operation of the Oxidation Ditches used for secondary treatment in this plant. Your answer should identify the parameters that are monitored and the actions that are taken if the values of these parameters are outside the expected range.

d) What will happen if the values of the important parameters of the Oxidation Ditches are not maintained within the expected ranges? Explain your answer.

e) A curved vertical wall, shown in Figure 1, has been constructed at the two ends of the Oxidation Ditches. Explain the purpose of this wall.

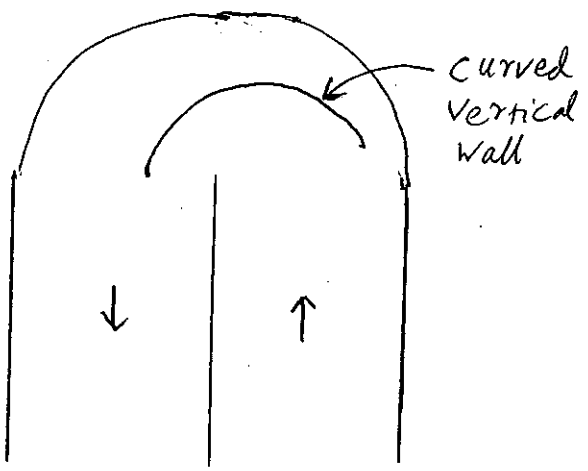

Figure 1 : Plan View of the end of the Oxidation Ditch

2) (a) A horizontal flow grit chamber has rectangular cross-section, with length, L, width, W and depth D . The chamber is to be designed to remove sand particles of a given settling velocity, v . The peak flow rate is Q .

Obtain relationships between the given quantities and the following parameters.

i) Residence (detention) time
ii) Surface overflow rate
iii) Weir loading rate

(b) (i) Explain the difference between Type I, Type II, and Type III sedimentation.

(ii) A rectangular settling basin is to be designed for a flow of 3.28×10^6 liters /day with an L:B ratio of 2:1. The overflow rate is 0.023 cm/s and the detention period is 2.5h. Calculate the weir length required if the water loading is $120 m^3/m^2$ /d.

(iii) If the settling velocity of a particle is 0.70 cm/s and the over flow rate of a horizontal clarifier is 0.80cm/s. What percent of the particles are retained in the clarifier?

(c) Circular sedimentation tanks can be used with horizontal flow and with vertical flow. Using neat diagrams explain the differences between horizontal flow circular sedimentation tanks and vertical flow circular sedimentation tanks with respect to

i) Inflow arrangements
ii) Flow path
iii) Outflow arrangements
iv) Sludge removal

3) An industry uses a Rotating Biological Contactors (RBC) as the secondary treatment unit of a wastewater treatment plant.

(a) Describe, using a neat diagram, the waste removal mechanism in an RBC.

(b) The attached growth process is employed by both RBC and trickling filters. Explain, using a neat diagram, the differences between RBC and trickling filters.

(c) RBCs, trickling filters and the activated sludge process are all examples of aerobic wastewater treatment. Compare these three methods with respect to
(i) requirements of space, machinery and energy
(ii) operation and maintenance
(iii) generation and quantity of sludge

(d) It is proposed to provide an RBC to treat a wastewater flow from a small colony of 1500 persons. The per capita consumption of water is 200 liters/day and the per capita generation of wastewater flow has been taken as 80% of the total consumption of water.

Calculate the disc surface area if the hydraulic loading rate is 0.05 $m^3/m^2/day$.

4) (a) Most of the reservoirs in dry zone of Sri Lanka are used for domestic uses in addition to irrigation. It is required to reserve at least 10% of the water for these domestic uses. Therefore catchment management is very important to maintain the quality of water.

(i) Explain what is meant by 'catchment management' with respect to a river or water body.

(ii) List four water quality parameters that should be maintained in these reservoirs if they are to used as a source of potable water.

(iii) For each of the parameters listed in section (ii) identify one 'catchment management' measure that you would propose to maintain the value of the parameter within acceptable limits.

(b) A reservoir with constant volume $5x10^6$ m^3 is fed by a stream with an average flow rate of 10 m^3/s in the dry zone of Sri Lanka. A non conservative pollutant with a concentration of 150 mg/l flows into the reservoir with the stream water. The pollutant has a reaction rate of coefficient K of 0.25/day.

(i) Find the steady state concentration of pollutant in the reservoir.

(ii) List and explain the assumptions you made to solve the above problem.

(ii) A smaller cascade reservoir which is used for domestic and irrigation purposes is located downstream of the main reservoir and receives a flow of 0.10 m^3/s from it. Calculate the volume of the smaller reservoir if the pollutant concentration in the outflow should be less than 50 mg/l .

5) a) (i) "Coliform bacteria are used as indicator micro-organisms when assessing the suitability of water for drinking". Explain this statement.

(ii) Why is a positive test for fecal coliform in a public water supply considered more serious than positive test for total coliforms?

(iii) Identify the microorganism group used as an indicator of fecal contamination of water and explain why it was selected.

(b) (i) Explain the difference between "water borne" and "water washed" diseases.

(ii) Cholera and leptospirosis are both water borne diseases that are potentially fatal. Compare these diseases in terms of how they are transmitted and where you may find them in Sri Lanka.

(c) Chlorination, ozonation and ultra-violet light are all used for the disinfection of drinking water. Discuss the advantages and disadvantages of these methods with reference to a developing country like Sri Lanka.

6) (a) (i) Explain, giving two examples for each category, how air pollutants are categorized as primary pollutants and secondary pollutants.

(ii) Measurements show that the SO_2 concentration in a city is 0.24 ppm . What is the equivalent concentration of SO_2 in mg/m^3 at 28°C and 1 atm. ? The molecular weights of S and O are 32 and 16 respectively.

(b) (i) List the two pollutants that you measured in the exhaust of the petrol engine during the laboratory classes.

(ii) Other than the two pollutants listed above, what is the other main pollutant emitted by petrol engines?

(iii) For each of these three pollutants listed in sections (i) and (ii) identify one problem that is caused when it is released into the atmosphere.

(iv) How do modern automobiles with petrol engines reduce the concentration of these three pollutants before the exhaust gases are released to the atmosphere?

(c) List three actions that can be taken to reduce the air pollution in a large city in a developing country and compare their advantages and disadvantages.

7) (a) (i) Explain what is meant by the BOD and the COD of a given sample of wastewater.

(ii) Which value, BOD or COD, would you expect to be greater? Explain your answer.

(iii) What are the advantages and disadvantages of BOD and COD when considering the impact of the release of industrial wastewater into natural water bodies?

(b) The Streeter-Phelps equation $D=\frac{k_d L_0}{k_r - k_d}(e^{-k_d t} - e^{-k_r t}) + D_0 e^{-k_r t}$ is used to calculate the deficit of dissolved oxygen, D , in a river downstream of a location where wastewater is discharged into the river.

(i) What are the processes represented by the rate constants k_d and k_r ?

(ii) What physical factors will affect the rate constants k_d and k_r ?

(iii) Sketch the variation of dissolved oxygen with distance downstream of the discharge location. Explain your answer.

(iv) Explain how this equation can be used to set effluent standards for industries discharging to a river.