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

CEX 6233 – ENVIRONMENTAL ENGINEERING

FINAL EXAMINATION 2012/2013

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

Date: 04th August, 2013 Time : 0930 - 1230

Answer any FIVE questions. All questions carry equal marks.

Question 1

(a) The Garandi-Ella village in the mountain region is identified as a landslide prone area. The Garandi-Ella stream, which flows through a tea estate is the only water source in the area.
(i) Discuss the suitability of using this water source considering water quality. [02 marks]
(ii)The quality of surface water generally varies throughout a watershed. What are the three major factors that affect water quality? Explain briefly. [03 marks]

(b) (i)Pathogens are disease-causing micro-organisms that can be transmitted by water. Provide three examples of water-borne diseases and their disease-causing organisms. [1.5 marks]
(ii) Pathogens are not always bacteria. Name two viruses and one protozoan sometimes found in water supplies. [1.5 marks]
(ii)What actions do you suggest to preserve, restore and enhance the water quality of the water source? [03 marks]

(c) (i) The Garandi Ella is fed by springs originate from the upper slopes and subsurface drains of the landslide area to the main stream. What landslide mitigation activities would contribute to the water quality of the flow? [03 marks]
(ii)What are the methods available to divert water in order to mitigate landslides? [03 marks]
(iii) How would these activities impact to the water source? [03 marks]

Question 2

(a) A rural water treatment system consists of a river intake, two 136 m^3 sedimentation tanks and a sump with chlorination as shown in the figure Q 2(a). Water is extracted from the river diverting the stream through a V-notch using an earth dam. The treated water is supplied to 150 dwellers for 4 hrs per day.
(i) Briefly discuss the adequacy of this treatment for potable water. [02 marks]
(ii) How do you improve this system to obtain compliance with Sri Lanka Standards for potable water? Provide a neat sketch of the proposed system and describe the function of the proposed unit processes. [05 marks]

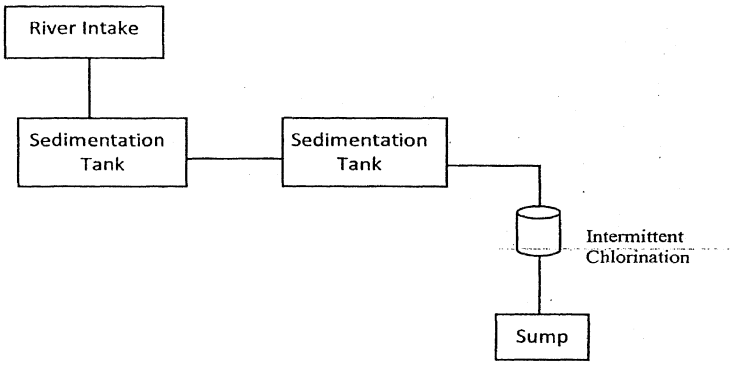

Figure Q2(a) Schematic for existing water treatment system

(b) (i) In many rural water supply systems chlorination is done twice a day. What are the consequences of such a practice? [01 marks]
(ii) Chlorine is preferred as a disinfectant over ozone because it has a residual. Why is the presence of residual important? [02 marks]
(iii) Chlorine may be added to the incoming flow (prechlorination) or some occasions before the filtration in water treatment. Give reasons. [02 marks]

(c) (i) What are the mechanisms of filtration? Explain with the help of a neat figure. [02 marks]
(ii) An engineer suggests the following design parameters for a city's proposed rapid sand filter: Flow rate = $0.6m^3$/sec, loading rate to filter - 125.0 $m^3/day.m^2$. How much surface area is required for the filter? [02 marks]
(iii) Select the number of equally sized filters, and size these filters assuming a width to length ratio of 1.0 to 2.5 with a maximum surface area of each filter tank of $75m^2$. [03 marks]

Question 3

(a) Stream pollution is significant due to waste discharge into surface waters in many places in Sri Lanka.
(i) How is dissolved oxygen (DO) in the water depleted by discharges of wastes? [02 marks]
(ii) What would happen if DO gets depleted from surface water? [02 marks]
(iii) If the critical point in a DO sag curve is found to be 18km downstream from the discharge point of untreated wastewater, would you expect the critical point to move upstream (toward the discharge point), downstream or remain in the same place, if the wastewater is treated? Explain your answer. [02 marks]

(b) A milk products industry discharges its wastewater into a municipal wastewater sewer. The characteristics of the two waters are as follows.

Milk Products Industry WW	Municipal WW
Flow = 2500 m^3/day	Flow = 16300 m^3/day
BOD_5 = 1500 mg/l	BOD_5 = 210 mg/l
PO_4^{3-} = 160mg/l	PO_4^{3-} = 2.1mg/l

Determine the characteristics of the mixture. [04 marks]

(c) Oxidation Ditches are used for secondary treatment in wastewater treatment at the Biyagama. Export Trade Zone. Figure Q3 (c) shows the plan view of an oxidation ditch. A curved vertical wall has been constructed at the two ends of the Oxidation Ditches.

(i) Explain the purpose of this wall. [03 marks]

The oxidation ditch is to treat 1000 m^3 per day of sewage with an influent BOD_5 of 200mg/l to have a desired effluent BOD_5 of 20mg/l. Assume that the F/m ratio is 0.18 day^{-1} and the MLVSS in the tank is 2500 mg/l. Estimate;

(ii) Volume of the ditch [03 marks]

(iii) Hydraulic retention time [02 marks]

(iv) Volumetric loading [02 marks]

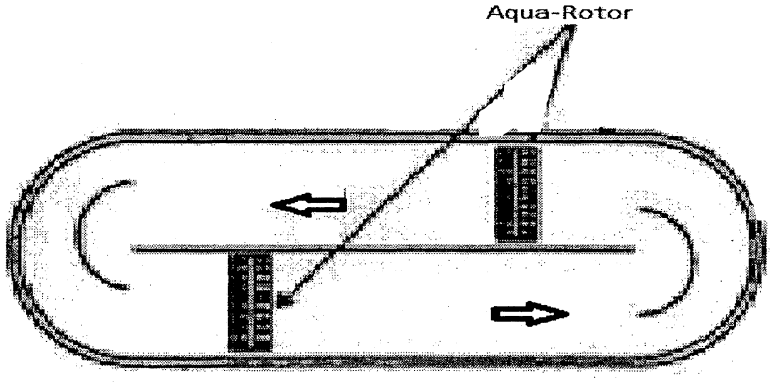

Figure Q 3 (c) **Plan View of the Oxidation ditch**

Question 4

(a) Nitrogen (N) is an important element in natural ecosystem. Total Nitrogen (TN) is sometimes regulated as an effluent parameter for municipal and industrial wastewater treatment plants

(i)What is the difference between TN and TKN (Total Kjeldahl Nitrogen)? [01 mark]

(ii) Why is acid digestion needed for the determination of TKN? [01 mark]

(iii) Explain briefly how nitrogen contributes to the pollution of lakes or streams. [02 marks]

(iv)What is 'methemoglobinemia'? Discuss it as a water related disease. [02 marks]

(b) A shrimp processing plant generates 0.012 m^3/s of wastewater each day. The wastewater is treated in an activated sludge plant. The average BOD_5 of the raw wastewater before primary settling is 1400 mg/l. The aeration tank has effective liquid dimensions of 8.0 m wide by 8.0m long by 5.0 m deep. The plant operating parameters are as follows;
Soluble BOD_5 after primary settling =966 mg/l
MLVSS=2000 mg/l
MLSS=1.25 (MLVSS)
Settled sludge volume after 30 min =225 ml/l
Aeration tank liquid temperature = 29°C
Determine the following:
(i) Aeration period [02 marks]
(ii) F/M ratio [02 marks]
(iii) Sludge Volume Index (SVI) (indicate units clearly) [02 marks]

(c) (i)During the laboratory practical classes a group of students took samples of the influent (raw sewage) and effluent (treated water) of the Raddolugama sewerage treatment plant. They use these samples to determine the BOD rate constant (k). Would you expect the rate constants to be the same or different? If different, which would be higher and why? [03 marks]
(ii) List four common advanced wastewater treatment processes and the pollutants they remove. [02 marks]
(iii) Describe the three basic approaches of land treatment of wastewater. [03 marks]

Question 5

(a) A small scale wood cutting industry using electric saws is located in a residential area in a semi urban city. The surrounding community objected to the industry due to noise.
(i) Classify this noise source by 'type' – i.e. continuous or intermittent. If the industry owner request your help and ask your recommendations to solve the problem list the steps you would follow. [04 marks]
(ii)What are the available methods to reduce the noise affecting the community? [02 marks]
(iii) Explain the recommendation you would make to overcome such a situation. [02 marks]

(b) (i)Highway traffic is a major source of noise. Explain how traffic creates noise. [02 marks]
(ii)How you would overcome this situation in highway designs and highway operations? [03 marks]

(c) (i)What are the primary natural and anthropogenic sources of the hydrocarbons found in the atmosphere? Highlight the major anthropogenic source? [02 marks]
(ii) A sample of exhaust gas taken from a petrol vehicle analyzed at 0°C and 1 atm pressure is reported to contain 12 ppm of CO. Determine the equivalent CO concentration in microgram per cubic meter and milligram per cubic meter. [03 marks]
(iii) Describe the available methods to control of automobile emissions. [02 marks]

Question 6

(a) Air pollution is a serious issue all over the world.
(i)List the oxides of sulfur and indicate which are of primary concern in air pollution. [01 mark]
(ii)What particular health hazards are posed by SO_2 in a dusty atmosphere? Discuss these hazards in relation to major air-pollution disasters of recent decades. [02 marks]
(iii)A power plant burns 20 tonnes of coal per hour and the average sulfur content of the coal is 4.5 percent. What is the approximate emission of SO_2 in tonnes per day? [03 marks]

(b) Effective Solid waste management is essential for any nation.
(i)What is the most important factor in integrated solid waste management? Explain briefly. [02 marks]
(ii) What are the 3Rs in solid waste management? List the '7Rs towards zero waste'. [04 marks]
(iii) Solid waste management will not take place effectively if the society does not carry out its duties and responsibilities. Discuss the duties of individual persons, Local Authorities and Policy makers towards sustainable solid waste management. [03 marks]

(c) Sanitary land filling is a final disposal method, which now practicing in Sri Lanka.
(i) Describe two methods of constructing a MSW landfill. [01 mark]
(ii) Considering the COD and BOD concentration of leachate discuss the appropriate leachate treatment methods for a sanitary landfill. [2.5 marks]
(iii)What are the problems associated with E-waste? Provide three examples. [1.5 marks]

Question 7

The Colombo-Katunayake expressway will be completed later this year. Most of the expressway runs through the Muthurajawela wetland and some of it is within the Negombo lagoon.

(a) What alternatives should have been considered before taking the decision to construct a separate expressway? Justify your answers. [04 marks]

(b) Compare the advantages and disadvantages of constructing an expressway to the alternatives listed in section a). [04 marks]

(c) Explain the relationship between the choice of the expressway and the alternatives listed in section a) and global warming and climate change. [04 marks]

(d) There were two main choices regarding the trace of the expressway – either west of the existing main road (A2) or east of it. Discuss the advantages and disadvantages of each trace. [04 marks]

(e) The expressway could have been constructed as an elevated highway or on an embankment. Compare the advantages and disadvantages of these two methods. [04 marks]

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