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

CEX 6233 – ENVIRONMENTAL ENGINEERING

FINAL EXAMINATION - 2014/2015

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

Date: 30th August, 2015 **Time : 0930 - 1230**

Answer any FIVE questions. All questions carry equal marks.

Question 1

(a) Water scarcity can be overcome by recharging.
(i) Does percolate from a recharge pond mix with entire mass of groundwater under the recharging site. [02 marks]
(ii) How wetlands help to recharge groundwater? [02 marks]
(iii) What are the primary concern regarding degradation of groundwater for (a) domestic consumption and (b) agricultural use? What are the principal pollutants in each case? [04 marks]
(ii) Under what circumstances salt water intrusion in water ways take place. Explain briefly. [03 marks]

(b) (i) Natural resources may be renewable and non-renewable. List renewable and non-renewable energy sources. [02 marks]
(ii) Why do many anthropogenic disturbances have such dramatic and long-lasting effects on natural ecological systems? Explain briefly. [02 marks]

(c) (i)Why a bacterial standards for drinking water based on the presence of nonpathogenic coliform bacteria? Explain briefly. [02 marks]
(iii) Identify the microorganism group used as an indicator of fecal contamination of water and explain why it was selected. [03 marks]

Question 2

(a) (i) What is eutrophication? What are differences between eutrophic and oligotrophic systems? [02 marks]
(ii) Outline the physical and chemical characteristic of a stream that make them susceptible in pollution. [02 marks]
(iii)What are the ecological consequences of wastewater discharged to the marine environment? [02 marks]

(b) (i) An industry wastewater outlet discharges treated water into a nearby natural stream as shown in Figure Q2(b). Determine the flow, and dissolved oxygen in the stream at downstream. [03 marks]

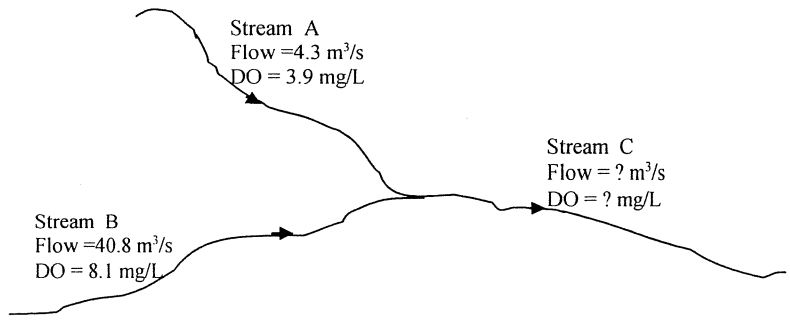

Figure Q 2(b)

(ii)What volume of above wastewater with an estimated BOD of 250mg/L should be added to conduct a five-day test in a standard 300ml bottle? [03 marks]

(c) (i) Determine the maximum concentration 2.5 km downstream of a sidewall discharge of concentration 25mg/L and flow rate 0.02 m^3/s. Assume the river is straight with a width of 50 m and a low flow velocity of 0.25 m/s. [04 marks]
(ii) For the question part c (i) determine the time required for a lake to reduce concentration of an influent pollution to 10 percent of an initial concentration C_o of 250 mg/L. Assume the lake volume is $5x10^5$ m^3 and an influent stream has a flow rate of 200 m^3/s. Assume first order decay with K =0.22/day. [04 marks]

Question 3

(a) (i) Define potable and palatable and explain why we must provide a water that is both potable and palatable. [03 marks]
(ii) Explain why a disinfectant that has a residual is preferable to one that does not. [02 marks]

(b) A settling tank is 20m long, 10 m deep, and 10 m wide. The flow rate to the tank is $10m^3$/minute. The particle to be removed all have a settling velocity of 0.1m/min.
(i) What is the hydraulic retention time [03 marks]
(ii)Will all the particles be removed? [04 marks]

(c) A water treatment plant has 6 setting tanks that operate in parallel (the flow gets split into six equal flow streams), and each tank has a volume of $600m^3$. If the flow to the plant is 440 L/s. what is the retention time in each of the settling tanks? If, instead the tank operated in series (the entire flow goes first through one tank, then the second, and so on), what would be the retention time in each tank? [08 marks]

Question 4

(a) (i)Explain the difference between bulking sludge and rising sludge and what circumstances cause each to occur. [03 marks]
(ii)What precautions to be taken to avoid bulking sludge and rising sludge. List those. [02 marks]
(iii)What sludge volume would you expect to find after settling the mixed liquor 2800mg/L for 30 minutes in a 1L graduated cylinder if the SVI is 95 mL/g? [03 marks]

(b) A 4000 m^3/day conventional activated sludge plant is needed for small municipality. Determine the tank volumes required for:
(i)Two rectangular primary tanks 3.5 m deep and having overflow rate not exceeding 60m^3/m^2.day and a detention time of at least 1 h (at peak flow). [03 marks]
(ii)Two aeration tanks operating at an F/M ratio of 0.25 kg BOD_5/kg MLVSS per day and an MLSS concentration of 2000 mg/L. [03 marks]

(c) Replacement of belt filters in a wastewater treatment plant results in an increase in the sludge solids concentration from 15 to 25% on a dry weight basis. Assuming the sludge (again on the dry weight basis) contains 20% fixed solids and 80% volatile solids, having specific gravities of 2.5 and 1.0 respectively, what reduction in sludge volume will be achieved by the change in the method of filtration? [06 marks]

Question 5

(a) Suppose a family of 4 fills up 3 garbage bins per week in a community of 100,000 people. If each bin is about 0.25m^3 and assuming that the uncompacted garbage is at about one fourth (¼) of the compacted density 120 m^3/kg. The community has about 20,000 m^3 of landfill left that can be filled to about 10 m deep with refuse compacted to somewhere between 350 kg/m^3 and 500 kg/m^3 a landfill.
(i)Estimate the per capita production [02 marks]
(ii)What is the remaining life of the landfill? [04 marks]
(iii)If the city is in crisis situation provide reasonable suggestions to overcome the garbage crisis [03 marks]

(b) (i) Discuss factors to be controlled when producing composting using municipal solid wastes? [02 marks]
(ii) Quality of composts are important when they use as a organic fertilizer. Explain what factors to be considered if they use as fertilizers. [02 marks]

(c) Consider the lifetime health risk of eating 100 g apple contaminated with 1ppb (parts per billion) heptachlor (a pesticide and probable human carcinogen). The potency factor for heptachlor has been estimated as 3.4 $(mg/Kg/d)^{-1}$.
(i) On the basis of 70 kg adults who eat one apple per day for 70 yr, roughly estimate the annual number of additional heptachlor related cancers one might expect in a population of 100,000. [04 marks]
(ii)Aside from the obvious consumption, life time and body-weight assumptions, briefly discuss at least <u>two</u> other assumptions that underlie the estimate calculated in part (i). [03 marks]

Question 6

(a) The concentration of carbon monoxide (CO) is a smoke-filled room can reach as high as 500ppm.
(i)What is this in µg/m^3 ? (Assume 1 atm and 298K) [03 marks]
(ii)What effect would this have on people who are sitting around having a political discussion or 4 hours? [03 marks]

(b) Stacks are common practice to avoid emissions and atmospheric conditions primarily determine the dispersion of air pollution.
(i)What factors are affecting on the dispersion patters of a plume? (List all possible factors) [02 marks]
(ii)Illustrate the effect of atmospheric stability on a plume and name those. [04 marks]

(c) Noise has been a part of urban life since the first cities.
(i) How the measurement of sound using sound meter take place? (You are expected to describe the concept behind the sound meter). [02 marks]
(ii) Mention the three strategies that can be used to control the noise. [03 marks]
(iii)List three method that can be implement to control noise pollution generated by the highway traffic. [03 marks]

Question 7

The main water intake for the City of Colombo is at Ambatale. Many industries, including the Biyagama Industrial Zone, are situated upstream of this intake and discharge wastewater to the river upstream of the intake. In August, 2015, operations at the intake were suspended for two days because the river had been polluted by an accidental discharge of diesel fuel from one of these industries. Over the last 20 years there have been several similar accidents that have affected the water supply.

(a) What effect would diesel have had on

(i) The water treatment plant [02 marks]
(ii)The water supply [02 marks]

(b) Identify and discuss two measures that the National Water Supply and Drainage Board can take to reduce the risk to the water supply from the location of these industries. Note that the NWSDB is only in control of its own operations. [04 marks]

(c) Discuss the relationship between the Environmental Pollution regulations in Sri Lanka and the location of these industries near the Kelani Ganga. [04 marks]

(d) One measure that the Government of Sri Lanka can take to reduce the risk to the water supply is to relocate the industries. Discuss the advantages and disadvantages of this measure. [04 marks]

(e) Identify and describe two steps that the Government of Sri Lanka can take to reduce the risk to the water supply as an alternative to relocating the industries. [04 marks]

---------XXX----------