00137

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

CEX 6233 – ENVIRONMENTAL ENGINEERING

FINAL EXAMINATION - 2016/2017

Time Allowed: Three hours Index No. ☐☐☐☐

Date:21st November, 2017 Time :0930 - 1230

Answer any FIVE questions. All questions carry equal marks.

Question 1

(a) (i)There are three main groups of organisms within an ecosystem. Name those and explain interaction among those organisms (food web) considering simple ecosystem. [04 marks]
(ii) Tropical forests and estuaries are generally considered as very stable ecosystem? Briefly explain? [03 marks]

(b) (i) The large-scale use of pesticides for the control of undesired organisms bringsimpactsto the human being. Explain using an example. [04 marks]
(ii) Define narratively the term 'eutrophication' and explain how it happens in an aquatic environment. [03 marks]

(c) A sewage lagoon (shallow pond) that has a surface area of 10ha and a depth of a 1m is receiving $8.640 m^3/d$ of sewage containing 100 mg/L of biodegradable contaminant. At steady state, the effluent from the lagoon must not exceed 20 mg/L of biodegradable contaminant. Assuming the lagoon is well mixed that there is no losses or gains of water in the lagoon other than the sewer input, what biodegradation reaction rate coefficient (d^{-1}) must be achieved for a first order reaction? ($100ha=1km^2$) [06 marks]

Question 2

(a) (i) Why can coliform bacteria be used as indicators of drinking water quality? [02 marks]
(ii)Discuss the limitations of coliforms as an indicator organism. [02 marks]
(ii) Why is a positive test for fecal coliform in a public water supply considered more serios than appositive test for a total coliform? [02 marks]

(b) Proper sampling and testing procedure are important to assess water (or wastewater) quality to check compliance with water quality standards.
(i)Differentiate grab sampling and composite sampling. [03 marks]
(ii)What is the difference between TDS and TSS? How are they measured? [03 marks]

(iii)The following data are from total solids and total volatile solids tests on a wastewater sample. Calculate the total and volatile solids concwentrations in milligram per liter.
Weight of empty dish = 68.942g
Weight of empty dish = 68.942g
Weight of dish plus ignited solids =60.003g
Volume of water sample=100ml
[03 marks]

(c) (i)What is meant by 'Pollutant load'? How do you estimate the pollutant load? [03 marks]

(ii) An unseeded five-dayBOD test is conducted on a polluted surface water sample by adding 100ml to a 300ml BOD bottle and filling with dilution water. The initial dissolved oxygen measured 8.3mg/L, and the final concentration after five days of incubation at 20°C measured 2.9mg/L. Calculate the five-dayBOD. [03 marks]

Question 3

(a) Consider the following sequences of unit operation and chemical addition used in the treatment of a river water supply. Briefly state the function of purpose if each unit process and the reason for each chemical addition.
(i)Presedimentation with polymer addition
(ii)Activated carbon available when needed
(iii) Mixing and flocculation with the addition of alum and polymer
(iv)Sedimentation
(v)Addition of activated carbon
(vi)Granular media filtration
(vii)Postchlorination
[07 marks]

(b) (i)Pre-sedimentation reduces 1500mg/L suspended solids of a raw water to 200mg/L. How many Kilograms of dry solids are removed per million liters? [02 marks]

(ii)If the settled sludge has a concentration of 8% solids and a specific gravity of 1.03 calculate the sludge volume produced per million liters of river water processed. [03 marks]

(c) (i)Coagulation is one of the processes of surface water treatment. How synthetic polymers helps in coagulation process? [01 marks]
(iii)Based on the Jar test results 16mg/L alum needs for coagulation process to treat surface water. If the treatment plant processes million liters of river water processed/day, estimated the daily and weekly requirement of alum. [03 marks]
(iii)For a flow of $10^3 m^3$/day how many rapid sand filter boxes of dimensions 10mx20m are needed for a loading rate of $110 m^3/d/m^2$. [04 marks]

Question 4

(a) Waste water form a fruit packaging industry was tested in a pilot activated sludge plant and the kinetic constant were found to be μ=3 day^{-1}; y=0.6ssKg/KgBOD; K_s=450 mg/L, the influent BOD is 1200mg/L and flow rate of 19,000m^3/day is expected. The areators to be used will limit the suspended solids in the aeration tank to 4500mg.L. The available aeration volume is 5100m^3.

(i) Calculate the effluent BOD [02 marks]

(ii) What efficiency of BOD removal to be expected? [01 marks]

(iii) Retention time [02 marks]

(iv) F/M ratio [02 marks]

(v) Suppose the flow rate is much higher 35,000 m^3/day and S_o=600mg/L, what removal efficiency might be expected? [03 marks]

Note: $(S_0 - S) = (\mu SXt)/Y(K_s - S)$ is given with usual notations.

(b) (i)Sludge bulking is a serious issue is activated sludge wastewater treatment plants. Provide reasons for such incidents. [02 marks]

(ii)What sludge volume would you expect to find after settling the mixed liquor 4500mg/L for 30 minutes in a 1L graduated cylinder if the Sludge Volume Index is 75 mL/g? [03 marks]

(c) (i) State two reasons why an activated sludge system is operated at a relatively low food/microorganism ratio [02 marks]

(ii)Describe the role of algae in biological stabilization of wastewater in a stabilization pond. [03 marks]

Question 5

(a) (i)Discuss three major environmental consequences of open dumping of waste. [02 marks]

(ii) Identify two properties important properties of Municipal Solid Waste and briefly describe how those are useful in waste Management. [02 marks]

(ii) Landfills are used as the final disposal option of solid waste management. List five factors pertinent to the selection of landfill site. [02 marks]

(b) Land fill leachate consists of Trichloroethylene (TCE) flowing into a reservoir through and complete mixing occurs to give the TCE concentration of 140ppb. Surrounding community consume fish from the above reservoir for several decades. Following facts are given. Assume a 70- Kg person consumes 35g of fish for 280 days per year for 40 years. Estimate the maximum risk of cancer due to the above exposure of TCE.

Cancer potency factor for an oral dose of TCE is 1.1×10^{-2} $(mg/kg\ day)^{-1}$.

Potency factor for an oral dose of TCE is 1.1×10^{-2} $(mg/kg\text{-}day)^{-1}$.

Bio concentration factor for TCE is given as 10.6 /kg,

Lifetime of a normal person is 60 yrs.

{Risk =CDI * Potency factor}
{CDI (mg/kg/day)=Total dose(mg)/[Body weight(kg) *Life time (days)]}
[06 marks]

(c) (i)What are the problems associated with E-waste to the human and environment? Explain briefly. [02 marks]
(ii)Why the e-waste has become a global issue? Explain briefly. [03 marks]
(iii) E-waste and clinical wastes are considered as hazardous waste. Brief the steps in hazardous waste management. [03 marks]

Question 6

(a) (i) Give two examples of synergism in air pollution. [02 marks]
(ii)A hi-vol clean filter weights 18.0g, and the dirty filter weights 18.6g. The initial and final air flows are 2000L/min and 1100L/min. What volume of air went through the filter in 24hrs? [03 marks]
(i) What was the particulate concentration? [02 marks]

(b) (i) Describe two methods available for controlling gaseous pollutants. [02 marks]
(ii)A 400m, one way, two lane rectangular tunnel (9mx4m) filled with cars is blocked by an accident at the exit. The ventilation system involves large exhaust fans blowing ambient air out of the exit end of the tunnel. Assume that the tunnel is full of cars, all with engine idling. One car occupies 6 linear meter in the lane and emits 2.0g/min CO. The fans pull 0.42 $x10^6$ m^3/min of fresh air containing 0.5mg/m^3 CO into the tunnel entrance. What is the concentration of CO in the exit air? Assume complete mixing. [05 marks]

(c) A large stream has a reoxygenation constant 0.4 d^{-1}.and a velocity of 0.85m/s. At the point of which organic pollutant is discharged, it is saturated with oxygen at 10mg/L (D_o=0). Below the outfall the ultimate demand for oxygen is found to be 20mg/L and the deoxygenation constant is 0.2 d^{-1}. What is the Dissolved Oxygen 48.3 Km downstream?
{The Streeter – Phelps equation is given as

$$D = \frac{k_1 L_o}{k_1 - k_2}(e^{-k_1 t} - e^{-k_2 t}) + D_o(e^{-k_2 t})$$

with usual notations.}
[06 marks]

Question 7

The Jaffna peninsula in the north of Sri Lanka has no rivers and reservoirs. All water supply needs are met using groundwater. The groundwater is polluted by nitrates and other contaminants and the quantity available is also limited. A desalination plant – using reverse osmosis technology to produce pure water from sea water – has been proposed to solve the water supply problem in the Jaffna peninsula.

(a) Identify two important sources of nitrate in the groundwater in Jaffna. [2 marks]

(b) What are the potential impacts of nitrate in the water supply? [3 marks]

(c) Explain briefly how you could remove nitrates from the groundwater before it is used for water supply. [3 marks]

(d) Explain, using neat diagrams, what is meant by reverse osmosis. [3 marks]

(e) Identify two alternatives to the desalination plant to improve the water supply of the Jaffna peninsula. [3 marks]

(f) Compare the desalination plant and the two alternatives identified in section. [3 marks]

(e) using a tabular format. Please limit your answers to the most important points. [3 marks]

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