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The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX6533/CEX6233 Environmental Engineering**
Academic Year	: 2018/19
Date	: 30th January 2019
Time	: 0930-1230 hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Five (5)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

Question 1.

(a) The manufacturing processes of industries indirectly or directly release toxic and harmful substances which find a way to the soils, rivers, lakes and oceans leading to biomagnifications.

(i) What is meant by biomagnification? [02 marks]

(ii) Explain the process of biomagnification in a water body. [03 marks]

(iii) Discuss two impacts due to biomagnification in rivers and lakes. [03 marks]

(b) Water borne diseases are serious issue in many upcountry estate population.

(i) What would be the main cause of pathogenic pollution of water? [02 marks]

(ii) How *'Escherichia coli (E. coli)'*is fit for use as an indicator organism to investigate presence of pathogenic bacteria in water? Explain giving the reasons. [04 marks]

(c) The following data are from total solids and total volatile solids tests on a wastewater sludge sample.

Weight of empty dish	=	65.631g
Weight of dish and sludge sample	=	134.745g
Weight of dish and dry sludge solids	=	70.237g
Weight of dish plus ignited solids	=	66.328g

Calculate,

(i) the weight of total solids and weight total volatile solids. [03 marks]

(ii) the percentage of total solids and percentage of total volatile solids. [03 marks]

Question 2.

(a) (i) Define effective size and uniformity coefficient and explain their use in designing rapid sand filter. [02 marks]

(ii) Determine the number of rapid sand filters to treat a flow rate of 75.7×10^3 m^3/d if the design loading rate is 300 $m^3/d.m^2$. The maximum dimension is 7.5m and the length to width ratio is 1.2:1. [05 marks]

(b) (i) What is the significance of alkalinity in coagulation? [02 marks]

(ii) Two parallel flocculation basins are to be used to treat a water flow of $0.150 m^3/s$. if the design detention time 20 minutes what is the volume of each tank. [04 marks]

(iii) If the coagulant dosage is 12mg/L, estimate the amount of coagulant to be used per day in this treatment system. [03 marks]

(c) (i) Why disinfectant that has a residual is preferable to one that does not? [02 marks]

(ii) Explain why UV disinfection has become a popular alternative to chlorine disinfection. [02 marks]

Question 3.

(a) (i) What is meant by 'self-purification capacity' of a river? [01 marks]

(ii) What physical parameters effect on self-purification of capacity of a river. [02 marks]

(b) A large stream has a reoxygenation constant of 0.4 d^{-1} and a velocity of 0.55m/s. At the point which an organic pollutant discharged, it is saturated with oxygen at 10 mg/L (at t=0, D_a=0). Below the outfall the ultimate demand for oxygen is found to be 20 mg/L, and the deoxygenation constant is 0.2 d^{-1}. Use the Streeter -Phelps deficit equation with usual notations. Provide the assumption that you made.

$$D = \frac{k_d L_0}{k_r - k_d}(e^{-k_d t} - e^{-k,t}) + D_0(e^{-k,t})$$

$$t_c = \frac{1}{k_r - k_d} \ln\left[\frac{k_r}{k_d}\left(1 - D_0 \frac{k_r - k_d}{k_d L_0}\right)\right]$$

(i) What is the dissolved oxygen at 42.5 km downstream. [04 marks]

(ii) Estimate the critical point in a DO sag curve. [04 marks]

(iii) 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? [02 marks]

(c) (i) Describe type of oxygen-demanding wastes and discuss the effect of oxygen-demanding wastes on rivers. [03 marks]

(ii) What factors affect the amount of DO available in a river? [02 marks]

(iii) Eliminating rapids by dredging or damming a river can have a severe impact on DO. Explain the reasons and mention how this can be overcome in a river. [02 marks]

Question 4.

(a) (i) Explain when a design engineer would select a rectangular clarifier rather than a circular secondaryclarifier and what, if any, negative impacts this may have on performance. [03 marks]

(ii) Two activated sludge aeration tanks at Raddolugama are operated in series. Each tank has the following dimensions: 7.0 m wide by 30.0 m long by 4.3 m effective liquid depth. The plant operating parameters are as follows:
Flow =0.0796 m^3/s
Soluble BOD_5 after primary settling =130 mg/L
MLVSS =1500 mg/L
MLSS =1.40 (MLVSS)
Settled sludge volume after 30 min =230.0 mL/L

Determine the following:
(i) Aeration period [03 marks]
(ii) F/M ratio [03 marks]
(iii) Sludge Volume Index [03 marks]

(b) The town in western Province has been directed to upgrade its primary WWTP to a secondary plant that can meet an effluent standard of 25.0 mg/L BOD_5 and 30 mg/L suspended solids. They have selected a completely mixed activated sludge system for the upgrade. The existing primary treatment plant has a flow rate of 2,506 m^3/d.
The effluent from the primary tank has a BOD_5 of 240 mg/L. Using the following assumptions, estimate the required volume of the aeration tank:
Assumptions:

- BOD_5 of the effluent suspended solids is 70% of the allowable suspended solids concentration.
- Growth constant values are estimated to be: Ks =100 mg/L BOD_5; Kd= 0.025 d^{-1}; m =10 d^{-1}; Y = 0.8 mg VSS/mg BOD_5 removed.
- The design MLVSS is 3,000 mg/L.

[06 marks]

(c) Why advanced wastewater treatment is needed? What methods/processes can be used for advanced wastewater treatment? [02 marks]

Question 5.

(a) (i) What is meant by ' e-waste'? Why e-waste is considered as a problem to the human and environment. Discuss. [03 marks]

(ii) E-waste management is a challenging aspect in Sri Lanka. Why? Explain briefly. [03 marks]

(b) (i) Solid waste with a density of 110 kg/m^3 is spread in a 0.5m layer a landfill at Kirindiwela. If a steel wheeled compactor can achieve a density of 400 kg/m^3, what thickness of waste will be achieved. [04 marks]

(ii) Estimate the weekly volume of solid waste being delivered to a municipal landfill if the average solid waste generation rate is 2.6 kg/person.d, the population is 17200, and the density as delivered is 122 kg/m^3. [04 marks]

(c) (i) How landfills or open dumps contribute to the global warming. Discuss briefly. [03 marks]

(ii) What is meant by calorific value or heating value of municipal solid waste and how it help for MSW management. [03 marks]

Question 6.

(a) (i) There are three fundamental ways in which noise can be controlled. List them. [01 marks]

(ii) What are the merits of having a noise map when developing a mega city? [02 marks]

(b) (i) List three potential chronic health effects of air pollution. [01 marks]

(ii) Discuss the photochemistry of Ozone in the upper atmosphere using the pertinent chemical reactions and the effect of chlorofluorocarbons on these reactions. [03 marks]

(ii) What is the chemical composition of CFC-114? [02 marks]

(iv) It is identified that NO_2 concentration in a city is about of 0.25 ppm. Express the equivalent concentration of NO_2 in μg/m^3 at 25°C and 1 atm. Molecular weights of N and O are 14 and 16 respectively. [03 marks]

(c) The town of Rathnapura discharges 0.126 m^3/s of treated wastewater into Kelani River. The BOD_5 of the wastewater is 34 mg/L. Kelani River has a 10-year, 7-day low flow of 0.126 m^3/s. Upstream of the wastewater outfall from Ratnapura, the BOD_5 is 1.2 mg/L. The BOD rate constants k are 0.222 d^{-1} and 0.090 d^{-1} for the wastewater and river respectively. The temperature of both the river and the municipal wastewater is 28ºC. Calculate the initial ultimate BOD after mixing. [08 marks]

Question 7.

The Central Expressway, which is currently under construction, is expected to reduce congestion on the existing roads to Colombo from Kandy and Kurunegala. Stage 1 of the project – from Kadawatha to Meerigama – is expected to be completed in 2019. There will be two interchanges at Gampaha and Veyangoda.

(a) What alternatives should have been considered before taking the decision to construct a separate expressway? Justify your answers. [02 marks]

(b) Compare the advantages and disadvantages of constructing an expressway to the alternatives listed in section (a). [03 marks]

(c) The expressway could have been constructed as an elevated highway or on an embankment. Compare the advantages and disadvantages of these two methods. [03 marks]

(d) List and discuss the factors to be considered when deciding on the number and locations of highway interchanges. [03 marks]

(e) List the three most significant environmental impacts of locating a highway interchange at a particular location. [03 marks]

(f) Propose and justify mitigatory measures for the three impacts identified in section (e). [03 marks]

(g) Propose monitoring measures for the three impacts identified in section (e). [03 marks]