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**
Academic Year	: 2019/2020
Date	: 03rd October 2020
Time	: 0930-1230hrs
Duration	**: 3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.

2. This question paper consists of **Seven (7)** questions in **Six (6)** 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 / equations are provided in last page

6. This is an Closed Book Test **(CBT).**

7. Answers should be in clear handwriting.

8. Do not use red colour pen.

Question 1

(a) (i) Micro plastics in marine and aquatic systems are one of the critical issues faced by the scientists in this decade. How micro plastics get into the aquatic ecosystems. Explain briefly.

(ii). Mention three pollutants that can be identified in micro plastics.

(iii) List three impacts that community can face due to marine microplastics.

(iv) How 'bioaccumulation' and 'biomagnification' of pollutant in microplastics travel via food chain is impacted on human health. Illustration can be given to support your answer.

[09 marks]

(b) New Diamond Oil tanker incident in North Eastern sea is one of critical issue for the marine ecosystem in Sri Lanka.

(i) List four problems that can be expected due to the marine ecosystem.

(ii) List three issues that would occur due to oil spill to the coastal ecosystem.

[05 marks]

(c) (i) Discuss the Photochemistry of ozone in the upper atmosphere using the pertinent chemical reaction.

(ii)What are the factors affecting dispersion of air pollutants?

[06 marks]

Question 2

(a) (i) What is meant by safe water?

(ii) In community-based water supply schemes in rural Sri Lanka are need water safely plan to have safe water. List three actions that can be taken in community level and as individuals at home.

[05 marks]

(b) (i) Saltwater intrusion is serious matter for the community in coastal region. What are main reasons for saltwater intrusion.

(ii) Explain how saltwater intrusion can be impacted on community and industries.

(iii) If there is water intake in upstream of a river, what precaution can be recommended to the waster supply industry to protect the supply from mixing salt water with the system. List two of them.

[08 marks]

(c)   A perennial river has average velocity of 0.7m/s and wastewater of a factory which contained organic pollutant of Trichloroethylene (TCE) is discharged into this river. The stream mixing with pollutant of Trichloroethylene (TCE) undergoes complete mixing to give the TCE concentration of 0.3mg/L. A water supply system situated 10 km distance supply water to the surrounding community for several decades. Following facts are given. assume a 70- Kg person consumes 2L of water for 365 days per year for 10 years. The reaction rate coefficient K is given as 1.9×10^{-4}/day. Lifetime of a normal person is 60 yrs.

(i)   Estimate the steady state pollutant concentration expected at the intake.

(ii)   If the potency factor for the contaminant of TCE is 2×10^{-2} $(mg/kg\ day)^{-1}$. What would be the individual risk of cancer due to the above exposure of TCE.

[07 marks]

Question 3

(a)   (i)   A diary production factory release its wastewater to a nearby stream with a flow rate of $5m^3/s$. The BOD_5 concentration of receiving stream is 10 mg/l. If the BOD_5 concentration of the diary wastewater is 1300 mg/l and the rate of discharge is $0.2\ m^3/s$ calculate the BOD_5 concentration at the downstream of the mixing zone.

(ii)   What assumptions have you made for solving this problem?

[06 marks]

(b)   A perennial river has average velocity of 0.7m/s and has a reoxygenation constant 0.4 d^{-1}. At the point of which organic pollutant is discharged, it is saturated with oxygen at 10mg/L.. Below the outfall the ultimate demand for oxygen is found to be 14mg/L and the $Kr = 0.2\ d^{-1}$. And $Kd = 0.14\ d^{-1}$. What would be the pollutant concentration 8 Km downstream? Mention the assumptions made for solving this problem. Assume if any data is needed.
(The Streeter – Phelps equation is given in the last page with usual notations)

[08 marks]

(c)   An aeration system with a hydraulic retention time of 5 hour receives a flow of 1500 m^3/d at a BOD of 1300 mg/l. The mixed liquor suspended solids (MLSS) concentration in the aeration tank is 3,500 mg/l. The effluent BOD is 20 mg/l.
Calculate,
(i)   The volume of the aeration tank.

(ii)   F/M ratio (Food to Microorganisms).

[06 marks]

Question 4

(a) (i) Explain why removal of residual suspended soils effectively removes residual BOD$_5$.

(ii) Describe five on-site alternatives for treating /or disposing of domestic sewage.

(iii) Sketch a graph showing the average variation of daily flow at a municipal wastewater treatment plant.

[06marks]

(b) (i) What is need of an equalization tank?

(ii) A treatment plant design for a city requires an equalization basin. The average daily flow rate is 0.42m³/s. If the overflow rate is 26.0 m³/d and detention time is 2.0 h what would be the volume of the primary sedimentation tank. Assume the depth of the basin is 3.5m.

(iii) If an equalization tank was installed ahead of the primary sedimentation tank and the average flow is reduced to 0.40m³/s what would be the new overflow rate and detention time of primary sedimentation tank.

[11 marks]

(c) In the above section (b), If the BOD$_5$ to the primary sedimentation tank is 360 mg/L, and the BOD$_5$ removal efficiency is 32%, how many BOD$_5$ kilograms are removed in the primary sedimentation tank each day?

[03 marks]

Question 5

(a) (i) Explain the purpose of the F/M ratio and F and M in terms of BOD$_5$ and mixed liquor volatile suspended solids.

(ii) Develop a relationship the volume of the aeration tank given F/M, BOD$_5$ and flow.

[03 marks]

(b) (i) Write the mathematical expression for the decay of a substance by first order kinetics with respect to the substance.

(ii) The city of Soyzapura has been directed to upgrade its primary WWTP to a secondary treatment 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 flow rate of 0.029 m³/s. The

effluent of primary sedimentation tank has a BOD$_5$ of 240mg/L. Using the following assumptions, estimate the required volume of the aeration tank and F/M ratio.

Assumptions:

1. BOD$_5$ of the effluent suspended solids is 70% of the allowable suspended solids concentration

2. Growth constant values are estimated to be:Ks =100mg/L BOD$_5$; Kd=0,025d^{-1}; m= 10d^{-1}; Y= 0.8 mgVSSmg BOD$_5$ removed

3. The design MLVSS is 3000 mg/L.

(iii) What would be the oxygen requirement per day, if the sludge age (mean cell residence time) is 12days. O$_2$ required per day = $1.47\ Q\ (S_0\text{-}S) - 1.42V(x/\theta_c)$ with usual notations.

[12 marks]

(c) (i) Define SVI and explain its use in the design and operation of an activated sludge plant.
(ii)An aeration system with a hydraulic retention time of 3 hour receives a flow of 2000 m^3/d at a BOD of 550 mg/l. The mixed liquor suspended solids concentration in the aeration tank is 3,500 mg/l. The effluent BOD is 20 mg/l. Calculate, the volume of the aeration tank.

(iii) SVI of the system

[05 marks]

Question 6

(a) (i) What are the salient features that can be highlighted in a control dumpsite?

(ii) What are the variables to be considered when selecting a location for a landfill? List five of them. Discuss the merits and demerits of placing a landfill site in Jaffna Peninsula?

(iii) Why a MSW landfill site needs a proper daily cover and a leachate collection system?

(iv) Completed landfills are generally require maintenance. Why?

[08 marks]

(b) (i) Explain why seismic risk is important in landfilling

(ii) Explain how permeability, porosity, and sorption capacity of soil limit the migration of hazardous waste

(iii) Explain what hydraulic features are important in siting a landfill.

(iv)   A sanitary landfill has available space of 16.2 ha at an average depth of 10m. 65 m³ of solid waste are dumped at the site 5 days per week. This waste is compacted to twice its delivered density. Estimate the expected life of the landfill in years.

[06 marks]

(c)   (i)Explain why impulsive noise is more dangerous than steady state noise.

(ii) Noise control in the transmission path is important in highway constructions. Explain three methods that can block or reduce the flow of sound energy.

[06 marks]

Question 7

The proposed Yan Oya reservoir project involves the construction of an earth dam across Yan Oya, upstream of the existing Yan Oya diversion weir at Pamburugaswewa, to establish a 169 mcm capacity reservoir. The proposed 2,350m long main dam will be located 30 km upstream of Yan Oya sea outfall at Pulmodai and 1.25 km downstream of the confluence of Kapugollewa Ela and Ebbe Ela with Yan Oya. In addition to the main dam, four saddle dams totaling to the length of 3,594 m will be constructed to complete the proposed Yan Oya Dam at the selected locations, which will give a total dam length of 5,944m. The head works of the project include a spillway with 5 radial gates (12m x 8 m), located at first right bank saddle dam and two tower sluices, located in left bank of the main dam and saddle dam number three for left bank and right bank conveyance canals, respectively. The discharge capacity of concrete lined, 22 km long left bank main canal will be 8.37 m³/ sec and it will directly serve 4190 ha of lands in the left bank irrigable lands of Yan Oya. The right bank main canal will be 11.7 km long with a discharge capacity of 3.25 m³/ sec and will serve 1812 ha of irrigable lands in the right bank area. In addition to main canals, 25.8 km of branch canals, secondary and tertiary irrigation infrastructure including operation and maintenance roads with bridges, culverts etc. will be established under the project.

(i)   Why should project alternatives to be considered in a EIA this study?

(ii)   It is understood that due to this project, a serious damage will be occurred to the archaeological sites. How it can be minimized. Provide three suggestions.

(iii) The proposed project will be in the wildlife reserves and the area. How this project will impact on existing human elephant conflict. Explain also three mitigatory measures for overcoming the situation

(iv)   What is e-flow. Why is to be maintained specially for reservoir development projects

(v)   What are the methods that are available for estimating e-flow. Name and Explain the procedures briefly.

(vi)   What is meant by vector based diseases. What suggestions can be given for preventing of vector based diseases and workers health and safety during the operation of this project

[20 marks]

Supplementary

Risk =CDI * Potency factor

CDI (mg/kg/day)=Total dose(mg)/[Body weight(kg) *Life time (days)]

$$C(t) = C(0)e^{-Kt}$$

$$Risk = CDI \times potency\ factor$$

$$r_u = -\frac{\mu_m S X_{avg}}{K_s + S}$$

$$\frac{1}{\theta_c} = \frac{Y\mu_m(S_o - S)}{(S_o - S) + (1 + \alpha)K_s ln(S_i/S)} - k_d$$

$$\frac{F}{M} = \frac{QS_0}{\forall X}$$

$$DO = DO_s - \left[\frac{k_d L_0}{k_r - k_d}\left(e^{-k_d t} - e^{-k_r t}\right) + D_0 e^{-k_t t}\right]$$

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