UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: July 2017

Module Number: CE7304 **Module Name: Environmental Management**

[Three Hours]

[Answer **all questions**, each question carries twelve marks]

Q1. a) "'Integrated Environmental Management' is a strategic approach to create a balance between the environment and economic development." Rationalize this statement.

[2.0 Marks]

b) (i) "'Environmental Audit Program' is a pro-active environmental management approach." Rationalize this statement giving emphasis to the objectives of conducting an Environmental Audit Program in a company.

[2.0 Marks]

(ii) State **two** merits and **two** demerits of 'ambient water quality standards' in the view point of a) the regulator and b) the beneficiaries living at the surround of the water body in consideration.

[2.0 Marks]

c) (i) Identify **five** operational impacts likely to be imposed on by one project out of the following list: a sea port construction project; a project for constructing a wastewater collection, treatment and disposal system; a project for constructing a cane sugar manufacturing industry.
Along with each identified impact above, mention the environmental resource factor associated with it.

[2.0 Marks]

(ii) Develop an interaction matrix suitable for an Environmental Impact Assessment (EIA) report developed for the selected project in part (c)(i) to summarize the environmental impacts so that it would ease the decision makers' role.
(Note: Use the impacts identified in part (c)(i), and consider an imaginary significance level for each impact).

[4.0 Marks]

Q2. a) (i) State a suitable sampling technique for each of the following situations:

- A sample that represents the instantaneous quality of a waste stream
- Rapid fluctuations are encountered or detailed characterization is required
- Wastewater flow rate is continuous but of varying quality
- The flow variations exceed $\pm$ 15 %

[1.0 Mark]

(ii) The characteristics of a wastewater out-fall having a varying flow rate is to be investigated. The hourly average flow rates of the above wastewater out-fall for a period from 6.00 a.m. to 12.00 noon are 70, 80, 65, 85, 75 and 60 *L/s*. A sample will be collected using 'flow proportionate composite sampling' technique. The total volume of the composite sample required will be 2 *L*. Estimate the volume of the sample that should be collected every hour.

[3.0 Marks]

b) An urban stream has recently indicated signs of eutrophication. There is no other pollution source to this stream except a number of industries discharging their treated effluent into the stream. Concentration-based effluent discharge standards are applied, and these industries strictly comply with those standards.

(i) State two types of standards other than the 'concentration-based effluent discharge standards' that can be enforced in order to reduce the eutrophication risk in the above stream. Give a reason for each answer.

[2.0 Marks]

(ii) Discuss briefly the possible methods under the 'economic instruments' approach that can be applied to solve the above eutrophication issue.

[2.0 Marks]

c) Fee for sewage treatment at a centralized treatment facility can be determined;

by the volume of wastewater and an additional surcharge for every parameter exceeding a pre-determined concentration (quantity-quality approach) or

by allowing all users the same amount of treatment per assessment rupee, after which a surcharge is applied (assessment/surcharge approach). In the 2nd method, every user has to pay a fixed amount of money annually, i.e. 'annual assessment', to the municipality for the sewage treatment.

(i) Discuss briefly the merits and demerits associated with each method above in the viewpoint of the service provider.

[1.0 Mark]

(ii) A dairy industry produces a wastewater flow of 1000 m^3/d with a BOD_5 value of 750 *mg/L*. The industry pays the municipal council in order to have its wastewater treated and disposed of at a central treatment facility. The treatment charge is calculated based on the 'quantity-quality' approach. BOD_5 concentration not exceeding 300 *mg/L* is calculated according to the volume of wastewater discharged. A surcharge is applied for the additional amount of BOD_5. The charge rates applied are; Rs 25 per m^3 of wastewater discharged and Rs. 75 per kg/BOD_5 removed. What would be the annual wastewater disposal cost of the industry?

[3.0 Marks]

Q3. Table Q3 (a) (i) gives the details of industrial effluents *A*, *B*, and the stream conditions just upstream to these industrial discharges.
Following equations are applicable:

$$D_c = \frac{k}{k_2} L_i e^{-k\theta_H^*} ; \theta_H^* = \frac{1}{(k_2 - k)} \ln \frac{k_2}{k} \left\{ 1 - \frac{D_i (k_2 - k)}{k L_i} \right\}; \quad L = L_i e^{-k\theta_H} ;$$

$$D_{O_2} = \frac{k L_i}{(k_2 - k)} (e^{-k\theta_H} - e^{-k_2\theta_H}) + D_i e^{-k_2\theta_H} ; k_T = k_{20} \times \theta^{(T-20)} ; x = \theta_H u$$

D_i = Initial dissolved oxygen deficit at the point of waste discharge, *mg/L*

D_c = Critical dissolved oxygen deficit, *mg/L*

θ_H = Hydraulic retention time, *d*

θ_H^* = Critical hydraulic retention time, *d*

k_2 = Re-aeration constant, d^{-1}

k = Carbonaceous organic matter degradation rate constant, d^{-1}

k_T = Reaction rate constant at $T\ ^0C$, d^{-1}

k_{20} = Reaction rate constant at 20^0C, d^{-1}

L_i = Ultimate *BOD* (BOD_u) at the point of waste discharge, *mg/L*

x = Distance from the mixing point, *m*

u = Velocity, md^{-1}

Table Q3 (i) Details of the industrial effluents A and B, and the stream.

Parameter	Industrial Effluent *A*	Industrial Effluent *B*	Stream
Flow rate, m^3/d	4,000	5,000	45,000
Ultimate *BOD*, *mg/L*	30	25	-
Ultimate *BOD* load, *kg/d*	-	-	225
DO (Dissolved Oxygen) load, *kg/d*	12	10	270
Temperature, ^0C	30	30	25
k at 20 ^0C, d^{-1}	0.36	0.36	-
k_2 at 20 ^0C, d^{-1}	-	-	0.60
Temperature coefficient (θ)	1.06		

Table Q3 (ii) Saturated DO concentrations at different temperatures.

Temperature(^0C)	21	22	23	24	25	26	27	28	29	30
Saturated *DO* concentration (*mg/L*)	8.9	8.73	8.56	8.4	8.24	8.09	7.95	7.81	7.67	7.54

a) State three deoxygenation and two re-oxygenation means of a stream.

[2.5 Marks]

b) Find the conditions in terms of BOD_u, *DO* and Temperature just downstream to the industrial effluents discharge point in the stream.

[2.5 Marks]

c) Find the time to the critical point of the stream.

[2.5 Marks]

d) Determine the oxygen sag at the critical point of the stream.

[2.0 Marks]

e) Estimate BOD_5 of a sample taken at the critical point of the stream. Consider the temperature at the critical point as the temperature at which the above BOD_5 value should be determined.

[2.5 Marks]

Q4. a) Read the following case and answer the questions:
A large-scale tannery industry has been in operation for about 6 years in proximity to a national reserve. To date, the results of all environmental auditory done so far show that this industry completely fulfills all legal requirements, laws and environmental standards established by the authorities. Since last year, this industry is part of a trial against the community, which argues that since the industry started its operation, water quality in a near-by stream has deteriorated significantly and is a major concern as this industry is located in an environmentally sensitive area. The industry argues that it has relevant proofs to demonstrate that their operations have not deteriorated the water quality in the stream mainly because the wastewater generated inside the plant is reclaimed and reused in the same process and no treated effluent is discharged outside. The industry emphasizes that when they began the activities, the water quality of this stream had already been poor.

(i) Discuss why the Environmental Impact Assessment (EIA) report can be used to prove that this industry is not guilty of deteriorating water quality of the above stream.

[2.0 Marks]

(ii) State three environmental impacts this industry operation can cause to the surrounding environment, along with the environmental resource factor being subject to each impact.

[2.5 Marks]

(iii) Explain briefly the possible strategies that can be taken to make the above industrial activities environmentally sustainable.

[2.5 Marks]

b) Using an example, explain briefly the nature of the decision-making process in an EIA study.

[2.5 Marks]

c) Give a brief note on water reclamation and reuse emphasizing the different types of contaminants, suitable reclaiming techniques for each type of contaminant and different reuse applications.

[2.5 Marks]

Q5. a) 12.2% of the population in a coastal town does not have proper sanitation facilities. This township is located very close to a large lagoon and therefore, the water table is high in sandy soil. The canal system in the city is polluted with domestic wastewater. During the wet season, the cesspools and soakage pits saturate and the wastewater overflows freely into the drainage canals. High

population density, poor drainage system, frequent sewage overflows into drains etc. have caused health hazards in the area. Therefore, a proper sewage disposal system is a necessity for this town to minimize the spreading of water borne diseases.

In order to improve this situation, a project of constructing a wastewater collection, treatment and disposal system, which will comprise a collection network, treatment system, effluent and sludge disposal system and operation and maintenance facilities, has been proposed. The collection network and the WWTP will be designed to cater a total design period until 2043.

The wastewater treatment plant (WWTP) will consist of a waste stabilization pond system, which can accommodate 1,500 m^3/d of wastewater including ground water infiltration. The collection network will be laid on the main roads in the town. The development of the collection network is limited to the populated roads and to roads that has the potential to grow further in near future. The treated wastewater from the WWTP will be released into the sea at a location beyond the lagoon using a short multiport outfall structure. The design parameters of each operation/process of the proposed WWTP will comply with the typical values. The estimated characteristics of the treated effluent satisfy the standards for discharging effluent into inland surface water bodies.

(i) Name **two** viable alternatives for the disposal of the treated effluent other than the proposed disposal method.

[1.0 Mark]

(ii) Construct an outline of a weighting-scaling checklist that could be used to compare the **three** alternative treated effluent disposal methods {the proposed disposal method and the two alternatives stated in part (i)} in developing an Environmental Impact Assessment *(EIA)* report for the above project.
The checklist should include at least 5 decision factors, an imaginary weight for each decision factor and an imaginary scale for each alternative. A composite index for each alternative has to be obtained based on the imaginary weights and scales.

[4.0 Marks]

(iii) Name **three** nos. of economic cost aspects and **six** nos. of economic benefit aspects associated with the above project that can be monetized to estimate a benefit-cost ratio for the above project.

[4.0 Marks]

b) Discuss the economic cost and benefit terms that can be monetized in order to carry out an extended benefit-cost analysis for a road development project.

[3.0 Marks]