UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering: December 2015

Module Number: CE8329 **Module Name: Environmental Management**

[Three Hours]

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

Q1. a) "An approach which continually compromises between quantity of production and quality of environment is a way to achieve a sustainable global environment." Rationalize this statement.

[2.5 Marks]

b) (i) Environmental-friendly options are preferred as alternative methods for road building and restoration. Stabilizing the existing soil to create durable and load-bearing layers is such an environmental-friendly option. This option is preferred to the traditional road-repair and construction methods that involve excavating and transporting the existing substandard soil and importing materials from borrow pits to the road site. Discuss why the former method is considered environmental-friendly compared to the latter.

[1.5 Marks]

(ii) Explain how "life Cycle Assessment" can be applied to select the best environmental-friendly option in the above case.

[1.5 Marks]

c) "'Integrated environmental management' is a pro-active environmental management strategy." Rationalize this statement giving emphasis to the definition of the 'Integrated Environmental Management'.

[2.5 Marks]

d) Various technologies available to control ammonia emissions include both add-on control devices and pollution prevention techniques. Following are some options available in this regard:
(1) The wet scrubber, specifically the packed tower scrubber, which has been successfully used to control ammonia emissions, demonstrating control efficiencies up to 99% (i.e. Scrubbed ammonia enters the water used for scrubbing);
(2) Condensers used to remove ammonia by converting the gas to a liquid demonstrating control efficiencies up to 80%;
(3) Reuse of the condensate, a residue left by the condensers used to remove ammonia, in the same process;
(4) Ammonia recycle, in which the ammonia is retrieved from the exhaust gas stream and returned to the process;
(5) Ammonia used as a feedstock in the fertilizer manufacturing industry;
(6)The reduction or elimination of ammonia emissions by using cleaner technology.
List these methods in the hierarchical order for waste minimization giving reasons for the selection. Assume that the removal of ammonia from water is

easier than that from air stream.

[4.0 Marks]

Q2. a) (i) Fee for sewage treatment at a centralized treatment facility is determined (1) by the volume of waste and an additional surcharge for every parameter exceeding a pre-determined concentration (quantity-quality formula) or (2) by allowing all users the same amount of treatment per assessment rupee, after which a surcharge is applied (assessment/surcharge formula). 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. An owner of a food processing industry generating a high BOD_5 (Biochemical Oxygen Demand) load, would prefer the 1st formula (quantity-quality formula) to 2nd (assessment/surcharge formula), while the 2nd formula is the best from the pollution control standpoint. Explain the reason/s.

[3.0 Marks]

(ii) A tannery industry produces a wastewater flow of 600 m^3/d with a BOD_5 value of 600 mg/L. The industry pays the municipal council in order to have its waste treated and disposed of at a central treatment facility. The treatment charges are calculated using the 'assessment - surcharge formula'. The average annual assessment of the tannery industry is Rs. 25 million, and a surcharge is not applied. A food processing industry served by the same municipality has been assessed at Rs. 20 million. If the food processing industry produces a wastewater flow of 600 m^3/d with BOD_5 of 600 mg/L, what would be the annual surcharge? The operating cost for removing BOD_5 is Rs. 50 per kg/BOD_5 removed. Assume that all users are entitled to the same amount of treatment per assessment rupee.

[3.0 Marks]

b) A large-scale and a medium-scale food processing industries are located nearby a lake. The food item processed by each industry is different from one another. Both the industries have permits to obtain sufficient water from the lake for its needs and to release treated effluent back to the lake. Both the industries should satisfy the effluent discharge standards. The flow rates of the large-scale and medium-scale industries are 500 m^3/d and 250 m^3/d, respectively. The effluent characteristics of both the industries are almost the same with high BOD_5 and nutrient concentrations. Recently the lake has been found polluted. The medium-scale industry accused the large-scale industry of being the reason for this pollution.

(i) Discuss the adverse effects on the lake ecosystem due to the discharge of these effluents.

[2.0 Marks]

(ii) State whether you agree with the accusation made by the medium-scale industry and explain the answer.

[2.0 Marks]

(iii) Describe how to integrate 'command and control approach' with 'economic tools (strategies)' to decrease the pollution load of these industries.

[2.0 Marks]

Q3. a) Table Q3 (a) (i) gives the details of industrial effluents *A*, *B*, and the stream conditions just upstream to these industrial discharges. Determine the oxygen sag at the critical point of the stream. Estimate the BOD_5 (25^0C) of a sample taken at the critical point. Consider the temperature at the critical point as the temperature at which the above BOD_5 value should be determined.
Following equations are applicable:

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

$k_T = k_{20} \times \theta^{(T-20)}$ Where;

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*

Table Q3 (a) (i) Measurements 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 (a) (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

[6.0 Marks]

b) In an industrial park, a cane sugar manufacturing industry, a chrome tanning industry, a dairy and a food processing industry are located.

(i) If the collective waste management is followed, discuss how to arrange the wastewater treatment facilities in this industrial park so that the treated effluent is able to be discharged to a surface water body nearby. (i.e. Draw a flow diagram to illustrate all the treatment unit processes).

[3.0 Marks]

(ii) In order to convert this into an eco-industrial park, discuss three possible ways to minimize the pollution arising from the wastewater without going for the end-of-pipe treatment.

[3.0 Marks]

Q4. In order to develop the water resources of Uma Oya basin, there is a proposal to construct a medium high dam across Uma Oya at its upper catchment area, and to divert water through a 25 *km* long tunnel to an underground power house at Randeniya on the right bank of Kirindhi Oya. The water released from the power house will be added to Kirindhi Oya basin in order to supplement Handapanagala and Lunugamvehera reservoirs the water of which subsequently used for irrigation in Hambantota and Monaragala districts.

a) Name and describe **five** aspects to be considered in the Terms of Reference (TOR) development of the Environmental Impact Assessment (EIA) for the above project?

[2.0 Marks]

b) Construct an outline of a weighting-scaling checklist that could be used to compare the alternative sites for the entire project. The checklist should include at least 10 decision factors, an imaginary weight for each decision factor and an imaginary scale for each alternative site. A composite index for each alternative has to be obtained based on the imaginary weights and scales.

[3.0 Marks]

c) Identify **five**(for each area) significant negative environmental impacts likely to arise during the operational phase of this project in the (i) dam and reservoir area at the Uma Oya basin and (ii) downstream area of the Uma Oya.

[2.5 Marks]

d) Explain briefly engineering mitigatory measures to minimize **six** of the identified impacts.

[2.5 Marks]

e) What is 'no-action alternative'? In carrying out an EIA for the above project, identify **four** viable options that could be considered under the 'analysis of alternatives'?

[2.0 Marks]

Q5. a) Identify the most significant impacts and list with reasons, key factors to be included in an Environmental Management Plan (EMP) of an Environmental Impact Assessment (EIA) report for one project out of the following list: a sea port construction project; a project of constructing a wastewater collection, treatment and disposal system; a project of constructing a cane sugar manufacturing industry.

[4.0 Marks]

b) Using an example, describe how a single development activity may impose a primary impact, secondary impact and cumulative impact.

[2.0 Marks]

c) "Baseline studies for the existing environment is important in carrying out an EIA because environmental systems are dynamic." Rationalize this statement.

[3.0 Marks]

d) Explain with examples why the magnitude as well as the significance of the environmental impact is important in decision making.

[3.0 Marks]