UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering (Repeat): November 2016

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

[Three Hours]

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

Q1. a) "'Life-Cycle Assessment (LCA)' is an environmental management tool as well as a way to achieve the sustainability in both the industrial sector and construction field." Rationalize this statement.

[3.0 Marks]

b) (i) Discuss the common components of a sustainable development.

(ii) "'Integrated environmental management' is a way to achieve the sustainability in the construction field." Rationalize this statement giving emphasis to the definition of the 'Integrated Environmental Management'.

[2.5+2.5 Marks]

c) Sulfur Dioxide (SO_2) is a major air pollutant emitted from the cane sugar manufacturing industry. Following are several options available to reduce SO_2 pollution from industrial activities: (1) Installing a condenser to recover SO_2 for reuse; (2) Inducing options to undergo chemical reactions to produce different and less objectionable emissions; (3) Reducing or eliminating the production of SO_2 using cleaner technology; (4) Selectively removing SO_2 from a gas stream by absorption (gas to liquid); (5) Installing a fume incinerator. List these methods in the hierarchical order for waste minimization giving reasons for your selection.

[4.0 Marks]

Q2. a) (i) Fee for sewage treatment at a centralized treatment facility is determined (1) by the volume of waste released (quantity formula) or (2) by the volume of waste and additional surcharge for every parameter exceeding a pre-determined concentration (quantity-quality formula). An owner of a tannery industry generating a high BOD_5 load, would prefer the 1st formula (quantity formula) to 2nd (quantity-quality formula) while the 2nd formula is the best from the pollution control standpoint. Explain the reason/s.

[3.0 Marks]

(iii) A food processing industry produces a wastewater of 500 m^3/d with BOD_5 (Biochemical Oxygen Demand) of 500 mg/L. This 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' by allowing all users to pay the same amount of treatment for an 'assessment rupee', after which a surcharge is applied. Every user has to pay a fixed amount of money annually, i.e. 'annual assessment', to the municipality for the sewage treatment. The average annual assessment of a commercial establishment of 5.0 persons is Rs. 60 000. BOD_5 contribution per a commercial establishment is 120 g/capita.d. The industry has been assessed at Rs. 20 million. 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. What would be the annual surcharge of this industry?

[4.0 Marks]

b) A cane sugar manufacturing industry is located nearby a lake. The industry has a permit to obtain sufficient water from the lake for its needs and to release treated effluent back to the lake. The wastewater treatment plant of this industry has had a history of exceeding the effluent standards. Therefore it has been pumping water from the lake and diluting plant effluent to lower the concentrations to satisfy the discharge standards.

(i) Discuss the adverse effects on the lake ecosystem due to the discharge of this effluent.

(ii) Describe how to integrate 'command and control approach' with 'economic tools (strategies)' to decrease the pollution load of this industry.

[2.5+2.5 Marks]

Q3. a) Table Q3 (a) 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 (30 ^{0}C) of a sample taken at the critical point. Saturation dissolved oxygen concentration at 30 ^{0}C is 8.0 *mg/L*.

Table Q3 (a) Measurements of the industrial effluents A and B, and the stream.

Parameter	Industrial Effluent A	Industrial Effluent B	Stream
Flow rate, m^3/d	5 000	6 000	55 000
Ultimate BOD load, *kg/d*	200	250	-
Ultimate BOD, *mg/L*	-	-	18
DO (Dissolved Oxygen) concentration, *mg/L*	0.3	0.2	6.0
Temperature, ^{0}C	30.0	30.0	30.0
k at 30 ^{0}C, d^{-1}	0.36	0.36	-
k_2 at 30 ^{0}C, d^{-1}	-	-	0.60

You may use the following equations:

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

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 = Reaeration constant, d^{-1}

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

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

[6.0 Marks]

b) In an industrial park, except for few, all industries discharge effluents similar to that of the municipal sewage. Three industries discharge effluents with chromium, ammonia and dissolved organic matter, respectively.

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).

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 +3.0 Marks]

Q4. There is a proposal to construct a wastewater collection, treatment and disposal system for the Monaragala Urban Council area. The proposed wastewater treatment plant (WWTP) consists of a mechanical pre-treatment system, aerated lagoon, secondary sedimentation tank and chlorination unit. The treated effluent will be released to an abandoned irrigation tank. This will be restored for the storage of the treated effluent. The stored water will be used for agricultural irrigation. The WWTP will be located in a mild hilly area remotely.

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?

[2.5 Marks]

b) Construct an outline of an interaction matrix that could be used to compare the significant impacts due to this project. (i.e. You may not fill the interaction boxes)

[2.0 Marks]

c) Identify significant negative environmental impacts likely to arise during the operational phase of this project.

[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'?

[2.5 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 a sea port construction project.

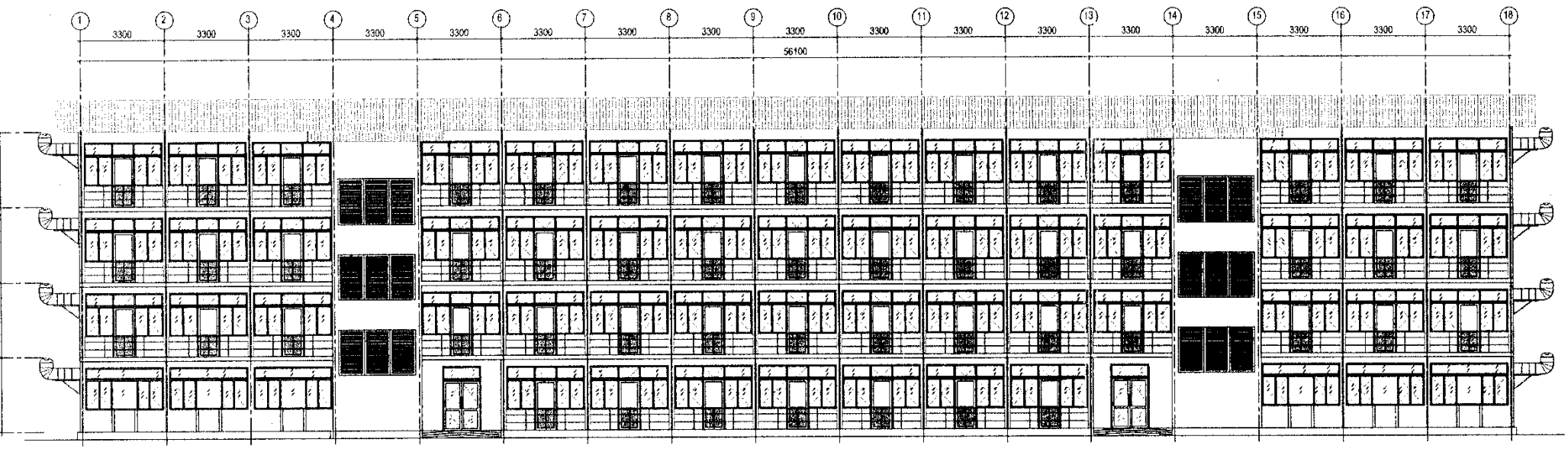
[5.0 Marks]

b) Using examples, explain the role of interaction matrices and check lists in (i) identifying and comparing significant impacts, and (ii) analyzing different alternatives in the decision making process of an EIA.

[4.0 Marks]

c) "The EIA process involves objective and subjective analyses. The differences and limitations of both must be recognized in the decision making." Rationalize this statement.

[3.0 Marks]



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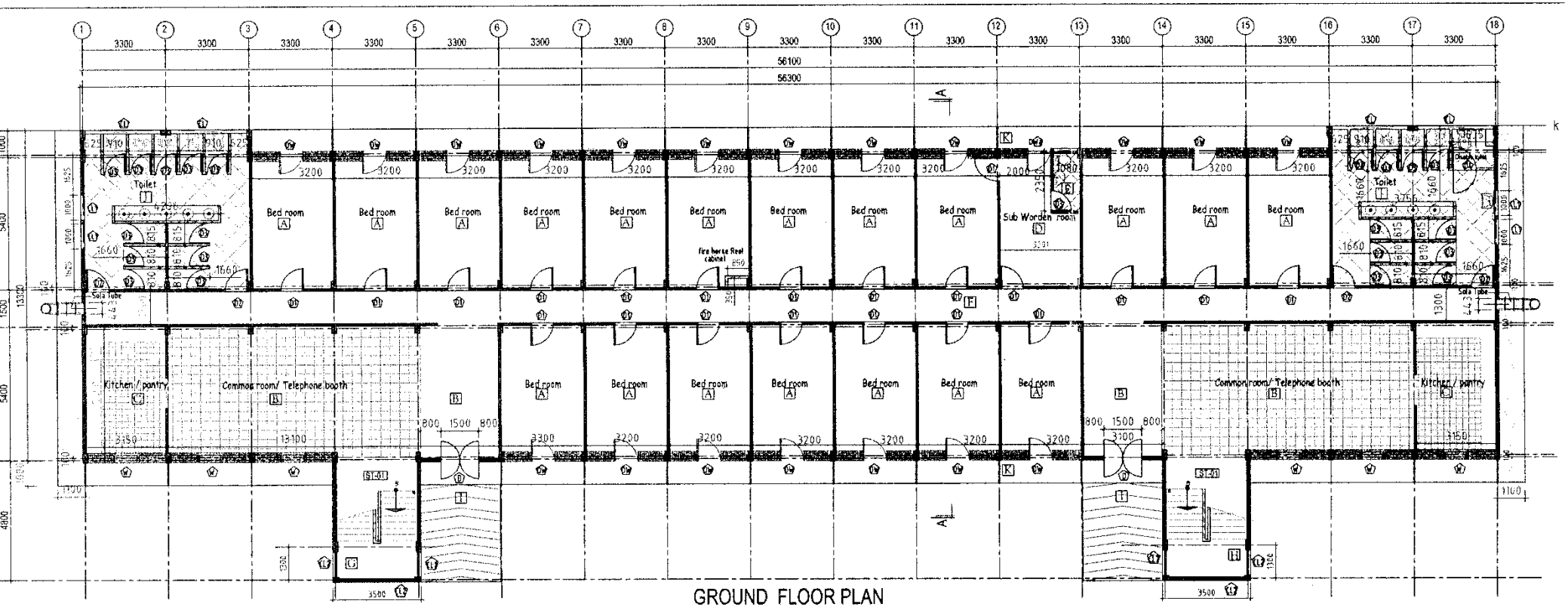

GROUND FLOOR PLAN