THE OPEN UNIVERSITY OF SRI LANKA
Department of Civil Engineering
Bachelor of Technology (Civil) - Level 6

CEX 6233 – ENVIRONMENTAL ENGINEERING

FINAL EXAMINATION - **2008/2009**

Time Allowed: **Three hours**   **Index No.**

Date : **21ˢᵗ March, 2009**   **Time : 1400 - 1700**

Answer any FIVE questions. All questions carry equal marks.

Question 1.

(a) The living environment is known as biosphere. Ecosystems are natural balancing systems in the bio sphere over a period of time and space.

(i) Name four major natural cycles in nature and explained one of them briefly.

[03 marks]

(ii)How does the ecological-balance breaks off? Briefly explain.   [02 marks]

(ii)What steps do you suggest to safeguard the ecosystems?   [02 marks]

(b) Environmental component plays a major role in passing on the diseases causing organisms from an infected person to a healthy individual. What are the environmental components involve in disease transmission? Elaborate your answer giving examples.   [04 marks]

(c) Toxic metal pollution has become a global concern. Unlike organics, metals are persistent in the environment and cannot be degraded and that show biomagnification in the food chain.

(i) 'Minamatha disease' occurred due to discharging industrial effluents to the environment. What metal is responsible for Minamatha disease? Also explain how biomagnification helps to spread the disease.   [02 marks]

(ii) Suppose an individual exposes to a carcinogenic pollutant releases to the Minamatha bay. Standard exposure factors for a healthy individual are given in the following table. Bio concentration factor for the pollutant is 16 l/kg and the potency factor for oral route is 6.1×10^{-3} $(mg/kg/day)^{-1}$. Estimate the chronic daily intake (CDI) and the life time cancer risk from the fish taken from waters containing a concentration of the pollutant equal to 60ppb (0.06 mg/l).   [07 marks]

Land use	Exposing pathway	Daily intake	Exposure frequency Days/year	Exposure duration years	Body weight Kg
Recreational	Consumption of locally caught fish	54g	350	30	70

Question 2.

(a) Compare the surface water and ground water for their quality, quantity and collection aspects. [05 marks]

(b) National Water Supply and Drainage Board has decided to supply water to Karrukapone, a small town situated at Puttlum district. For investigations, it is needed to estimate the distance to be expected of a drawdown of 4.81m from a pumping well under the following conditions. [08 marks]

Pumping rate = 0.0280 m³/s
Pumping time = 1.066d
Drawdown in observation well = 9.52m
Observation well is located 10.00 m from the pumping well
Aquifer material = medium sand
Aquifer thickness = 14.05m
Assuming that the well is fully penetrating in the unconfined aquifer, estimate

the distance as required above. For unconfined aquifer $Q = \dfrac{\pi k (h_1^2 - h_2^2)}{\ln(r_1 / r_2)}$

(c) Water drawn from the above well was tested for parameters of drinking water quality. Physical parameters and some of the chemical parameters were tested in-situ and the water shows brownish colour and gave metallic taste. In-situ test results are as follows.

Conductivity = 1400μs/cm
pH = 6.9
Temperature = 30°C
Colour = 200 Hazen unit

(i) Discuss the suitability of this water for domestic usage highlighting possible reasons for the above test result. [02 marks]

(ii) Can you suggest any treatment method which would be suitable for purify the above water before distribution. Draw a sketch of the proposed treatment process. [03 marks]

(iii) If this source is fail to produce wholesome water, what would be your alternative water supply for the community. [02 marks]

Question 3.

(a) Out breaks of algae in reservoirs, lakes, dams, rivers, streams and channels have become more frequent in many times. Water suppliers, farmers, and community groups in Eastern and North Central provinces in Sri Lanka have all being seeking information on practices that will reduce incident of algal blooms, particularly the potentially toxic blue green algae or cyanobacteria.

(i) What are the factors leading to cyanobacterial blooms? [02 marks]

(ii) What are the possible causes for enrichment of cyanobacteria? [01 marks]

(iii) Cynotoxines, the product of cynobacteria are highly toxic. Estimate the exposure dosage, if a person of 70kg drinks 2 liters of water/day for 50 years if the concentration of the cyanotoxin in the water is 0.163μg/ml. Assume the life expectancy is 70years. [03 marks]

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(iv) Suggest methods that can be used for removal of cynobacteria at the water treatment? [02 marks]

(b) A community discharges a wastewater flow of $1000 m^3$/day to a small stream. The 7-day, 10-year minimum flow in the stream is 5.74 m^3/min. The maximum stream temperature is 30°C and this coincides with minimum flow. At this condition, the stream dissolved oxygen concentration is 6.1 mg/l above the sewage outfall. The values of K_1 and K_2 at 20°C are 0.23/day and 0.46/day respectively. Determine the time and the distance of the critical DO from the sewage treatment plant which will not deplete the dissolved oxygen concentration to less than 4mg/l under this condition. Assume that the Saturation DO is 7.63mg/l ultimate BOD is 10.5 mg/l and the waste is assumed to be having at least 2.0mg/l of Dissolved Oxygen.

[07 marks]

$$[\ k=k_{20}\theta^{(T-20)};\ \ BOD_5 = Lo\ (1 - e^{-kt});\ \theta = 1.047]$$

$$D_c = D_o e^{-k_1 t} + \frac{1}{(K_2 - K_1)} \ln\left\{\frac{K_2}{K_1}\left[1 - \frac{D_0(K_2 - K_1)}{K_1 L_0}\right]\right\} \text{ where } D_0 = \text{is initial deficit}$$

$$t_c = \frac{1}{(K_2 - K_1)} \ln\left\{\frac{K_2}{K_1}\left[1 - \frac{D_0(K_2 - K_1)}{K_1 L_0}\right]\right\}$$

(c) A grab sample of treated wastewater is collected by dipping a bottle in the outfall of the treatment plant. A sample of the influent is collected in a similar fashion. BOD analyses of the two samples yield values of 33mg/l and 188 mg/l respectively. The plant, supposedly, was designed to produce an effluent BOD of 30mg/l, or less when the influent BOD is 200mg/l. Can any conclusion be drawn concerning the adequacy of the plant? Explain. Are the two samples equally likely to be representative of the flows which they sample? [05 marks]

Question 4.

(a) A clarifier with cross sectional area of $300 m^2$ treats a flow of $6000 m^3$/day. The water entering the clarifier contains a substantial number of clay agglomerates with sand particles.

(i) What is the settling velocity of the particles this basin is intended to remove?

[1.5 marks]

(ii) What diameter sand particles ($\rho = 2650$ kg/m^3) will be entirely removed? What diameter flocculated clay particles ($\rho = 1050$ kg/m^3) will be removed?.

$$v_s = \frac{gd^2(\rho_s - \rho)}{18\mu}; \mu = 1.0087$$

[1.5 marks]

(iii) If the loading rate of $150 m^3$/m/d how many linear meters of weir are required?

[02 marks]

(b) (i) Distinguish between a slow sand filter and a rapid sand filter from construction and operational considerations. [02 marks]

(ii) A rapid sand filter plant contains 10 units, each 5m long and 2.5 m wide. The filter medium is sand with an effective size of 0.55 mm, a uniformity coefficient of 1.4 and a depth of 1m. The filters are each washed once per 24 h period. The backwashing process involves 10min of fluidization and requires that the filter be out of service 30min. The treated flow is wasted for the first 30min of each run. Determine the volume of treated water produced per day at a nominal filtration rate of 180m/day and the percentage of the product water required for backwash. [07 marks]

(c) (i) Why sludge digestion is important in wastewater treatment. Briefly explain. [02 marks]

(ii) Design a sludge digester for a town with a population of 100000, given that volume of the fresh sludge and digested sludge are $2.1m^3$/day/1000 persons and $8m^3$/day/1000persons. Assume that the digester period =30 days at 28°C. [04 marks]

Question 5.

(a) Energy in Sri Lanka is mainly depending on fossil fuels and hydropower. Percentage wise distribution shows that, fossil fuel is 60% and hydropower is about 40%. The country is seeking avenues to increase renewable energy.

(i) "Carbon foot print" is one of the key indexes to show the green activities in industries at present. What is meant by 'carbon foot print'? [02 marks]

(ii) Motorcycle with rechargeable batteries is one of the solutions to reduce fossil fuel usage. Briefly discuss suitability of using rechargeable batteries instead of fossil fuel as a 'zero emission' source. [03 marks]

(iii) Renewable energy (RE) options in Sri Lanka are numerous. Bio mass is one of the RE. Discuss the merits and demerits of usage of biomass energy. [02 marks]

(iv) Industries with boiler related activities are now moving to use using *Giriseria* (Weta mara) as the bio mass to generate energy focusing 'carbon credits'. Anyhow, burning generates emissions. Can they claim for carbon credits? Support your answer. [03 marks]

(b) To reduce vehicle emissions government has introduced a public bus service at metropolitan area of the capital city of Sri Lanka. Discuss the merits and demerits of the above action. [04 marks]

(c) Road license for vehicles are given only if they have passed through the "green test", which examines the vehicle emission levels. However, vehicle owners still do not satisfy of the way that tests are carried out and the consistency of the test records.

(i) What are the gases testing at the "green test" and how they affect to the atmospheric pollutions? [03 marks]

(ii) How would you develop the consistency of the test results from one station to another? Explain. [02 marks]

Question 6.

(a) (i) Many proposed developments require knowledge on what level of noise might be expected in the surrounding area. How do you carry out a study on noise levels before planning the development work? [02 marks]

(ii) A metal quarry near by a village use explosives and it has measured the average noise level is 110dB. Villagers are protesting to remove the quarry. As an environmental engineer, compare the noise levels received with the acceptable levels and give recommendations/solutions on methods for controlling the noise levels. Your solution may involve attention to one or all of the three elements involved; source, transmission path and receiver. [04 marks]

(iii) If the metal quarry has a pressure of 3000 μPa at 500m distance, compute the sound pressure level in dB and the sound intensity in W/m^2. The density of the air is 1.185. *(Use the equations $L_p = 20 \log_{10} (P/P_0)$ and $I = p^2/\rho c$ with usual notations if necessary)* [04 marks]

(b) (i) "Waste is a resource". Build up the statement giving examples of recovery and reuse of wastes. [03 marks]

(ii) A hotel promoting eco tourism is planning to have "zero waste". In order to achieve this target, describe what steps do they have to follow at purchasing and services (food and beverages) stages. Also discuss how their policy on garbage would be. [04 marks]

(c) Due to potential negative impact and conflicting reasons, the location of the landfill is a significant element in the general process of planning, design and construction. As land fills always have some impacts to the surrounding area, what <u>factors</u> do you consider at the pre-planning stage of a landfill? Elaborate your answer accounting environmental and health impacts. [03 marks]

Question 7.

Electronic waste – also known as "e-waste" – is a term used to denote discarded electronic and electrical equipment. E waste contains various kinds of plastics and resins, toxic organic compounds and metals such as gold, aluminum, iron, lead, tin, copper, cadmium and mercury.

(a) State one principal use of lead and of cadmium in electronic and electrical equipment. [02 marks]

(b) What would be the environmental impacts of uncontrolled burning of e-waste? [02 marks]

(c) It is proposed to bring e-waste from developed countries to Sri Lanka so that the components can be separated and recycled. Discuss the advantages and disadvantages of this proposal. [04 marks]

(d) Explain how the following groups or institutions could contribute to reducing the environmental impacts of e-waste. [12 marks]
i) Manufacturers   ii) Retailers   iii) Consumers   iv) Governments
v) United Nations and related organizations vi) Non-governmental organizations