THE OPEN UNIVERSITY OF SRI LANKA
Department of Civil Engineering
Bachelor of Technology (Civil) - Level 6 ('67

CEX 6233 – ENVIRONMENTAL ENGINEERING

FINAL EXAMINATION - 2005/2006

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

Date : **4th May, 2006** Time : **0930 - 1230**

Answer any FIVE questions.

Q1.

(a) Water plays an essential role in supporting human life and if contaminated, there is great potential for transmitting a wide variety of diseases and illnesses. In Sri Lanka the most common organisms causing water borne intestinal infections include bacteria such as *Vibrio cholerea*, *Salmonella typhi*, *Shigella dysentriae*.

(i) What are the water borne diseases caused by the above organisms? (01 mark)

(ii) Explain the mode of transmission of the above diseases. (01 mark)

(iii)What factors affect the prevalence of the diseases? (01 mark)

(iv)As an Environmental Engineer, illustrate how you could help to control or eradicate the diseases from the affected area. (02 marks)

(b) Microbiological examination of a reservoir water sample in Ampara shows that the total and fecal coliform counts are 38MPN/100ml and 0mg/l repectively. It is planned to use the above water for drinking due to scarcity of water during dry months.

(i) Comment on the suitability of the above water for drinking, considering the Sri Lankan Standards or WHO guidelines for safe drinking water. (02 marks)

(ii) Describe briefly how you would determine the availability and quantity of the total and fecal coliforms. (02 marks)

(c) Surface waters generally contain suspended matter variying in size and amount. Suspended matters enhance the turbidity of water, which should be removed at the treatment work. Adding a coagulant such as alum or iron salts followed by flocculation and sedimentation improve turbidity removal.

(i) In water treatment plants sometimes clay is added to the raw water before adding alum. What is the function of the clay? Briefly explain. (02 marks)

(ii) Discuss the factors affecting coagulant dosage in water treatment. (02 marks)

(iii)The Water supply of a town treats 25 x 10^6 l/day. The water is treated by coagulation /flocculation and then by sedimentation. The requirement of alum is estimated as 16 mg/l of water. If the alkalinity of the water is equivalent to 4.5 mg/l of $CaCO_3$, determine the quantity of alum and the quick lime (containing 80% of CaO) required per month by the water treatment plant. Molecular weights are given as

Ca = 40, C = 12, S = 32, O =16, Al = 27, and H=1.

The Following Chemical reactions take place during treatment

1. $Al_2(SO_4)_3 .18H_2O + 3\ Ca(HCO_3)_2 \longrightarrow 2Al(OH)_3 + 3\ CaSO_4 = 18\ H_2O + 6\ CO_2\uparrow$
2. $CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$
3. $CaCO_3 \longrightarrow CaO + CO_2$ (07 marks)

Q2.

(a) A tourist hotel in the coastal zone uses groundwater for its water supply. During some seasons of the year the water has a bad odour and taste. They use only softening plant to treat water as usually the water satisfies the guide lines for drinking water.

(i)What could be the reasons for the odour? (01 mark)

(ii)Mention a simple experiment, that you can perform in the field to test the water in order to confirm your hypothesis. (02 marks)

(iii)If the hotel management seeks advice from you, as an environmental engineer, what will be your suggestion? (01 mark)

(iv)If there is no space for new construction and the hotel needs an urgent action, will your advice change from the above part **(iii).** Explain your answer. (02 marks)

(b) (i) What is meant by "oxygen demanding wastes" and how do these wastes affect the aquatic environment? (01 mark)

(ii) If the BOD_5 of a wastewater sample measured at 20°C is 250 mg/l and the reaction constant is 0.35/ day, compute the ultimate and 3 day BOD of the wastewater at 20°C. (03 marks)

(iii)The following data were obtained in a BOD test for determining the performance of a wastewater treatment plant:

	Initial DO mg/l	Final DO mg/l	Volume of dilution water (ml)	Volume of wastewater (ml)
Influent	6.5	3.0	295	05
Effluent	7.0	4.0	280	20

The blank DO remained the same; this plant is expected to produce an effluent BOD not exceeding 50mg/l, with at least 85% BOD removal. Would you conclude that this plant is operating properly? Give reasons. (05 marks)

(c) A factory producing processed meats and milk is discharging its wastewater into a nearby stream. The people living downstream of the discharge point are complaining of bad odours, and there appear to be very few fish in the water.

(i)What is the most significant parameter you expect in that wastewater? (01 mark)

(ii) Explain the processes that take place in the stream downstream of the discharge point, giving reasons for the people's complaints. (02 marks)

(ii)What suggestions would you come up with to solve the above problem? (02 marks)

Q3.

(a) A foreign agency has donated a housing complex with 300 house units for tsunami affected people at Panadura secretarial division. 5 people can be accommodated in one unit and the design water demand has been estimated as 200 lpcd. National Water Supply and Drainage Board (NWS & DB) agrees to supply water. It is expected that 80% of water supply goes to the domestic wastewater treatment plant.

(i) If you are appointed as the environmental engineer of the donor agency, what are the factors that you consider to design a suitable domestic wastewater treatment system for this community based project? (03 marks)

(ii)Compute the total wastewater generation. (01 mark)

(iii)The donor agency prefers to have a constructed wetland before release the treated wastewater to the sea. However the local consultant suggests using a treatment plant with a trickling filter, a clarifier (sedimentation tank) and sludge drying beds. What could be the best option? Explain your answer highlighting the merits and demerits. (02 marks)

(iv) It is planned to discharge the treated water in respect to a natural perennial river. Do you agree with the proposal? Explain your answer with the significance of permissible levels for discharged wastewater into a water body. (02 marks)

(b) Early in the British period the entire Colombo canal network and the Beira Lake were an integrated system used for transportation. Later it fell into disuse and now it serves as a natural drainage outlet.

The figure shows the depth profile and variation of dissolved oxygen certain location in the Beira Lake on June 17th and 18th in 1993. The solid line is for the upper most level of the lake (near the surface) while the dash and double dot line is for the lowest level (near the bottom). Refer the graphs and answer the following questions.

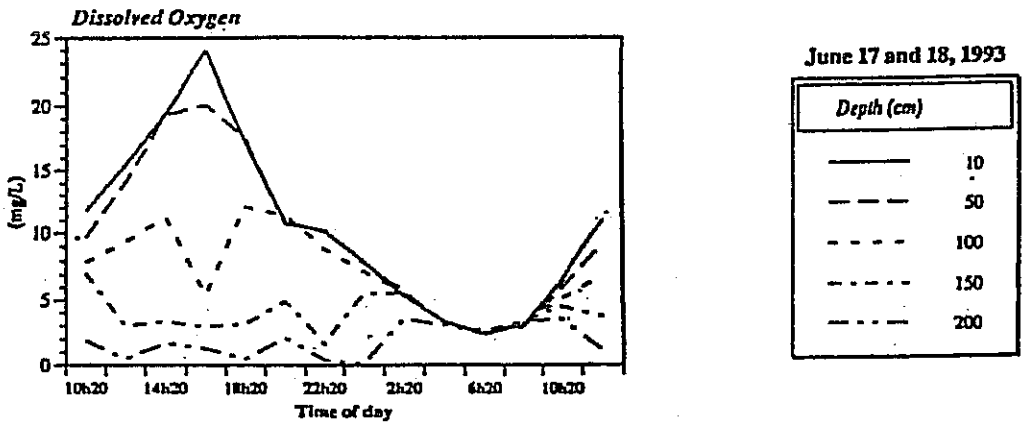

Figure Q2(b) Variation and depth profile of Dissolved Oxygen in the Beira Lake

(i)The Dissolved Oxygen changes rapidly at shallow depths within a day and becomes uniform over the depth in the early morning. Why? (02 marks)

(ii) The figure shows a high level of DO in the upper layers at the daytime. Explain. (02 marks)

(iii) How does the reduction of Dissolved Oxygen affect the biotic and abiotic environment? (02 marks)

(iv)In the dry months of each year the lake has an offensive smell. Why? (01 mark)

(v)As an environmental Engineer, what is your suggestion to over come above problems? (02 marks)

(c) A factory discharges their wastewater into the Beira Lake, which has a two-pond system. The lake is fed by a stream with flow rate of $5m^3$/min and BOD_5 (a non conservative pollutant) concentration of 500mg/l. The rate of decay is 0.23 /day. The volume of the first pond is 100 million liters and the second is 10 million liters. Assuming complete mixing within each pond, find the BOD concentration leaving each pond. (03 marks)

Q4.

(a) It is proposed to locate a textile-processing factory at Biyagama Free Trade Zone. It is decided to have a wastewater treatment plant with a Dissolved Air floatation (DAF) unit, which helps to make flocs by using pressurized air dissolved in water.

(i) What are the advantages of having a DAF unit, when compared with a conventional settling system in the wastewater treatment plant at a textile-processing factory? (03 marks)

(ii) What factors affect the solubility of air in the process? (01 marks)

(b) (i) With the help of a neat sketch explain the activated sludge process briefly. (03 marks)

(ii) Raw sewage with BOD of 220 mg/l is applied to a conventional sewage treatment plant based on activated sludge process. If the primary treatment units remove 25% of the BOD, determine the MLVSS to be maintained in the reactor to control an F/M ratio of 0.6 assuming a wastewater flow rate of 0.5 MLD. (06 marks)

(c) (i)Define Sludge Volume Index (SVI) and explain its significance in the design of wastewater treatment plant. (01 mark)

(ii) Calculate the sludge volume index for mixed liquor with 2400 mg/l suspended solids having settled volume of 164 ml with 1 liter sample. Indicate whether this volume index is good or poor? (02 marks)

(iii) What is the relationship between SVI and bulking of activated sludge process? (02 marks)

(iv)The sludge of the waste treatment plant is obtained from the primary and secondary treatment units. What are the main objectives of the sludge treatment? (02 marks)

Q5.

(a) Kandy is a historical city upgraded as a world heritage site. The recent studies on air pollution in Sri Lanka reveal that Kandy is one of the major cities with high pollution levels. Automobile exhaust gases are found to be the major reason for such pollution.

(i) What gases are emitted from the automobiles, which contribute the air pollution? (01 mark)

(ii) How does air pollution affect the biotic (human being and animals, vegetation) and abiotic (buildings) environment. Explain briefly. (03 marks)

(iii)Discuss the methods, which you can suggest to control/reduce auto-exhaust in Kandy City? (03 marks)

(b) Especially, during festival holidays, heaps of garbage could be seen near the roadsides in Sri Lankan cities.

(i)What are the impacts do you expect from the above unauthorized garbage disposal methods? (02 marks)

(ii)Suggest a suitable action plan, which could help the local authority in future to avoid or minimize the garbage heaps/open dumps in Sri Lanka. (04 marks)

(c) (i) How do 'sound maps' help to reduce noise pollution? Explain briefly. (03 marks)

(ii)In what range of frequencies can individuals with normal hearing perceive sounds. (01 marks)

(iii)An ambulance siren causes a sound pressure of 200 μbars. Compute the sound pressure level (SPL) of the siren. SPL = 20 x Log (P/Po) (03 marks)

Q6.

Carbon dioxide from the combustion of fossil fuels and deforestation is the dominant contributor of global warming with 57 percent of major green house gases. It is the gas that has received the most attention in discussions on the green house effect.

(a) (i) How do the global warming and climate change affect the environment? (02 marks)

(ii) Discuss how do adaptation and prevention deal with potential climate change. (2 marks)

(iii) The 1980s were especially warm years and it was recorded that CO_2 increased from 280 ppm from in 1850 to 360ppm in 1988. Assuming the total mass of air equals 5.1×10^{18} kg, and the density of air at standard temperature and pressure (STP 0°C and 1 atm) is 1.29 kg/m^3, estimate the tons of carbon in the atmosphere corresponding to a concentration of 360ppm of CO_2. (Molecular weights of C=12, O =16) (05 marks)

(iv) In 1988 the contribution of CO_2 emissions from bio mass and fossil fuels are 0.9 GtC/yr and 5.8 GtC/yr respectively, and if all of those stayed in the atmosphere, what would be the increase in CO_2 in atmosphere. (02 marks)

(v)Assuming that the actual CO_2 increase is about 1.5 ppm /yr, compute the air borne fraction of CO_2. (02 marks)

(b) Ozone is a gas that occurs naturally in the atmosphere. A layer of ozone encircles the earth at a height of about 15- 30 km. However, the depletion of Ozone layer is happening due to results of human activities. Chlorofluorocarbons (CFCs) have received the most attention, in the context of ozone depletion.

(i)How do CFCs cause the Ozone depletion. Explain briefly. (02 marks)

(ii)What are the major impacts on the biotic and abiotic environment due to depletion of Ozone layer? (02 marks)

(c) Air pollution take place due to man made activities. The main causes of air pollution is generally associated with man's industrial and domestic activities. This is particularly noticeable in dense urban areas and near large emission sources.

(i) CO is one of the air pollutants produced when carbonaceous fuels are burned under less than ideal conditions. How does the CO adversely affect human health? (1.5 marks)

(ii) "Cement, lime and brick manufacturing industries are typical air polluting agents". Do you agree with the above statement? Discuss. (1.5 marks)

Q7.

You are hired as the environmental engineering consultant to help plan a large Automobile Service Station. The station will offer services such as refuelling, vehicle washing, engine servicing, replacement of engine oil and replacement of tyres and other spare parts.

(a) List five important categories of waste that would be generated during the operation of the service station. (2.5 marks)

(b) Describe the impact on the environment and human health that may arise if the service station is operated without a planned waste management program. (3.5 marks)

(c) Identify the most important pollutants you would expect in the wastewater generated by the operations in the service station and explain what treatment processes you would use to remove them. (08 marks)

(d) Explain how the government authorities can reduce the threat to the environment and human health posed by such service stations by taking the following types of actions.

(i) Urban planning and zoning

(ii) Regulations

(iii) Incentives (06 marks)

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