THE OPEN UNIVERSITY OF SRI LANKA

Department of Civil Engineering
Bachelor of Technology (Civil) - Level 6

CEX 6233 – ENVIRONMENTAL ENGINEERING

FINAL EXAMINATION - 2009/2010

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

Date: **14th March, 2010** Time : **0930 - 1230**

Answer any FIVE questions. All questions carry equal marks.

Question 1.

(a) The following microbial sample results were recorded during a twelve month period at two distribution system locations in a small water supply system. The system is unfiltered but chlorinated. The results have been collected from a routine monitoring program and do not include the results from any non-routine samples. (The units of coliforms are colonies/100ml)

Sample date	Distribution Tank		Customer Tap	
	Total Coliforms	E. coli	Total Coliforms	E. coli
06/01/2008	0	0	0	0
08/02/2008	0	0	1	0
03/03/2008	0	0	0	0
09/04/2008	0	0	0	0
08/05/2008	12	1	3	1
12/06/2008	0	0	1	0
02/07/2008	6	2	2	2
13/08/2008	0	1	0	0
04/09/2008	0	0	0	0
05/10/2008	0	0	0	0
02/11/2008	0	0	0	0
07/12/2008	0	0	0	0

(i) Explain the significance of the detection (s) of total coliforms and Ecoli, in terms of risk to public health [02 marks]

(ii) What types of operational response should the water authority take following each detection of these organisms? [02 marks]

(iii) Comment on the microbiological performance of this water treatment system against the criteria set out in the Sri Lankan potable water guidelines.[03 marks]

(iv) What long-term action should the water authority consider in order to prevent the entry of these organisms into the drinking water system? [03marks]

(b) Chlorination is the usual method for disinfecting water in Sri Lanka

(i) Name the two parameters that control the extent of disinfection. [01 marks]

(ii) Why is it necessary to guard against an overdose of chlorine? [02 marks]

(iii) Why does the presence of ammonia in water reduce the bacteriological efficiency of chlorine? [02 marks]

(c) Tetrachloromethane is a by product of common disinfection processes in Sri Lanka. A research conducted by the OUSL has been found that a water treatment plant at Maha Oya shows average 46µg/L of THM in distribution lines. Oral carcinogenic potency factor is 6.1 x 10-3 $(mg/kg/day)^{-1}$; Risk= CDI x potency factor

(i) If a person with body weight of 65kg, consumes 2L of water per day for 64 years, what would be the daily exposure for THM. [02 marks]

(ii) Estimate the maximum life time risk of cancer, for an adult associated with the chloroform in that drinking water. [03 marks]

(iii)If the water supply has extended to 300,000 is served by this supply, what number of extra cancers per year would be expected? [02 marks]

Question 2.

(a) You have been asked to review a consultant's proposal for the design and construction of a new water treatment plant. The plant will treat surface water from a nearby reservoir that experienced frequent algal blooms during dry season.

The physical water quality in this reservoir is heavily influenced by the catchment conditions. The catchment is characterized by rich, humic soils and substantial parts of the catchment contain natural forest. The average rainfall for the catchment is 1500mm. The rainfall is evenly distributed through out the year and the catchment streams are managed effectively to minimize the potential for erosion during rain events.

With the aid of schematic diagram, describe the conventional processes that are likely to be recommended by the consultants. Include the following points in your answer.

- The expected physical water quality to be treated;
- The selection of the treatment processes to be used;
- The order of each unit process
- A brief description of each process including their objectives and key design parameters; and
- The location of chemical dosing points

[07 marks]

(b) Due to dry weather salinity intrusion of Nilvala river becomes a serious issue at present.

(i) How salinity intrusion occurs? [02 marks]

(ii) What are the impacts of higher levels of salinity in domestic, industrial and agricultural water supply? [02 marks]

(iii) How do you overcome this problem at the river intake ? [02 marks]

(iv) List treatment methods available to remove salinity from water? [02 marks]

(c) Two sedimentation tanks operate in parallel. The combined flow to the two tanks is $0.1 m^3/s$. The depth of each tank is 2m and each has a detention time of 4.hrs. What is the surface areas of each tank and what is the overflow rate of each tank in $m^3/d.m^2$?

[05 marks]

Question 3.

(a) Ridiyagama Ela is an irrigated canal and it is used by people for their day today activities such has bathing, cleaning etc. A few weeks ago, it was recorded that the water in the stream is very turbid and it is no more use for domestic purposes. Further the fish has been died and the stream also gives bad smell and the Public Health Inspector (PHI) in the area has sent the fish samples for further investigations.

(i) As an Environmental Engineer, what would be your conclusion based on such observations? [02 marks]

(ii)List the possible causes for such pollution of this stream? [02 marks]

(ii) What is the minimum DO level that fish can be survived? [01 marks]

(iii) If the precautions have not been taken for some period, what conditions do you expect from this river? [02 marks]

(iv) If the PHI in the area consults you as an Environmental Engineer, what would be your suggestions to overcome this problem? [03 marks]

(b) (i)Explain what chemical oxygen demand (COD) is and how it is measured. How might the COD of a wastewater relate to its biochemical oxygen demand (BOD)? [03 marks]

(ii) A research student set a sample for a BOD_5 determination in an incubator at 20°C. The sample had an ultimate BOD_5 of 330mg/l and the rate constant for this waste water was 0.13/day at 20°C. On the beginning of day 3, a researcher adjusted the temperature of the incubator to 25°C for another analyses. The incubator temperature changed to the new temperature within 20 minutes. What was the true 5 day BOD_5 of sample and the 5 day BOD_5 that was determined? [05 marks]

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

(c) The following results were obtained when the effluent from a septic tank was analyzed for Biochemical Oxygen Demand (BOD_5). Due to the abundance of microorganisms in the effluent, seeding of the sample was not required. Determine the 5 day BOD for the sample.

Volume of sample used 15ml
Volume of BOD bottle 300ml
Initial dissolved oxygen (DO) 9.5 mg/l
5 day DO 1.1 mg/l

If the effluent was from a source that required seeded dilution water, determine the BOD_5. Assume the decrease in the DO concentration of the seeded dilution water over the test period was 1.1 mg/l. [05 marks]

Question 4.

(a) A sewage treatment plant consists with aerated tank and Rotating biological discs (RBC). Due to a mechanical failure, RBC unit has broken down. It was decided that the repair needs a one week. If you are unable to stop the treatment process till the repair completed, what temporary action are you taken to treat wastewater? [04 marks]

Contd....

(b) An industry discharges its liquid waste into a river that has a minimum flow rate of $10m^3/s$. The major pollutant in the waste is a non reactive organic material called *P*. The waste stream has flow rate of $0.1m^3/s$, and the concentration of *P* in the waste stream is 3000mg/L. Upstream pollution has caused a concentration of 20mg/L, *P* in the river upstream of the industrial discharge under the minimum flow rate conditions. The Central Environmental Authority has set maximum limit of 100 mg/L, *P* in the river. Assume that complete mixing occurs in the river. Will the industry be able to discharge the waste without treatment? [05 marks]

(c) A 4000 m^3/day conventional activated sludge plant has an influent with BOD_5 of 190 mg/L and SS of 225 mg/L.

(i) Draw an labeled a flow diagram showing the unit process in the plant and the routes followed by the wastewater and sludge (primary, activated return, waste activated and digested). No explanation of the flow diagram is required. [03 marks]

(ii) What population would this plant serve? [01 marks]

(iii) If the primary tanks remove 60% of the SS, what volume (m^2) of primary sludge at 4% solid concentration must be removed from the primary tanks each day? Assume that the waste activated sludge is not returned to the primary tanks. [03 marks]

(iv) If the primary tanks remove 30% of the BOD_5, what MLSS (80% volatile) should be maintained in the 3 aeration tanks, each 10m x 10m x 3.5m, to provide an F/M ratio of 0.3 per day? [04 marks]

Question 5.

(a) (i) List the renewable and nonrenewable sources of energy. [02 marks]

(ii) "Water is unlimited resource" Do you agree with this statement? Support your answer giving reasons. [02 marks]

(b) (i) List the methods available for composting in Sri Lanka. [02 marks]

(ii) What are the important control parameters for an optimum composting operation?

(iii) What are the merits and demerits of composting as a solid waste management process in a country like Sri Lanka? Your answer should demonstrate the general composition of solid waste in Sri Lanka. [02 marks]

(c) You have been contracted to advice on risk management for development of a proposed regional landfill to service a rural area. The landfill is proposed to be used for 30 years deposal of 15,000 tones per year of municipal solid waste received from curbside collections from residences in the townships and from commercial businesses. A summary of characteristic at the proposal site include the following;

- The quarry site covers an area of 4 hectares and was formerly used as a quarry to extract materials to produce aggregate for concrete and crushed rock for road construction;
- The subsurface profile comprises clay to 5 m depth, overlaying sandstone and quartzite rock;

- Groundwater is located at depth of 13m below the surface and has a salinity of 2,000mg/l;
- Groundwater is likely to discharge into a watercourse located 1km from the site;
- Annual rainfall is 800mm;
- Rural dwelling and a light industrial site are located 500m from the proposed landfill; and
- Strong wind can occur

(i) Describe four potential environmental hazards posed by a landfill at the site [04 marks]

(ii) Recommend three risk management measures to protect human health and the environment due to the landfill operation, and a reason for each measure. [04 marks]

Question 6.

(a) Exposure of mankind to the day by day increasing noise nuisance must be reduced and abated.

(i) What are the sources and causes for noise pollution in city? [02 marks]

(ii) Noise can be categorized into three types such as continuous noise, impulsive noise and intermittent noise. Explain each providing examples. [02 marks]

(iii) There are certain noises that can be kept under control by legal laws and ordinances and some can be dampened and attenuated by the use of town planning. What those noises and how town planning help for abating noise effects. Explain briefly. [02 marks]

(b) Motor vehicle numbers in the Western province are about 50,000 numbers, running in the Colombo city every day. The average nitrogen oxides emission rate from a car is 3.1g/vehicle mile (VM) and Average HC emission rate is 1.6g/VM. Each car travels about 10 miles round trip per working day.

(i) What are the major pollutants emitted from the tailpipe of an automobile when it moves? [02 marks]

(ii) Name one control unit or device used on present day automobiles to control each pollutant. [02 marks]

(iii) Calculate the total volume of NO_x (NO nd NO_2) and HC (CH_4) put into the Colombo city atmosphere each working day. Molecular weights of NO_2 and CH_4 are 46 g/ molecular volume and 16g/molecular volume respectively. (Molecular volume can be considered as 22.4 L) [02 marks]

(c) "E waste" is becoming a considerable problem in Sri Lanka at present. The management of e-wastes is an important part of urban solid waste management. Successful management of this problem has to involve various groups.

(i) What is meant by "e-waste"? [02 marks]

(ii) Some e wastes are hazardous. What are the sources of hazardous "e-waste" and how do you separate them. Explain briefly. [02 marks]

(iii) What actions do you propose for better management of "e-waste"? What parties need to be involved with such an e-waste management program? Explain briefly. [02 marks]

Question 7.

Colombo and Kandy are two important cities in Sri Lanka. There is a high demand for the transportation of people and goods between the two cities. There are currently two alternatives available for transportation – by road and by rail.

(a) Compare, briefly, the environmental impacts of road and rail transport between Colombo and Kandy. Your answer should include the following aspects. [07 marks]

(i) The environmental impacts of construction
(ii) The environmental impacts of operation and maintenance
(iii) Sri Lanka's greenhouse gas emissions

(b) List three steps that the Government can take to encourage people to travel between Colombo and Kandy by rail instead of by road. Explain your answer briefly. [05 marks]

(c) All trains in Sri Lanka are currently run on using diesel as a fuel. It has been proposed that all or part of the Colombo – Kandy railway line be converted for use by trains driven by electric motors.
Compare the use of diesel and electric trains between Colombo and Kandy with respect to

(i) Air pollution [1.5 marks]
(ii) Greenhouse gas emissions [1.5 marks]

(d) Discuss the relationship between the proposal to convert the Colombo – Kandy railway line for use by electric trains and the Kyoto Protocol. [05 marks]