INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Civil Engineering Department **B.Tech. (Civil) and M. Tech (EEM)**

CE 41601/ 60135 Solid Waste Management **Autumn 2012**

FINAL EXAM

Max time 3 hours **Total = 50 points**

1. Are the following statements true or false? CORRECT, if false and justify both true and corrected statements in a sentence or two. *10 points*

   1. Composting is a strictly aerobic process.

   2. Landfill clay liners of equal thickness but different hydraulic heads above them can be hydraulically equivalent.

   3. Compaction in a landfill increases over time.

   4. E-waste rules will come into effect from 2013.

   5. The manufacture, storing, distributing and selling of plastic carry bags of less than 8" x 12" and <20 micron thickness is allowed

2. A city of 1 million people generates waste at the rate of 400 g/capita-day. No segregation or waste recovery programs have been initiated. The moisture content of the waste is 20% and the organic fraction is 65%. The compostable fraction of the waste is 50% while the inert matter constitutes 20%. *10 points*

   a. What amount of waste will have to be collected per day?

   The city has to choose between the following treatment options:

   b. Combustion: The entire waste that is collected is combusted; what amount of waste will have to be disposed off in a landfill? Cost of combustion is Rs 250/ton.

   c. Composting: The moisture content of the waste is 20%, the biodegradable fraction is 50%, what amount of waste has to be landfilled? Cost of composting is Rs 100/ton

   d. Landfilling of the entire waste as is, if cost of landfilling is Rs 100/ton

   e. Any other combination of the above three options is also possible.

Which option would you recommend; explain your choice. You must determine the financial costs and list the environmental costs and benefits of each option, thus arriving at your final answer (best option) based on your assessment.

3. Assume that the biodegradable fraction of MSW has the chemical formula $C_{60}H_{100}O_{40}N$. Determine the total O_2 requirements per unit weight of SW if the waste is to be treated aerobically. Determine the total amount of methane produced per unit weight of waste if the waste is to be treated anaerobically. *10 points*

4. Monthly household waste generation data were collected in Kharagpur from Jan to Dec for a year. The total MSW generated in kg/month were: 3.6, 22.4, 29.2, 20, 6.4, 12, 32, 16, 19.2, 19, 14, 9.6. What is the mean, median and mode for this data. Also determine standard deviation and coefficient of variation. *10 points*

5. What should the thickness of the clay liner be if the breakthrough time for leachate to penetrate is 20 years? Assume coefficient of permeability is 5 x 10-8 cm/s, effective porosity is 0.17 and the hydraulic head is one foot greater than the thickness of the liner. *10 points*