

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2012
Program: B. Sc. Engineering (Civil)

Course Title: Environmental Engineering III
Time- 2 hour

Course Code: CE 431
Full marks: 100

Answer any four questions out of five.
(Note: Assume any missing data)

1. (a) Discuss the different stages of decomposition in a typical landfill. (9)
- (b) What is a sanitary landfill? Describe different types of landfills. (2+4)
- (c) Write explanatory notes on the following: (10)
- i) Leachate, ii) Liner, iii) Final Cover, and iv) Street Cleansing
2. (a) Define the following terms as per HCS and SCS: (3)
- i. pick-up time
ii. haul time
iii. at site time
- (b) Estimate the overall energy of a solid waste sample. Use the given table and formula. (15)

| Component | Wet mass (kg) | Moisture Content, % (wet) |
|---------------|---------------|---------------------------|
| Food waste | 35 | 70 |
| Paper (mixed) | 32.5 | 6 |
| Cardboard | 4 | 5 |
| Plastics | 3 | 2 |
| Yard Waste | 0.5 | 60 |
| Wood | 3 | 5 |

- (e) Explain transfer station including its advantages and disadvantages. (7)
3. (a) Write down the disadvantages of recycling process. (5)
- (b) Classify and describe recycling process based on the reuse of the recycled materials. (5)
- (c) Determination of screen recovery efficiency and effectiveness. (10)
- Given that 3000 kg/h of municipal solid waste with 15 percent glass is applied to a rotary screen for the removal of glass prior to shredding. Weight of underflow is 600 kg/h and weight of glass in screen underflow is 300 kg/h, determine the recovery efficiency and effectiveness of the screen.

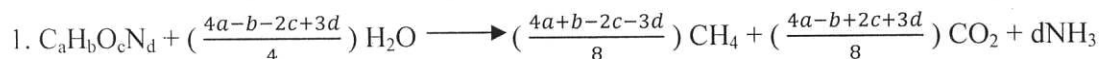
- (d) Discuss the present practices of recycling in developing countries. (5)
4. (a) Discuss the different types of maintenance of collection vehicles. (4)
- (b) What is break-even distance (with figure)? (2)
- (c) What are the objectives of thermal treatment process? Write down the benefits and drawbacks of incineration. (2+7)
- (d) A transfer station handling 400 tons/day, 5 days per week, costs \$6 million to build and \$160,000 per year to operate. An individual tractor-trailer costs \$150,000 and carries 20 tons per trip. Operation and maintenance costs (including fuel) of the truck are \$65,000 per year and the driver makes \$45,000 per year (including benefits). The capital costs of the building and transfer trucks are to be amortized over a 10 year period using a 12 percent discount factor. Suppose it takes 30 minutes to make a one way trip from the transfer station to the disposal site, and 7 round trips per day are made. Find the transfer station and hauling cost in dollars per ton. (10)
5. (a) Estimation of the amount of gas produced from the organic fraction of MSW under anaerobic conditions. Estimate the total theoretical amount of gas that could be produced under anaerobic conditions in a sanitary landfill per unit weight of solid wastes given that the chemical formula of the typical waste are as follows: (10)

Without water: $C_{60.0}H_{94.3}O_{37.8}N$

Given that the total weight of the organic material in 100 lb of solid waste is equal to 75 lb including moisture. Assume 5% of the decomposable material will remain as an ash. Also given that the specific weight of methane and carbon dioxide are 0.0448 and 0.1235 lb/ft³ respectively.

- (b) Discuss the mechanisms (different stages) of anaerobic digestion. (10)
- (c) Write down the advantages of anaerobic digestion. (5)

Formulae:



$$2. \text{Percentage Recovery} = \frac{W_1 f_1 (100)}{W_2 f_2}$$

$$3. \text{Effectiveness} = \frac{W_1 f_1}{W_2 f_2} \left\{ 1 - \frac{W_1 (1-f_1)}{W_2 (1-f_2)} \right\}$$

$$4. \text{Energy content (kJ/kg)} = 338.2C + 1430 (H-O/8) + 95.4S$$

$$5. CRF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Table 2.10: Ultimate analysis of solid waste (per cent by weight in dry basis)

| Component | Carbon (C) | Hydrogen (H) | Oxygen (O) | Nitrogen (N) | Sulphur (S) | Ash (A) |
|---------------|---------------|-----------------|---------------|-----------------|----------------|------------|
| Food waste | 49.1 | 6.6 | 37.6 | 1.7 | 0.2 | 4.8 |
| Paper (mixed) | 43.4 | 5.8 | 44.3 | 0.3 | 0.2 | 6.1 |
| Newsprint | 49.1 | 6.1 | 43.0 | 0.1 | 0.2 | 1.5 |
| Cardboard | 44.0 | 5.9 | 44.6 | 0.3 | 0.2 | 5.0 |
| Rubber | 77.8 | 10.4 | - | - | 2.0 | 9.8 |
| Plastics | 60.0 | 7.0 | 23.0 | - | - | 10.0 |
| PVC | 45.2 | 5.6 | 1.6 | 0.1 | 0.1 | 47.4 |
| Leather shoes | 42.0 | 5.3 | 22.8 | 6.0 | 1.0 | 22.9 |
| Textiles | 55.0 | 6.5 | 31.2 | 4.5 | 0.2 | 2.6 |
| Yard waste | 48.7 | 6.3 | 37.9 | 3.0 | 0.3 | 3.8 |
| Wood | 50.5 | 6.0 | 42.4 | 0.2 | 0.1 | 0.8 |

Source: adapted in part from Kaiser (1978)