University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2013
Program: B.Sc. Engineering (Civil)

Course Title: Environmental Engineering III — Course Code: CE 431
Time- 2 hour — Full marks: 100 (=25×4)

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

1. (a) Discuss the general considerations for selecting a suitable collection vehicle. (5)

   (b) Discuss the different stages of landfill gas generation. (5)

   (c) Describe the leachate management system. (5)

   (d) Explain the mechanisms of anaerobic digestion process. (10)

2. (a) To estimate future waste quantities, what factors need to be considered? (5)

   (b) Categorize collection method based on the mode of operation. (5)

   (c) In a hauled-container system, solid waste from a new industrial park is to be collected in large containers, some of which will be used in conjunction with stationary compactors. Based on traffic studies at similar parks, it is estimated that the average time to drive from the garage to the first container and from the last container to the garage each day will be 35 and 45 minutes, respectively. The average time required to drive between containers is 8 minutes and the one-way distance to the disposal site is 35 km (speed limit: 56 km/h). The off-route factor is 14%. Determine the number of containers that can be emptied per day, based on 9 hour working day. Also determine the actual length of the working day. (10)

   (d) Describe briefly the risks associated with poor management of solid waste. (5)

3. (a) Discuss the potential environmental impact of landfill gases. (5)

   (b) Categorize and discuss the activities involved in materials recycling processes. (5)

   (c) Suppose the annualized cost of purchasing, fueling, and maintaining a compactor truck is given by the following expression: (10)
   Annualized cost ($/yr) = 25000 + 4000V; where V is the truck volume in cubic meter. These trucks require three person crew with labor charged at $20 per hour each (including benefits). Do an economic analysis of the collection system where an 11 m^3 truck collects refuse from 355 households each day. The generation of waste is 65 lb per week. The truck and crew work for 5 days a week, and curb side pick-up is provided twice a week for each house. What is the cost per ton of waste collected and what is the cost per household annually.

(d) Compare between pyrolysis and thermal gasification. (5)

4. (a) Write down explanatory notes on any three of the following: (3×3)
i) Underground injection, ii) Hazardous waste management, iii) Land farming and iv) Incineration.

(b) What do you understand by biogas technology? Discuss the environmental aspects of biogas technology. (3+3)

(c) 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: $C_{65.0}H_{96.3}O_{41.8}N$

Given that the total weight of the organic material in 110 lb of solid waste is equal to 90 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/ft^3 respectively.

5. (a) Given that 3000 kg/h of municipal solid waste with 800 kg/h 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 250 kg/h, determine the recovery efficiency and effectiveness of the screen. (10)

(b) Compare between Material Recovery Facility and Full Stream Processing Facility. (5)

(c) Define composting. What are the main objectives of composting? (2+3)

(d) Do you suggest ocean can be a place for dumping hazardous waste? Justify your answer. (5)

Formulae:

1. $C_aH_bO_cN_d + (\frac{4a-b-2c+3d}{4})\, H_2O \longrightarrow (\frac{4a+b-2c-3d}{8})\, CH_4 + (\frac{4a-b+2c+3d}{8})\, CO_2 + dNH_3$

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

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

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

5. $T_{hcs} = PT_{hcs} + q + m + nx$

6. $PT_{hcs} = pc + uc + dbc$

7. $M_{dc} = \{(1- W) * L - (t_1 + t_2)\} / T_{hcs}$

Table 4.1: Typical values for haul constant coefficients m and n

Type of haul	Speed limit km/h	m h/trip	n h/km
Communal	88	0.016	0.011
Block	72	0.022	0.014
Kerbside	56	0.034	0.018
Door-to-door	40	0.050	0.025

Adapted from: Peavy et al., 1985

Table 4.2: Typical data for computing equipment and labour requirements for hauled- and stationary-container collection

Collection					
Vehicle	Loading method	Compaction ratio, z	Pick up loaded container and deposit empty container, h/trip	Empty contents of loaded container, h/container	At-site time q_s h/trip
Hauled container (Tilt-frame)	Mechanical	2.0–4.0	0.50		0.129
Stationary container (Compactor)	Mechanical	2.0–4.0		0.050	0.15