



UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 5 Examination in Engineering: June 2014

Module Number: CE5316

Module Name: Solid Waste Management

[Two Hours]

[Answer all questions, each question carries five marks]

- Q1. a) List four impacts of mismanagement of solid wastes. [1.0 Mark]
- b) Explain briefly the difficulties of solid waste management in any urban community. [2.0 Marks]
- c) Explain briefly the 4R concept of solid waste management. [1.0 Mark]
- d) What may be the highest rank in an integrated solid waste management hierarchy and explain the degree of its applicability in developing countries. [1.0 Mark]
- Q2. a) Estimate the "as discarded density", "overall moisture content" and the "energy content" of the municipal solid waste sample given in Table Q2.

Table Q2: Characteristics of a municipal solid waste sample

Component	Percent by mass	Typical moisture content (percent by mass)	Typical density (kg/m ³)	Typical energy content (kJ/kg)
Food wastes	20	70	* 290	4 652
Paper	30	6	85	16 750
Plastics	10	2	65	32 600
Textiles	5	10	65	17 450
Leather	5	10	160	17445
Wood	10	20	240	18600
Glass	10	2	195	140
Garden trimmings	10	60	105	6500

dry (wet) 0
 ↓
 energy as discarded
 ↓
 X

You may use following equation:

$$Energy(dry\ basis) = Energy(as\ discarded) \left(\frac{100}{100 - \% moisture} \right)$$

[2.5 Marks]

- b) List different sources and types of solid waste. [1.5Marks]
- c) Explain the importance of understanding the composition of solid waste?

Q3 a) List three methods of quantifying solid wastes. Explain briefly one of the methods listed. [1.0 Mark]

b) It is understood that one of the problems of effective municipal solid waste management is the lack of political commitment. Describe briefly how politicians can be involved with an effective municipal solid waste management. [1.0 Mark]

c) i) Details of the municipal solid waste (MSW) collection system of a municipal ward are given by Table Q3. The municipal ward consists of 1200 houses. Estimate the daily per capita waste generation in this ward if each household is comprised of 5 persons on average. [1.0 Mark]

not done *of waste collected* [2.0 Marks]



Table Q3: Details of the municipal solid waste collection system

Vehicle Type	Number of loads per week	Average capacity of each vehicle (m ³)	Typical specific weight of MSW for each vehicle (kg/m ³)
Compactor truck	10	15	295
Flat bed truck	20	1.50	110
Individual private vehicle	25	0.25	100

ii) Does the estimation made in Q3,c i) truly represent the solid waste generation rate in the given municipal ward? Explain briefly. [1.0 Mark]

Q4. a) Explain briefly the solid waste handling and separating procedures adapted at low-rise detached dwellings. [1.0 Mark]

b) List common solid waste processing methods in low-rise detached dwellings. [0.5 Mark]

c) Based on the mode of operation, solid waste collection systems are classified into 3 categories as Hauled Container System (HCS) – Conventional mode; Hauled Container System (HCS) – Exchange Container mode; and Stationary Container System. Explain each mode briefly. [1.5 Marks]

d) Solid waste from a shopping complex is to be collected in large containers (drop boxes), some of which will be used in conjunction with stationery compactors. Based on traffic studies at similar shopping complexes, it is estimated that the average time to drive from the garage to the first container location (t₁) and from the last container location (t₂) to the garage each day will be 18 minutes and 30 minutes, respectively. One-way distance to the disposal site is 9 km. Determine the number of containers that can be emptied per day, based on an 8-h weekday. The average time required to drive between containers is 12 minutes. Assume the following criteria:

- i. Speed limit of the collection vehicle is 40 km/h.
- ii. The off-route factor (W) is equal to 0.15.

- iii. Vehicle type is Hauled Container Systems (HCS) with a tilt frame and mechanically loading method.
- iv. Time required to pick up a loaded container and to deposit an empty container is 0.4 h/trip.
- v. At site time per trip (s) is 0.133 h/trip.
- vi. Haul speed constants of the haul equation ($a + bx$) for a given speed limit of 40 km/h are; $a = 0.050$ h/trip and $b = 0.025$ h/km.
- vii. Average distance between container locations is 0.16 km.
- viii. Constants for estimating driving time between container locations are $a' = 0.060$ h/trip and $b' = 0.068$ h/km.
- ix. Following equations may be used with usual notations:

$$N_d = [H(1 - W) - (t_1 + t_2)] / T_{hcs}$$

$$T_{hcs} = P_{hcs} + s + a + bx$$

[2.0 Marks]

dbc ?

↳ should be worked out by the student.