UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 5 Examination in Engineering: June 2015 REPEAT

Module Number: CE5316   Module Name: Solid Waste Management

[Two Hours]

[Answer **all questions**, each question carries five marks]

Q1. a) Discuss the current state of solid waste management in Sri Lanka.

[1.0 Mark]

b) Explain major challenges in the municipal solid waste management.

[1.0 Mark]

c) Describe adverse effects due to the unplanned solid waste disposal.

[1.0 Mark]

d) Reduction is a one step in 4R concept of the solid waste management. Discuss how to implement 'reduction' in a municipal solid waste management system.

[2.0 Marks]

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

Component	Percent by mass	Typical moisture content (percent by mass)	Typical density (kg/m³)	Typical energy content (kJ/kg)
Food wastes	30	70	290	4652
Paper	20	6	85	16750
Plastics	10	2	65	32600
Textiles	5	10	65	17450
Leather	5	10	160	17445
Wood	10	20	240	18600
Glass	5	2	195	140
Garden trimmings	15	60	105	6500

You may use the following equation:

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

[3.0 Marks]

b) The composition of solid waste varies with the type and income of a community. Discuss this statement with examples.

[2.0 Marks]

Q3 a) 'The mass balance analysis of the materials is the best way to determine the generation and movement of solid wastes with any degree of reliability." Rationalize this statement.

[2.0 Marks]

b) i) A municipal area uses the following vehicles for collection of solid wastes (SW). The number of loads per week for each type of vehicle in collection of SW, the capacities and typical specific weight of municipal SW for each vehicle are shown in Table Q1.The municipal area consists of 1000 houses. Estimate the daily per capita waste generation in this area if each household comprises 4 persons on average.

[2.0 Marks]

Table Q1 SW collection information of a municipal area

Vehicle Type	Number of loads per week	Average capacity of each vehicle (m³)	Typical specific weight of municipal SW for each vehicle (kg/m³)
Compactor truck	10	15	295
Flat Bed Truck	20	1.50	110
Individual private vehicle	25	0.25	100

ii) Does the estimation in the part 1 truly represent the solid waste generation rate in the given municipality? Explain.

[1.0 Mark]

Q4. a) Discuss the negative effects of using open vehicles for collecting and transporting solid wastes.

[1.5 Marks]

b) 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 (t_1) and from the last container location (t_2) to the garage each day will be 18 minutes and 30 minutes, respectively. One-way distance to the disposal site is 10 km. Determine the number of containers that can be emptied per day, based on an 8-h weekday. Following criteria are applicable:
Average time required to drive between containers is 12 minutes
Speed limit of the collection vehicle is 40 km/h;
The off-route factor, W, is equal to 0.15;
Vehicle type- Hauled Container Systems (HCS), tilt frame, mechanically loading method;
Time required to pick up a loaded container and to deposit an empty container is 0.4 h/trip; At site time per trip (s) is 0.133 h/trip;
Haul speed constants of the haul equation (a + bx) for given speed limit of 40 km/h are; a = 0.050 h/trip and b = 0.025 h/km.
Average distance between container locations is 0.16 km;
Constants for estimating driving time between container locations are;
a' = 0.060 h/trip and b' = 0.068 h/km.
Following equations may be used with usual notations:
$N_d = [H(1 - W) - (t_1 + t_2)]/T_{hcs}$
$T_{hcs} = P_{hcs} + s + a + bx$

[3.5 Marks]