MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS
2013/2014 ACADEMIC YEAR

FIFTH YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF ENGINEERING
IN
CIVIL and STRUCTURAL ENGINEERING

COURSE CODE: CSE 531E
COURSE TITLE: ENVIRONMENTAL ENGINEERING AND MANAGEMENT

DATE: TIME: 3 HOURS

INSTRUCTIONS TO CANDIDATES

- The paper contains FIVE (5) questions.
- Answer ALL FIVE (5) questions.
- Marks for each part of a question are indicated in brackets.

QUESTION ONE

a) What is sustainable integrated solid waste management? (2 Marks)
b) Why have solid waste management practices been so slow in developing? Will changes come more quickly in the future? Explain (6 Marks)
c) Explain Policy and Programme Matrix on Solid Waste Management (5 Marks)
d) Table 1 below shows typical data on moisture content of municipal solid waste.

Component	Moisture % by weight	
	Range	Typical
Food wastes	50 - 80	70
Paper	4 - 10	6
Card board	4 - 8	5
Plastics	1 - 4	2
Textiles	6 - 15	10
Rubber	1 - 4	2
Leather	8 -12	10
Garden trimmings	30-80	60
Wood	15-40	20
Misc. organics	10 -60	25
Glass	1 -4	2
Tin cans	2-4	3
Nonferrous metals	2-4	2
Ferrous metals	2-6	3
Dirt, ashes, brick, etc	6-12	8
MSW	15-40	20

Estimate the moisture content for a waste sample with the following composition based on 100 kg of sample:

Component	% by weight
Food waste	18
Paper	35
Card board	12
Plastic	4
Garden trimmings	12
Wood	5
Dirt, ashes, brick, etc	14

(7 Marks)

QUESTION TWO

a) Illustrate with neat diagrams the difference between pick-up time for a haul container system operated on the following
   i. Conventional mode
   ii. Exchange container mode (5 marks)
b) Outline the procedure to be followed in planning a solid waste collection program in your locality. (5 Marks)
c) The following average speeds were obtained for various round trip distances to a disposal site. Find the haul speed constants (a, and b) and round trip haul time for a site that is located 5.5 km away. (5 Marks)

Round trip distance (x, km/trip)	average haul speed (y, km/h)
4	25.5
10	42.0
16	48.0
24	54.0
32	60.0
40	63.0
50	67.5

d) Solid waste is to be collected from a new industrial area using large containers. Based on the traffic studies, the average time to drive from the garage to the first container location and from the last container location to the garage each day will be 20 and 25 min, respectively. The time required to pick up the loaded container and to deposit empty container is about 0.3 h/trip. Collection vehicles spent an average of 12 min, to unload the containers at the disposal site. The average time required to drive between containers is 8 min and the one way distance to the disposal site is 17.5 km. Determine the number of containers that can be emptied per day based on an 8 hours workday. Assume the off-route factor, W, is equal to 0.15, and haul speed constants (a, and b) as 0.015 and 0.020 h/trip respectively. (5 Marks)

QUESTION THREE

a) What are the advantages of sanitary land fill over incinerator? (4 Marks)
b) The problem of managing the increased volume of solid waste is compounded by rising public resistance to siting new landfills. Discuss FOUR general phases of landfill construction. (8 Marks)
c) Discuss the basic composting processes that contribute to the successful development and operation of a composting program. (8 Marks)

QUESTION FOUR

a) Using neat diagrams differentiate between *constant* and *variable retention capacities* of contaminants by soils and sediments. (5 Marks)
b) List FIVE processes that affect enrichment ratios resulting in higher concentrations of contaminants in the eroded soil material, aquatic sediments and surface runoff. (5 Marks)
c) Fertilizer was applied to a field at the rate of 150 kg/ha. The fertilizer was ploughed and distributed uniformly to a depth of 280 mm. The soil was silt loam and contained 20% clay, 55% silt and 25% sand. The porosity of the soil was 45%, pH was 6.3, and organic C content was 1.5%, and the specific density of soil sample was 1650 kg/m^3. Assuming that all water infiltrated into the soil, the infiltration rate being slow enough that full equilibrium between the adsorbed and dissolve P was established and that antecedent adsorbed P was negligible,
   i) Estimate for P, the approximate groundwater contamination and the adsorbed concentration during a long period of rain with an average intensity of 0.125 mm/min (8 Marks)
   ii) Calculate the maximum soil retention capacity for phosphorous. Express the capacity in kg/ha. (2 Marks)

QUESTION FIVE

a) Give THREE reasons why the pollution effect of *combined sewer overflows* (CSOs) is of great concern. (3 Marks)

b) The mass balance accumulation function for street solids is given below;

$$\frac{dP}{dt} = I - \xi P \quad \text{and}$$

$$\xi = 0.0116e^{-0.08H}(TS + WS)$$

P is the amount of pollutants in the curb storage, *t* the time, *I* the sum of all inputs, ξ removal coefficient (day^{-1}), *H* is the curb height (cm), *TS* the traffic speed (km/h) and *WS* the wind speed (km/h).

From the following information:

Traffic emissions, TE	1.3 g/axle.km
Vehicle type	2 axles
Traffic count, TC	300 cars/day
Traffic velocity, TS	60 km/h
Wind velocity, WS	12 km/h
Curb height, H	80 mm
Atmospheric deposition rate	102 $kg/km^2.day$ ($mg/m^2.day$)
Daily street refuse deposition, I_r	6 g/m.day
Street width, SW	15 m
Road condition index, RCC	1.0 (average conditions)

i) Estimate the equilibrium solids load in curb storage of a medium-density residential area. (5 Marks)

ii) What will be the equilibrium solids accumulation if the curb height above is lowered to 40 mm? (2 Marks)

c) In many cases, a leachate from a localized point source e.g. a storage lagoon, landfill, leaking petroleum and gasoline storage tanks, scrap yard etc. becomes a regional diffuse pollution problem. Discuss the various approaches that have been used to clean up contaminated groundwater. (10 Marks)