Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B. TECH (BIOTECHNOLOGY)
END SEMESTER EXAMINATIONS (REGULAR), DEC 2020/JAN 2021
SUBJECT: SOLID WASTE MANAGEMENT [BIO 4004]
REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. Explain the functional elements of SWM and Illustrate the interrelationships of each elements. **3**

1B. Derive an approximate formula for solid waste sample with the composition given below with and without sulfur and with and without water. Calculate the energy content for chemical composition of with sulfur using modified dulong formulae. **7**

Component	Wet mass, Kg	MC (%)	Chemical Composition, Kg					
			C	H	O	N	S	Ash
Food Wastes	15	70	48	6.4	37.6	2.6	0.4	5
Paper	45	6	43.5	6	44	0.3	0.2	6
Cardboard	10	5	44	5.9	44.6	0.3	0.2	6
Plastics	10	2	60	7.2	22.8	0	0	10
Yard wastes	10	60	47.8	6	38	3.4	0.3	4.5
Wood	5	20	49.5	6	42.7	0.2	0.1	1.5

2A. Estimate the unit waste generation rate per week for a residential area consisting of 1200 homes. The observation location is a local transfer station that receives all of the wastes collected for disposal. The observation period was one week. **2**

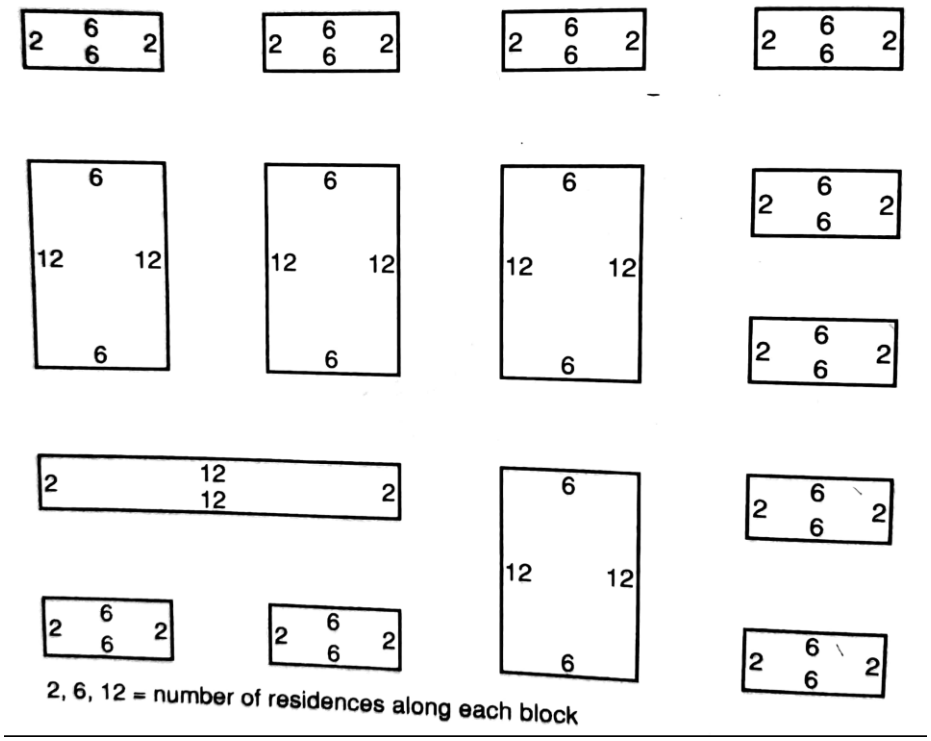
Number of compactor truck loads (Avg. volume 20 yd^3 and specific weight 500lb/yd^3) = 9

Number of flatbed truck loads (Avg. volume 2 yd^3 and specific weight 225lb/yd^3) = 7

Number of loads from individual residents private cars and trucks (Avg. volume 8ft^3 and specific weight 150 lb/yd^3) = 20

2B.	The solid waste treatment site collects 12 tons of raw produce (on a given day), 5 tons of cans, 0.5 tons of cartons, and 0.3 tons of miscellaneous materials. Of the 12 tons of raw produce, 10 tons become processed product, 1.2 tons end up as produce waste, which is fed to cattle, and the remainder is discharged with the wastewater from the plant. Four tons of the cans are stored internally for future use, and the remainder is used to package the product. About 3 % of the cans used are damaged. Stored separately, the damaged cans are recycled. The cartons are used for packaging the caned product, except for 3 % that are damaged and subsequently separated for recycling. Of the miscellaneous materials, 25 % is stored internally for future use; 50 % becomes waste paper, of which 35 % is separated for recycling with the remainder being discharged as mixed waste. Assume the materials separated for recycling and disposals are collected daily. Prepare a materials balance for the cannery on this day and a materials flow diagram accounting for all of the materials. Also determine the amount of waste per ton of product.	**6**
2C.	List and explain the methods used to estimate the waste quantities.	**2**
3A.	For separation and collection of items, three recycling containers have been provided to each resident of a community (1200 houses @3.5 residents per house). Residents separate newspaper & cardboard, plastics & glass, and aluminium & tin cans, and place these segregated materials in separate containers (60% of houses are expected to participate in this program). The containers are emptied once per week for collection. The MSW generation rate is 1.732 Kg/capita/day. Assuming 80 % material separation rate, determine: i). the proportion of the space required for each group of materials in the collection vehicle, and ii). The number of trips per week required if the size pf the collection vehicle id 11.5 m^3.	**4**

Component	% by wt	Specific weight (Kg/m^3)
Food Wastes	8.0	288.34
Paper# (Newspaper constitutes 20% of all paper by weight)	35.8	89.7
Cardboard	6.4	49.66
Plastics	6.9	65.68
Textiles	1.8	65.68
Rubber	0.4	129.75
Leather	0.4	160.20
Yard wastes	17.3	100.92
Wood	1.8	237.10
Glass	9.1	195.43
Tin cans	5.8	89.70
Aluminium	0.6	160.20
Other metals	3.0	320.38
Silt and ash	2.7	480.60

3B.	A person weighing 65 Kg consumes an average of 50g of fish every week. The fish has been caught from a pond with a concentration of DDT equal to 1.0 ppb. The bioaccumulation factor for DDT is 54000 and the potency factor is 0.34(mg/kg/day)$^{-1}$. Estimate the maximum lifetime risk of cancer due to this exposure.	**3**
3C.	Describe the steps involved in the segregation and identification of hazardous waste with the help of a process flow diagram	**3**
4A.	Layout collection routes for the residential area shown in the Fig. The service area map would be prepared as the first step in the layout of collection route. Assume that the following conditions apply, Occupants per residence = 3.5 Solid waste collection rate =3.5lb/person.d Collection frequency =once/week Type of collection service =curb Collection crew size =one person Collection vehicle capacity =14yd^3 Compacted specific weight of solid waste in collection vehicle =540 lb/yd^3 No U-turns in streets Collection from each side of the street with stand-up right-hand-drive collection  	**4**

<table>
<tr><td>4B.</td><td>Determine the distance at which a materials recovery facility should be located from the source of MSW, such that the weekly costs of the hauled system remains same as that of the stationary container system. Assume that one collector-driver will be used with each system and that the following data are applicable. For the purpose of this example assume the travel times t_1 and t_2 are included in the off-route factor (0.15). Length of work day is 8hour/day. The data pertaining to both systems are as follows:
<table>
<tr><td></td><td>HCS</td><td>SCS</td></tr>
<tr><td>Quantity of solid waste</td><td>300 yd^3/wk</td><td>300 yd^3/wk</td></tr>
<tr><td>Container size</td><td>8 yd^3/trip</td><td>8 yd^3/location</td></tr>
<tr><td>Container utilization factor</td><td>0.67</td><td>0.67</td></tr>
<tr><td>Container pickup time</td><td>0.033 h/trip</td><td>-</td></tr>
<tr><td>Container unloading time</td><td>0.033 h/trip</td><td>-</td></tr>
<tr><td>Haul-time constants</td><td colspan="2">a=0.022h/trip and b=0.022 h/mi</td></tr>
<tr><td>At-site time</td><td>0.053h/trip</td><td>0.10 h/trip</td></tr>
<tr><td>Overhead costs</td><td>$400/wk</td><td>$750/wk</td></tr>
<tr><td>Operational costs</td><td>$15/h of operation</td><td>$20/h of operation</td></tr>
<tr><td>Container utilization factor</td><td>-</td><td>0.67</td></tr>
<tr><td>Collection vehicle capacity</td><td>-</td><td>30 yd^3/trip</td></tr>
<tr><td>Collection vehicle compaction ratio</td><td>-</td><td>2</td></tr>
</table>
The average distance between container locations is 0.1 mi and the time constants a` and b` for estimating time between container locations are 0.060 h/trip and 0.067 h/mi, respectively for both the systems.</td><td>6</td></tr>
<tr><td>5A.</td><td>Explain the aerobic and anaerobic decomposition in landfill</td><td>2</td></tr>
<tr><td>5B.</td><td>Enlist and discuss the components of modern landfill facility.</td><td>3</td></tr>
<tr><td>5C.</td><td>Diagrammatically explain the different methods of landfilling.</td><td>2</td></tr>
<tr><td>5D.</td><td>Estimate the required landfill area for a community with a population of 31000. Assume that the following conditions apply, solid waste generation, 6.4 lb/capita.day; compacted specific weight of solid wastes in landfill, 800 lb/yd^3; and average depth of compacted solid wastes, 20 ft.</td><td>3</td></tr>
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