Ref No: Ex/CE/PE/B/T/422F/2025

B.E. Civil Engineering Fourth Year Second Semester Examination 2025

Solids and Gaseous Waste Management

Time: Three Hours (**50 marks for Part 1** & 50 marks for Part 2) Full Marks: 100

Use separate answer script for each part

Part-I

Answer briefly. Any relevant data may be assumed. **σ_y and σ_z curves** and **Pasquill stability charts** may be allowed.

1. (**CO3**) a) Why is modelling essential to get environmental clearance for a proposed industry?

b) Define mixing height with a sketch.

c) How is a wind rose developed for a place? 2X3=**6**

2. (**CO4**) a) What are possible coordinates of the source according to the coordinate system of Gaussian Air Pollution Model (GAPM) ?

b) What are the key characteristics of time averaged plumes?

c) Why is ground level center line modification of GAPM significant?

d) What are the two vertical constraints?

e) Why is the effective height of a plume generally greater than physical stack height?

f) When are σ_y and σ_z respectively absent from the equation of Gaussian model?

g) What are the main limitations of GAPM? 2x7=**14**

[Turn over

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Part I

3. (CO4) a) $C_{(x,y,z;H)} = Q/(2\pi \sigma_y \sigma_z U) [Exp \{-y^2/2 \sigma_y^2\}] [Exp \{-(H-Z)^2/2 \sigma_z^2\} + Exp \{-(H+Z)^2/2 \sigma_z^2\}]$

The notations have their usual meanings.

This is general Gaussian expression with the modification of vertical constraint only. *Explain that modification with a sketch.*

Develop equations for concentration for following situations from abovementioned general equation:

(i) ground level centerline concentration for a ground level source

(ii) plume centerline concentration

b) It is estimated that 50 g/sec of SO_2 is being emitted from a petroleum refinery from an effective height of 100 meters. In an overcast condition, the wind speed was 4m/sec.

(i) What is the GL concentration directly downwind from the refinery at 500 meters?

(ii) What is the concentration at $C_{(500,50,0;100)}$? Comment on the results.

c) Answer the following very briefly:

(i) What type of sensor is a wind vane, Eulerian or Langrangian, and why?

(ii) How downwind distance of a receptor with respect to a source may be assessed?

(iii) Mention one stability class each for stable and unstable atmospheric conditions.

8+6+6 = **20**

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Part-I

4. (**CO3**) (a) Calculate mixing height graphically for a ground level release at 30°C with following temperature profile:

Height in meter	Temperature in °C
0	25
100	24
200	23
300	22
400	23
500	24
600	25

b) Answer the following briefly:

(i) Give one example where the GAPM needs to be modified with reference to the assumption of 'concentration of mass'.

(ii) What is a NW wind and why? $6 + 2 \times 2 =$ **10**

Some of the following equations may be required (notations have their usual meanings):

1) $\Delta h = 2.6\,(F/uS)^{1/3}$

2) $F = gr^2 v_s (1 - T_a/T_s)$

3) $S = (g/T_a)(\Delta T_a/\Delta z + 0.01°C/m)$

4) $\Delta h = [1.6F^{1/3}(x_f)^{2/3}]/u$

5) $x_f = 120\,F^{0.4}$, if $F \geq 55 m^4/s^3$

6) $x_f = 50\,(F)^{5/8}$ if $F \leq 55 m^4/s^3$

7) $C = Q / [(2\pi)^{1/2}\, u\, \sigma_y L]$

8) $\Delta h = [\, v_s d/u\,][1.5 + 2.68 \times 10^{-3} p\,(1 - T_a/T_s)d]$

9) $C = 2q/[(2\pi)^{1/2}\, \sigma_z u]$

Ref No. –Ex/CE/PE/B/T/422F/2025

B.E.C.E. 4th Year EXAMINATION, 2025
(2nd Semester)
SUBJECT: Solid and Gaseous Waste Management

Full Marks 100

Time: Three hours

Use a separate Answer-Script for each part

Part II (50 Marks for This Part)

Answer all the questions. Assume any data if not provided. All the drawings should be in pencil. All abbreviations are commonly used.

Part-A (CO1)

Q1. (a) **State true or false with proper justification. No marks will be credited if justification will not be added.** — 1.5×4

I. As per hierarchy of integrated solid waste management system stated in SWM rule 2016, composting is the better option than waste-to energy.

II. Material balance analysis is the best method for quantification of MSW for Kolkata municipality.

III. If collection frequency of a particular area is more, rate of solid waste generation for the area is less.

IV. Community bin waste collection is the most convenient method for waste generators.

(b) **Match the two columns:** — 5

Column A	Column B
Field capacity	Building materials
Permeability	Compaction factor
Specific density	Slope failure
Shear strength	Leachate generation
Fusing point of ash	Liner

(c) **Fill in the blanks:** — 1×4

i. When the rate of waste generation for a particular place is low the best mode of waste collection and transfer is----------container collection system.

ii. The time required for travelling to and forth from collection point to the disposal site is----------.

iii. During waste transfer, the time spent at facility site for disposal, waiting etc. is known as----------.

iv. For designing storage container for single dowelling low rise building the most important factor deciding the size is ----------.

Q2. (a) With derivation proof break even time analysis does not depend on the distance between collection points to transfer station but on transfer station to facility site. — 5

(b) After ultimate analysis it was obtained for a 100kg of dry solid waste, carbon content is 30%, H content is 20%, O content is 15%, N content is 12%, S content is 8% and ash content is 15%. Determine the chemical formula of the solid waste with sulfur and without sulfur. — 5

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Time: Three hours

Use a separate Answer-Script for each part

No. of Questions	Part II (50 Marks for This Part)	Marks
	Part-B (CO2)	
Q3.(a)	For combusting 100 ton of solid waste of chemical formula $C_{60}H_{94}O_{38}N$ you have supplied 450 m^3 of air. Now writing the necessary equation check whether the supplied air is sufficient for fully combustion of the solid waste. Consider air contains 23% of oxygen and density of air is 1.3 kg/ m^3.	5+2
(b)	Determine the area loading for a windrow composting plant for a town generating 200 tons of waste per day. The specific density of the waste is 500 kg/m^3. The time taken for complete composting is 21 days for 3 turning cycles@ 7 days per interval. The windrow width is 3m and height is 1.5m. Space between two windrows is 1.25m. There will be a road of 7.5m in each side. Adopt longitudinal turning and turning allowance 10%. Draw a neat labelled sketch of plan of that windrow compost plant.	5+3
Q4. (a)	With a neat labelled sketch of binary separation write the equations to calculate purity, recovery and efficiency for a trommel screen? What are the desirable values of moisture content and low calorific value for thermochemical treatment of solid waste as per SWM Manual, 2016.	5+2
(b)	Draw a neat labelled sketch of single composite bottom liner of an engineered landfill as mentioned in SWM Manual, 2016.	3