Ref No: EX/CE/5/T/506C/2023

# Bachelor of Engineering (Civil Engineering) Examination 2023

## (5th Year 2nd Semester)

## Solid and Gaseous Waste Management

Time: Three Hours | Full Marks: 100

Use separate answer script for each part

(50 marks for each part)

**Part-1**

Answer **Question No. 1** and any **Two** from the rest. Answers should be brief. Any relevant data may be assumed, if needed. Please answer Question No 1 first. $\sigma_y$ and $\sigma_z$ **curves** and **Pasquill stability charts** may be allowed.

1. a) Why is Gaussian Air Pollution Model (GAPM) so named? What is 'PGT' model?

   b) Define plume.

   c) Mention limitations of Gaussian Model.

   d) How do you ascertain the origin of the coordinate system of GAPM?

   e) What is Xg? What is its significance in GAPM?

   f) Why is $\sigma_x$ missing in GAPM? What is the limitation of the related assumption?

   g) Define 'night' as per Pasquill Stability Class Chart.

   h) Mention the correction factors of Holland's Plume Rise Model (HPRM).

   i) What is the assumption related with wind shear in Gaussian Models?

   j) Why should Gaussian Model be modified to use it for $SO_2$ dispersion? 2x10=**20**

[ Turn over

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2.. a) The general Gaussian expression is as follows:

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

The notations have their usual meanings. Now find expressions for following modifications

(i) receptor at ground level (GL) (ii) receptor at GL centerline

(iii) source is at GL, receptor is at a height (iv) receptor at plume center line

b) A stack emitting 60 g/sec of NO has an effective stack height of 80m. The wind speed at anemometer height is 4.5m/s and it is clear summer day with sun nearly overhead. Estimate the ground level NO concentration at: (i) directly downwind at a distance 2.0 km ii) at a point (2000,200,0) iii) at a downwind point where NO concentration is maximum 6+9= **15**

3. a) A burning solid waste dump emits 20 g/s of oxides of nitrogen ($NO_x$). What may be the concentration of $NO_x$ directly downwind from the source at a distance of 3 km on an overcast night with wind speed 6m/s? The background concentration of $NO_x$ at the receptor location is 50$\mu g/m^3$.

b) A stack with effective height 45m, emitting at the rate of 150 g/s. Winds are estimated at 5 m/s at the stack height, the stability class C, and there is an inversion at 100 m. Estimate the ground-level concentration at the point where reflections begin to occur from the inversion and at a point twice the distance downwind. What may be the type of inversion? What may be the probable plume pattern?

c) A highway has 10 vehicles per second passing a given spot, each emitting 2.13 g/km of CO. If wind is perpendicular to the highway and blowing at 2 m/s on an overcast day, estimate the ground level CO concentration 200m from the road. 4+6+5=**15**

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4. Name/Explain the followings:

(i) a secondary criteria air pollutant (CAP) (ii) photo-dissociable CAP

(iii) 'bad' ozone (iv) a CAP most relevant as input data of a line source GAPM

(v) a criteria pollutant which is a PAH (vi) the wind direction which is blowing towards SW

(vii) the graphical representation of wind speed, wind direction and their frequencies

(viii) wind speed measuring instrument (ix) the condition when wind speed<1m/sec

(x) the turbulence which is neglected (xi) plot in x-axis in Gaussian coefficient ($\sigma_y$ & $\sigma_z$) curves

(xii) probable plume pattern during subsidence inversion (xiii) vertical constrains to plume dispersion

(xiv) the environmental lapse rate during 'D' stability class (xv) type of models, where reference is fixed

1X15=**15**

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

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

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

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 $F\geq 55m^4/s^3$

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

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

8) $\Delta h=[\,v_s d/u\,][1.5 + 2.68x10^{-3}p\,(1-T_a/T_s)d]$

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

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BE(CE)5th YEAR EXAMINATION, 2023
(2nd Semester)
SUBJECT: Solid & Gaseous Waste Management

Full Marks 100
Time: Three hours (50 marks for each part)

Use a separate Answer-Script for each part

| No. of Questions | Part II (50 Marks) | Marks |
|---|---|---|
| | **Answer question number 1(compulsory) and any four questions from the rest. All the drawings should be in pencil. Assume relevant data if not provided.** | |
| Q1. | **Differentiate between:**<br>a. Purity and recovery of trommel screen<br>b. At site time and breakeven time<br>c. Acidogenesis and acitogenesis stages of anaerobic digestion<br>d. Community bin collection system and private bin collection system<br>e. Primary collection and secondary collection of solid waste | 2×5 |
| Q 2. | Determine the area required for a windrow composting plant for a town generating 150 tons of waste per day. The specific density of the waste is 450 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 transverse turning. Draw a neat labeled sketch of plan of the windrow compost plant. Why atleast 70°C temperature is maintained for atleast 10 hours in compost heap? | 5+3 +2 |
| Q3.(a) | For a 12 m long trommel screen of 3.5 m diameter and angle of inclination 2° with horizontal axis determine the angular speed in rpm for which the feed<br>a. Simply cascade down the length of the trommel screen<br>b. Simply centrifuge on the side of the screen<br>c. Cataracting through the pores for required separation | 5 |
| (b) | Write the significances of size reduction, volume reduction and size separation for solid waste treatment. | 5 |
| Q4. | Draw a neat labelled sketch of bottom cover of an engineered landfill site. How will you calculate the pollution potential of leachate? Explain the classifications of landfill based on the environmental control measures present within the landfill. | 5+1 +4 |
| Q5. | Draw a neat labeled sketch of the hierarchy of integrated solid waste management specified in Solid Waste Management Rule, 2016. Name two factors affecting solid waste generation. The ultimate analysis of MSW presents the following data. Determine the chemical formula for the MSW with sulfur and with water. Wet weight=79.5 kg, dry weight=58.1kg, C= 27.38kg, H= 3.62 kg, O=22.95kg, N=0.54kg, S=0.1kg and ash=3.49 kg | 3+2+ 5 |
| Q6. (a) | With a neat label sketch explain the process of haul container system for solid waste collection. | 2+5 |

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|---|---|---|
| Q6. (b) | **Match the most appropriate one for the followings:** | 3 |

| Column A | Column B |
|---|---|
| (i) Kick's law | (a)Component separation |
| (ii) Trommel screen | (b) Size reduction |
| (iii) Blower | (c) Size separation |