Ref No: EX/PG/CE/T/127E/2024

ME Civil Engineering First Year Second Semester Examination 2024

Air Pollution and Control

Time: Three Hours **Use separate answer script for each Part** Full Marks: 100

Part 1

(**60 marks for Part 1** & 40 marks for Part 2)

Answer Question No. 1 and any Two from the rest. Turner's σ_y & σ_z curves and Pasquill's stability chart related with Gaussian Air Pollution Model (GAPM) may be used. Any relevant data may be assumed, if necessary.

1. i) What is a Gaussian Air Pollution Model (GAPM)?

   ii) What is the significance of 'flat terrain' assumption in GAPM?

   iii) Why is molecular diffusion neglected in GAPM?

   iv) With a sketch define 'SW' wind.

   v) With a sketch show how 'downwind' direction in GAPM is selected.

   vi) With a sketch show the origin of the coordinate system of GAPM located.

   vii) In which modified forms of GAPM σ_z is missing (give a sketch)?

   viii) With a sketch show the roll of 'image source' in GAPM.

   ix) Why is centerline modifications of GAPM important?

   x) What is the full form and significance (with respect to GAPM) of 'insolation'?

   xi) Holland's Plume Rise Model was developed imperially perhaps during neutral condition' – explain.

   xii) Comment about correction of 'p' used in wind profile power law.

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

   xiv) What are the vertical constraints with respect to GAPMs?

   (xv) Define a plume. **2 x 15 = 30**

[Turn over

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Part 1 (60 marks for Part 1 & 40 marks for Part 2)

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

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

The notations have their usual meanings.

The second exponential term in the vertical factor is due to one modification. With a sketch explain that modification.

Now find expressions for following modifications

(i) receptors on ground level (ii) maximum concentration

b) A stack emitting 100 g/sec of NO has an effective stack height of 100m. The wind speed at stack tip is 4.5m/s and it is an overcast day. Estimate the ground level NO concentration at:

(i) directly downwind at a distance 500m ii) at a point (500,200,0), Comment on the result. 8+7= **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 50μg/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) What are the significance of following coordinates with respect to Gaussian Coordinate System?

(i) (0, 0, -H) (ii) (x, 0, H) (iii) (x, 0, 0) (iv) (0, 0, h) and (v) (0, 0, 0) 4+6+5=**15**

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Part 1

Time: Three Hours

Full Marks: 100

4. a) What is a line source model? Why is σ_y missing in the expression of a line source model?

b) What is a source appointment study? Why is it very relevant for controlling NO?

c) Explain the role of GAPM in an EIA study.

d) If you are given some fund for betterment of air quality of your locality, how will you spend the fund?

e) What may be the roll of air quality models in management of area sources? 3x5 =**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) $\Delta h=[\,v_sd/u\,][1.5 + 2.68x10^{-3}p\,(1-T_a/T_s)d]$

9) $C_{(x,y,0:H)} = [\,2q/(2\pi)^{1/2}\,\sigma_z u \sin\theta][\,\exp(-H^2/2\,\sigma_z^2)]$

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M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER - 2024

SUBJECT: AIR POLLUTION AND CONTROL (EE)

Full Marks 100

Time: Three hours (40 marks for part II)

Use a separate Answer-Script for each part

Part-II

Answer all question

(Assume any data, if required, reasonably)

(Lapple's Efficiency Curve is allowed during examination)

1. Explain the significance of isokinetic sampling for SPM and SO_2 monitoring.
   Describe one post-combustion non-regenerable wet system of flue gas desulfurisation.
   Describe one treatment process in which SOx and NOx can be removed simultaneously. 5+5+5

2. An air stream with a flow rate of $7m^3/s$ is passed through a cyclone of standard properties. The diameter of the cyclone is 2 m. and the viscosity of air is 2.1×10^{-5} kg/m.s. Determine the amount of removal/m^3 of flue gas, for particles with a density of 1.55 g/cm^3 and diameter of 5μm and 10μm (30:70 w/w) when their total concentration is 300 μg/m^3 of flue gas. 9

3. Design a parallel plate single-stage electro static precipitator (ESP) from the following data:
   Required efficiency = 99.9%; Gas flow rate = 175000 m^3/hr
   Particle drift velocity = 0.15 m/s; Collectrode spacing = 0.28 m
   Depth of collectrode = 3.5m; Height of collectrode = 6m; Gas flow velocity = 1.8 m/s 9

4. In a test for measuring k_o and k_d (with usual notations) following data are obtained:
   Pressure drop after cleaning = 550 N/m^2
   Pressure drop before cleaning = 2300 N/m^2
   Flow rate = 0.6 m^3/s; Mass collected = 65 kg; and Filter area = 50 m^2
   Determine k_o and k_d. 7