Ref No: EX/PG/CIV/PC/T/122/2025

ME Civil Engineering First Year Second Semester Examination 2025

Air Pollution and Control

Time: Three Hours | Full Marks: 100

Part 1

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

Answer all questions. 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) Why is Gaussian Air Pollution Model (GAPM) referred to as 'Gaussian'?

   ii) Why doesn't the GAPM take mechanical turbulence into account?

   iii) Why is molecular diffusion not considered in the development of the GAPM?

   iv) Define 'NNE' wind with the aid of a sketch.

   v) With the help of a sketch show how the crosswind direction is identified in the GAPM.

   vi) Illustrate, using a sketch, the location of the origin of the coordinate system in the GAPM.

   vii) In which modified form of the GAPM is σ_Z missing (give a sketch)?

   viii) With the help a sketch show the role of eddy reflection in the GAPM.

   ix) What is the significance of centerline modification of the GAPM?

   x) What is the full form of the abbreviated word 'insolation' and what is its significance?

   xi) Why is the plume rise correction factor in Holland's model sometimes equal to 1?

   xii) How is wind speed determined at the stack tip?

   xiii) What does 'day' mean in the Pasquill stability class chart?

   xiv) Name two vertical constraints that limit plume propagation.

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

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Part 1 (**60 marks for Part 1** & 40 marks for Part 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.

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) source on ground level (ii) receptors on centerline of plume

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 300m ii) at a point (300,150,0). Comment on the result. 9+6= **15**

a) A burning solid waste dump emits 30 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 2.5 km on an overcast night with wind speed 5m/s? The background concentration of NO_x at the receptor location is 30μg/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 is 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

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

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M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER - 2025

SUBJECT: AIR POLLUTION AND CONTROL

Time: Three hours

Full Marks 100
(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.

a) What are the different types of NOx and SOx generation from furnace? Nane different types of NOx control system. Describe one treatment process which can remove NOx and SOx simultaneously from the combustion gas. 10

b) How the settling efficiency of Gravitational settling chamber in air pollution can be increased without changing the size of the equipment? 4

b) Explain the significance of isokinetic sampling in stack monitoring for particulate matter and gaseous pollutants? 6

2.

An air stream with a flow rate of 6.5m^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 1.5 g/cm^3 and diameter of 6μm and 11μm (35:65 w/w) when their total concentration is 350 μg/m^3 of flue gas. 10

3.

a) Design a parallel plate single-stage electrostatic precipitator (ESP) from the following data:

Required efficiency = 99.8%; Gas flow rate = 170000 m^3/hr

Particle drift velocity = 0.16 m/s; Collectrode spacing = 0.25 m

Depth of collectrode = 3.5m; Height of collectrode = 8m; Gas flow velocity = 1.8 m/s

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b) In a Baghouse filter how k_o and k_d (with usual notations) are determined? 3