Ref. No.: Ex/Che/PC/H/T/413/2025

BACHELOR OF CHEMICAL ENGINEERING EXAMINATION, 2025

(4th Year, 1st Semester)

INDUSTRIAL POLLUTION CONTROL ENGINEERING (HONS.)

Full Marks: 100 Time: 3 hours

Assume any missing data

Answer **any three (3) between Q. No. 1 to Q.No. 4 and Q. No. 5**

Q.No.	CO	Question	Marks
1.	2	a) A rectangular, well mixed aeration lagoon is 60 m long, 5 m wide and 2 m deep. It receives 400 m^3/day of wastewater with a BOD_5 of 336 mg BOD_5/L for treatment. The biodegradation rate constants for the wastewater are yield coefficient, Y = 0.8 mg VSS/mg BOD_5, endogenous decay constant = 0.08 d^{-1}, maximum specific microbial growth rate = 1.1 d^{-1}, and the half velocity constant = 76 mg BOD_5/L. i) what is the BOD_5 removal efficiency of the pond? ii) the pond's efficiency depends on oxygen being always available for the microbes to use in degrading the wastewater organic carbon. How much oxygen (in kg) must be supplied daily to the pond?	15
		b) i) Briefly describe how primary wastewater treatment differs from secondary wastewater treatment? ii) Discuss the working principle of scrubbers as particulate matter (PM) removal device. iii) What is the photochemical smog? How it causes formation of peroxyacetyl nitrate (PAN)?	5+5+5
2.	1	a) The following results are to be used to design a setting chamber. The horizontal velocity is to be 0.3 m/s, temperature 650°C, specific gravity of particle equals 2.0 and chamber length and depth equal 7.5 m and 1.5 m, respectively. Assume that β equal to 0.9. What is the terminal settling velocity of the particle that is removed 100%? Determine the expected percent removal of the particles?	15

[Turn over

Size (μm)	Wt (%)
0-10	8
10-20	10
20-30	12
30-40	15
40-50	19
50-60	14
60-70	13
70-80	9

b)i) What are the important gaseous pollutant of air? Give details of one of the gaseous pollutant control methods. 5+5+5

ii) Derive the following for a centrifuge:

$$t = \frac{18\mu}{D_P^2 \omega^2 (\rho_S - \rho)} \cdot \frac{h}{R}$$

Where, t = minimum retention time of solid having size $>D_P$
ω: angular velocity
h: thickness of liquid layer in centrifuge bowl
R: radius of centrifuge bowl

iii) "Electrostatic Precipitator (ESP)" often used in series with "Cyclone Separator" for particulate removal from air. How and why?

3. 3 a) Describe a Howard settling chamber 5+10

A multi-tray settling chamber handles 6 m^3/s of air at 20°C. There are 8 trays including bottom surface, spaced 0.25 m apart. The chamber is 4m long and 1m wide. For particles of density 2000 kg/m^3 and sizes (i) 70 and (ii) 25 μm, calculate the residence time, the distance settled and efficiency of collection. Is the tray spacing sufficient to collect all the particles of each size. Assume laminar flow.

b) i) Discuss about the head loss in a rapid sand filter. 5+5+5

ii) In water disinfection step, free chlorine and combined chlorine are added. How and why?

		iii) What are ponding and sloughing of trickling bed filter?	
4.	4	a) A water sample is analyzed and found to have the composition shown in the following table:	20

Component	Concentration
CO_2	6 mg/L
Ca^{2+}	50 mg/L
Mg^{2+}	20 mg/L
Na^{+}	5 mg/L
alkalinity	3.1 millimole/L
SO_4^{2-}	85 mg/L
pH	7.6

i) what concentrations (expressed as mg/L) of slaked lime and soda ash must be added to water to remove the maximum practical hardness?
ii) if water is the source of water for 15 MGD water softening plant, estimate the mass of sludge (kg/day) produced by the softening process.

b) What is the terminal settling velocity of a particle with a specific gravity of 1.4 and a diameter of 0.01 mm in 20°C water? Would the particles of the size 0.01 mm be completely removed in a settling basin with a width of 10.0 m, a depth of 3.00 m, a length of 3.0 m and a flow rate of 7500 m^3/d? What is the smallest diameter particle of specific gravity 1.4 that would be removed in the sedimentation basin? — 10

5.	1	a) What are the biological routes for solid waste treatment? Briefly discuss any one of them.	10
		OR	
		Answer any **four (4):**	2.5 x 4 = 10
		a) Define sludge volume index (SVI) of activated sludge tank.	
		b) A 10 mL sample of sewage mixed with enough water to fill a 300 mL bottle has an initial DO of 9.0 mg/L. it is desired to have at least 2 mg/L drop in DO during 5 day run and final DO should be at least	

		2 mg/L. For what range of BOD_5 would this dilution produce the desired result. c) What are the industrial dry methods for desulphurization of flue gases? d) What are the different types of solid waste? e) What are the sources of lead in air as pollutant and their effects?	