GATE 2020

GRADUATE APTITUDE TEST IN ENGINEERING

CHEMICAL ENGINEERING PAPER SOLUTION

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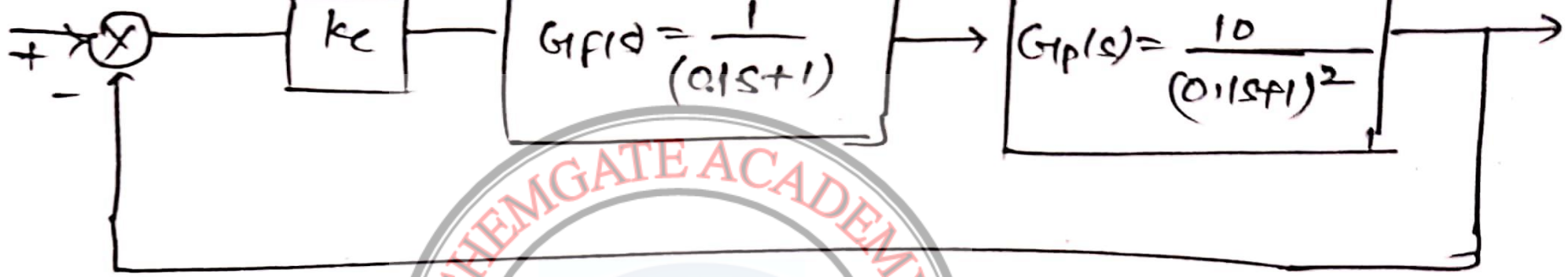
(Unacademy GATE educator)

Subject → Process Dynamic and Control

Que → 1
(2 marks)



$G_m(s) = 1$, Gain margin (G.M) = 1.6

Calculate K_c for controller.

Sol → The open loop transfer function $G_{OLTF}(s) = \frac{K_c \times 10}{(0.1s+1)^2 \cdot (0.1s+1)}$

$$G_{OLTF}(s) = \frac{10 K_c}{(0.1s+1)^3}$$

$$G_{OLTF}(s) = \frac{10K_c}{(0.1s+1)^3}$$

$$\boxed{G.M = \frac{1}{AR|_{\omega=\omega_{co}}}}$$ calculate $\omega = \omega_{co}$ at $\phi = -180$

Phase shift $\phi = 3\tan^{-1}(-0.1\omega)$ ✓

$$-180 = 3\tan^{-1}(-0.1\omega_{co})$$

$$60 = \tan^{-1}(0.1\omega_{co})$$

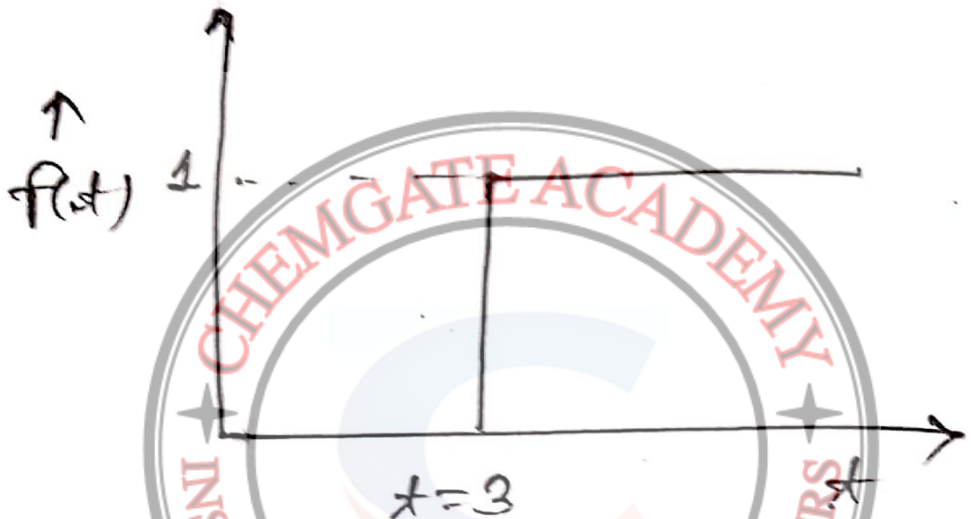
$$\sqrt{3} = 0.1\omega_{co} \Rightarrow \omega_{co} = 10\sqrt{3} \text{ rad/time}$$

Amplitute Ratio $AR = \frac{10K_c}{\left(\sqrt{(1+0.1^2\omega_{co}^2)}\right)^3}$ Put $\omega_{co} = 10\sqrt{3}$

$$G.M = \frac{1}{AR|_{\omega=\omega_{co}}} = 1.6 \Rightarrow \frac{1}{1.6} = \frac{10K_c}{\left(\sqrt{(1+0.1^2\times(10\sqrt{3})^2)}\right)^3}$$

$$\boxed{K_c = 0.5}$$ Answer

Ques 2) (1 marks) find out the Laplace Transform of the following function.

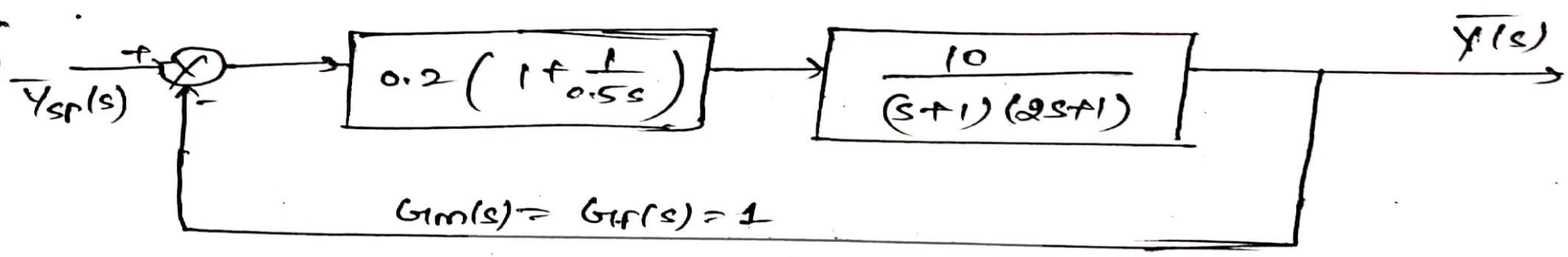


Sol→ $f(t) = 1 \cdot u(t-3)$

Laplace transform of time delay function,

$$L\{f(t)\} = \frac{1}{s} e^{-3s}$$ Answer

Que. 3 (2 marks)



for unit step change in set point, find the steady state value of the output.

Sol:- The closed loop transfer function for servo problem

$$G(s) = \frac{Y(s)}{Y_{sp}(s)} = \frac{G_c G_f G_p}{(1 + G_c G_f G_p G_m)}$$

$$= \frac{0.2\left(1+\frac{1}{0.5s}\right)\left(\frac{10}{(s+1)(2s+1)}\right)}{1 + 0.2\left(1+\frac{1}{0.5s}\right)\left(\frac{10}{(s+1)(2s+1)}\right)}$$

$$= \frac{0.2\,(0.5s+1)\,(10)}{0.5s\,(s+1)(2s+1) + 0.2\,(0.5s+1)\,10}$$

By final value theorem, $\overline{Y_{sp}}(s) = \frac{1}{s}$

U.V.R $\Rightarrow$ $\lim_{t \to \infty} y(t) = \lim_{s \to 0} s\,\overline{Y}(s)$

$$= \lim_{s \to 0} s \times \frac{1}{s} \left\{ \frac{0.2(0.5s+1)(10)}{0.5s(s+1)(2s+1) + 0.2(0.5s+1)10} \right\}$$

steady state value = 1 Answer

Ques 4 (1-marks) Instrumentation

Hot wire Anemometer is used for

(a). Flow

(b) Pressure

(c) Concentration

(d) level

Ans → option (a) flow (velocity)

Que-5) (2 marks) Equal percentage valve characteristics

given $q_1 = 900 \frac{m^3}{hr}$ at $x_1 = 30\% = 0.30$

$q_2 = 1080 \frac{m^3}{hr}$ at $x_2 = 35\% = 0.35$

$q_3 = ?$ at $x_3 = 45\% = 0.45$

Sol $\rightarrow$ $\boxed{f = f_0 e^{Bx}}$ $\quad x \geq 0.8, \quad f = \frac{q}{q_{max}}$

$$\frac{q_1/q_{max}}{q_2/q_{max}} = \frac{f_0 \times e^{Bx_1}}{f_0 \times e^{Bx_2}} \Rightarrow \frac{900}{1080} = e^{B(0.3-0.35)}$$

$$\Rightarrow B = 3.64$$

$$\frac{900}{q_3} = e^{B(0.3-0.45)} \Rightarrow \frac{900}{q_3} = e^{3.64 \times (0.3-0.45)}$$

$$\Rightarrow \boxed{q_3 = 1555 \ m^3/hr}$$

Subject:- Plant Design and Economics

Ques 1) (2 marks) Annual plant capacity = 100 metric ton

selling price = 200 Rs/kg

cost price = 50 Rs/kg

fixed cost = 3×10^6 Rs

&

operating cost

ϕ_T = Tax Rate = 18% = 0.18

Net profit = ?

Sol→ profit After tax = $(S - C - d)^0 (1 - \phi_T)$

$= (S - C)(1 - \phi_T)$

Sol→ Profit After tax = $(S - C - d)(1 - \phi_T)$

$= (S - C)(1 - \phi_T)$

$S = 200 \frac{Rs}{kg} \times 100 \times 10^3 kg = 20 \times 10^6 Rs$

Cost $= C_1 + C_2$

$= (50 \frac{Rs}{kg} \times 100 \times 10^3 kg) + (3 \times 10^6 Rs)$

$= (5 \times 10^6 + 3 \times 10^6) Rs$

$= 8 \times 10^6 Rs$

$PAT = (20 \times 10^6 - 8 \times 10^6)(1 - 0.18)$

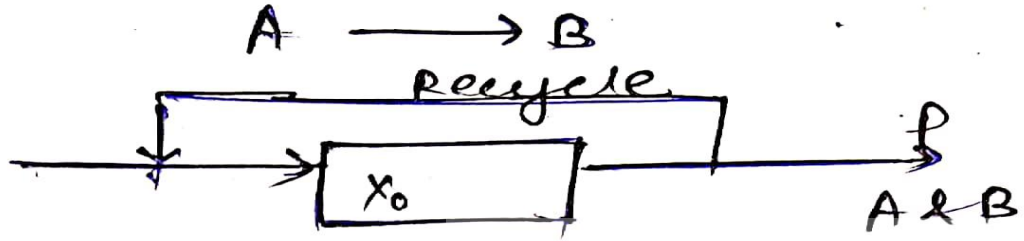
$= 12 \times 10^6 \times (0.82)$

PAT = 9840000 Rs Answer

= 98.4 lakh

subject :- Process calculation

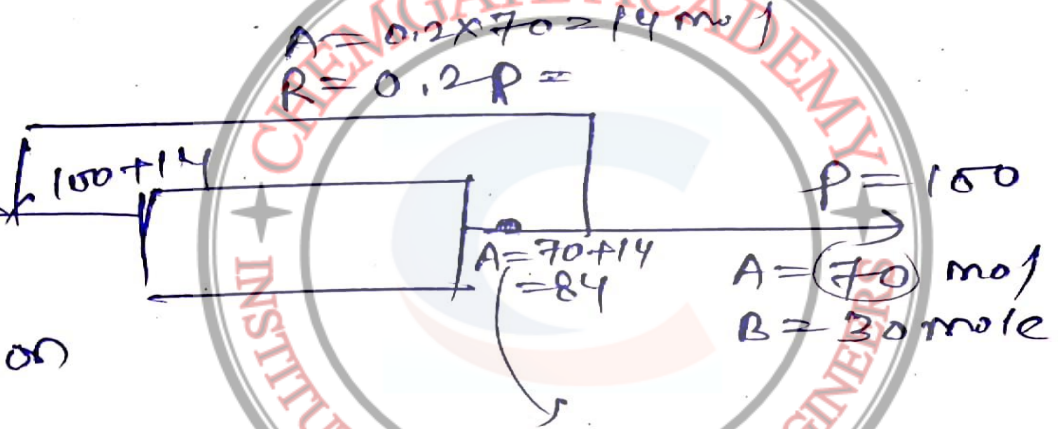
Ques 1 (2 marks)



F = Feed
A

overall conversion = 30%,
Calculate single pass conversion
Recycle is 20% of product.

Sol →



Let F = 100 mole

30% conversion

P ⇒ 30 mol B
70 mol A

Single pass conversion

$$X_p = \frac{114 - 84}{114} = 0.2631$$

$X_p = 26\%$ Answer.

Subject - CHEMICAL TECHNOLOGY

Que 1) (1 marks) Which of the following option is Incorrect -

(a) High density polyethylene (HDPE) is a condensation polymer.

(b) Nylon 6, 6 is a condensation polymer.

(c) Polyethylene terephthalate (PET) is a polyester

(d) Phenol-formaldehyde resin is a thermoset polymer

Answer:- option (a)

because HDPE is a chain growth polymer

Ques 2) Match the column (1 marks)

process	Reaction
a. solvay process	I. $RCOOH + NaOH \longrightarrow RCOONa + H_2O$
b. oxo-process	II. $C_2H_4 + CO + H_2 \longrightarrow CH_3CH_2CHO$
c. saponification	III. $2NaCl + CaCO_3 \longrightarrow Na_2CO_3 + CaCl_2$

Answer: a-III, b→II, C→I

Que-3) (1 marks) production of Ammonia by Haber process, where temperature range is 350-450°c.

a. 20 Mpa, Endothermic rxn, Fe catalyst

b. 20 MPa, Exothermic rxn, Fe catalyst

c. 0.1 Mpa, Exothermic rxn, Pt catalyst

d. 0.1 MPa, Endothermic rxn, Pt catalyst

Ans → $N_2(g) + 3H_2(g) \xrightarrow[\text{Catalyst}]{Fe} 2NH_3(g)$ $\underline{\Delta H = -ve}$ (exothermic rxn)

1 : 3 by volume

Pressure → 200 atm = $200 \times 1.013 \times 10^5$ Pa ≈ 20 MPa

Option (b)

Ques 4) (1 marks) Match the column

process	catalyst
a. Hydrodesulphurization	I. zeolite
b. Fluid catalytic cracking	II. Pt/Al_2O_3
c. Naphtha Reforming	III. $Co\text{-}Mo/Al_2O_3$

Ans→ a → III, b → I, c → II

Subject → THERMODYNAMICS

(Que → 1) (1 marks)

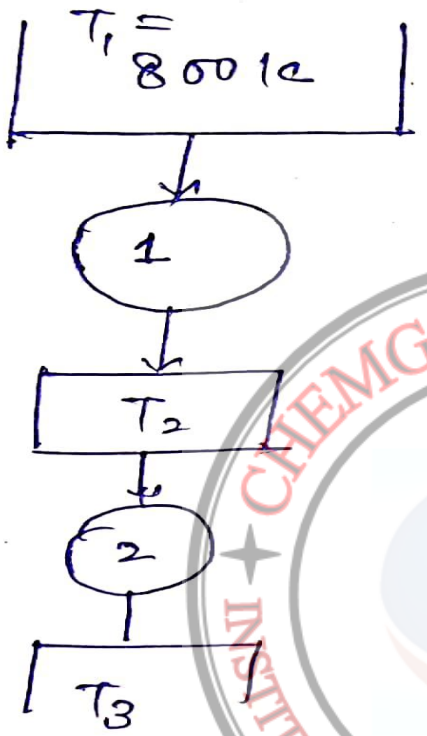
calculate · $T_3 = ?$

carnot engine based question

efficiency

$\eta_1 = 0.4$

$\eta_2 = 0.35$



Solution:

$$\eta_1 = 1 - \frac{T_2}{T_1} = 0.4$$

$$1 - \frac{T_2}{800} = 0.4$$

$$T_2 = 480\ K$$

$$\eta_2 = 1 - \frac{T_3}{T_1} \Leftarrow 1 - \frac{T_3}{480} = 0.35$$

$$\Rightarrow 1 - 0.35 = \frac{T_3}{480}$$

$$\Rightarrow 0.65 = \frac{T_3}{480} \Rightarrow \boxed{T_3 = 312\ K}$$

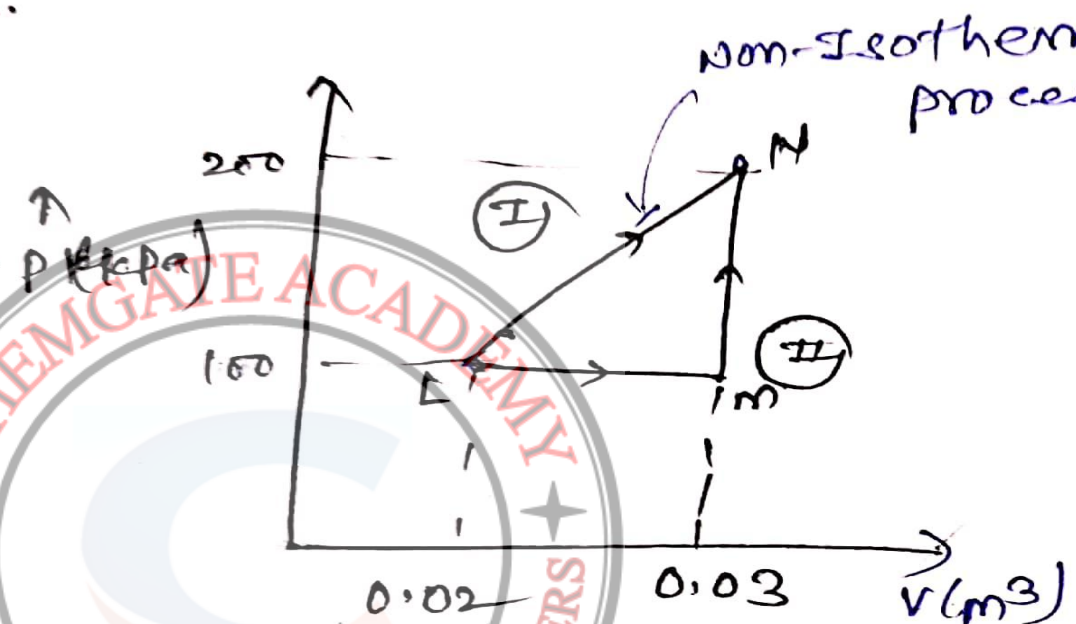
Answer

Ques 2. (2 marks) Calculate the difference of Heat transfer b/w path I and II.

LN = process- I

LMN = process- II

$Q_I - Q_{II} = ?$



So $\rightarrow dU = dQ - dW$

$dQ = dU + dW$

Note $\rightarrow$ $\Delta U_I = \Delta U_{II}$ same internal energy as initial and final state is same

$Q_I - Q_{II} = \{(\Delta U_I + W_I) - (\Delta U_{II} + W_{II})\}$

$Q_I - Q_{II} = W_I - W_{II}$ = Area of triangle only

$$Q_I - Q_{II} = W_I - W_{II}$$

$$= \text{Area of triangle only}$$

$$= \frac{1}{2} \times 100 \times 0.01$$

$$= 0.5 \text{ kpa} \cdot m^3$$

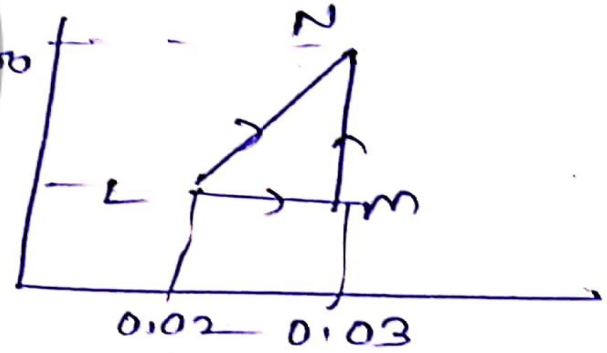
$$Q_I - Q_{II} = 500 \text{ kJ} \quad \text{Answer}$$

(II) solution $\quad Q_I - Q_{II} = ?$

for path L–N

$$Q_I = dU_I + dW_I$$

$$Q_I = \Delta U_I + W_I$$



W_I = Area of trapezium

$$= \frac{1}{2} [100 + 200] \cdot (0.03 - 0.02) \Rightarrow \text{or} \left| \begin{array}{l} \text{Area of} \\ \text{Rectangle} \end{array} + \begin{array}{l} \text{Area of} \\ \text{triangle} \end{array} \right.$$

$$= 150 \times 0.01$$

$$W_I = 1.5 \text{ kJ}$$

$W_I = 1.5$ kJ

for path L-M-N

$Q_{II} = \Delta U_2 + W_{II}$

W_{II} = Area of ~~Rectangle~~

$W_{II} = 100 \times 0.01 = 1$ kJ

$Q_I - Q_{II} = (\Delta U_I + W_I) - (\Delta U_{II} + W_{II})$

$= W_I - W_{II}$

$= (1.5 - 1)$ kJ

$= 0.5$ kJ

$Q_I - Q_{II} = 500$ J : Answer.

Ques→3 (1 marks) → Which one is correct always.

a. $\lim_{x_1 \to 1} g^E/RT = 0$

b. $\lim_{x_1 \to 1} g^E/RT = 0.5$

c. $\lim_{x_1 \to 1} \ln \gamma_1 = 0$

d. $\lim_{x_1 \to 1} \ln \gamma_1 = 0.5$

Ans→ option (a) $\boxed{\lim_{x_1 \to 1} g^E/RT = 0}$ at $x_1 \to 1$

Pure component

$g^E = 0$

$g^E = g - g^{id}$

Ques 4 > (2 marks) Residual properties question

$$Z = 1 + \frac{BP}{RT}, \quad B = 10^{-4}\ m^3/mol$$

$$P = 1000\ kPa$$

$$T = 300\ K$$

given that $\boxed{\frac{G^R}{RT} = \int_0^P \left(\frac{Z-1}{P}\right) dP}$ — (1)

Calculate $H^R = ?$

Sol →

$$\boxed{\left[\frac{\partial (G^R/RT)}{\partial T}\right]_P = -\frac{H^R}{RT^2}}$$ — (2) Imp.

given $Z = 1 + \frac{BP}{RT}$

$$\Rightarrow (Z-1) = \frac{BP}{RT}$$

$$\left(\frac{Z-1}{P}\right) = \frac{B}{RT}$$

$$\Rightarrow \frac{G^R}{RT} = \int_0^P \frac{B}{RT}\, dP$$

$$\Rightarrow \frac{G^R}{RT} = \frac{BP}{RT}$$ — put in eqn (2)

$$-\frac{H^R}{RT^2} = \frac{\partial}{\partial T}\left(\frac{BP}{RT}\right)\Big|_P = \frac{BP}{R}\left(-\frac{1}{T^2}\right) = -\frac{BP}{RT^2}$$

$$\boxed{H^R = BP} = 10^{-4} \times 1000\ kPa$$

$$= 10^{-4} \times 10^6\ Pa$$

$$H^R = 100\ Pa \Rightarrow$$

Answer.

$$\boxed{H^R = 100\ J/mol}$$

Subject - Mechanical operation

Que→1) (1 marks) for stokes law regime calculate the teminal setting velocity ?

given $d_p = 2 \times 10^{-4}$ m $\quad \mu_f = 9.81 \times 10^{-3}$ pa-s

$\rho_p = 3000$ kg/m^3

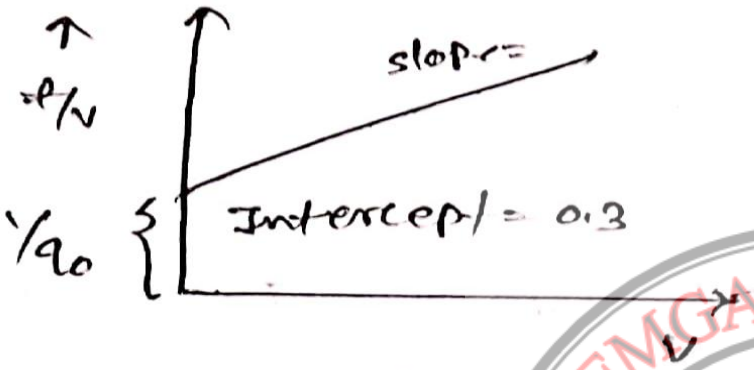
$\rho_f = 750$ kg/m^3

Sol-

$$\boxed{V_t = \frac{D_p^2 \, g \, (\rho_p - \rho_f)}{18 \, \mu}} = \frac{(2 \times 10^{-4})^2 \times 9.81 \times (3000 - 750)}{18 \times 9.81 \times 10^{-3}}$$

$$V_t = 5 \times 10^{-3} \text{ m/s} \quad \text{Answer}$$

Que. 2 (1-marks) Question on Cake filtration



given

$\Delta P =$

$\mu =$

$A = 0.04\ m^2$

Calculate filter medium resistance (m^{-1}) ?

R_m in m^{-1}

Sol:-

$$\left[\frac{dt}{dV} = \frac{\mu}{A \cdot \Delta P}\left\{\frac{\alpha (V \cdot C)}{A} + R_m\right\}\right] \Rightarrow \left[\frac{dt}{dV} = kc\,V + \frac{1}{q_0}\right]$$

Intercept $\frac{1}{q_0} = \left\{\frac{\mu R_m}{A \cdot \Delta P} = 0.3\right\}$

Put μ, , A, ΔP & calculate R_m

$$R_m = \frac{0.3 \times A \times \Delta P}{\mu}$$

(Data is not available)

$R_m = 1 \times 10^{1}$ Answer

Que → 3 (2 marks) → Minimum fluidisation (problem) velocity

given $h = 1\,m$ $\quad g = 9.81$ $\quad$ void fraction

$\rho_f = 1\ kg/m^3$ $\quad L = 1\,m$ $\quad \epsilon = 0.1$

$\rho_p = 3000\ g$

calculate pressure drop ΔP

Sol-

$$\boxed{\frac{\Delta P}{L} = (1-\epsilon)(\rho_p - \rho_L)\, g}$$

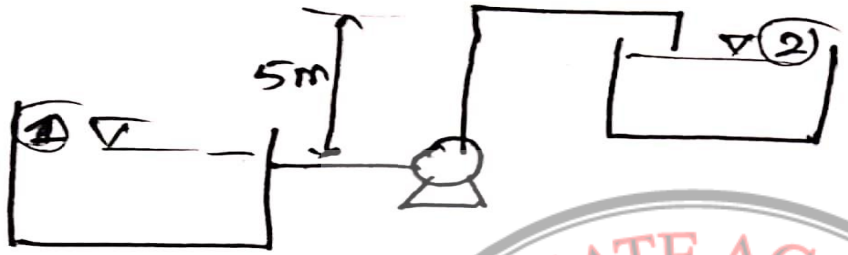
$$\frac{\Delta P}{1} = (1-\epsilon)(3000-1) \times 9.81$$

$$\Delta P = (0.9) \times (2999)(9.81) = 26478.17$$

$$\underline{\Delta P = 26478.17} \quad \text{Answer}$$

Subject → Fluid Mechanics

Ques 1 (2 marks)



Calculate the power required for pumping ?

given :

fractional Head loss = 1 m of H_2O

$Q = 0.02\ m^3/sec$

$\rho_{water} = 1000\ kg/m^3$

$g = 9.81\ m/s^2$

$\eta = 100\%$

Sol → Apply B.E equation b/w point 1 and 2

$$\frac{P_1}{\rho g} + \overset{0}{\cancel{\frac{v_1^2}{2g}}} + z_1 + \overset{1}{\cancel{H_p}} = \frac{P_2}{\rho g} + \overset{0}{\cancel{\frac{v_2^2}{2g}}} + z_2 + h_f$$

$$H_p = (z_2 - z_1) + h_f$$

$$H_p = 5 + 1 = 6\ m$$

Sol-1 Apply B.E equation b/w point 1 and 2

$$\frac{P_1}{\rho g} + \overset{0}{\frac{V_1^2}{2g}} + z_1 + \overset{1}{\eta} H_p = \frac{P_2}{\rho g} + \overset{0}{\frac{V_2^2}{2g}} + z_2 + h_f$$

$$H_p = (z_2 - z_1) + h_f$$

$$H_p = 5 + 1 = 6\,m$$

Power required $P = \dot{m} g h$

$$\boxed{P = \rho g H Q}$$

$$P = 1000 \times 9.81 \times 6 \times (0.02)$$

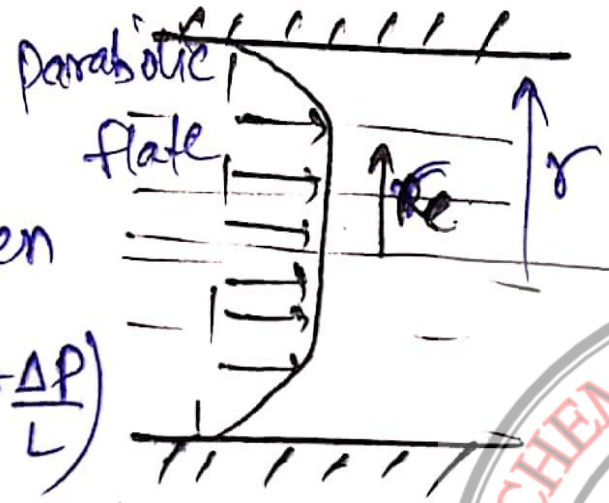
$$P = 1177.2 \text{ watt}$$ Answer

Que-2)

(2-marks)

Relation given

$$\frac{d}{dr}(r\tau_{rx}) = r\left(-\frac{\Delta P}{L}\right)$$



$R_e = 0.001\ m$

$\frac{\Delta P}{L} = 10\ kPa$

$$\tau = \tau_0 + \mu\frac{du}{dy}$$

Calculate threshold shear stress for Bingham plastic fluid

Sol→

$$\frac{2\tau}{R} = \frac{\Delta P}{L} \Rightarrow \frac{2}{R}\left(\tau_0 + \mu\frac{du}{dy}\right) = \frac{\Delta P}{L}$$

at $R_e = 0.001\ m$, $\frac{du}{dy} = 0$ $\Rightarrow \frac{2}{0.001}(\tau_0 + 0) = 10\times10^3\ Pa \Rightarrow \tau_0 = 5\ N/m^2$

Answer.

Que→3) (2marks) Two pipes having laminar, steady, incompressible flow. pipe-I having diameter d_I and pipe II having diameter d_{II}. given $d_{II} = 2d_I$.

Both pipe having same discharge. wall shear stress ratio τ_I / τ_{II} will be ?

Sol→ $\boxed{Q_I = Q_{II}}$ given $d_{II} = 2d_I$

(I) method

fully developed laminar flow

$\boxed{U_{max} = 2\bar{U}_{avg}}$ ⇒ $\left[\frac{R^2}{4\mu}\left(-\frac{dp}{dx}\right)\right]$

put $\frac{dp}{dx} = -\frac{2\tau_w}{R}$

Sol →

$\boxed{Q_I = Q_{II}}$ given $d_{II} = 2d_I$

(I) method

fully developed laminar flow

$\boxed{u_{max} = 2\bar{u}_{avg}} \Rightarrow \left[\because \frac{R^2}{4\mu}\left(-\frac{dp}{dx}\right)\right]$

Put $\frac{dp}{dx} = -\frac{2\tau_w}{R}$

$2\bar{u}_{avg} = \frac{R^2}{4\mu}\left(\frac{2\tau_w}{R}\right) = \frac{\tau_w R}{2\mu}$

$Q = A\bar{u}_{avg} \Rightarrow \bar{u}_{avg} = \frac{Q}{A} = \frac{Q}{\frac{\pi}{4}D^2}$

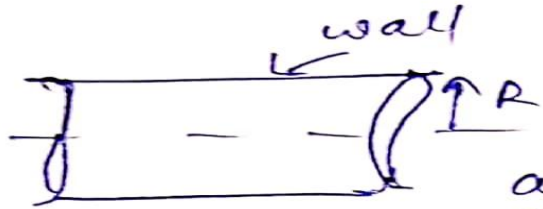
$\Rightarrow 2 \times \frac{Q}{\frac{\pi}{4}D^2} = \frac{\tau_w D}{4\mu}$

$\boxed{\tau_w \propto \frac{1}{D^3}} \Rightarrow \frac{\tau_{w_1}}{\tau_{w_2}} = \left(\frac{D_2}{D_1}\right)^3$

$\Rightarrow \frac{\tau_{w_I}}{\tau_{w_{II}}} = (2)^3 = 8$

$\boxed{\frac{\tau_{w_I}}{\tau_{w_{II}}} = 8}$ Answer

(II) method :- given fully developed laminar flow



$$\tau = -\frac{dp}{dx}\frac{r}{2}$$

at $r = R$

$$\boxed{\tau_{max_w} = -\frac{dp}{dx}\frac{R}{2}}$$

$$\left[h_f = \frac{32\mu NL}{\rho g d^2}\right]$$

$$\left(\frac{P_1 - P_2}{\rho g}\right) = \frac{32\mu \bar{v} L}{\rho g d^2 A}$$

$$P_1 - P_2 = \frac{32\mu \bar{v} L}{d^2 \times \frac{\pi}{4} d^2}$$

$$P_1 - P_2 \propto \frac{1}{d^4}$$

$P = \rho g h$

$h = \frac{P}{\rho g}$

$Q = AV$

$$P_1 - P_2 \propto \frac{1}{d^4}$$

$$\tau_{max} = -\frac{dP}{dx} \times \frac{R}{2}$$

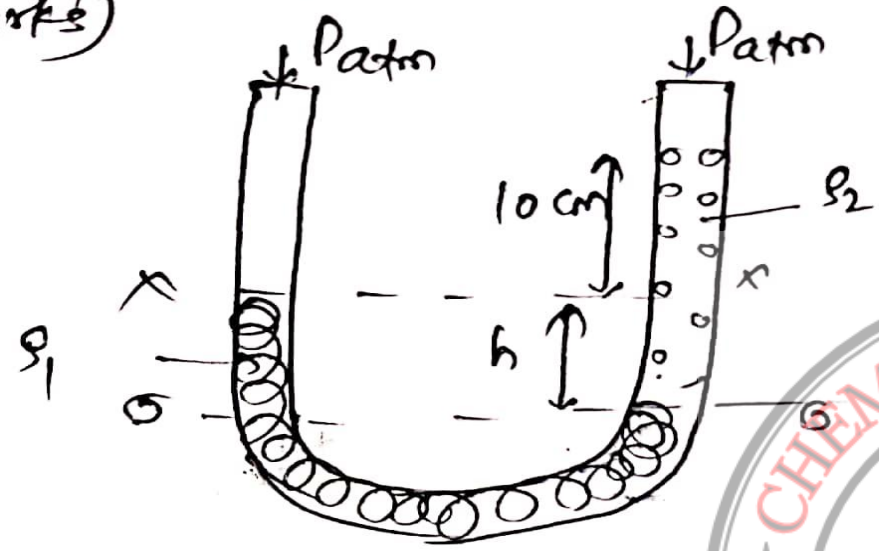
$$\tau_{max} \propto \left(-\frac{dP}{dx}\right) \times d$$

$$\tau_{max} \propto \frac{1}{d^4} \times d \propto \frac{1}{d^3}$$

$$\boxed{\tau_{max} \propto \frac{1}{d^3}} \Rightarrow \tau_{max} = \frac{k}{d^3}$$

$$\frac{\tau_{max_1}}{\tau_{max_2}} = \left(\frac{d_2}{d_1}\right)^3 = (2)^3 = 8 \quad \text{Answer}$$

Ques → 4 (2 marks) Manometer question



$\rho_1 = 1000\ kg/m^3$

$\rho_2 = 600\ kg/m^3$

To raise another 20cm column of 600 kg/m3 liquid required absolute pressure is — — — —

sol:- To find h take liquid column balance at o-o $\boxed{P_1 = P_2}$

$P_{atm} + \rho_1 g h = P_{atm} + \rho_2 g (h + 0.1)$

$1000 \times 9.81 \times h = 600 \times 9.81 \times (h + 0.1)$

$1.67 h = h + 0.1 \Rightarrow h = 0.149\ m$

$h = 14.90\ cm$

$\boxed{h \simeq 15\ cm}$

sol- To find h take liquid column balance at o-o $\boxed{P_1 = P_2}$

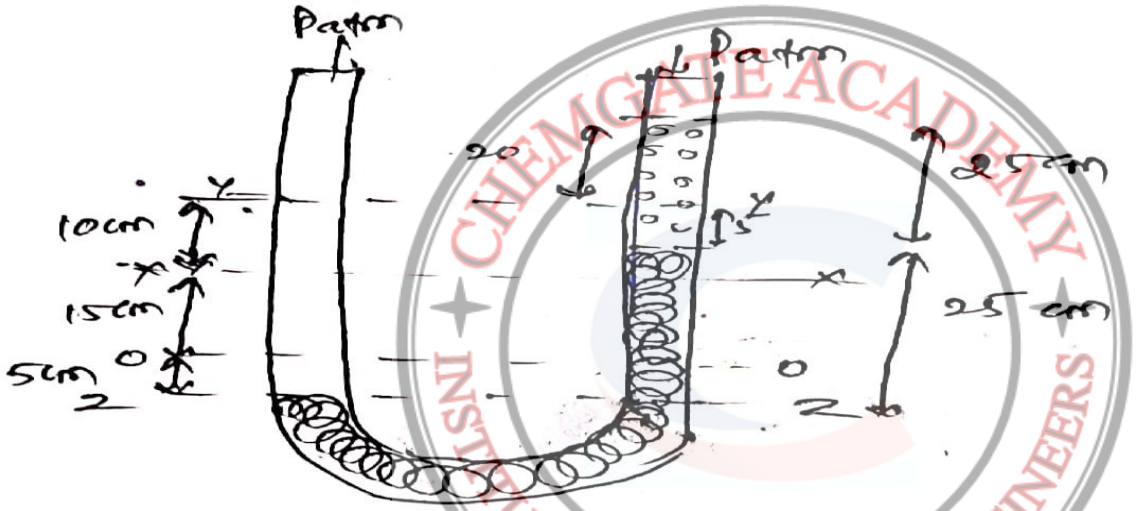
$P_{atm} + \rho_1 g h = P_{atm} + \rho_2 g (h + 0.1)$

$1000 \times 9.81 \times h = 600 \times 9.81 \times (h + 0.1)$

$1.67 h = h + 0.1 \Rightarrow h = 0.149\ m$

$h = 14.90\ cm$

$\boxed{h = 15\ cm}$



Take liquid column balance at 2-2

$P_{abs} = P_{atm} + \rho_1 g h + \rho_2 g h$

$P_{abs} = 100 \times 10^3 Pa + (1000 \times 9.81 \times 0.25) + (600 \times 9.81 \times 0.25)$

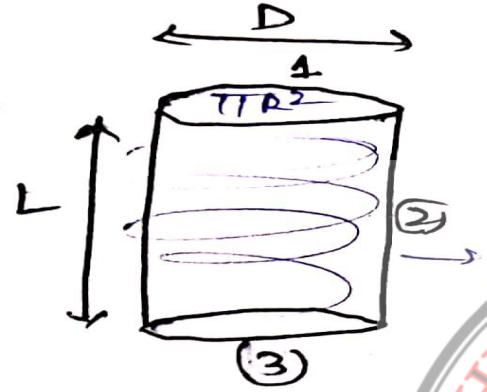
$P_{abs} = 103925\ Pa$

$P_{abs} = 103.925\ kPa$ Answer

Subject - Heat transfer

Ques 1) (1 marks) Calculate the shape factor F_{21}

Cylinder



given $L = D$

$F_{13} = 3 - 2\sqrt{2}$

$2\pi rL = 2\pi RL = \pi D^2 = \pi(2R)^2 = 4\pi R^2$

Sol→ $F_{11}^{0} + F_{12} + F_{13} = 1$

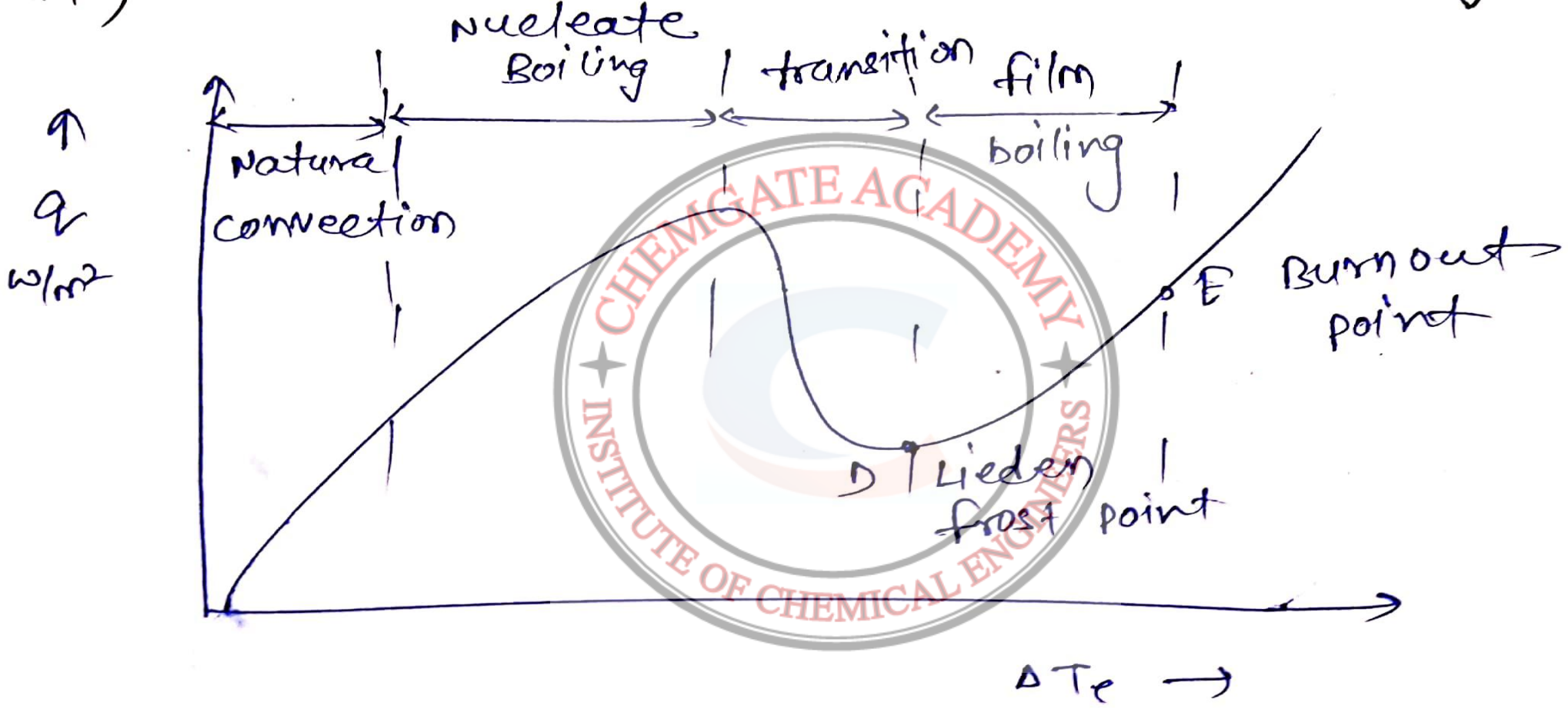
$F_{12} = 1 - F_{13} = 1 - (3 - 2\sqrt{2}) = (2\sqrt{2} - 2)$

$A_1 F_{12} = A_2 F_{21} \Rightarrow \therefore F_{21} = \frac{A_1}{A_2} \times F_{12}$

$F_{21} = \frac{\pi R^2}{4\pi R^2} \times (2\sqrt{2} - 2)$

$F_{21} = \frac{\sqrt{2} - 1}{2}$ Answer

Ques 2) (1 marks) Leindenfrost point ⟶ film Boiling



Excess temp. $\Delta T_e = T_s - T_{sat}$

Ques→3 (2 marks) Question on fins (fin of infinite length)

$$\frac{d^2\theta}{dx^2}(x) - m^2\theta(x) = 0 \qquad \frac{\theta(x)}{\theta_b} = \frac{T(x) - T_\infty}{T_b - T_\infty} = e^{-mx}$$

given, $m = 4$, $\frac{\theta(x)}{\theta_b} = \frac{T(x) - 27^\circ C}{227 - 27^\circ C} = e^{-mx}$

temp. distribution profile

Solution:-

at $x = 0.25$, $T(x) = ?$

$$T(x) = 27 + (200 \times e^{-4 \times 0.25})$$

$$T(x) = 27 + \left(\frac{200}{e}\right) = 100.57^\circ C$$

$$\boxed{T(x) = 100.57^\circ C}$$ Answer

Ques-4) (1-marks) calculate log mean temperature (cross current flow)

$$LMTD = (\Delta T)_{LMTD} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}}$$

$$LMTD = \frac{40 - 30}{\ln\left(\frac{40}{30}\right)} = 34.76^{\circ}C$$

Answer

Que-5) (1-marks) Momentum diffusivity to thermal diffusivity ratio is

Answer: Pr = Pradtle number

$$\left\{ Pr = \frac{C_p \mu}{k} = \frac{\nu}{\alpha} = \frac{\text{Momentum diffusivity}}{\text{thermal diffusivity}} \right\}$$

Que-6) (2-marks) Evaporators question (2-stage)

$\lambda = 2200$ kJ/kg

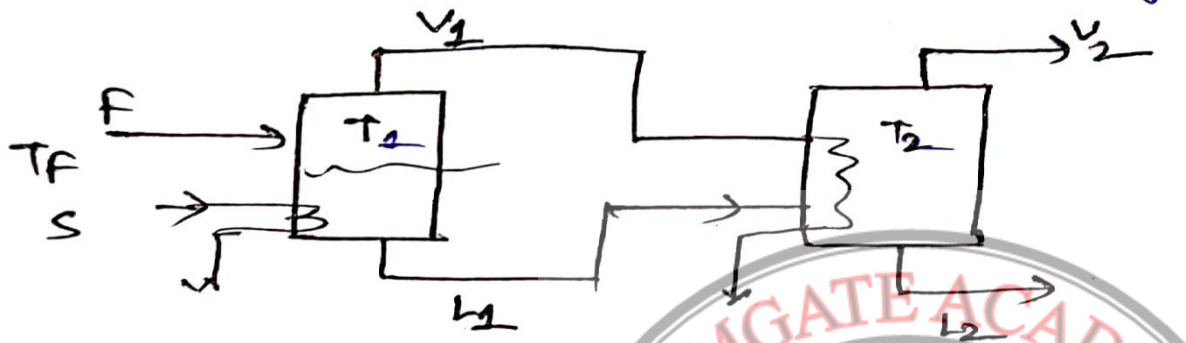
given. $F = 1.25$ kg/sec, $T_F = 60^\circ C$, , $C_p = 4$ kJ/kg.k

$T_1 = 100^\circ C$,

$T_2 = 60^\circ C$

$$\text{Calculate economy} = \frac{V}{S} = \frac{\text{steam produced}}{\text{steam used}}$$

Q.no-6) (2-marks) Evaporators question (2-stage)



$\lambda = 2200$ kJ/kg

given. $F = 1.25$ kg/sec, $T_F = 60^\circ C$, $C_p = 4$ kJ/kg.k

$T_1 = 100^\circ C$,

$T_2 = 60^\circ C$

Calculate economy $= \frac{V}{S} = \frac{\text{steam produced}}{\text{steam used}}$

Sol→ Let $V_1 = x$ kg/sec, $V_2 = (1-x)$ kg/sec

$F = L_1 + V_1$

$1.25 = L_1 + x \Rightarrow L_1 = (1.25 - x)$ kg/sec

Energy Balance on 1st stage

Calculate economy $= \frac{V}{S} = \frac{\text{steam produced}}{\text{steam used}}$

Sol$\rightarrow$ Let $V_1 = x$ kg/sec, $V_2 = (1-x)$ kg/sec

$F = L_1 + V_1$

$1.25 = L_1 + x \Rightarrow L_1 = (1.25 - x)$ kg/sec

Energy Balance on 1st stage

$FC_p(T_1 - T_F) + V_1 dv = S d_s$

$1.25 \times 4 \times (100 - 60) + x(2200) = S(2200)$ ——— (1)

Energy Balance on 2nd stage

$L_1 C_p (T_2 - T_1) + V_2 dv = V_1 d_s$

$(1.25 - x) \times 4 \times (60 - 100) + (1-x) \times (2200) = (x) \times (2200)$ ——— (2)

$\Rightarrow$ on solving $x = 0.439$

Put in eq-(1) $\Rightarrow S = 0.5295$ kg/sec

Economy $= \frac{V}{S} = \frac{1}{0.5295} =$ **1.88** Answer

Subject → MASS TRANSFER

Ques 1) (2 marks) calculate NTU for Dilute solution

given

$y_2 = Y_2 = 0.005$ ← $x_2 = X_2 = 0$

$L_s = L_s = 2$ kmol/hr

$G_1 = G_{s_1} = 0.05$

$y_1 = Y_1 = 0.015$ → x_1

equilibrium Reaction

$y = 40x$

for Dilute system

$y = Y$, $x = X$

$L_s = L$, $G_{s_e} = G$

sol→ Absorption factor $A = \dfrac{L_s}{m G_{s_1}} = \dfrac{2}{(0.05) \times 40} = 1$

$Y = 40X$ (Dilute solution)

for special case → $\boxed{A = 1}$

$$\boxed{NTU = \frac{Y_1 - Y_2}{Y_2 - mX_2}} = \frac{0.015 - 0.005}{0.005 - 0}$$

$\boxed{NTU = 2}$ Answer

Ques.2 > Calculate fractional resistance offered by liquid phase

2 Marks

given $k_x = 3$, $k_y = 2$, $y = 0.1x$

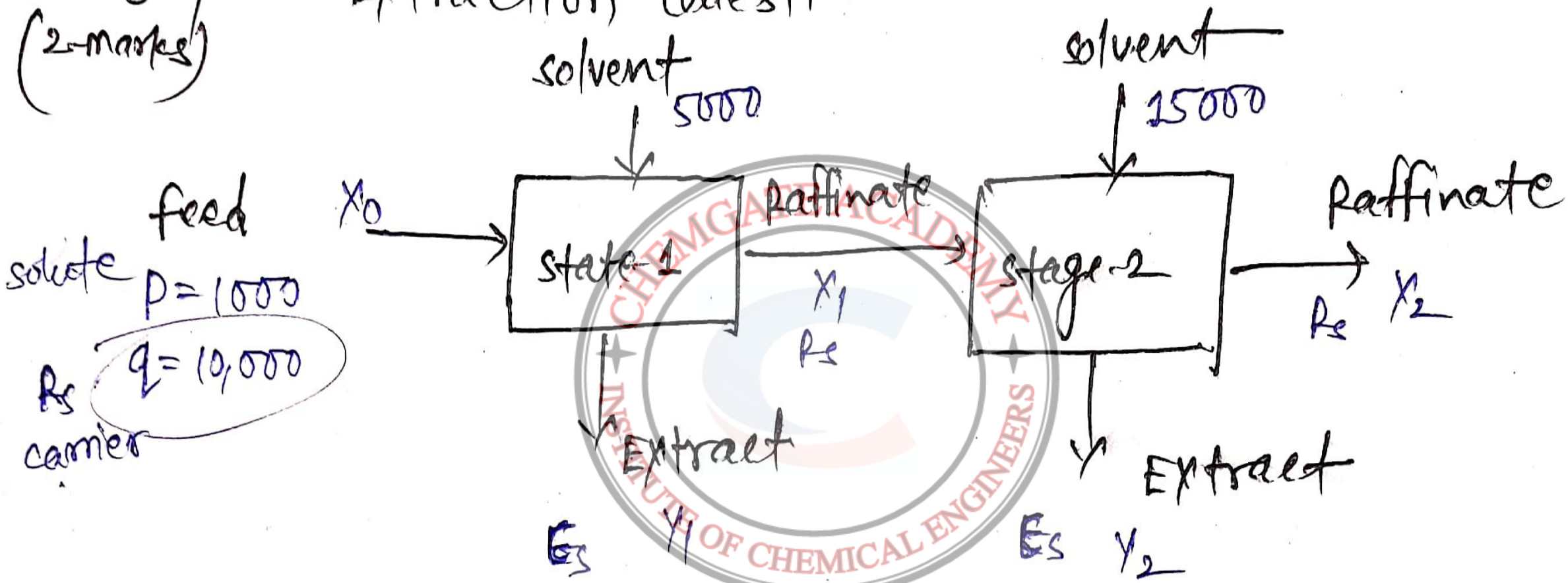
Sol→ $\left\{\frac{1}{K_x} = \frac{1}{k_x} + \frac{1}{m k_y}\right\} = \frac{1}{3} + \frac{1}{(0.1) \times 2} = \frac{16}{3}$

Resistance offered by liquid phase $= \frac{1/k_x}{1/K_x} = \frac{1/3}{16/3} = \frac{1}{16} = 0.0625$

Answer

Ques 3 (2 marks)

Extraction question



given $Y = 1.5X$ (on solute free basis)

Solution →

(I) method :- Let x amount left in the Raffinate leaving from stage 1

then in the Extract it will be (1000 − x)

for stage 1

$$\left(\frac{1000-x}{5000}\right) = 1.5\left(\frac{x}{10000}\right)$$

$$2000 - 2x = 1.5x$$

$$3.5x = 2000 \Rightarrow x = 571.428$$

similarly, for stage-1

$$\left(\frac{571.428-x}{15000}\right) = 1.5\left(\frac{x}{10,000}\right)$$

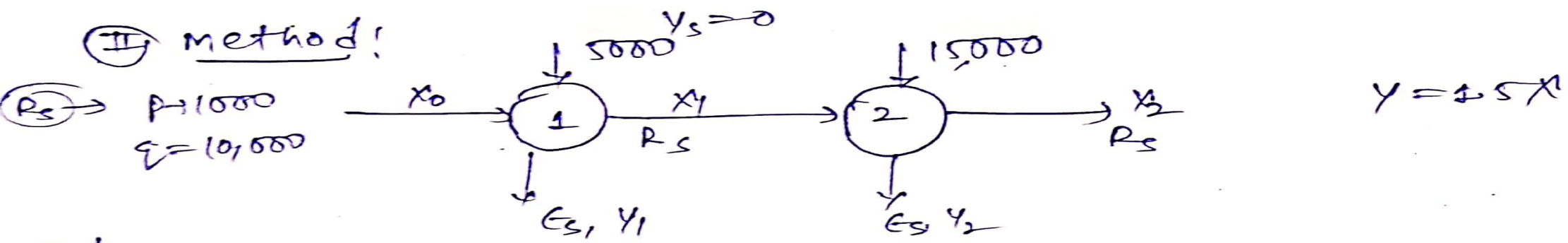
$$11428.57 - 2x = 4.5x$$

$$x = 175.824$$

Amount of solute in Raffinate of stage - II

$$\boxed{x \simeq 176} \text{ kg}$$

(II) method!



$Y = 1.5X$

sol→

simple material balance

$$R_s X_0 + E_s Y_s = P X_1 + E_s Y_1$$

$Y_s = 0$

$$X_0 = \frac{1000}{10,000} = 0.1$$

$$10,000(0.1) + 0 = 10,000 X_1 + 5000(1.5 X_1)$$

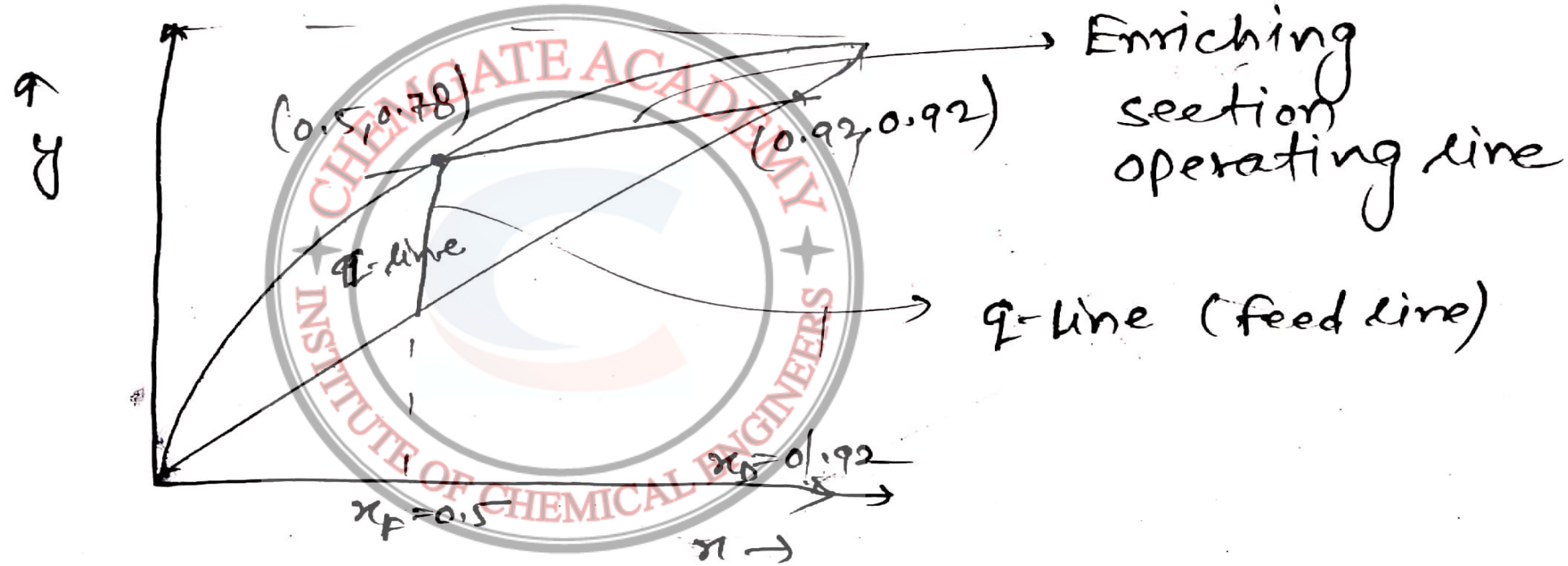
$$X_1 = 0.0571$$

$$10,000(0.0571) + 0 = 10,000 X_2 + 15000(1.5 X_2)$$

$$X_2 = 0.01756$$

$$R_c = (10,000) \times (0.01756) = 175.6 \simeq \underline{176} \text{ Answer}$$

Ques 4 (4 marks) > Calculate the minimum reflux ratio ?
composition of more volatile component in the feed $(x_F) = 0.5$



Sol → $\frac{R_{min}}{R_{min}+1} = \frac{0.92 - 0.78}{0.92 - 0.50} = \frac{0.14}{0.42} = \frac{1}{3}$

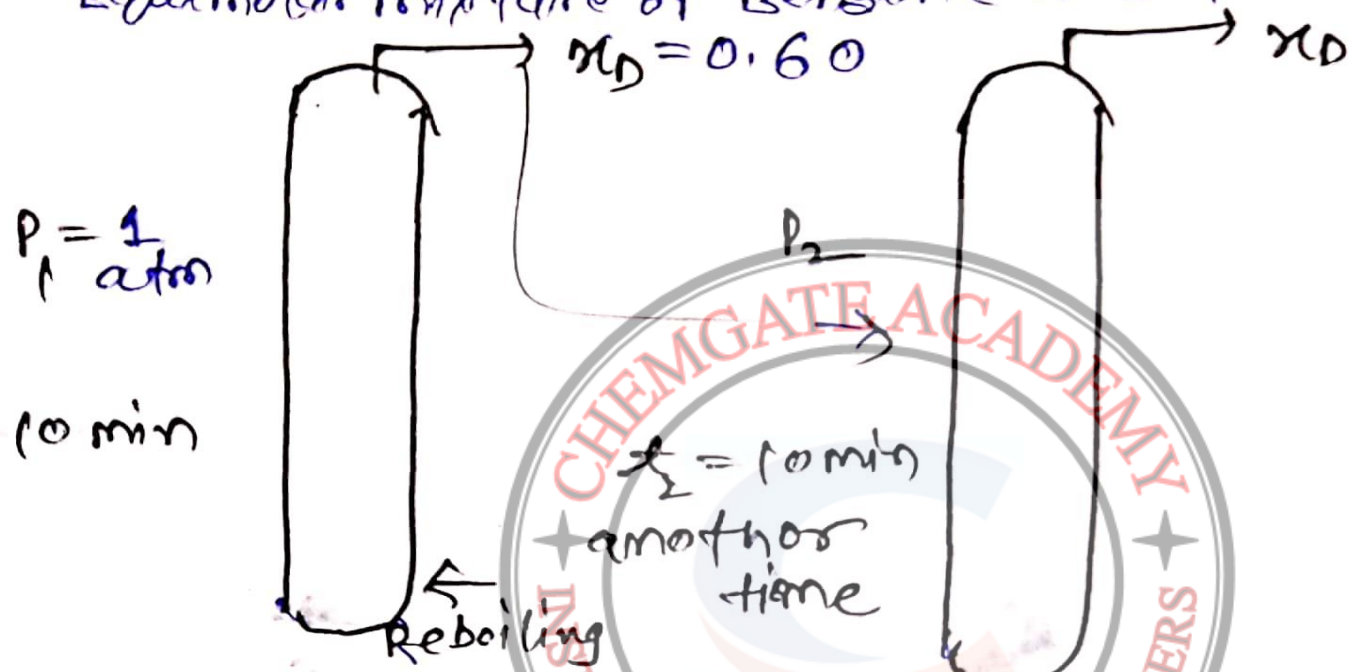
$\Rightarrow 3R_{min} = R_{min} + 1$

$2R_{min} = 1$

$\boxed{R_{min} = 0.5}$ Answer

Que -5 (2 marks) Batch Distillation question about distillate purity

Equimolar mixture of Benzene and toluene



(a) same mole fraction $x_D = 0.6$ because distillation is not depends on time.

(b)

(c)

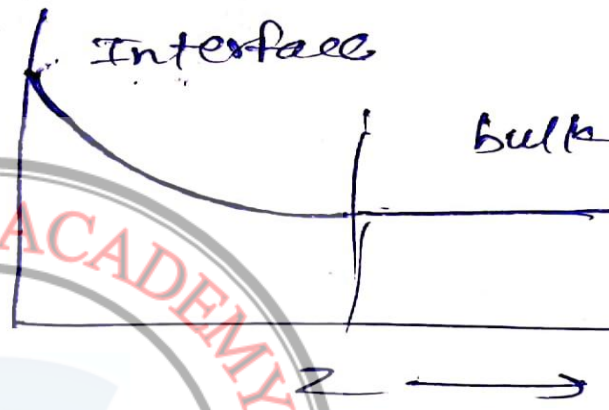
(d)

Ques 6) Choose the correct concentration profile in liquid side (1-mark) (MT/CRE)

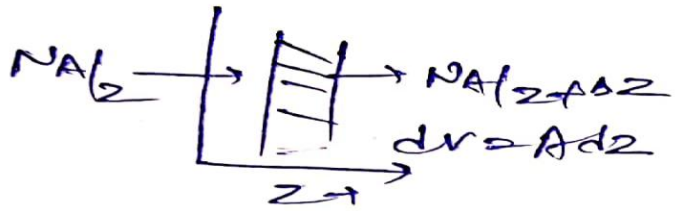
Absorption $G \Rightarrow L$

$n=1$ order

Option (A) correct



(a) (b) (c) (d)



(MT/CRE)

$$N_{A|z} - N_{A|z+dz} - (+r_A)(dz)\cdot A$$

$$A\left[N_{A|z} - N_{A|z+dz}\right] - (+kC_A)\,A\,dz = 0$$

$$-\frac{dN_A}{dz} - kC_A = 0$$

$$-\frac{d}{dz}\left[-D_{AB}\cdot\frac{dC_A}{dz}\right] = kC_A$$

$$D_{AB}\cdot\frac{d^2C_A}{dz^2} = kC_A$$

$$\frac{d^2C_A}{dz^2} = \frac{k}{D_{AB}}C_A$$

$$\frac{d^2C_A}{dz^2} - \frac{k}{D_{AB}}\cdot C_A = 0$$

$$\boxed{\frac{d^2C_A}{dz^2} - m^2C_A = 0}$$

Soln $C_A = C_1 e^{mz} + C_2 e^{-mz}$

(B.C) at $z=0$, $C_A = C_{A_i}$

at $z=\delta$ $dC_A/dz = 0$

Subject → CRE (CHEMICAL RXN ENGINERING)

Que 1) (1 marks) For a chemical rxn $2P \longrightarrow 4Q + S$, calculate fractional volume change when feed has 50% P and 50% Inert. for complete conversion of P.

Sol→ We know that for VVRS

$$V = V_0 (1 + \varepsilon_A y_A)$$

ε_A = fractional change in volume

$$\varepsilon_A = \delta_A y_{A0}$$

$$\delta_P = \frac{Q + S' - P'}{P'}$$

$$\delta_P = \frac{4 + 1 - 2}{2} = 1.5$$

$y_{A0} = 0.5$

$$\varepsilon_A = \delta_P \cdot y_{P0} = 1.5 \times 0.5$$

$\varepsilon_A = 0.75$ Answer

Ques 2 (2-marks) for packed Bed Reactor, $W = 4g$, $C_{A0} = 2\ mol/lit$, $v_0 = 1\ \frac{lit}{min}$, $C_A = 0.4\ mol/lit$.

Calculate K (rate constant) for 2nd order reaction,

sol→ for packed Bed Reactor (similar to plug flow reactor)

$$\boxed{\frac{W}{F_{A0}} = \int_0^{X_A} \frac{dX_A}{(-r_A)}}$$

CVRS system

$$C_A = C_{A0}(1 - X_A)$$

$$dC_A = -C_{A0}\, dX_A$$

$$\left(dX_A = dC_A / -C_{A0}\right)$$

$$\Rightarrow \frac{W}{F_{A0}} = \frac{-1}{C_{A0}} \int_{C_{A0}}^{C_A} \frac{dC_A}{(-r_A)}$$

$$\Rightarrow \frac{W C_{A0}}{F_{A0}} = -\int_{C_{A0}}^{C_A} \frac{dC_A}{k' C_A^2} = \frac{1}{k'}\left[\frac{1}{C_A} - \frac{1}{C_{A0}}\right]$$

$$\left[\frac{W C_{A0}}{F_{A0}} = \frac{1}{k'} \left(\frac{1}{C_A} - \frac{1}{C_{A0}} \right) \right]$$

Put $W = 4\,g$, $C_{A0} = 2\,mol/lit$, $C_A = 0.4\,mol/lit$, $v_0 = 1\,lit/min$

$$F_{A0} = C_{A0} v_0 = 2 \times 1 = 2\,mol/min$$

$$\Rightarrow \frac{4 \times 2}{2} = \frac{1}{k'} \left(\frac{1}{0.4} - \frac{1}{2} \right)$$

$$\Rightarrow k' = \frac{1}{4} \left(2 \right) = \frac{1}{2} = 0.5$$

$$\boxed{k' = 0.5\ l^2/g\,catalyst \cdot mol \cdot min}$$

Answer

Ques 3) (2 marks) Non-Isothermal system $A \longrightarrow$ product

given $k = 109 \exp\left(\frac{-6500}{T}\right)$, $T_0 = 50^\circ C$

$\Delta H = -42000$ J/mol, $F_{A0} = 1$ mol/sec

$C_p = 4.2$ J/mol.K, $\rho_0 = 1\ m^3/sec$

$\rho = 1000$ kg/m^3, $X_A = 90\% = 0.9$

Calculate volume of Reactor

sol→ Energy balance

$$T - T_0 = \frac{(-\Delta H_r) F_{A0} X_A}{\sum F_{i0} C_{pi}}$$

→ ρ_{mix}, C_{mix} for liquid kg/m^3, J/mol.K

$$T - 50 = \frac{42000 \times 1 \times 0.9}{(1000 \times 4.2)}$$

$T = 59^\circ C + 273.15 \Rightarrow T = 332.15$ K

k at 332 K = 3.14

$k = 3.14$ at 332 K

$$\frac{V}{F_{A0}} = \frac{X_A}{(-r_A)} = \frac{X_A}{k C_A} = \frac{X_A}{k C_{A0}(1 - X_A)}$$

$$\Rightarrow \frac{V}{F_{A0}} = \frac{X_A}{k C_{A0}(1 - X_A)}$$

$$\frac{V}{1} = \frac{0.9}{3.14 \times (1)(0.1)}$$

$$V = 2.866 \text{ lit}$$

Answer

given $F_{A0} = 1$ mol/sec

$v_0 = 1 \text{ m}^3/\text{sec}$

$F_{A0} = C_{A0} v_0$

$C_{A0} = 1/1 = 1$

Ques-> (44) (2 marks) Reversible reaction $P \rightleftharpoons Q$, (volume const).

CSTR, 1st order reaction both, $X = 0.75 X_{Ae}$ given

Calculate space time τ $C_{P_0} = 1$ mol/lit

Sol- $-r_P = C_P - 0.5 C_Q$ given

for equilibrium $(-r_P) = 0$

$\Rightarrow C_P = 0.5 C_Q$

$C_{P_0}(1 - X_{Ae}) = 0.5 C_{P_0} X_{Ae}$

$\boxed{X_{Ae} = 0.3}$

$C_Q = \frac{1}{1} C_{P_0} X_{Ae}$

$X_P = 0.75 X_{Ae} = \left(\frac{3}{4}\right)\left(\frac{2}{3}\right) = 0.5 \Rightarrow \boxed{X_P = 0.5}$

for CSTR (eqvs) $\boxed{\tau = \frac{C_{A_0} X_A}{-r_A}} = \frac{C_{P_0} X_P}{-r_P} = \frac{1 \times (0.5)}{C_P - 0.5 C_Q}$

$C_P = C_{P_0}(1 - X_P)$ | $C_Q = C_{Q_0}^{0} + \frac{1}{1} C_{P_0} X_P$

$C_P = 1 \cdot (1 - 0.5)$ | $C_Q = 1 \times 0.5$

$C_P = 0.5$ | $C_Q = 0.5$

$\Rightarrow \tau = \frac{1 \times 0.5}{0.5 - 0.5 \times 0.5}$

$\tau = \frac{0.5}{0.5 - 0.25} = \frac{0.50}{0.25}$

$\boxed{\tau = 2}$ Answer

Que→ 5) (2 marks)

$P \xrightarrow{k_1} Q$

$P \xrightarrow[k_2]{} R$

given selectivity $S_{Q/P} = 0.5$

CSTR & $\tau = 1$

conversion = $X = 0.6$

$C_{A0} = 1$

Calculate k_1

Sol→ $S_{Q/P} = 0.5 = \frac{k_1 C_P}{k_2 C_P} = \frac{k_1}{k_2} \Rightarrow$ $\boxed{k_2 = 2k_1}$

∵ 1st order rxn (CSTR) $\Rightarrow$ $\boxed{\frac{X_A}{1-X_A} = k C_{A0} \tau}$

$k = k_1 + k_2$

$\Rightarrow (k_1 + k_2) \times 1 \times \tau = \frac{X}{1-X_A}$

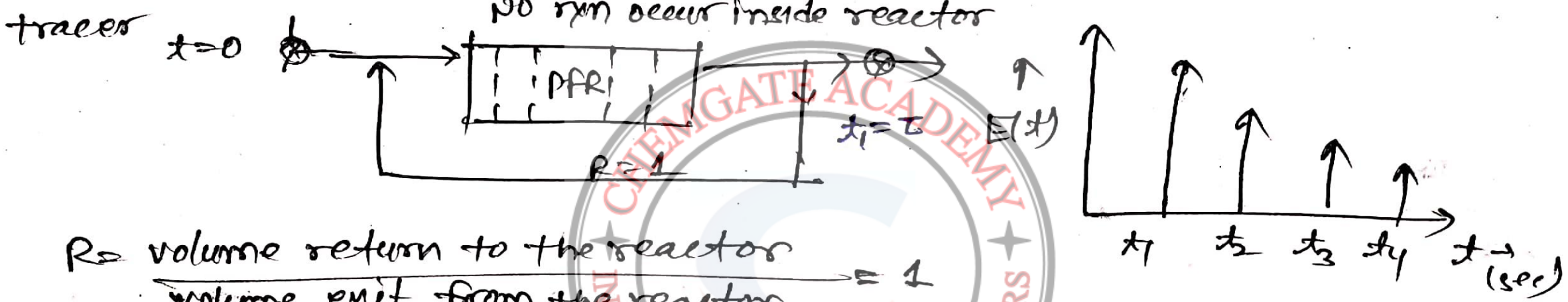
$(k_1 + k_2) \times 1 \times \tau = \frac{0.6}{1-0.6} = 1.5$

$(k_1 + 2k_1) = 1.5 \Rightarrow 3k_1 = 1.5$

$\boxed{k_1 = 0.5}$ Answer

Que-6) (1 marks) Question on PFR

choose correct arrangement of τ at t_1, t_2, t_3, t_4



R = volume return to the reactor / volume exit from the reactor = 1

correct Answer: τ, 2τ, 3τ, 4τ

space time $t_1 = \tau$, $t_2 = 2\tau$, $t_3 = 3\tau$, $t_4 = 4\tau$

* PFR behave as a ideal reactor

(i) $x_1 = \frac{\tau}{3}$, $x_2 = \frac{2\tau}{3}$, $x_3 = \tau$, $x_4 = \frac{4\tau}{3}$

(ii) $x_1 = \frac{\tau}{2}$, $x_2 = \frac{\tau}{4}$, $x_3 = \frac{\tau}{8}$, $x_4 = \frac{\tau}{16}$

(iii) $x_1 = \tau$, $x_2 = 2\tau$, $x_3 = 3\tau$, $x_4 = 4\tau$

(iv) $x_1 = \tau/2$, $x_2 = \tau$, $x_3 = 3\tau/2$, $x_4 = 2\tau$

Que-7) (1-Marks) Heterogenous Reaction

ϕ = Thiele Modulus

$$\phi = \sqrt{\frac{K}{D_A}} \cdot L$$

Choose correct option for $(\text{Thiele modulus})^2$

Ans→ $$\phi = \frac{\text{surface rxn rate}}{\text{Rate of diffusion}}$$

since rate is inversely proportional to time,

so, $$\left\{ \phi^2 = \frac{\text{time scale of diffusion}}{\text{time scale of reaction}} \right\}$$ → Answer

(Ques: 8) (2 marks)

given $(-r_A) = \underbrace{k_2 \left(\frac{k_1}{2k_3}\right)^{1/2}}_{k_{overall}} C_A^{3/2}$

Calculate $E_{obs} = ?$

Arrhenius law

$(k \propto e^{-E_a/RT})$

$k = k_0 e^{-E_a/RT}$

given that $E_1 = 320$ kJ/mol

$E_2 = 40$ kJ/mol

$E_3 = 0$ kJ/mol

Sol: $(-r_A) = k_{obs} C_A^{3/2}$

$k_{obs} = k_2 \left(\frac{k_1}{2k_3}\right)^{1/2}$

$k_{obs} \propto e^{-E_2/RT} \left[\frac{e^{-E_1/RT}}{e^{-E_3/RT}}\right]^{1/2}$

$\propto e^{-\frac{E_2}{RT} + \frac{E_3 - E_1}{2RT}}$

$\propto e^{\frac{1}{RT}\left[E_2 + \frac{(E_1 - E_3)}{2}\right]}$

$k_{obs} \propto e^{-E_{obs}/RT}$

$E_{obs} = E_2 + \frac{(E_1 - E_3)}{2} = 40 + \left(\frac{320 - 0}{2}\right)$

$= 40 + 160$

$\boxed{E_{obs} = 200}$ Ans.

Subject Aptitude

Ques 1 (2 marks) Sum of first $2n$ natural numbers − first n odd numbers

$2N \Rightarrow 1, 2, 3, 4 \cdots 2n$ $\qquad$ $1, 3, 5, 7 \cdots n$

Sol →

$$\frac{2n(2n+1)}{2} - n^2$$

$$\Rightarrow 2n^2 + n - n^2 = \underline{n^2 + n}$$

Solution $\quad 2N \Rightarrow 1, 2, 3, 4 \cdots 2N \qquad 1, 3, 5, 7 \cdots n$

$$S_n = \frac{n}{2}[2a + (n-1)d]$$

$$S_{n_1} = \frac{2n}{2}[2\times 1 + (2n-1)1]$$

$$S_{n_1} = n(2n+1)$$

$$S_{n_1} = 2n^2 + n$$

$$S_{n_2} = \frac{n}{2}[2\times 1 + (n+1)\times 2]$$

$$= \frac{n}{2}[2 + 2n - 2]$$

$$S_{n_2} = n^2$$

$$\Delta S = 2n^2 + n - n^2 \Rightarrow \underline{n^2 + n} \quad \text{Answer}$$

Que-2 }
(1-marks)

cover : uncover :: Associate : _____

The opposite of Associate is Dissociate.

Que→3 }
(1-marks)

Mary Kom Question

correct answer→ to, at

Que→ 3)
(1-marks)

Mary Kom Question

correct answer → to , at

Que→ 4) (2-marks) In sitting arrangement question, the answer is

→ option (A) p is not opposite to R.

Que→ 5) (1-marks) Despite having bed performance the chances for K.L. Rahul to get selected are _____ .

a. slim b. obvious c. uncertain d. bright

Answer: option (d) Bright

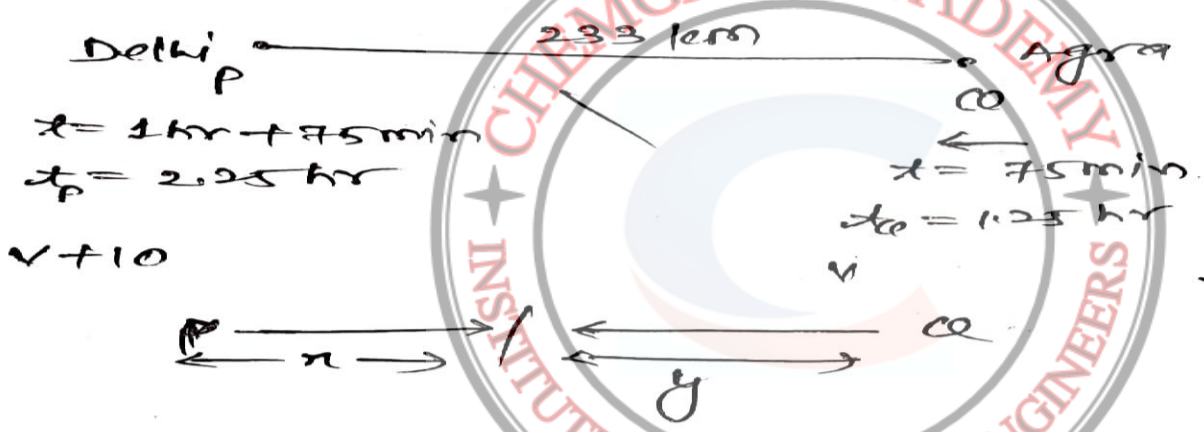
Que→6 (2 marks) Question on kharif and Rabi crops

option-(c) hope

Que 7) (2 marks) Distance travelled by Q before meeting with P

(total distance 233 km)

speed of P = (speed of Q) + 10 km/hr



total distance
$x + y = 233$

$$\left[\text{speed} = \frac{\text{distance}}{\text{time}}\right]$$

for P

$$v + 10 = \frac{x}{2.25}$$

for Q

$$v = \frac{y}{1.25}$$

$$\Rightarrow \frac{y}{1.25} + 10 = \frac{x}{2.25}$$

use $x + y = 233$

$x = 233 - y$

$$\frac{y}{1.25} + 10 = \frac{x}{2.25}$$

We $x + y = 233$

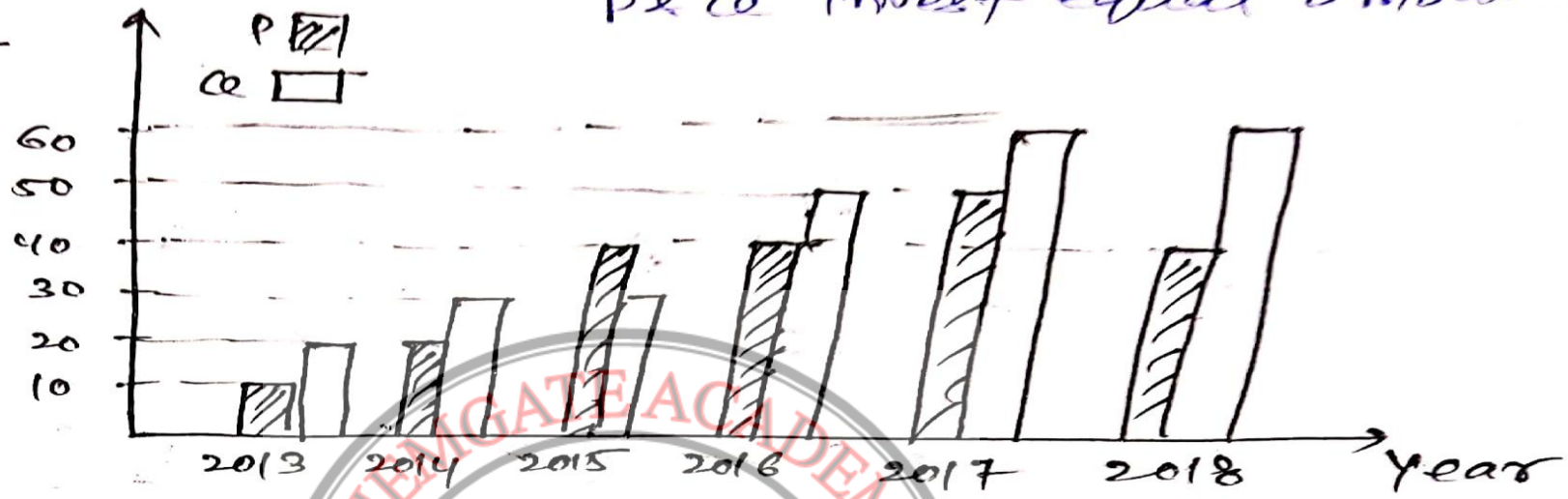
$x = 233 - y$

$$\frac{y}{1.25} + 10 = \frac{233 - y}{2.25}$$

$y = 75.178$ km $\simeq 75.2$ km Answer

Ques 8 (2 marks)

P & Q invest equal amount



Profit e/o

$\Rightarrow P/Q = ?$

b/w 2013-2018

Sol → (Return)

Revenue = profit + Investment

profit = Revenue − Investment

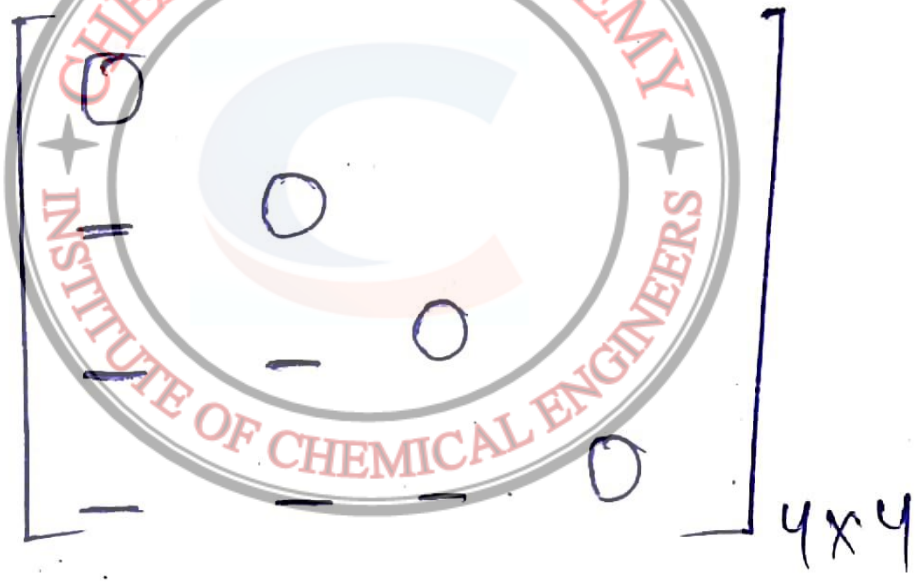
Let Investment = 100

$P_{revenue} = (100+10) + (100+20) + (100+40) + (100+40) + (100+50) + (100+40)$

$Q_{revenue} = (100+20) + (100+30) + (100+30) + (100+50) + (100+60) + (100+60)$

$= \frac{800}{850} = \frac{16}{17}$ Answer

Ques 9, (1-Marks) A 4×4 matrix is given as a. $m_{ij} = -m_{ji}$ (skey symmetric). The total no. of elements required to define the matrix is



Answer → 6

Que 10 (2-marks) General Aptitude Question RBI → Reserve Bank of India.

* Repo rate → The rate at which commercial banks borrow money be selling their securities to central bank (RBI).

↳ to keep inflation under control

* Reverse Repo rate → Is the short term borrowing rate at which RBI borrows money from bank.

Conclusion:- Repo rate ↑ means, commercial banks borrow less

Reverse repo rate ↑ ; It will allow commercial banks to transfer more funds to RBI

Option: A, D

Subject - MATHEMATICS

Que 1) (1-marks) Match the column

Function column - I	Expression column
(a). $\tanh x$	I. $\frac{e^x + e^{-x}}{e^x - e^{-x}}$
(b) $\coth x$	II. $\frac{2}{e^x + e^{-x}}$
(c) $\operatorname{sech} x$	III $\frac{2}{e^x - e^{-x}}$
(d) $\operatorname{cosech} x$	IV. $\frac{e^x - e^{-x}}{e^x + e^{-x}}$

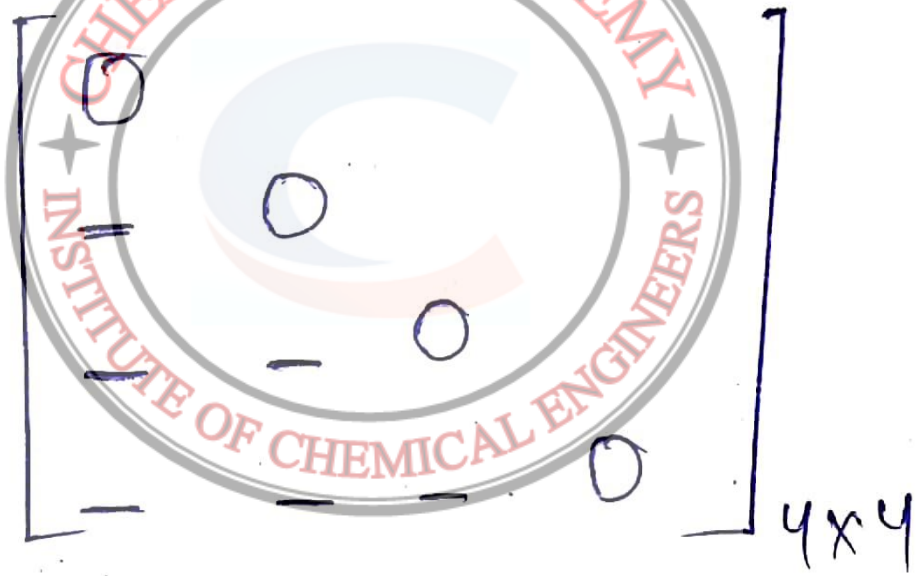
Answer → (a) $\tanh x \rightarrow$ (IV) $\frac{e^x - e^{-x}}{e^x + e^{-x}}$ $\left(\tanh(x) = \frac{\sinh x}{\cosh x}\right)$

(b) $\coth x \rightarrow$ (I) $\frac{e^x + e^{-x}}{e^x - e^{-x}}$

(c) $\operatorname{sech} x \rightarrow$ (II) $\frac{2}{e^x + e^{-x}}$

(d) $\operatorname{cosech} x \rightarrow$ (III) $\frac{2}{e^x - e^{-x}}$

Ques→ 2 (1-Marks) A 4×4 matrix is given as a. $m_{ij} = -m_{ji}$ (skey symmetric). The total no. of elements required to define the matrix is



Answer→ 6

Que→ 3) Sum of eigen values for given matrix
(1-marks)

$$\begin{bmatrix} 2 & - & - \\ - & 5 & - \\ - & - & 7 \end{bmatrix}$$

Sol→ Sum of eigen values = sum of Diagonal elements
= Trace of a matrix

= 2+5+7 = 14 Answer

Que-4 (1-marks) for which method, two initial approximation is required to find out the next root..

(a) Newton-Raphson method

(b) Secant method

(c) Regula-falsi (false-position) method

(d) Fixed Iteration method

Answer option (c)

Que→5 (2 marks) In a beg, there are 5 green balls and 10 blue balls. 6 balls chosen randomly. find out the probability that in 6 balls, 4 balls are green and 2 balls are blue. (probability)

Sol- $$P = \frac{{}^{5}C_4 \times {}^{10}C_2}{{}^{15}C_6} = \frac{45}{1001}$$ Answer

Que→ 6 (2 marks) The differential equation is given as

$$\frac{dy}{dx} = y - 20 \quad , \quad \text{at} \quad x=0,\ y=40$$

Calculate y at $x = 2$

Sol→ (1) variable separable method

$$\int \frac{dy}{y-20} = \int dx$$

$$\ln(y-20) = x + C$$

$$y - 20 = e^{x+C}$$

Put $x=0,\ y=40 \Rightarrow \ln(40-20) = 0 + C$

$$C = \ln 20$$

$$\Rightarrow \ln(y-20) = x + \ln 20$$

Put $x = 2,\ y = ?$

$$\ln(y-20) = 2 + \ln 20$$

$$y - 20 = e^{2+\ln 20}$$

$$y = 20 + e^2 \cdot e^{\ln 20} = 20 + 20e^2$$

$$y = 20(1 + e^2)$$

$$\boxed{y = 168}$$ Answer

$$\ln(y-20) = 2 + \ln 20$$

$$y - 20 = e^{2+\ln 20}$$

$$y = 20 + e^2 \cdot e^{\ln 20} = 20 + 20e^2$$

$$y = 20(1+e^2)$$

$$\boxed{y = 168}$$ Answer

(II) Linear first order differential equation:-

$$\frac{dy}{dx} = y - 20 \Rightarrow \frac{dy}{dx} - y = -20$$ compare with $\frac{dy}{dx} + Py = Q$

$$I.F = e^{\int P\,dx}$$

$$I.F = e^{\int -1\,dx} = e^{-x}$$

$$y \times I.F = \int Q \cdot (I.F)\,dx + C$$

$$y \cdot (I.F) = \int Q\,(I.F)\,dx + C \qquad \text{Put } I.F = e^{-x}$$

$$y\,e^{-x} = \int (-20)\,x\,e^{-x}\,dx + C$$

$$y\,e^{-x} = 20e^{-x} + C \quad \checkmark$$

Put $x = 0$ & $y = 40$

$$40 \times e^{0} = 20e^{0} + C \Rightarrow C = 20$$

$$y \times e^{-x} = 20e^{-x} + 20$$

$$y = 20 + 20e^{x}$$

at $x = 2$, $y = ?$ $\Rightarrow y = 20 + 20e^{2}$

$$y = 20(1 + e^{2})$$

$$y = 167.78$$

$$\boxed{y = 168}$$ Answer

Que. 7 Calculate curl $\vec{V}$.

(1-marks)

$$\text{curl } \vec{V} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ & & \end{vmatrix}$$

option (A) $(5x^2 \quad)\hat{i} + (\quad)\hat{j} + (\quad)\hat{k}$

correct

Que-8. Maximum value of given mathematic function for a given range?

Answer:- 16

Que→ 9 simpson 1/3rd rule

(2 marks)

X	1	3	5	15	25
F(X)	6	8	10	12	5

Sol- $$\int_{x_0}^{x_n} y\,dx = \frac{h}{3}\left[(y_0+y_n) + 4(y_1+y_3+\cdots) + 2(y_2+y_4+\cdots)\right]$$

Sol:- $$\int_{x_0}^{x_n} y\,dx = \frac{h}{3}\left[(y_0+y_n)+4(y_1+y_3+\cdots)+2(y_2+y_4+\cdots)\right]$$

$$\int_{x_0}^{x_n} y\,dx = \int_{1}^{5} y\,dx + \int_{5}^{25} y\,dx$$

$h=2$, $h=10$

$$= \left\{\frac{2}{3}[(6+10)+4(8)]\right\} + \left\{\frac{10}{3}[(10+5)+4(12)]\right\}$$

$$= \left\{\frac{2}{3}[16+32]\right\} + \left\{\frac{10}{3}[15+48]\right\}$$

$$= \frac{2}{3}\times 48^{16} + \frac{10}{3}\times 63^{21}$$

$$= 32 + 210$$

$$= 242 \quad \text{Answer}$$

Ques * Fluid Mechanics Question on fully developed ~~laminar~~ flow (1 Marks)

flow given $Re = 8000$ at $x = 2$

at $x = 1$, flow should be ? (for flate plate)

a) Laminar flow
b) turbulent flow
c) ——
d) ——

Ans → option a) Laminar flow

for flate plate, - flow should be laminar below

$Re = 5 \times 10^5$

so, in this case flow is laminar.

→ No need to solve.

↔ If you want to solve :- at $x = 2$, $Re = \frac{\rho V x}{\mu} = 8000$

$\frac{\rho V}{\mu} \times (2) = 8000 \Rightarrow \frac{\rho V}{\mu} = 4000$

at $x = 1$, $Re = \frac{\rho V x}{\mu} = 4000 \times (1)$

My Courses on Unacademy

(1) Plant Design and Economics

(2) Heat Transfer – 2 part

(3) Chemical Reaction Engineering- 5 part

(4) Mechanical Operation

(5) Process Calculation

(6) Mass Transfer

(7) Fluid Mechanics – 5 part

(8) Chemical Technology

(9) Process Dynamics and Control

(10) Thermodynamics

* How to avoid mistakes in GATE

* Paper Solution of CH GATE - 2018 & 2019

BEST OF LUCK FOR YOUR Result..