Q3:- $2A + B \longrightarrow 3C$

6 vanes [A] [B] unreacted.

[A] at $t=0$ = 10 Ib
[B] at $t=0$ = 20 Ib
[C] at $t=20$ = 6 Ib   [C] at $t=0$ = 0

$$\frac{dc}{dt} = (10 - \tfrac{2}{3}c)(20 - \tfrac{1}{3}c)k$$

$$= (200 - \tfrac{10}{3}c - \tfrac{40}{3}c + \tfrac{2}{9}c^2)k$$

$$\frac{dc}{dt} = (200 - \tfrac{50}{3}c + \tfrac{2}{9}c^2)k$$

$$\frac{dc}{dt} = 200k - \tfrac{50}{3}kc + \tfrac{2}{9}kc^2$$

$$\frac{dc}{dt} + \tfrac{50}{3}kc = 200k + \tfrac{2}{9}kc^2$$

$$u = c^{1-2} = c^{-1}$$
$$u' = -c^{-2} c'$$

$$u' = -c^{-2}\left[200k - \tfrac{50}{3}kc + \tfrac{2}{9}kc^2\right]$$

خولتها linear

* nonlinear لمعادلة

$$u' = -\frac{200k}{c^2} + \frac{50}{3}\frac{k}{c} + \frac{2}{9}k$$

$$u' + 200k\,u' - \tfrac{50}{3}ku = \tfrac{2}{9}k$$

$$(200k + 1)u' - \tfrac{50}{3}ku = \tfrac{2}{9}k$$

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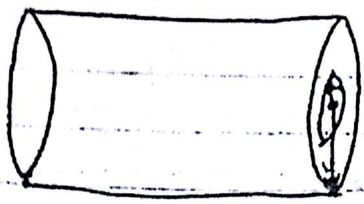
$l = 20m$ $\quad$ $K = 0.15$

Q41



$r_1 = 10cm$
$r_2 = 20\ cm$
$T_1 = 200°C$
$T_2 = 50°C$

$*$ -ve sign

$q = KA \dfrac{dT}{dr}$ $\qquad$ $T\ (at\ r = 10cm) = 200°C$

$\qquad\qquad\qquad\qquad$ $T\ (at\ r = 20cm) = 50°C$

$q = 0.15\ (2\pi r l)\ \dfrac{dT}{dr}$

$= 2\pi(0.15)(20)\ r \dfrac{dT}{dr}$

$\dfrac{\frac{dr}{r}}{2\pi(0.15)(20)} = \int dT$

$T = \dfrac{\ln|r|}{2\pi(0.15)(20)} \cdot q = c$

$T = \dfrac{\ln|r|}{18.8} \cdot q + c$ $\qquad$ a) $\boxed{T = \dfrac{\ln|r|}{18.8}(-4068) + 698}$

$200 = \dfrac{\ln|10|}{18.8} \cdot q + C$ $\qquad$ b) If $r = 15\ cm$
$\qquad\qquad$ $T = 112\ cm$

$\left(50 = \dfrac{\ln|20|}{18.8} \cdot q + C\right) * -1$ $\qquad$ c) $q = -4068\ cal/sec$

$150 = -0.0368q$

$q = -4068$ $\qquad$ $c = 698$

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Qs :-

$$\frac{dT}{dt} = -k(T - Ta)$$

$$\frac{dT}{dt} = -k(T - 18)$$

$$\frac{dT}{dt} + kt = 18k$$

$$T = e^{-\int k.dt}\left[\int e^{\int k dt} . 18k .dt + c\right]$$

$$= e^{-kt}\left[\int e^{kt} . 18k .dt + c\right]$$

$$= e^{-kt}\left[18e^{kt} + c\right].$$

$18 + ce^{-kt} = T$ at $t = 0 \rightsquigarrow T = 10$

$t = 1 \rightsquigarrow T = 14$

$\rightarrow 10 = 18 + ce^{0}$

$\boxed{c = -8}$

$\rightarrow T = 18 - 8e^{-kt}$

$\overset{+14}{-18} = 18 - 8e^{-k(1)}$
$\quad -18$

$\frac{-4}{-8} = \frac{-\cancel{8}e^{-k}}{\cancel{-8}} \rightsquigarrow \frac{1}{2} = e^{-k} \rightsquigarrow \frac{1}{2} = \frac{1}{e^{k}}$

$e^{k} = 2 \rightsquigarrow k = 0.69314$

$$T = 18 - 8e^{-0.693t}$$

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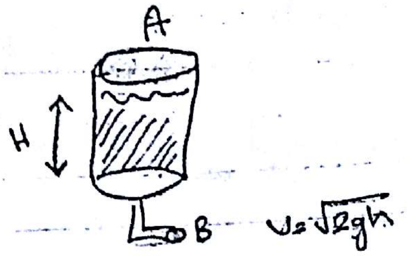
Q6 :-



$$\frac{dh}{dt} = k\sqrt{2gh} \cdot \frac{A}{B} \qquad h(\text{at } t=0) = H$$

$$h' = k\frac{A}{B}\sqrt{2gh}$$

$$h' = k\frac{A}{B}(2g)^{1/2}\, h^{1/2}$$

let $u = h^{1-1/2} = h^{+1/2}$

$u' = +\frac{1}{2} h^{-1/2}\, h'$

$$u' = k\frac{A}{B}(2g)^{1/2} \cdot h^{1/2}\left[+\frac{1}{2}h^{-1/2}\right]$$

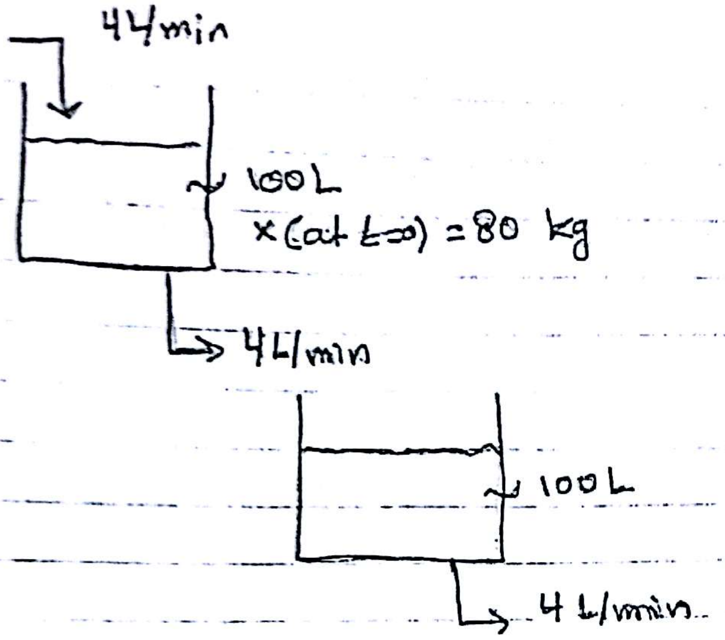
$$u' = \underbrace{\frac{kA}{B}\,\frac{\sqrt{2g}}{2}}_{r(t)} \qquad \therefore \text{ linear} \qquad p(t) = 0$$

$$u = e^{-\int 0 \cdot dt}\left[\int e^{\int 0 \cdot dt} \cdot \frac{kA}{B}\frac{\sqrt{2}}{2}g \cdot dt + c\right]$$

$$= \left[\int \frac{kA}{B} \cdot \frac{\sqrt{2}}{2}\sqrt{g}\; dt + c\right]$$

$$u = \frac{\sqrt{2}}{2} \cdot \sqrt{g} \cdot \frac{kA}{B} \cdot t + c$$

Q7:-



$\frac{80\,kg}{100\,L} = 0.8\,kg/L$

$x^*(\text{at } t=0) = 0\,kg$

For Vessel $\boxed{1}$:-

$$\frac{dx}{dt} = In - Out$$

$$= 0 - \frac{x}{100L} \cdot \frac{4L}{min}$$

$$= \frac{-4x}{100}$$

$$dx = \frac{-4x}{100}\,dt$$

$$\int \frac{dx}{-0.04x} = \int dt$$

$$-25 \ln|x| = t$$

$$\ln|x| = \frac{-t}{25}$$

$$\boxed{x = e^{-t/25} + C_1}$$

$$\boxed{C = 80}$$

For Vessel $\boxed{2}$:-

$$\frac{dx^*}{dt} = In - Out$$

$$= \frac{e^{-t/25}}{100L} \cdot \frac{4L}{min} - \frac{4x^*}{100}$$

$$\frac{dx}{dt} = 0.04e^{-t/25} - 0.04x^*$$

$$x' + \underbrace{0.04x}_{p(t)} = \underbrace{0.04e^{-t/25}}_{r(t)}$$

$$x^* = e^{-0.04t}\left[\int e^{0.04t} \cdot 0.04\, e^{-t/25}\, dt + c\right]$$

$$= e^{-0.04t}\left[0.04t + c\right]$$

$$= 0.04e^{-0.04t} \cdot t + e^{-0.04t} c_2$$

$$\boxed{0 = C_2}$$

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Q8 $\frac{dm}{dt} = km$

$\int \frac{dm}{m} = \int k\,dt$

$\ln|m| = kt + c$

$m = e^{kt} c_1$ where $c_1 = e^c$

$m(\text{at } t=0) = m_0 = 100$

$m(\text{at } t=1\,\text{hr}) = \frac{1}{2} m_0$

a) $\boxed{m_0 = c_1}$

$\frac{1}{2} m_0 = e^{k} c_1$

$\frac{1}{2} \cancel{m_0} = e^{k} \cancel{m_0}$

$\boxed{k = \ln|1/2|}$

b) $0.1 \cancel{m_0} = e^{\ln|1/2|\, t} (\cancel{m_0})$

$0.1 = \frac{1}{2} t$

$t = 0.2$ hour

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