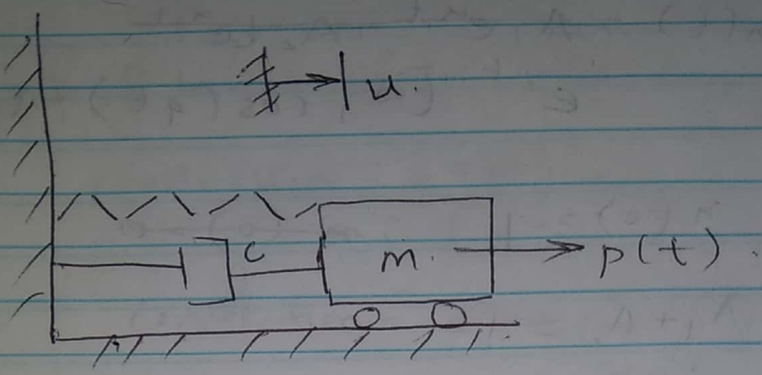
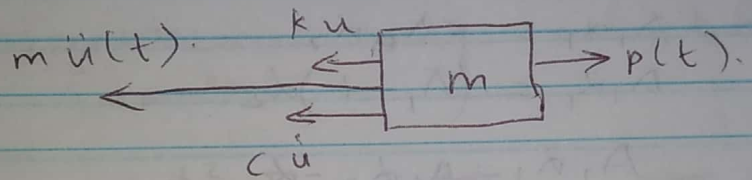
Q. 1]



FBD:



$$0 + c\dot{u} = ku + m\ddot{u}(t)$$

$$m\ddot{u} - c\dot{u} + ku = 0$$

$$u = Ae^{\alpha t}$$

$$m\alpha^2 - c\alpha + k = 0$$

$$\alpha = \frac{c \pm \sqrt{c^2 - 4mk}}{2m}$$

1] $c^2 - 4mk > 0$, α_1 & α_2.

$$x_n(t) = A_1 e^{\alpha_1 t} + A_2 e^{\alpha_2 t}$$

2] $c^2 - 4mk = 0$

$$x_n(t) = A_1 e^{\alpha_1 t} + A_2 t e^{\alpha_1 t}$$

3] $c^2 - 4mk < 0$

$$x_n(t) = \cancel{A_1 e^{\alpha_1 t} + A_2 t e^{\alpha_1 t}}$$

$$e^{pt}\left[A_1 \cos(qt) + A_2 \sin(qt)\right]$$

5] i) $x(0) = 1$, $\cancel{\dot{x}(0) = 0}$

$$A_1 + A_2 = 1$$

ii) $\dot{x}(0) = 0$

$$A_1 \alpha_1 + A_2 \alpha_2 = 0$$

$$A_1 \alpha_1 = -A_2 \alpha_2$$

$$A_1 \alpha_1 = (A_1 - 1)\alpha_2$$

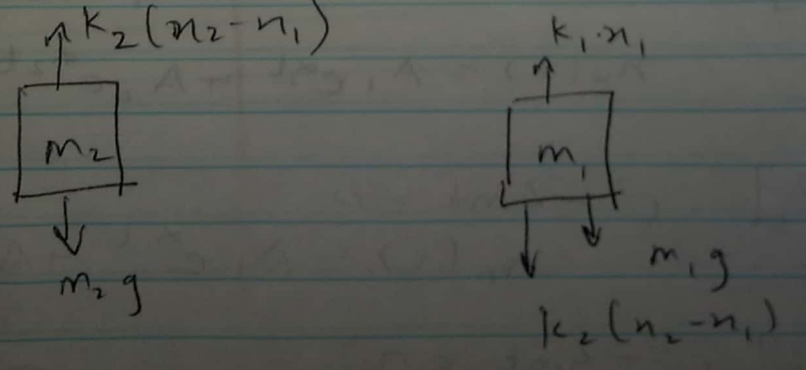
$$A_1 \alpha_1 = A_4 \alpha_2 - \alpha_2$$

$$A_1 \left(\frac{\sqrt{c^2 - 4mk}}{m}\right) = \frac{\sqrt{c^2 - 4mk} - c}{2m}$$

$$\therefore A_1 = \frac{1}{2}\left(1 - \frac{c}{\sqrt{c^2 - 4mk}}\right)$$

$$A_2 = \frac{1}{2}\left(1 + \frac{c}{\sqrt{c^2 - 4mk}}\right)$$

2]



FBD:

[Q.18]

Eq^n of heat transfer.

$$\text{conduction} = \frac{d^2T}{dx^2}.$$

$$\text{Convection} = h(T_\infty - T).$$

$$\text{Radiation} = \sigma(T_\infty^4 - T^4)$$

Discretization: using centered finite difference formula:

$$\frac{d^2 \cdot T}{dx^2} = \frac{(T_{i+1} - 2T_i + T_{i-1})}{(\Delta x^2)}$$

$$T_\infty^4 - T^4 = (T_\infty^2 - T^2)(T_\infty^2 + T^2)$$

$$= (T_\infty - T)(T_\infty + T)(T_\infty^2 + T^2)$$

$$=$$

Q.19]

$$f(x) = au' - vu'' - 1 \quad , \quad 0 < x < 1$$

$$u(0) = 0$$

$$u(1) = 0.$$

$$Pe = \frac{a\Delta x}{2V}$$

Discretized differential equation using central difference approximation.

$$f(x) = a\left(\frac{u_{i+1} - u_{i-1}}{2\Delta x}\right) - v\left(\frac{u_{i+1} - 2u_i + u_{i+1}}{\Delta x^2}\right)$$

Discretization using backword difference rule for first order & central difference approximatio for second order.

$$f(x) = a\left(\frac{u_i - u_{i-1}}{\Delta x}\right) + v\left(\frac{u_{i+1} - 2u_i + u_{i+1}}{\Delta x^2}\right)$$

$$\Delta x = \frac{1}{n+1}$$