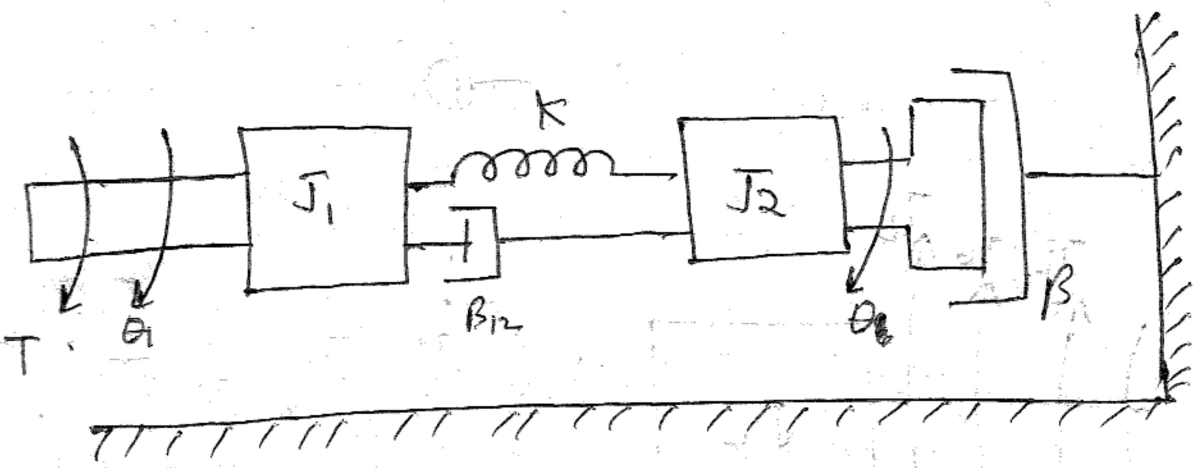
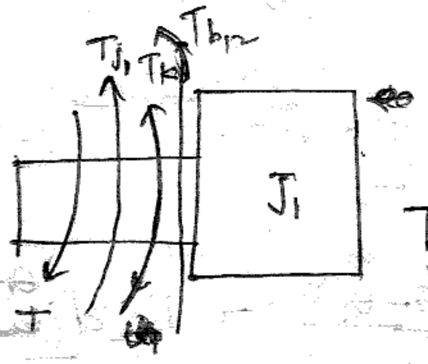


Sol^n:



$$T = T_{J_1} + T_k + T_{b_{12}}$$

$$T = J_1 \frac{d^2\theta_1}{dt^2} + k(\theta_1 - \theta) + B_{12} \frac{d(\theta_1-\theta)}{dt} \quad —(1)$$

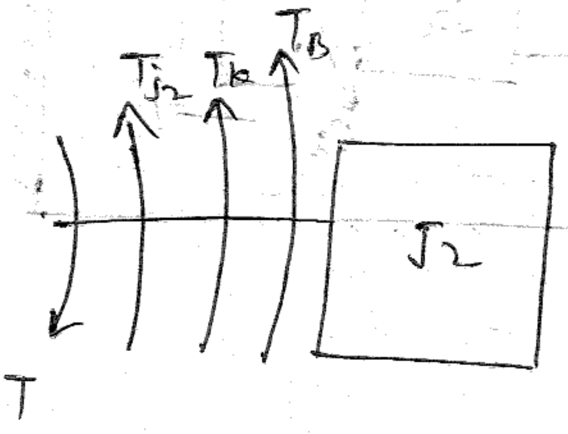
Taking laplace transform,
we get

$$T(s) = J_1 s^2 \theta_1(s) + k\theta_1(s) - k\theta(s) + B_{12}[s\theta_1(s) - s\theta(s)]$$

$$T(s) = J_1 s^2 \theta_1(s) + k\theta_1(s) - k\theta(s) + B_{12} s\theta_1(s) - B_{12} s\theta(s)$$

$$= \theta_1(s)[J_1 s^2 + k + B_{12} s] - \theta(s)[k + B_{12} s]$$

$$T(s) = \theta_1(s)\left[J_1 s^2 + K + B_{12} s\right] - \theta(s)\left[K + B_{12}\right. \quad \text{—(1)}$$



$$T = T_{J_2} + T_K + T_B + T_{B_{12}}$$

$$= J_2 \frac{d^2\theta}{dt^2} + K(\theta - \theta_1) + B\frac{d(\theta-\theta_1)}{dt} + B_{12}\frac{d(\theta_1-\theta)}{dt}$$

Taking laplace transform,

$$0 = J_2 s^2 \theta(s) + K\theta(s) - K\theta_1(s) + Bs\theta(s) - Bs\theta_1(s) + B_{12} s \theta_1(s) - B_{12} s \theta(s)$$

$$0 = \theta(s)\left[J_2 s^2 + K + Bs - B_{12} s\right] - \theta_1(s)\left[K + Bs + B_{12} s\right] \quad \text{—(2)}$$

$$\Rightarrow \theta(s)\left[J_2 s^2 + K + Bs - B_{12}s\right] = \theta_1(s)\left[K + Bs + B_{12}s\right]$$

$$\Rightarrow \cancel{\theta(s)\left[J_2 s^2 + K + Bs - B_{12}s\right] =}$$

$$\theta_1(s) = \frac{\theta(s)\left[J_2 s^2 + K + Bs - B_{12}s\right]}{K + Bs + B_{12}s} \quad — ③$$

Put ③ in ①.

$$T(s) = \frac{\theta(s)\left[J_2 s^2 + K + Bs - B_{12}s\right]}{K + Bs + B_{12}s}\left[J_1 s^2 + K + B_{12}s\right] - \theta(s)\left(K + B_{12}s\right)$$

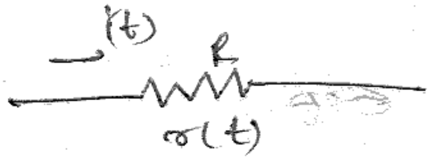
$$= \theta(s)\left[\frac{\left(J_2 s^2 + K + Bs - B_{12}s\right)\left(J_1 s^2 + K + B_{12}s\right)}{K + Bs + B_{12}s} - \left(K + B_{12}s\right)\right]$$

$$\boxed{\frac{\theta(s)}{T(s)} = \frac{K + Bs + B_{12}s}{\left(J_2 s^2 + K + Bs - B_{12}s\right)\left(J_1 s^2 + K + B_{12}s\right) - \left(K + B_{12}s\right)\left(K + Bs + B_{12}s\right)}}$$

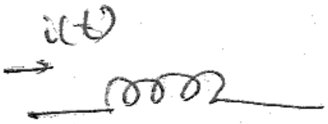
Ans

~~29/6/11~~

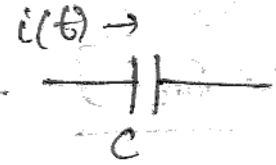
30/6/11

① 

$v(t) = i(t)R \Rightarrow \boxed{i(t) = \frac{v(t)}{R}}$

② 

$v(t) = L\frac{di}{dt} \Rightarrow \boxed{i(t) = \frac{1}{L}\int v\,dt}$

③ 

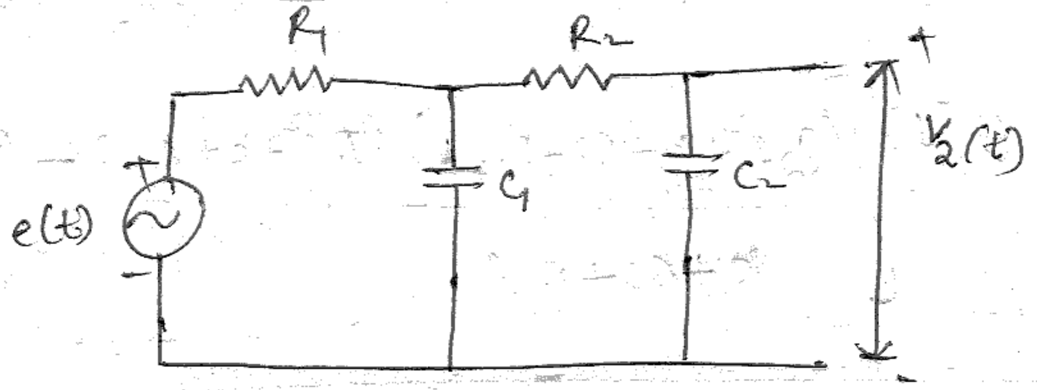
$v(t) = \frac{1}{C}\int \frac{di(t)}{\cancel{dt}}\,dt$

$\Rightarrow$

$$\boxed{i(t) = C\frac{dv(t)}{dt}}$$

④ Find the transfer function :-

Q

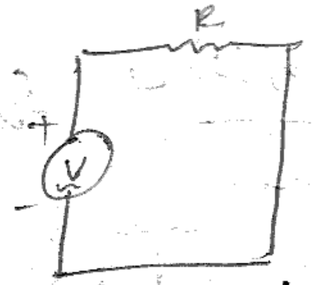


Solⁿ

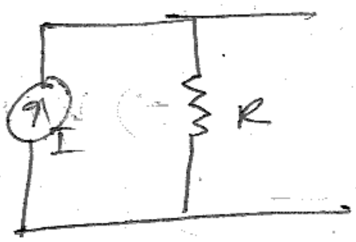
The transfer functⁿ is $\frac{V_2(t)}{e(t)}$.

$= \frac{v(t)}{R}$

$= \frac{1}{L}\int v\,dt$

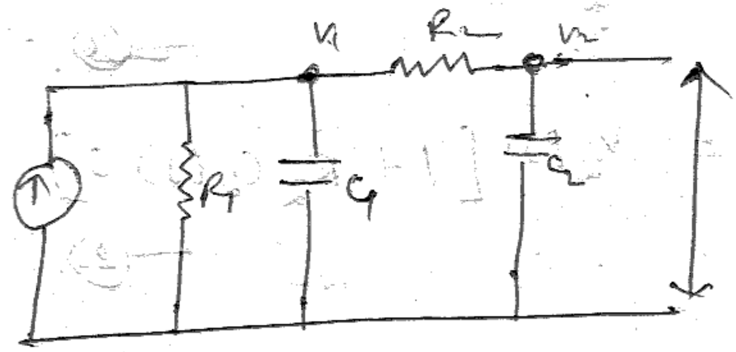


↓ equi



$I = \frac{V}{R}$

$I = \frac{v}{R}$



at node 1

$$\frac{V_1}{R_1} + C_1\frac{dv_1}{dt} + \frac{V_1 - V_2}{R_2} = \frac{e}{R_1}$$

Apply laplace transform,

$$\Rightarrow \frac{V_1(s)}{R_1} + C_1(s)\frac{dV_1(s)}{dt} + \frac{V_1(s) - V_2(s)}{R_2} = \frac{e(s)}{R_1}$$

$$\Rightarrow \frac{V_1(s)}{R_1} + C_1(s)\cdot sV_1(s) + \frac{V_1(s) - V_2(s)}{R_2} = \frac{e(s)}{R_1} \quad \text{—}(1)$$

at node 2,

$$\frac{V_2 - V_1}{R_2} + C_2\frac{dv_2}{dt} = 0$$

Applying laplace transform,

$$\frac{V_2(s) - V_1(s)}{R_2} + C_2(s)\cdot sV_2(s) = 0 \quad \text{—}(2)$$

$$\frac{V_2(s) - V_1(s)}{R_2} + C_2(s)\, s V_2(s) = 0$$

$$\Rightarrow \frac{V_1(s)}{R_2} = \frac{V_2(s)}{R_2} + C_2(s)\, s V_2(s)$$

$$\Rightarrow V_1(s) = V_2(s) + R_2 C_2(s) \cdot s V_2(s) \quad \text{--- (3)}$$

$$V_1(s) = V_2(s)\left[1 + R_2 C_2(s)\, s\right] \quad \text{--- (2)}$$

from (1),

$$\frac{V_1(s)}{R_1} + C_1(s)\, s V_1(s) + \frac{V_1(s)}{R_2} - \frac{V_2(s)}{R_2} = \frac{e(s)}{R_1}$$

$$\Rightarrow \cancel{V_1(s) \left[\frac{1}{R_1} + C_1(s) \cdot s + \frac{1}{R_2}\right.}$$

$$(1 + sR_2C_2)\, V_2(s)\left[\frac{1}{R_1} + sC_1 + \frac{1}{R_2}\right] - \frac{V_2(s)}{R_2} = \frac{E(s)}{R_1}$$

$$\Rightarrow \frac{(1+sR_2C_2)(R_2 + R_1 + sC_1R_1R_2 - R_1)}{R_1R_2} V_2(s) = \frac{E(s)}{R_1}$$

$$\Rightarrow \frac{V_2(s)}{E(s)} = \frac{R_2}{(1+sR_2C_2)\,(R_2 + R_1 + sC_1R_1R_2 \ldots)}$$