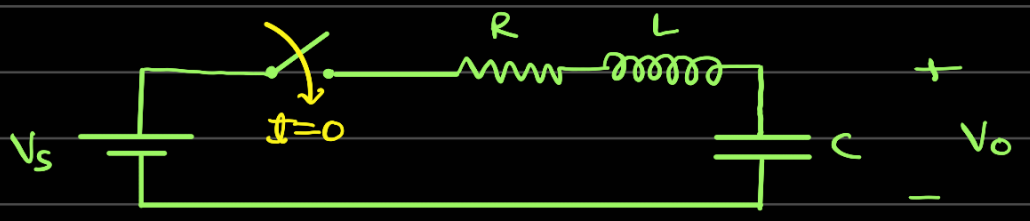
Day-13



Overdamped ($\alpha > \omega_0$) :

$$V_o = V_s + A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

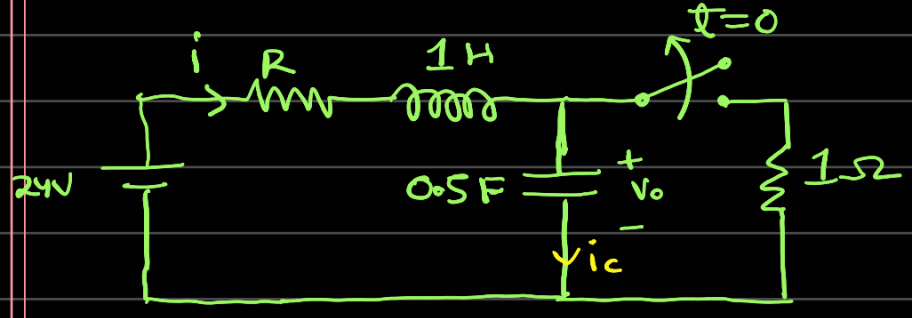
Critically damped ($\alpha = \omega_0$):

$$V_o = V_s + (A_1 + A_2 t) e^{-\alpha t}$$

Underdamped ($\alpha < \omega_0$):

$$V_o = V_s + (A_1 \cos \omega_d t + A_2 \sin \omega_d t) e^{-\alpha t}$$

1.)



Find $V_o(t)$, $i(t)$ for $R = 5\Omega, 4\Omega, 1\Omega$

Ans) $\underline{R = 5\Omega}$

At $t = 0^-$, $V_o = \frac{24}{5+1} \times 1 = 4\,V$

$$\omega_0 = \frac{1}{\sqrt{1 \times 0.5}}\, s^{-1} = 1.4142\, s^{-1}$$

$$\alpha = \frac{5}{2 \times 1}\, s^{-1} = 2.5\, s^{-1}$$

$\alpha > \omega_0$, so $s_1 = -2.5 + \sqrt{6.25 - 2}$ s^{-1}

$= \sqrt{4.25} - 2.5$ s^{-1}

$= -0.438\ s^{-1}$

$s_2 = -\sqrt{4.25} - 2.5$ s^{-1}

$= -4.562\ s^{-1}$

$V_o = 24 + A_1 e^{-0.438t} + A_2 e^{-4.562t}$

$V_o(0) = 4\ V$

so $-20 = A_1 + A_2$

$i_c(0) = 0$

$\Rightarrow C \left.\frac{dV_o}{dt}\right|_{t=0} = 0$

$\Rightarrow -0.438 A_1 - 4.562 A_2 = 0$

$\Rightarrow A_2 = -0.096 A_1$

so $-20 = 0.904 A_1 \Rightarrow A_1 = -22.124\ V$

$A_2 = 2.124\ V$

so $V_o(t) = 24 - 22.124 e^{-0.438t} + 2.124 e^{-4.562t}$ V

$i(t) = \frac{V_o(t)}{1} + C\frac{dV_o(t)}{dt}$

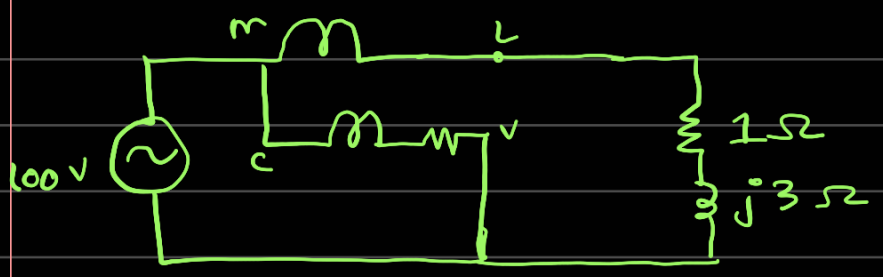
$= 24 - 22.124 e^{-0.438t} + 2.124 e^{-4.562t}$

$+ 0.5 [22.124 \times 0.438 e^{-0.438t} - 2.124 \times 4.562 e^{-4.562t}]$

$$= 24 - 17.279\, e^{-0.438t} - 2.721\, e^{-4.562t} \text{ A}$$

(do same for $R = 4\,\Omega$, $1\,\Omega$)

2.)



Find wattmeter reading.

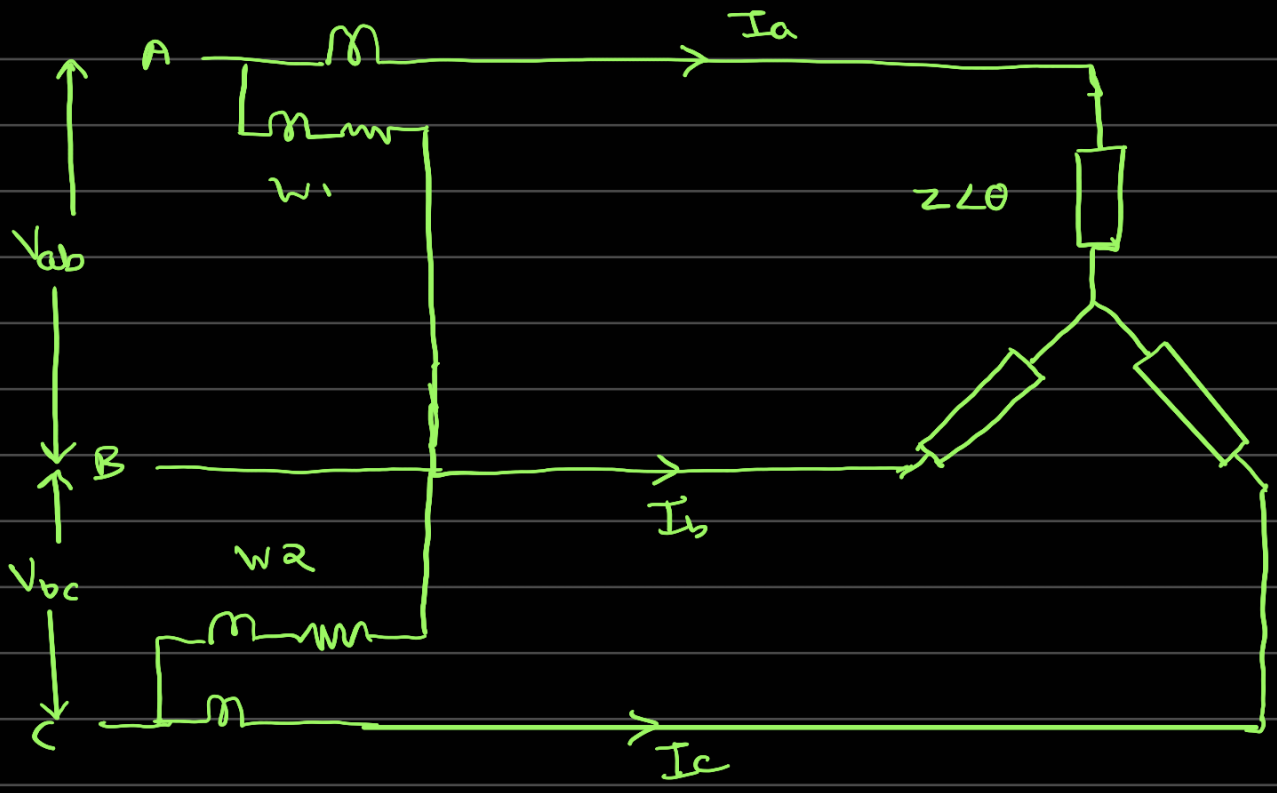
Ans.) $P = VI\cos\theta$

$$= 100 \times \frac{100}{\sqrt{10}} \times \frac{1}{\sqrt{10}}$$

$$= 1000 \text{ W}$$

$$= 1 \text{ kW}$$

3.)



Find reading of W_1, W_2.

Ans.) $P_1 = V_{ab} I_a \cos(\theta + 30^\circ)$, $P_2 = V_{cb} I_c \cos(\theta - 30^\circ)$

so $P_1 + P_2 = \sqrt{3} V_L I_L \cos\theta$

$$P_2 - P_1 = VI \times 2\sin(30°)\sin\theta$$
$$= V_L I_L \sin\theta$$

$$\tan\theta = \frac{(W_2 - W_1)\sqrt{3}}{(W_2 + W_1)}$$