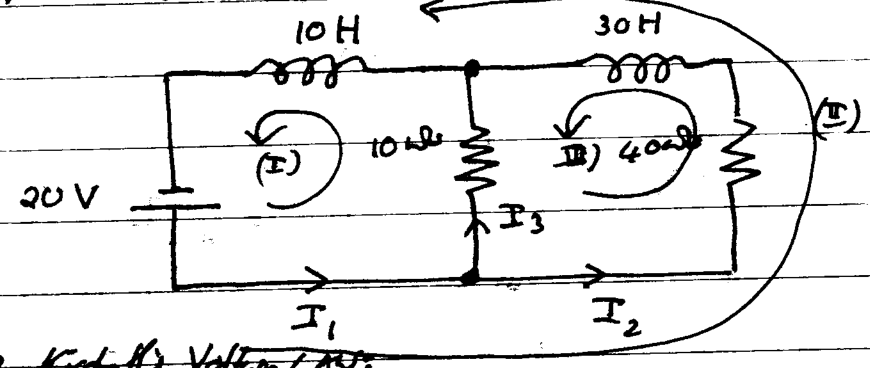
#10 Assume all initial currents are zero.



$E_R = RI$

$E_L = L\frac{dI}{dt}$

$E_c = \frac{1}{c}\frac{dq}{dt}$

By Kirchhoff's Voltage LAW:

Loop(I) : $10 I_3 + 10\frac{dI_1}{dt} = 20$ (a)

Loop(II) : $40 I_2 + 30\frac{dI_2}{dt} + 10\frac{dI_1}{dt} = 20$ (b)

Loop(III) : $40 I_2 + 30\frac{dI_2}{dt} - 10 I_3 = 0$ (c)

Note: Equation (c) follows from (b)-(a)

By Kirchhoff's current law:

$$I_1 = I_2 + I_3 \quad (d)$$

From (a) & (d)

$$10 I_3 + 10(\dot{I}_2 + \dot{I}_3) = 20$$

or $I_3 + \dot{I}_2 + \dot{I}_3 = 2$

From (c), $I_3 = 4I_2 + 3\dot{I}_2 \Rightarrow \dot{I}_2(0) = 0$ since $I_3(0) = I_2(0) = 0$.

$$\dot{I}_3 = 4\dot{I}_2 + 3\ddot{I}_2$$

$$I_3 + \dot{I}_3 = 4I_2 + 7\dot{I}_2 + 3\ddot{I}_2$$

$$I_3 + \dot{I}_3 + \dot{I}_2 = 4I_2 + 8\dot{I}_2 + 3\ddot{I}_2$$

We solve

$$3\ddot{I}_2 + 8\dot{I}_2 + 4I_2 = 2, \quad I_2(0) = \dot{I}_2(0) = 0.$$