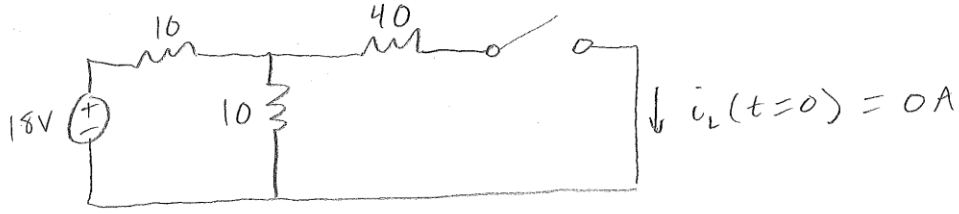
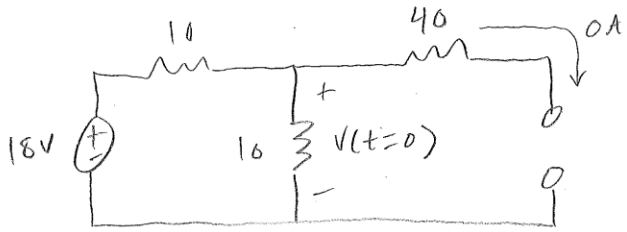
1.

Snapshot just before switch closes:



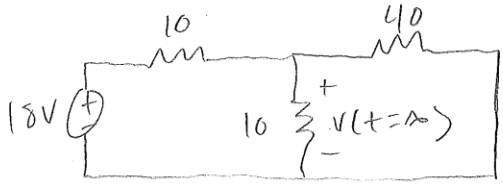
Just after switch closes:



current thru inductor can't change instantaneously so it's going to act like an open circuit so that no current can flow thru it

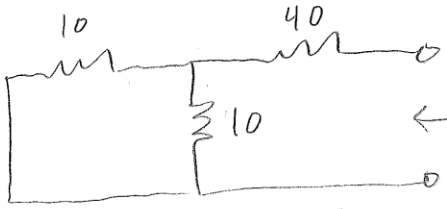
$$V(t=0) = 18V \cdot \frac{10}{10+10} = 9V$$

At $t=\infty$:



$$V(t=\infty) = 18V \cdot \frac{(10//40)}{(10//40)+10} = 8V$$

To find τ, look at the circuit for $t \geq 0$ from the perspective of the inductor. Zero-out any independent sources



$\leftarrow R_{eq} = (10 // 10) + 40 = 45\,\Omega$

$$\tau = \frac{L}{R_{eq}} = \frac{2\,H}{45\,\Omega}$$

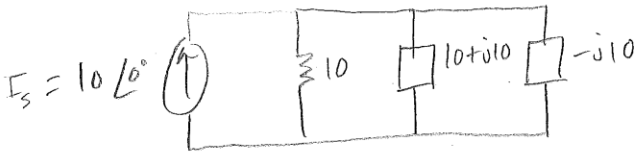
$$v(t) = v(t=\infty) + \left[v(t=0) - v(t=\infty) \right] e^{-t/\tau} \quad V$$

$$v(t) = 8 + (9-8)\, e^{-1.8t} \quad V$$

$$\boxed{v(t) = 8 + e^{-1.8t} \quad V}$$

2. $X_C = \frac{1}{\omega C} = 10\ \Omega$

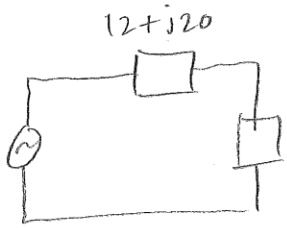
$X_L = \omega L = 10\ \Omega$



$z_{eq} = 10 // (10+j10) // (-j10) = 6 - j2$

$V_{10\Omega} = I_s z_{eq} = 60 - j20 \simeq 63.24 \cos(1000t - 18.43°)\ A$

3.

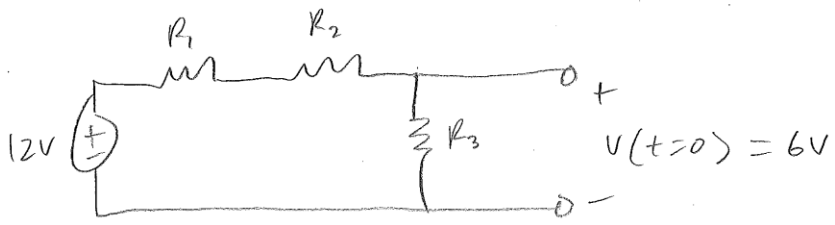


$$Z_{eq} = 12+j20+4-j8 = 16+j12$$

$$I_s = \frac{V_s}{Z_{eq}} = 2.5\cos(\omega t + 83.13°)\ \text{Arms}$$

$$S = \frac{|V_s|^2}{Z_{eq}^*} = \frac{50^2}{16-j12} = 100+j75$$

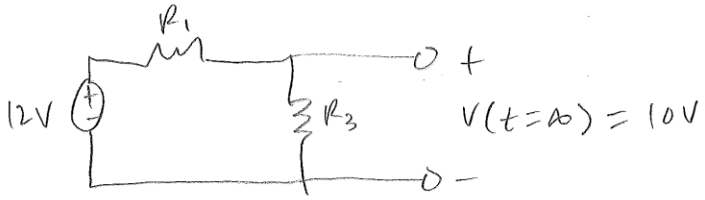
4. Want initial capacitor voltage to be 6V



Constraint 1

$$6V = 12V \cdot \frac{R_3}{R_1+R_2+R_3}$$

Final capacitor voltage needs to be 10V

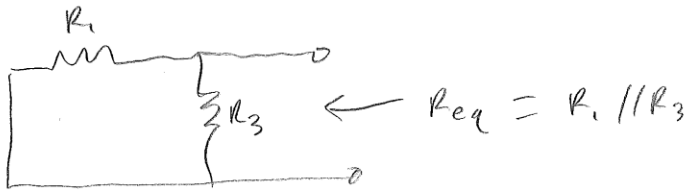


$$10V = 12V \cdot \frac{R_3}{R_1+R_3}$$

constraint 2

$5\tau = 10\,ms$; $\tau = 2\,ms = R_{eq} C$

Find R_{eq} :



$$2\,ms = (R_1 // R_3)\, C$$ | constraint 3

From constraint 2, $R_3 = 5R_1$

Plugging this into constraint 1, $R_2 = 4R_1$

Say $R_1 = 1K\Omega$, then $R_2 = 4K\Omega$, $R_3 = 5K\Omega$

From constraint 3, $C = \dfrac{2\times10^{-3}}{(R_1 // R_3)} = \dfrac{2\times10^{-3}}{3/2500} = 2.4\,\mu F$