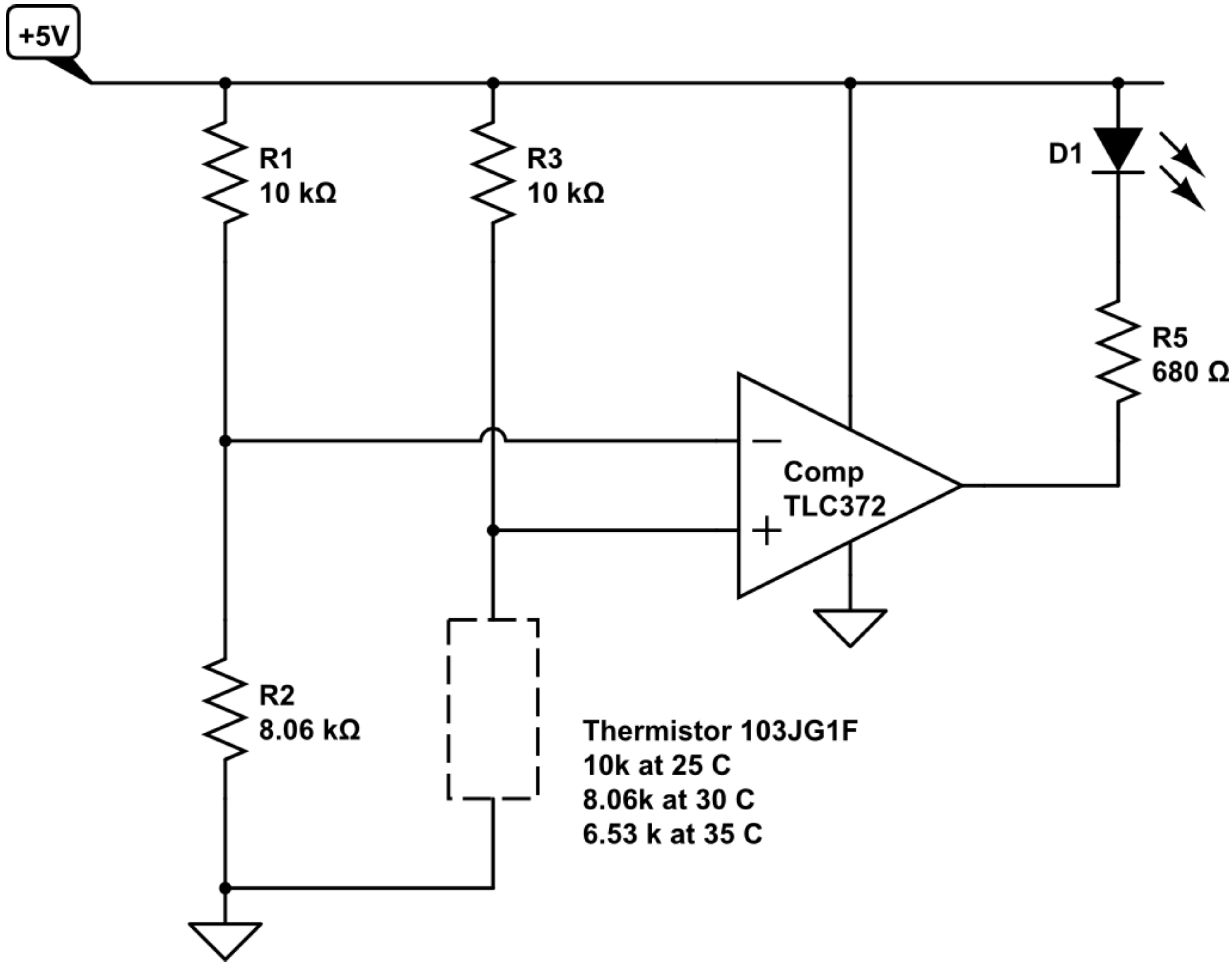
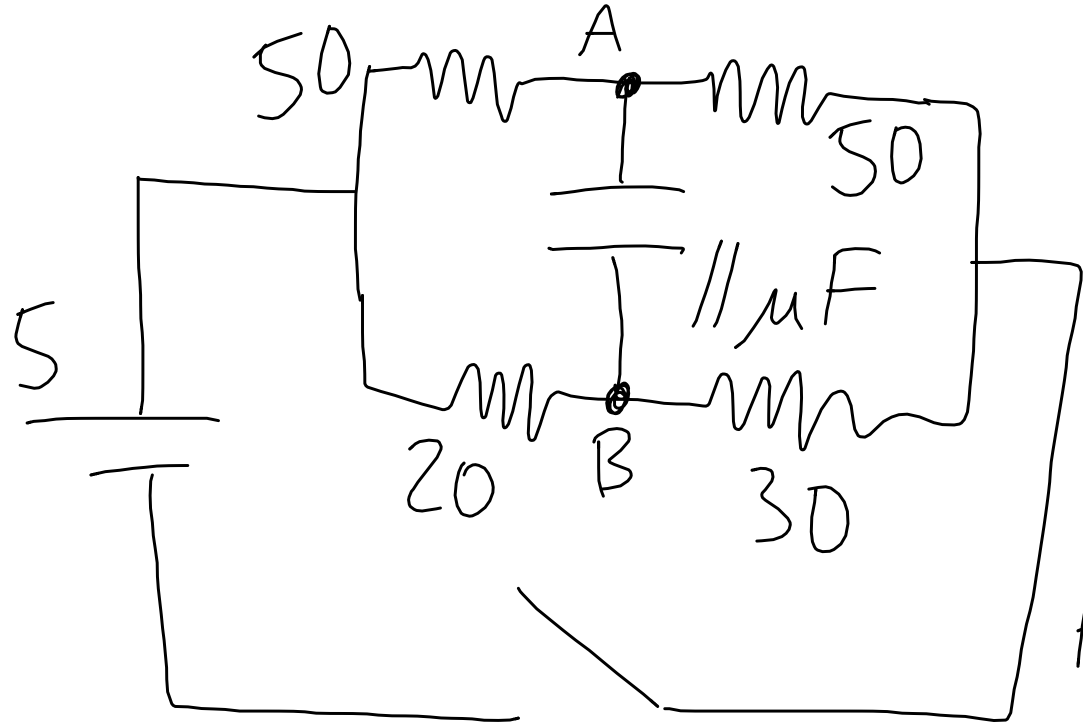

+5V
R1
10 kΩ
R3
10 kΩ
D1
R5
680 Ω
Comp
TLC372
R2
8.06 kΩ
Thermistor 103JG1F
10k at 25 C
8.06k at 30 C
6.53 k at 35 C

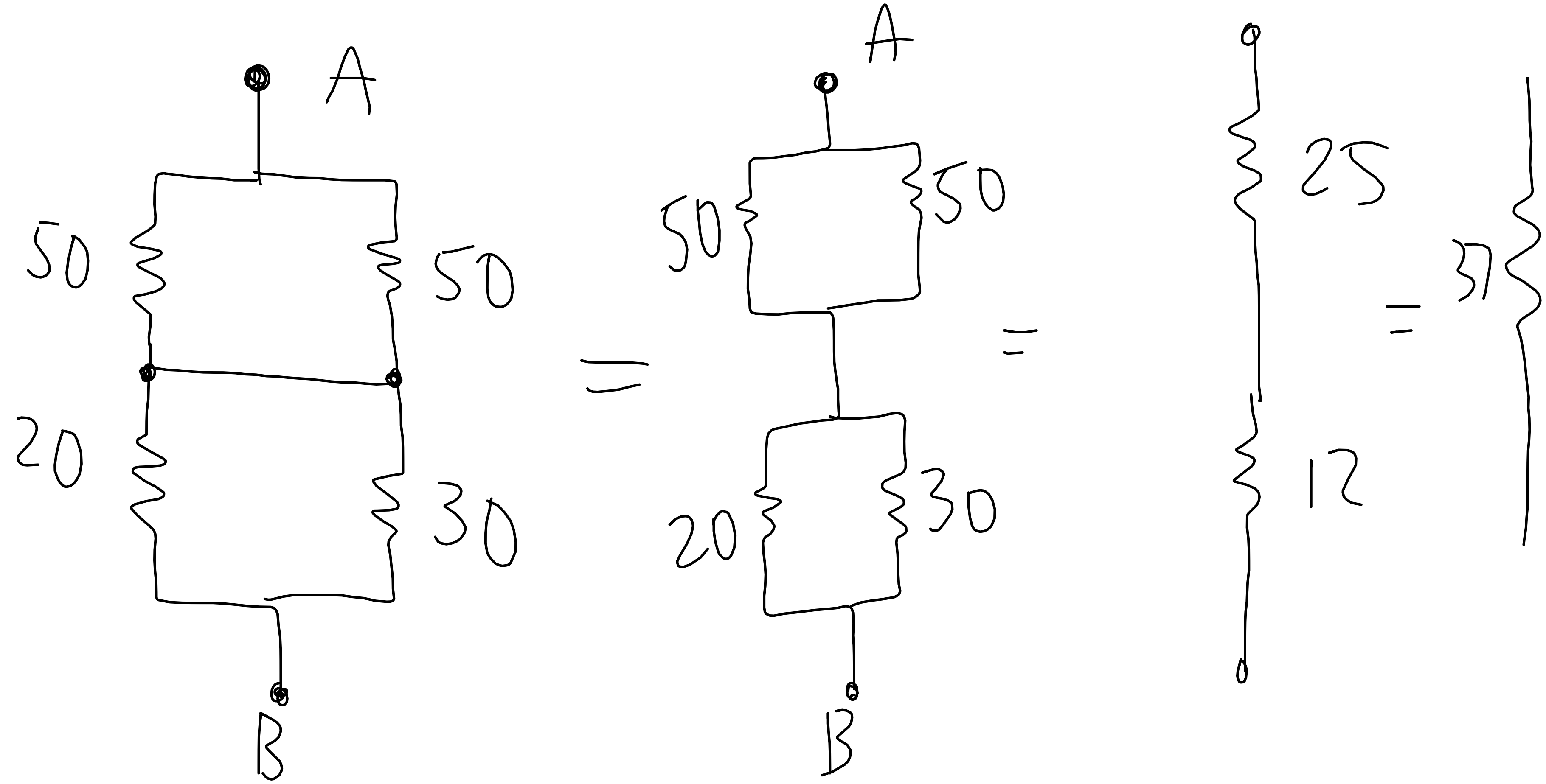


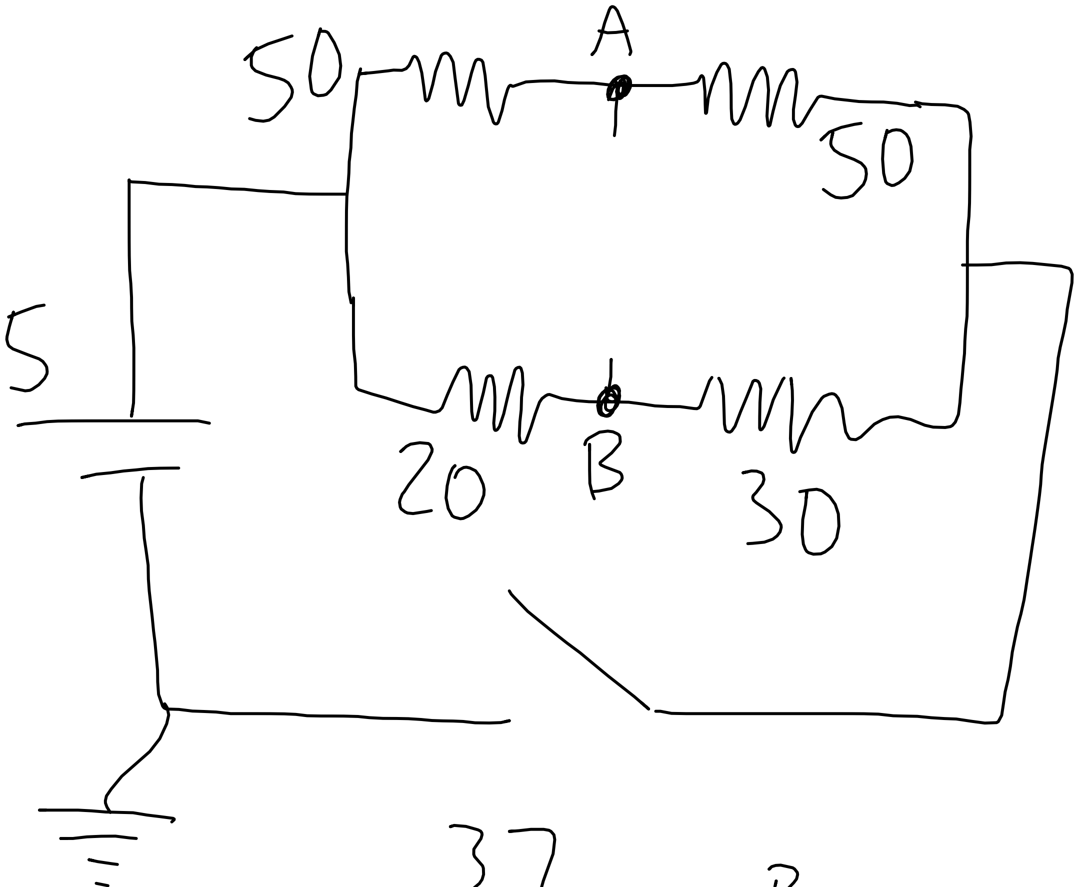
Initially uncharged

Close switch @ $t=0$

At what t is $V_c = .2V$?

$R_{TH} \Rightarrow$

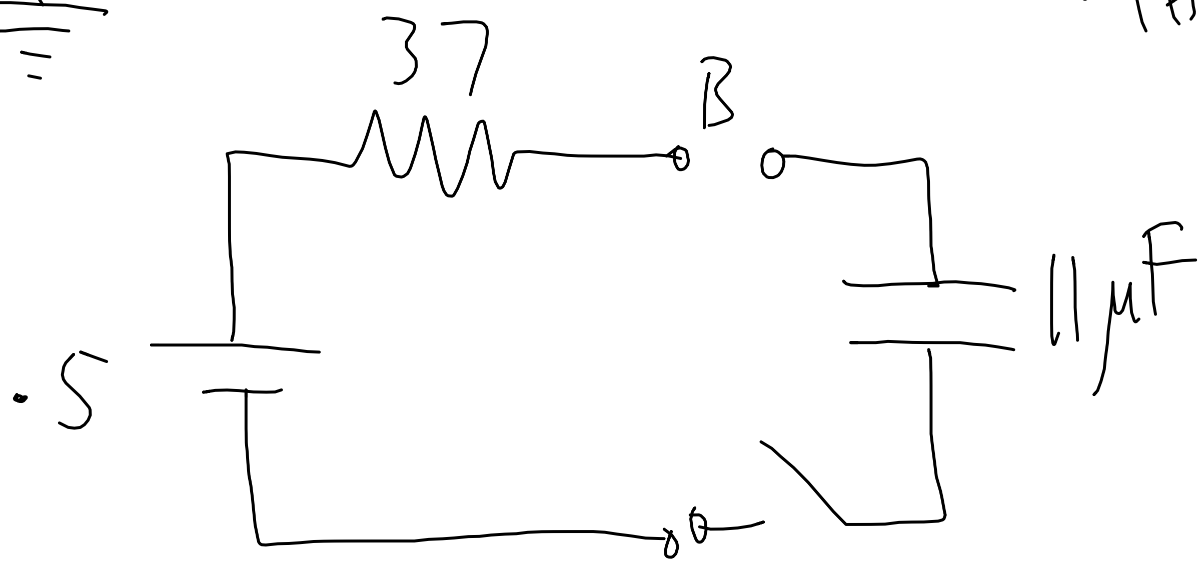




$V_A = 2.5\text{ V}$

$V_B = 3\text{ V}$

$V_{TH} = .5\text{V}$ (B is higher)



$RC = (37)(11\times10^{-6})$

$= 407\times10^{-6}\text{ s}$

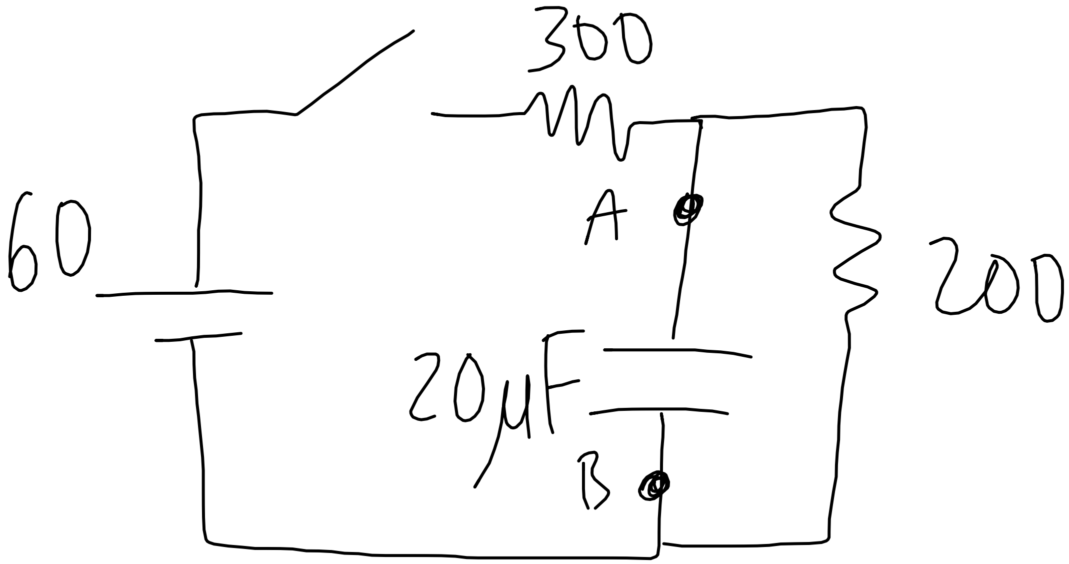
$= .407\text{ ms}$

$$V_c = .5\left(1-e^{-t/RC}\right) = .5\left(1-e^{-t/.407\,ms}\right)$$

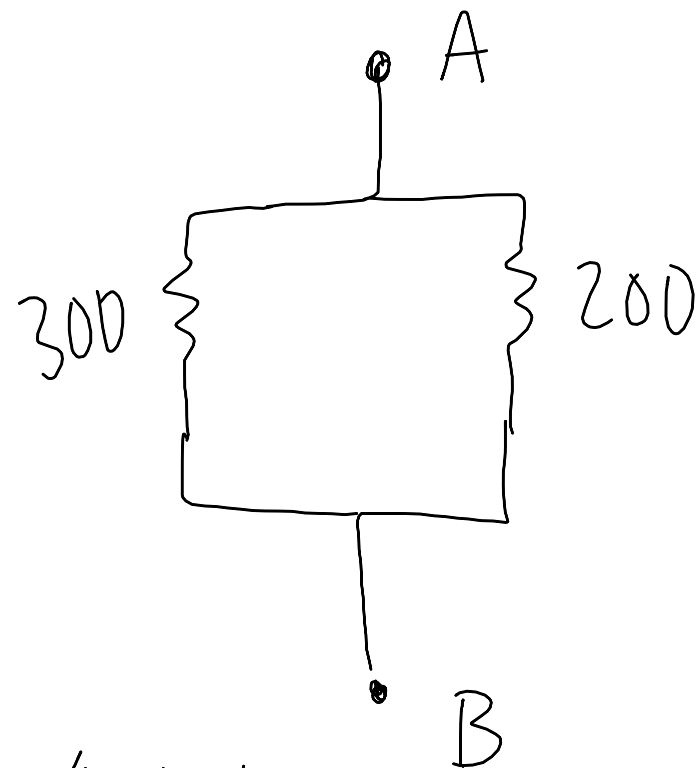
Set $V_c = .2$

$$.2 = .5\left(1-e^{-t/.407\,ms}\right)$$

$$\frac{t}{.407} = \ln(1-.4) \qquad t = .208\ ms$$



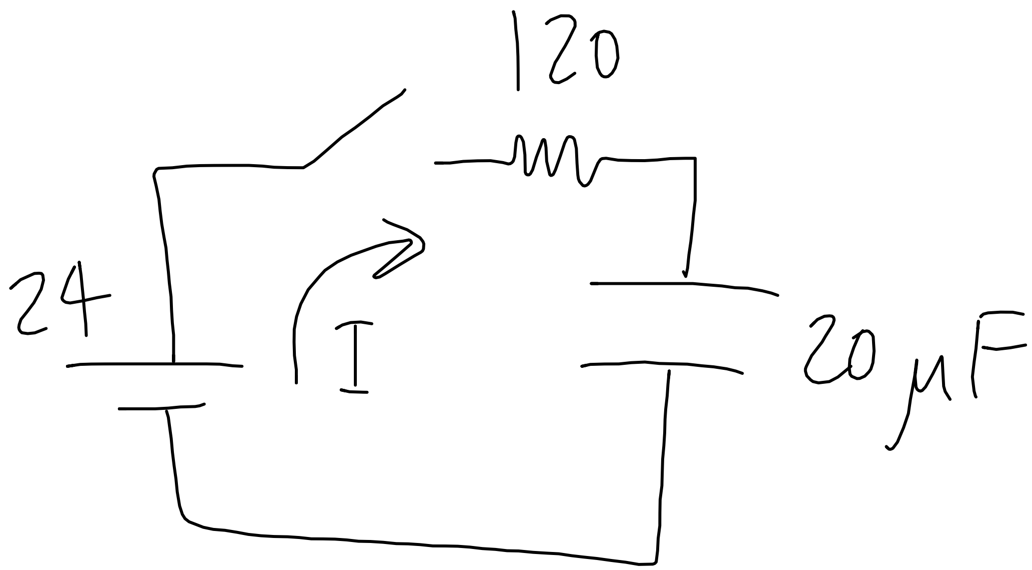
I_{batt} @ $t = 1.2$ ms



$$\frac{200(300)}{200+300}$$

$$R_{TH} = 120\,\Omega$$

$$V_{TH} = ? \quad \left(\frac{200}{200+300}\right)60 = 24\text{ V}$$



$RC = (120)(20\times10^{-6})$

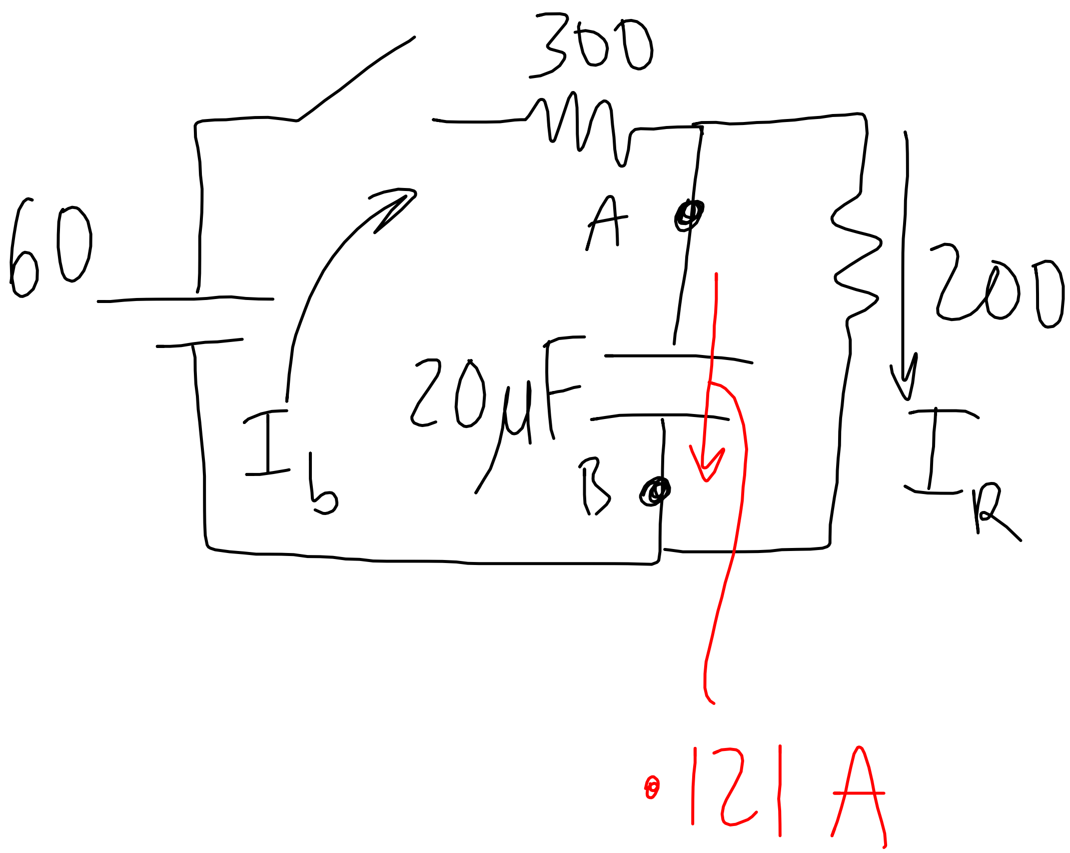
$= 2.4\ ms$

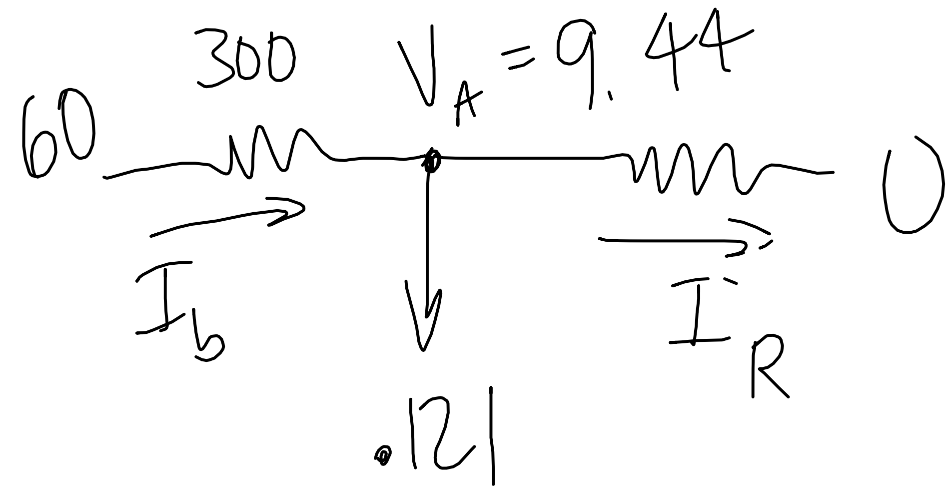
$V_c = 24\left(1 - e^{-t/2.4ms}\right)$

$V_c(t=1.2ms) = 24\left(1-e^{-1/2}\right) = 9.44\ V$

KVL: $24 - I(120) - 9.44 = 0 \quad I = .121\ A$

This is I_c!





$$I_b = .121 + I_R$$

$$60 - 9.44 = 300\, I_b$$

$$I_b = \frac{60 - 9.44}{300} = .168 \text{ A}$$

Assume $V = V_p \sin \omega t \qquad \omega = 2\pi f$

$V_{Avg} = 0$

rms $\Rightarrow \sqrt{\overline{V^2}}$

$$\overline{V^2} = \int_0^T V_p^2 \sin^2 \omega t \, dt = V_p^2 \, \text{"} \frac{\int_0^T \sin^2 \omega t \, dt}{T} \text{"}$$

$$\sqrt{\overline{V}^{2}} = \frac{V_p}{\sqrt{2}}$$

why worry about sine waves?

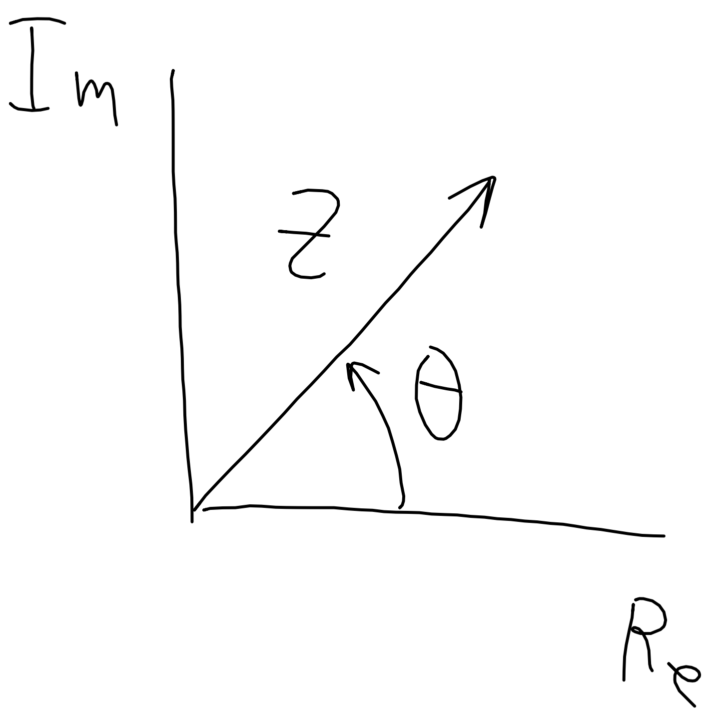
Go away from them.....

$\Longrightarrow$ complex numbers

$$z = a + ib \qquad i = \sqrt{-1}$$

$$z^* = a - ib$$

$$z z^* = a^2 + b^2 = |z|^2$$



$$\theta = \tan^{-1}\left(\frac{b}{a}\right)$$

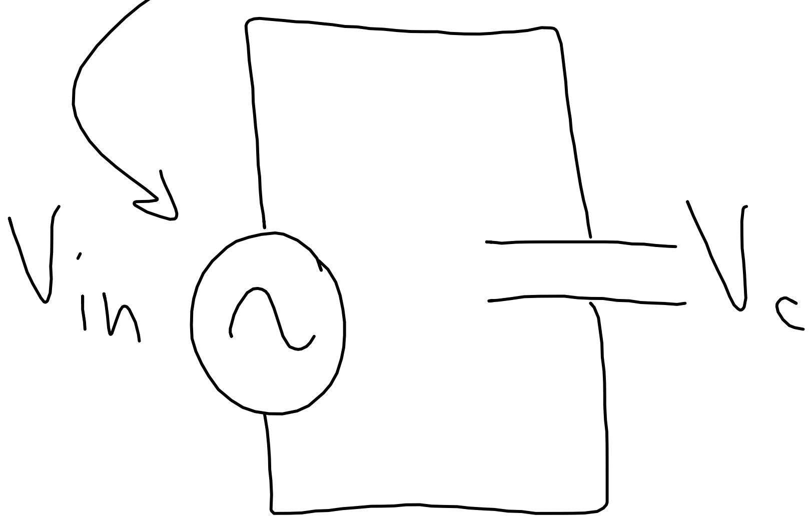
Im part

Re part

$$z = z_0 e^{i\theta}$$

$$e^{i\theta} = \cos\theta + i\sin\theta$$

Write $V = V_p e^{i\omega t}$



$$V_c = V_{in}$$

$$Q = CV_c$$

$$I_c = \frac{dQ}{dt} = C\frac{dV_c}{dt} = C\frac{dV_{in}}{dt}$$

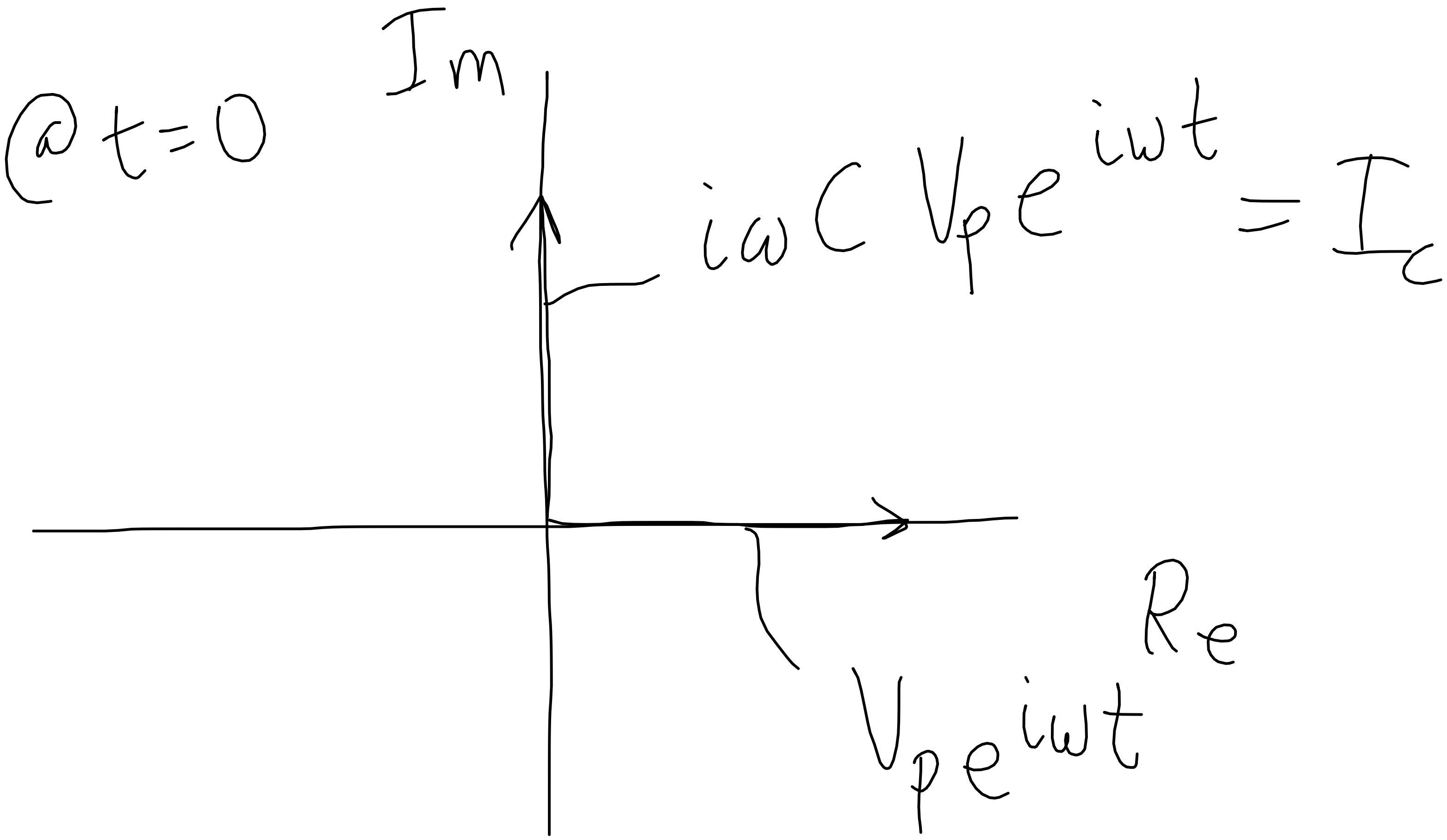
$$I_c = C\frac{dV_{in}}{dt} = C\frac{d}{dt}\left(V_p e^{i\omega t}\right)$$

$$= i\omega C V_p e^{i\omega t}$$

$$\frac{V_c}{I_c} = \frac{V_p e^{i\omega t}}{i\omega C V_p e^{i\omega t}} = \frac{1}{i\omega C} = \frac{-i}{\omega C}$$

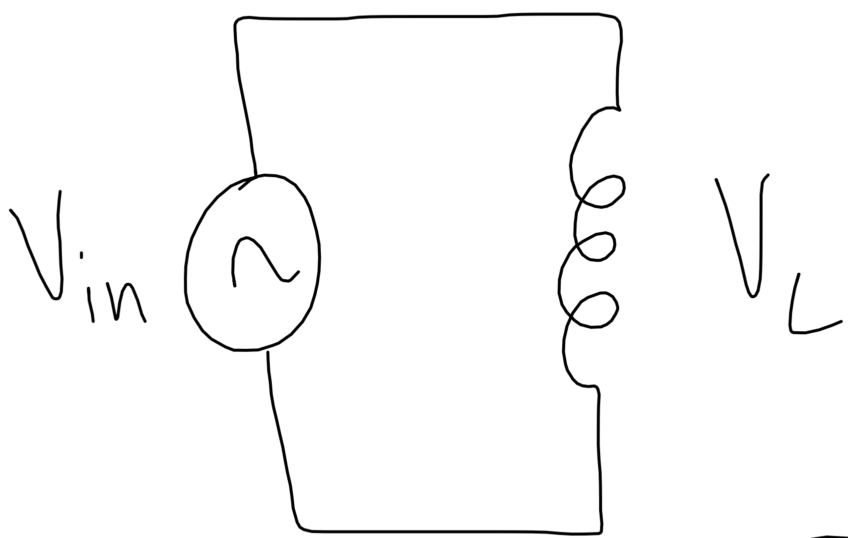
$$X_c = \frac{1}{\omega C} \qquad Z = \frac{-i}{\omega C}$$ impedance

@ $t=0$



which leads, I_c or V_c ?

ELI the ICE man



$$V_L = V_{in}$$

$$V_L = L\frac{dI_L}{dt}$$

$$I_L = \int \frac{1}{L} V_L \, dt$$

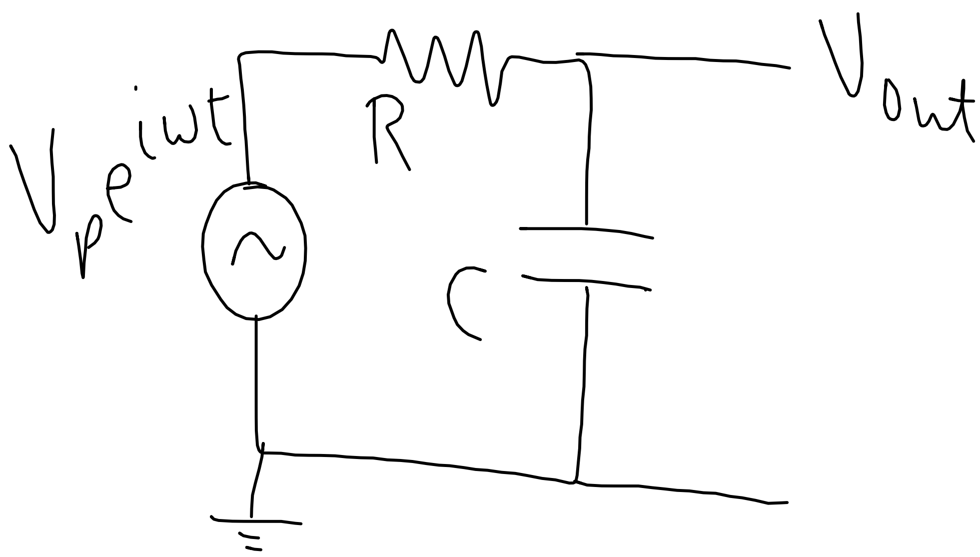
$$= \frac{1}{L}\int V_p e^{i\omega t} \, dt = \frac{1}{i\omega L} V_p e^{i\omega t}$$

$$Z_L = \frac{V_L}{I_L} = i\omega L \qquad X_L = \omega L \quad Z_L = i\omega L$$

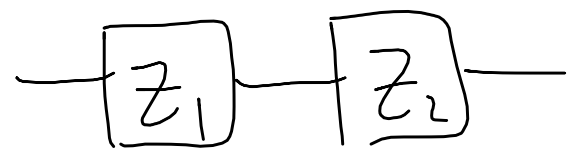
Cap $\Rightarrow Z_c = \frac{-i}{\omega C} \Rightarrow 0$ as $\omega \to \infty$

Inductor $\Rightarrow Z_L = i\omega L \Rightarrow \infty$ as $\omega \to \infty$

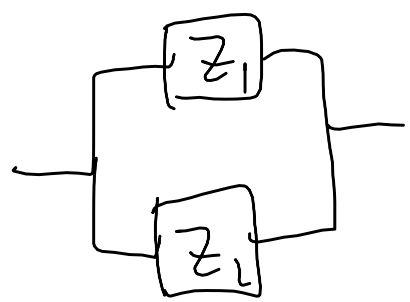
RC Filters



Impedances add like resistors



$Z_{total} = Z_1 + Z_2$



$$\frac{1}{Z_{tot}} = \frac{1}{Z_1} + \frac{1}{Z_2}$$

$$V_{out} = V_{in} \frac{Z_C}{Z_R + Z_C} = V_p e^{i\omega t} \frac{-i/\omega C}{R - i/\omega C}$$

$$\frac{V_{out}}{V_{in}} = \frac{-i/\omega C}{R - i/\omega C} = \frac{-i}{\omega RC - i} \left(\frac{\omega RC + i}{\omega RC + i} \right)$$

$$= \frac{1 - i\omega RC}{(\omega RC)^2 + 1}$$

$$\left| \frac{V_{out}}{V_{in}} \right| = \frac{\sqrt{1 + (\omega RC)^2}}{1 + (\omega RC)^2}$$

$$= \frac{1}{\sqrt{1 + (\omega RC)^2}}$$