Electrical Circuit Lab

Experiment Six: Step Response of AC Circuit

Student's Name: ID:

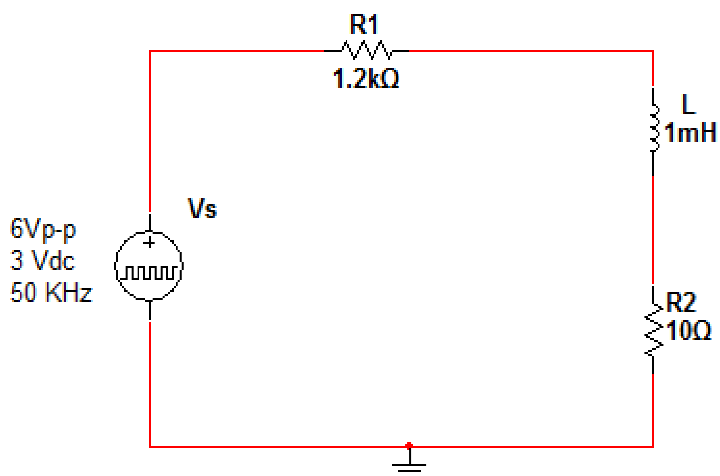
Razan Monther Jaradat 1931783

1- Transient RL Circuit

a. Construct the following circuit.

b. Measure the internal resistance of the inductor.

Element	Unit	Theoretical	Measured
R1	KΩ	1.2	1.19
R2	Ω	10	9.9
R_{int}	Ω		12.3
L	mH	1	
τ	s	8.264×10^{-7}	



c. Calculate the time constant τ.

$$\tau = \frac{L}{R_{eq}} = \frac{1 \times 10^{-3}}{1200 + 10}$$

$$= 8.264 \times 10^{-7}\ \text{s}$$

d. Draw the inductor current & evaluate it at t= $\tau, 3\tau$ *and* 5τ.

At t= τ :

$$I(t) = \frac{V_s}{R1+R2}\left[1\text{-}e^{\frac{-\tau}{\tau}}\right] = \frac{6(1-\frac{1}{e})}{1210} = 3.134\ \text{mA}$$

$$I(t) = \frac{V_s}{R1+R2}\left[e^{\frac{-\tau}{\tau}}\right] = \frac{6(\frac{1}{e})}{1210} = 1.8242\ \text{mA}$$

At t= 3τ :

$$I(t) = \frac{V_s}{R1+R2}\left[1\text{-}e^{\frac{-3\tau}{\tau}}\right] = \frac{6(1-\frac{1}{e^3})}{1210} = 4.712\ \text{mA}$$

$$I(t) = \frac{V_s}{R1+R2}\left[e^{\frac{-3\tau}{\tau}}\right] = \frac{6(\frac{1}{e^3})}{1210} = 0.2469\ \text{mA}$$

At t= 5τ :

$$I(t) = \frac{V_s}{R1+R2}\left[1\text{-}e^{\frac{-5\tau}{\tau}}\right] = \frac{6(1-\frac{1}{e^5})}{1210} = 4.925\ \text{mA}$$

$$I(t) = \frac{V_s}{R1+R2}\left[e^{\frac{-5\tau}{\tau}}\right] = \frac{6(\frac{1}{e^5})}{1210} = 0.0334\ \text{mA}$$

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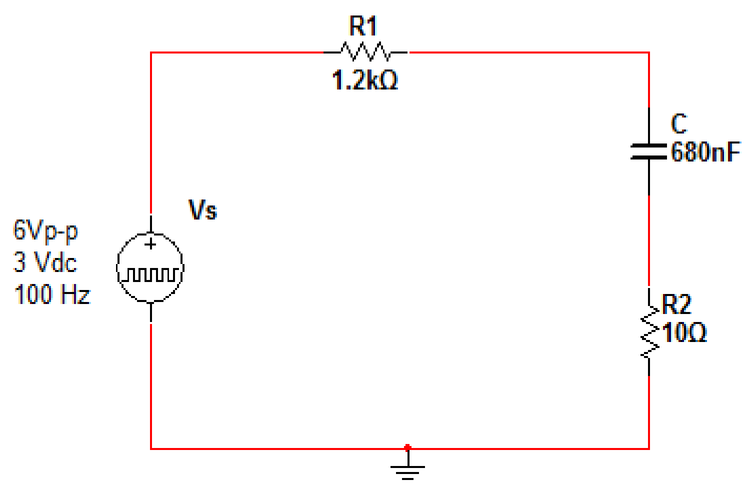
e. Draw the voltage source and inductor voltage in the same graph.

$V_{pp} = 54\ mV$

$I_{pp} = \frac{V_{pp}}{R} = 5.4\ mA$

2- Transient RC Circuit



a. Construct the following circuit.

b. Calculate the time constant τ.

c. $\tau = R_{eq} \times C = 1210 \times 680 \times 10^{-9} = 8.228 \times 10^{-4}\ s$

d. Draw the capacitor voltage & evaluate it at t= $\tau, 3\tau$ *and* 5τ.

At t= τ :

$$I(t) = \frac{V_S}{R1+R2}\left[1-e^{\frac{-\tau}{\tau}}\right] = \frac{6(1-\frac{1}{e})}{1210} = 3.134\ mA$$

$$I(t) = \frac{V_S}{R1+R2}\left[e^{\frac{-\tau}{\tau}}\right] = \frac{6(\frac{1}{e})}{1210} = 1.8242\ mA$$

At t= 3τ :

$$I(t) = \frac{V_S}{R1+R2}\left[1-e^{\frac{-3\tau}{\tau}}\right] = \frac{6(1-\frac{1}{e^3})}{1210} = 4.712\ mA$$

$$I(t) = \frac{V_S}{R1+R2}\left[e^{\frac{-3\tau}{\tau}}\right] = \frac{6(\frac{1}{e^3})}{1210} = 0.2469\ mA$$

At t= 5τ :

$$I(t) = \frac{V_S}{R1+R2}\left[1-e^{\frac{-5\tau}{\tau}}\right] = \frac{6(1-\frac{1}{e^5})}{1210} = 4.925\ mA$$

$$I(t) = \frac{V_S}{R1+R2}\left[e^{\frac{-5\tau}{\tau}}\right] = \frac{6(\frac{1}{e^5})}{1210} = 0.0334\ mA$$

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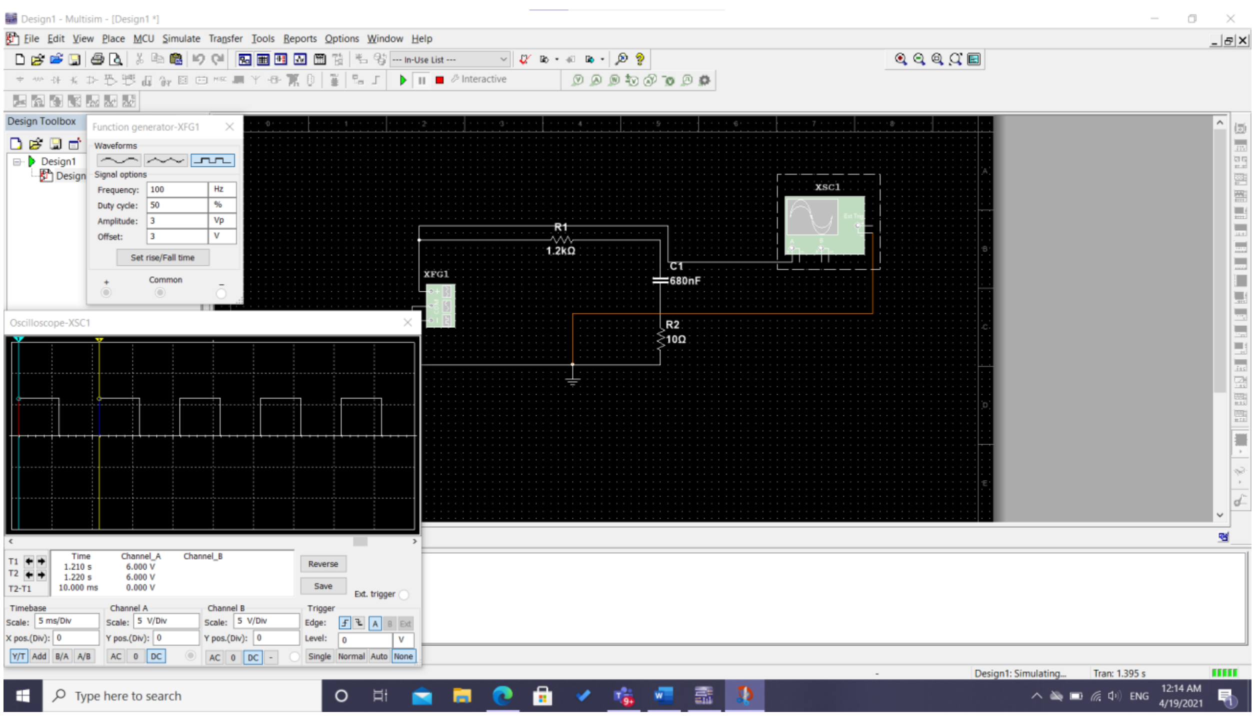
e. Draw the voltage source and capacitor current in the same graph.

$$\frac{V_{R2}}{R2} = IR_2 = I(t)$$

$$V_{R2} = 49.6 \text{ mA}$$

$$\frac{49.6}{10} = 4.96\ mA$$



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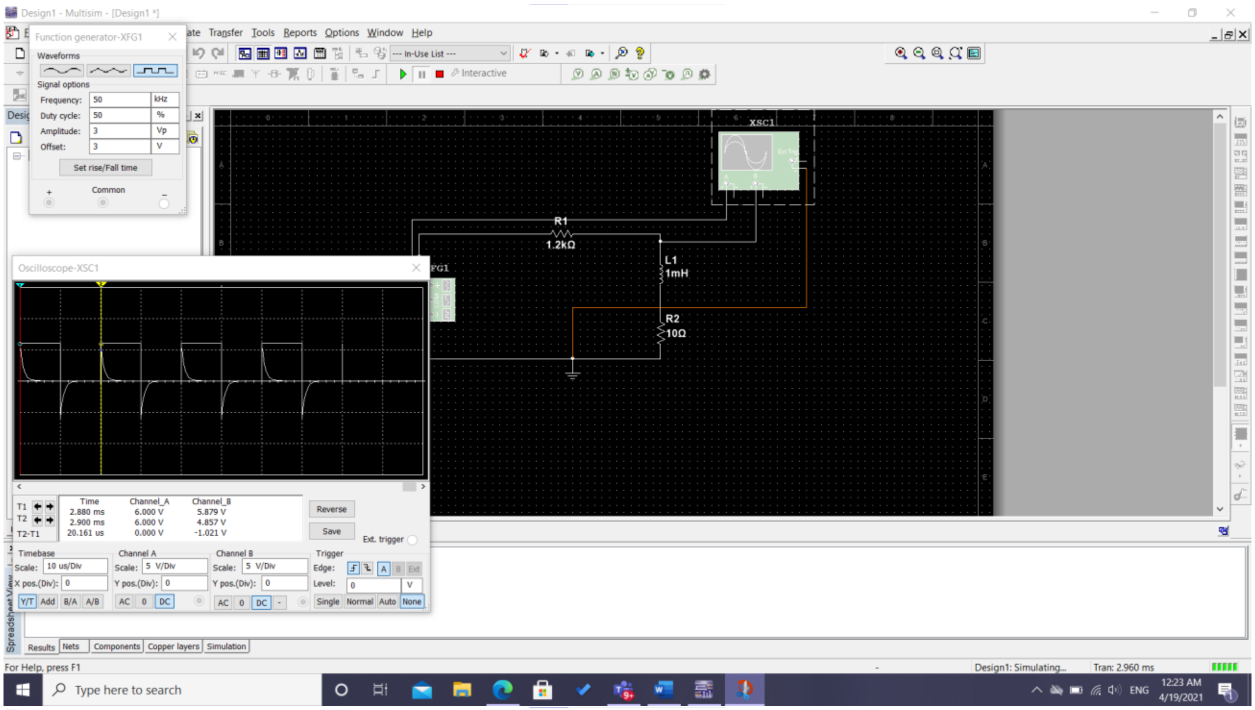

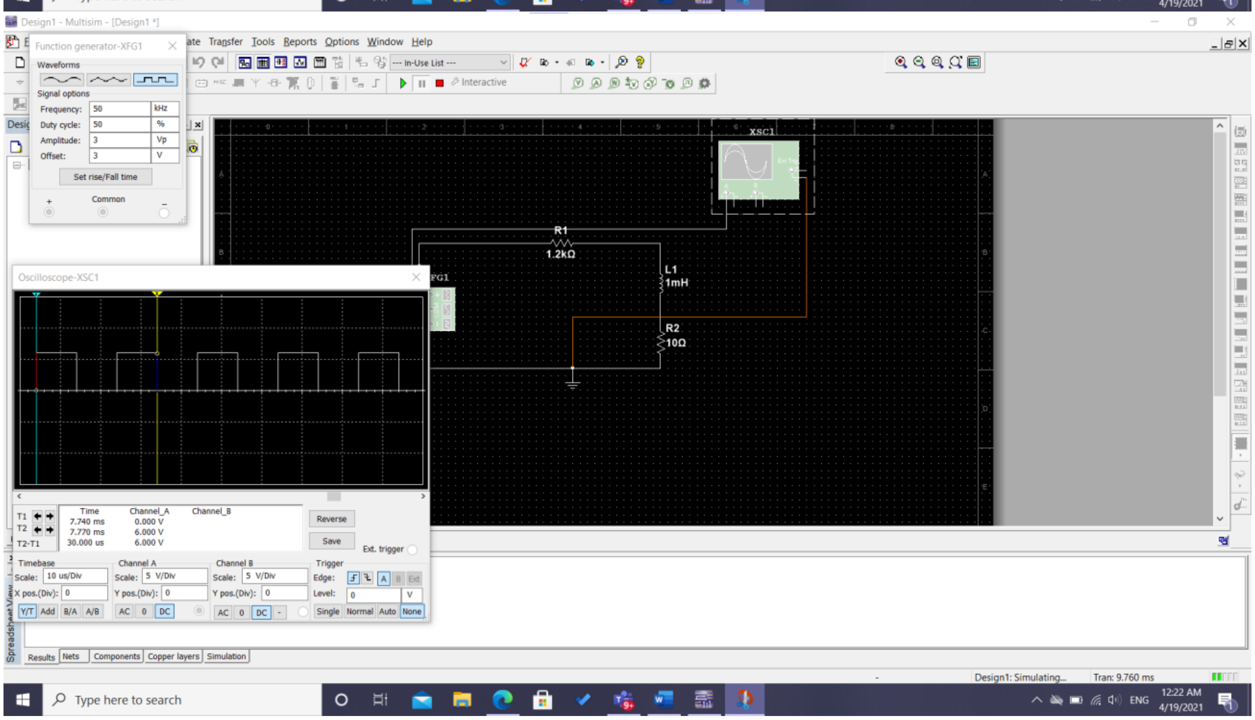

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