Phys219_2017 - Ryan Kaufmann/Exp. 1 (RC Circuit)/Prelab assignment for Exp 1

SIGNED by Ryan Kaufmann Sep 17, 2017 @09:10 PM PDT

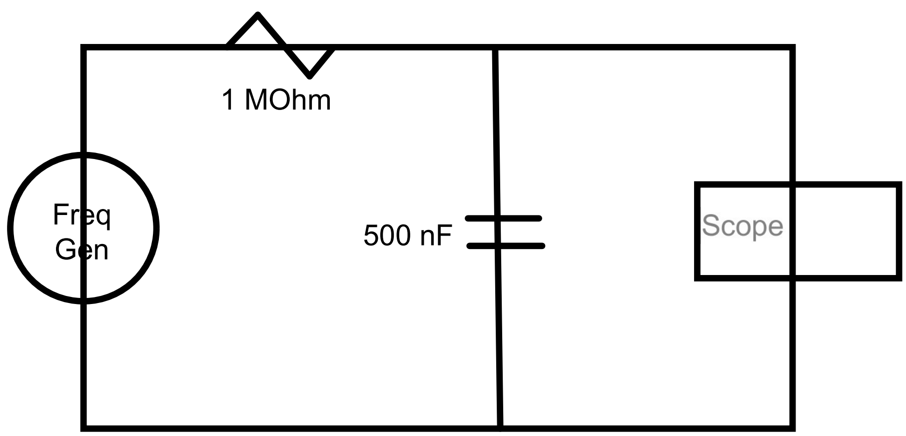
Rob Kiefl Sep 07, 2016 @10:25 AM PDT

Answers to prelab questions on RC circuit go on this page . Don't forget to sign the page, and bring a hard copy with you to the lab.

Ryan Kaufmann Sep 15, 2017 @10:13 AM PDT

Consider the circuit in Fig.1 where the function generator is set to produce a square wave such that so the voltage applied alternates between +1V and 0V every 1000s.

Ryan Kaufmann Sep 15, 2017 @10:17 AM PDT



Ryan Kaufmann Sep 15, 2017 @10:12 AM PDT

How long does it take for the Voltage across the capacitor to reach 10 mV after the voltage suddenly goes from +1V to zero?

Ryan Kaufmann Sep 15, 2017 @11:00 AM PDT

In order to find the time it takes for the voltage to drop, we need to use the capacitor discharge equation. We can plug in our known variables of resistance, capacitance, and initial voltage and then solve for time, as such:

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$$Q = CV_B[1-e^{\frac{-t}{RC}}]$$ $$V_C = \frac{Q}{C} = V_B[1-e^{\frac{-t}{RC}}]$$ $$R = 1M\Omega = 1000000 \Omega$$ $$C = 500nF = 0.0000005F$$ $$RC = 0.5s$$ $$0.01 = 1-e^{\frac{-t}{0.5}}$$ $$e^{\frac{-t}{0.5}} = 0.99$$ $${\frac{-t}{0.5}}=ln(0.99)$$ $$t \approx 0.005025167926751s$$

Ryan Kaufmann Sep 15, 2017 @11:02 AM PDT

Suppose the 1M Ohm resistor in Fig. 1 is replace with a 10K Ohm resistor. How long does it take for the voltage across the capacitor to reach 10 mV after the voltage from the function generator drops from +1V to zero?

Ryan Kaufmann Sep 15, 2017 @11:03 AM PDT

For this problem again, we use the same formula as above but now with a different resistance:

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$$Q = CV_B[1-e^{\frac{-t}{RC}}]$$ $$V_C = \frac{Q}{C} = V_B[1-e^{\frac{-t}{RC}}]$$ $$R = 1K\Omega = 10000 \Omega$$ $$C = 500nF = 0.0000005F$$ $$RC = 0.005s$$ $$0.01 = 1-e^{\frac{-t}{0.005}}$$ $$e^{\frac{-t}{0.005}} = 0.99$$ $${\frac{-t}{0.005}}=ln(0.99)$$ $$t \approx 0.000050251679268s$$

Ryan Kaufmann Sep 17, 2017 @08:57 PM PDT

Sketch the voltage output from the generator, the voltage across the capacitor, and the voltage across the resistor as a function of time.

Ryan Kaufmann Sep 17, 2017 @09:08 PM PDT

Getting the equation of the voltage output is easy, as it is a sinusoidal with a given amplitude and frequency. With those given, the output voltage is:

\({V_{out} = {\cos(100\pi*t)}}\)

We could then calculate the formula for the voltage across the capacitor using a given formula. The amplitude of this voltage and the phase shift needed to be calculated as so:

\({V^0_C(\omega) = {V^0_{in} \over \sqrt{1+(\omega RC)^2}} {\phi_C(\omega) = tan^{-1}(-\omega RC)}\)

This was calculated to be 0.537 and -1.004, respectively. Then the equation of the voltage across the capacitor becomes:

\({V_C = 0.537\cos(100\pi t -1.004)}\)

The voltage across the resistor becomes simple, as it is the difference between the two functions. It is, or in a simplified, as follows:

\({V_R = \cos(100\pi t)-0.537\cos(100\pi t - 1.004)} {V_R = 0.843625\cos(100\pi t + 0.566877)}\)

The functions graph as follows:

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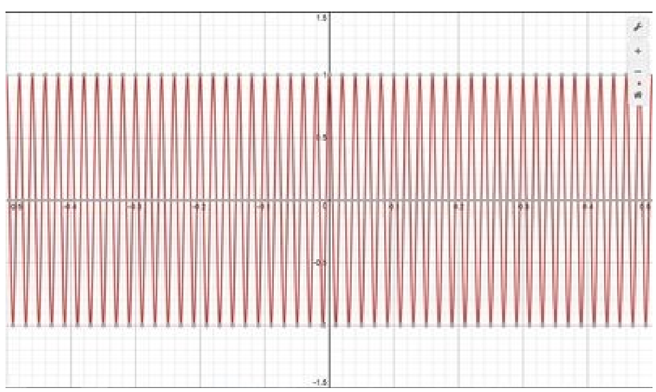

PreLabVoltage.JPG(257.3 KB)

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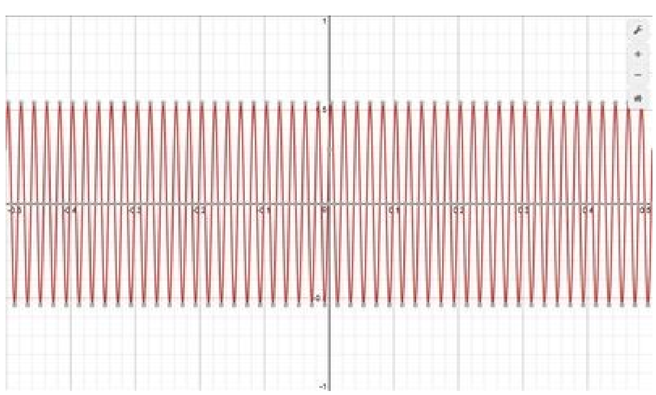
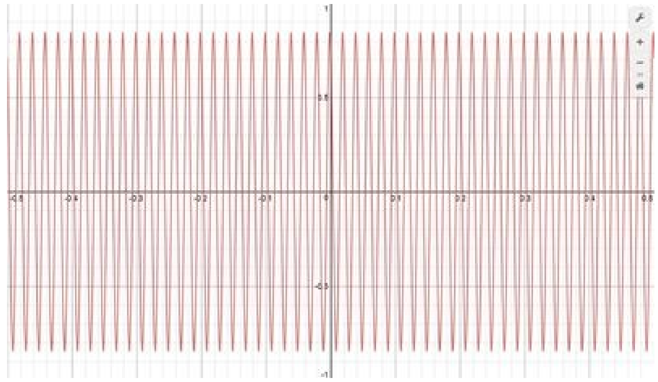


PreLabCapacitor.JPG(224.4 KB)

Ryan Kaufmann Sep 17, 2017 @09:09 PM PDT



PreLabResistor.JPG(238.3 KB)

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Each of the graph has time on the x axis and voltage on the y axis, measured in seconds and volts, respectively, and are in the order of Voltage, Capacitor, and Resistor.