ECE210 Laboratory
PRE-LAB#1

Spring 2022

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Net ID: _____ ,
Student Name:

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Lab section:

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Lab 1: RC-Circuits

Over the course of five laboratory sessions in ECE 210 you will build a working AM radio receiver that operates on the same principles as commercially available systems. The receiver will consist of relatively simple subsystems examined and discussed in class. We will build the receiver up slowly from its component subsystems, mastering each as it is added.

In Lab 1 you will begin your AM receiver project with a study of *RC* circuits. Although *RC* circuits, consisting of resistors R and capacitors C, are simple, they can perform many functions within a receiver circuit. They are often used as audio filters (the circuitry behind the "bass" and "treble" knobs, for example), and as you will see later in this lab, envelope detectors, with the inclusion of diodes. Lab 1 starts with an exercise that will familiarize you with sources and measuring instruments to be used in the lab, and continues with a study of characteristics of capacitors and steady-state and transient behavior in *RC* circuits. Then you convert an *RC* filter circuit into an envelope detector and test it using a synthetic AM signal.

1 Prelab

Prelab exercises are meant to alert you about topics to be covered in each lab session. Make sure to complete them before coming to lab since their solutions will often be essential for understanding/explaining the results of your lab measurements.

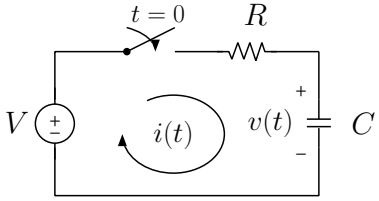

Figure 1: *RC* circuit for prelab exercise 1 ($V = 10\,\text{V}$, $R = 10\,\text{k}\Omega$, $C = 10\,\mu\text{F}$).

1. For the circuit of Figure 1, calculate the following:

   (a) The *RC* time constant (τ): $\tau = RC =$ (____/2)

   (b) Find $v(t)$ across the capacitor for $t > 0$, assuming the capacitor is initially uncharged: (____/4)

   Show your work:

   $v(t) =$ _____

(c) Find the voltage $v(t)$ at $t = 1\,\tau$: $v(t)|_{t=\tau} =$ (____/2)

Useful approximations: ($e^{-1} \approx 0.37$; $e^{-2} \approx 0.14$; $e^{-3} \approx 0.05$; $e^{-4} \approx 0.02$; $e^{-5} \approx 0.01$)

(d) Find the voltage $v(t)$ at $t = 5\,\tau$: $v(t)|_{t=5\tau} =$ (____/2)

(e) The initial current $i(0^+)$ that will flow in the circuit, assuming the capacitor is initially uncharged: (____/4)

Show your work:

$i(0^+) =$ _____

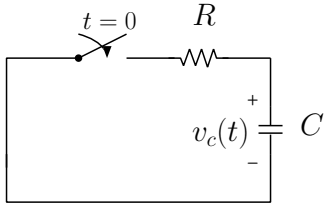

Figure 2: RC circuit for prelab exercise 2 ($R = 10\,\text{k}\Omega$, $C = 10\,\mu\text{F}$).

2. (a) Find $v_c(t)$ across the capacitor for $t > 0$, assuming $v_c(t) = 10\,\text{V}$ right before the switch is closed (initial condition: $v_c(0^-) = 10\,\text{V}$): (____/4)

Show your work:

$v(t) =$ _____

(b) Find the voltage $v_c(t)$ at $t = 1\,\tau$: $v_c(t)|_{t=\tau} =$ (____/2)

(c) Find the voltage $v_c(t)$ at $t = 5\,\tau$: $v_c(t)|_{t=5\tau} =$ (____/2)

3. Suppose you are given an unknown capacitor. Describe an experimental technique that you could use to determine its value: (____/3)