Department of Electrical and Computer Engineering
The Johns Hopkins University
520.137 Introduction to Electrical and Computer Engineering – Fall 2016

Homework Assignment III

Reading Assignment: Lecture Notes; Kerns-Irwin Chapter 3.

1. Consider a simple RC circuit with a DC voltage source V_S sketched below. At some time in the distant past, the DC voltage source was connected to the circuit to charge up the capacitor C. You can assume that C has been fully charged prior to $t = 0$.

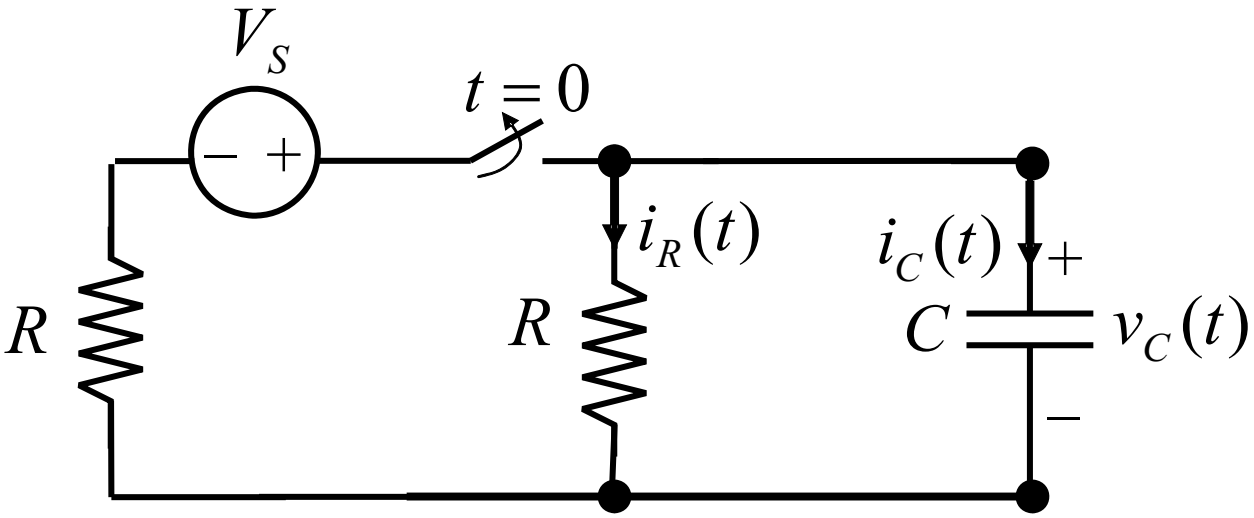

Figure 1: RC Circuit with a DC Voltage Source.

   (a) Find the voltage that the capacitor is charged up to right before $t = 0$. *Hint: In DC steady state, the capacitor behaves as an open circuit.*

   (b) The switch opens at $t = 0$. Find the differential equation describing the behavior of $v_C(t)$ after the switch opens ($t > 0$).

   (c) Find the expression for the voltage across the capacitor $v_C(t)$ for $t > 0$. Sketch it as a function of time.

   (d) Find and sketch the current $i_R(t)$ through the middle resistor R after the switch opens.

   (e) Suppose that the switch will then be closed at a distant time $t = T >> RC$ (T is much larger than RC) in the future. Re-sketch the voltage across the capacitor $v_C(t)$ for $t > 0$ taking into account this switch-closing situation. You do not have to find the exact expression for $v_C(t)$.

2. Consider an RC circuit with a DC current source I_S sketched below. At some time in the distant past, the DC current source was connected to the circuit to charge up the capacitor C (the switch stays open). You can assume that C has been fully charged prior to $t = 0$.

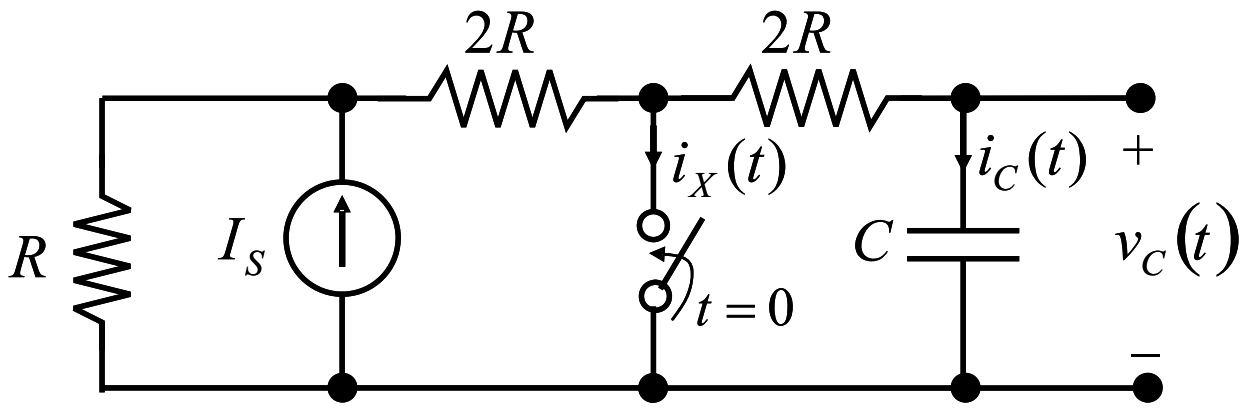

Figure 2: RC Circuit with a DC Current Source.

(a) The switch closes at $t = 0$. Find the differential equation describing the behavior of $v_C(t)$ after the switch closes ($t > 0$).

(b) Given that $R = 5K\Omega$, $C = 100\mu F$, and $I_S = 2mA$, find the voltage that the capacitor is charged up to right before $t = 0$.

(c) Find the expression for the voltage across the capacitor $v_C(t)$ for $t \geq 0$ by solving the differential equation in Part (a) using the initial condition in Part (b). Sketch $v_C(t)$ as a function of time.

(d) Find and sketch $i_C(t)$ for $t \geq 0$.

(e) Find the current i_X through the switch branch a long time after the switch closes.

Due date: **Friday September 30th** in class