# EECE 2150 - Circuits and Signals: Biomedical Applications Fall 2018, Quiz 6

Prof. Charles A. DiMarzio

25 October 2018

Student Name: ____________________

Consider the circuit in the figure. This is a simple example of a Marx generator, which can be used to generate high–voltage pulses.

All capacitors are $0.1\,\mu$F, all resistors labelled $R_1$ are $1\,\mathrm{k}\Omega$, and the load resistor is $R_L = 1\,\Omega$. The switches are open for a long time, and then closed at $t = 0$.

1. What is the capacitance of each series combination of two capacitors?

$C_{series} =$ ____________________ $\mu$F.

2. The switches are opened for a long time, so that the circuit has reached steady state. What is the voltage across each series pair of capacitors?

$V_{left}(0^-) =$ ____________________ Volts.

$V_{right}(0^-) =$ ____________________ Volts.

3. How much energy is stored in the capacitors in total? Hint: Do this for one capacitor at a time.

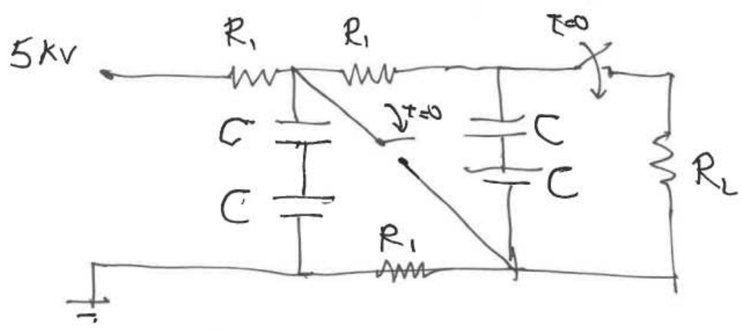
$W(0^-) =$ ____________________ Joules.

4. Then the switches are closed at time, $t = 0$. What is the voltage just after the switches are closed?

$V(0^+) =$ ____________________ Volts.

5. What is the time constant of the circuit with the switches closed? Use appropriate approximations to make it an easy calculation.

$\tau =$ ________________________________ Sec.



1. Series Capacitors; $1/C_{series} = 1/C_1 + 1/C_2 = 2/C$

$$C_{series} = C/2 = 0.05\,\mu\text{F}.$$

2. $V(0^-) = 5\,\text{kV}$ for both.

3. Each capacitor sees half the voltage, so the energy in one is

$$W_1 = \frac{1}{2}C\left(\frac{V}{2}\right)^2 = \frac{1}{2} \times 0.1 \times 10^{-6}\,\text{F} \times (2500\,\text{V})^2$$

In total

$$W = 4W_1 = 4 \times \frac{1}{2} \times 0.1 \times 10^{-6}\,\text{F} \times (2500\,\text{V})^2 = 1.25\,\text{J}$$

4. Now capacitors are stacked all in series; $10\,\text{kV}$.

5. The total capacitance is the series combination of all 4, so

$$C_{after} = C/4 = 0.025\,\mu\text{F}$$

$$RC = 0.025\,\mu\text{F} \times 1\,\Omega = 25\,\text{ns}.$$