

## ECE 214 - Lab #9 — Astable Multivibrator

12 April 2016

**Introduction:** This is the third of four labs that will culminate in a circuit that will convert a 9 volt DC source into a 50 volt DC source. In this lab, you will design, simulate, build and test an astable multivibrator oscillator that will be used to drive the boost circuit you built in Lab 8.

### Pre-Lab:

A basic astable multivibrator oscillator circuit is shown in Figure 1.

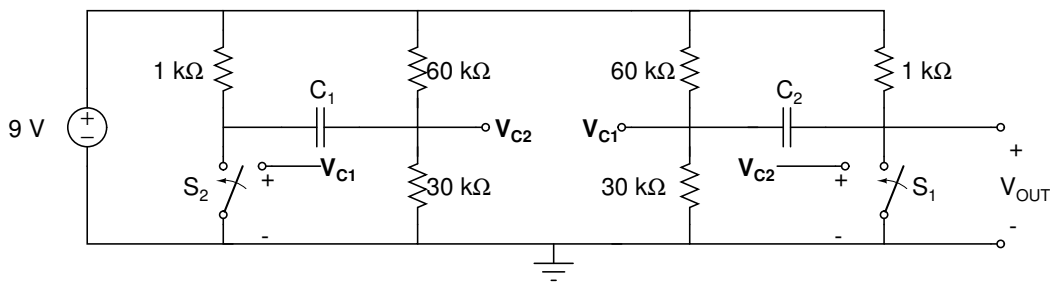


Figure 1: Astable multivibrator circuit.

1. For this circuit, assume the switches are closed when the control voltage is  $> 2$  V and open when the control voltage is  $< 2$  V. Analyze this circuit. Explain the function of this circuit and describe how it works. Reference the description in the table of contents of your laboratory notebook.
2. Derive an equation describing the frequency of the output as a function of the component values. Reference the equation in the table of contents of your laboratory notebook.
3. If  $C_1 = C_2 = 0.1\mu\text{F}$ , what is the expected output frequency?
4. Use Micro-Cap to analyze the operation of this circuit using the Micro-Cap test circuit shown in Figure 2. For the voltage-controlled switch (V-Switch), set the resistance of the switch to  $1\Omega$  when the switch is closed and set  $V_{\text{on}} = 2.1$  V and  $V_{\text{off}} = 2.0$  V. Make sure to include the indicated initial conditions on the capacitors.
5. Does the circuit oscillate at the frequency predicted above? If not, explain the discrepancy.
6. Plot the voltage at each end of one of the capacitors with respect to ground. It does not matter which capacitor you choose. Are the voltages the same for each capacitor? Have this in your notebook to compare with what you measure in lab.

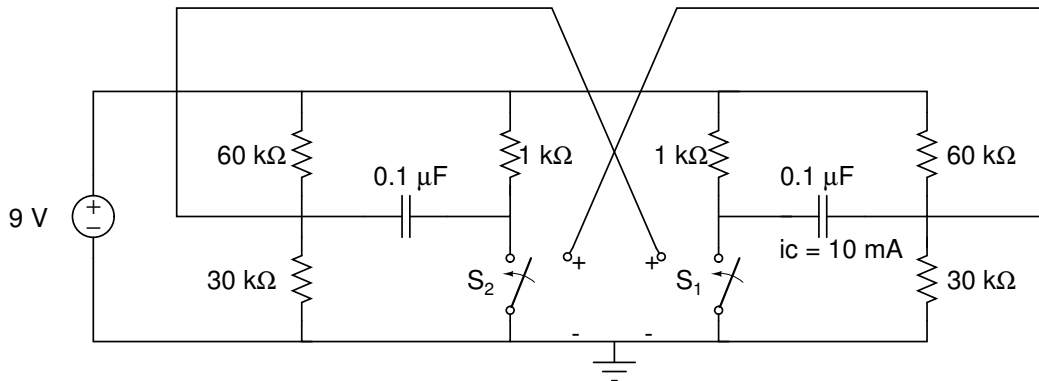


Figure 2: Astable multivibrator Micro-Cap test circuit.

### Lab Procedure:

1. Build the multivibrator half-circuit shown in Figure 3.
2. Set the function generator to produce a triangular wave with a voltage from 0 to 5 volts and a frequency equal to what you found in the pre-lab. Use the scope to watch the voltage at the gate of the MOSFET and at the drain of the MOSFET. At what gate voltage does the MOSFET turn-on? At what gate voltage does it turn-off? Record these values in your notebook.
3. Examine the voltage across the 30 KΩ resistor. How does it compare with the simulation results from the pre-lab?
4. Build the astable multivibrator circuit shown in Figure 4. This is the complete multivibrator circuit and it should oscillate when the power is supplied.
5. Measure the frequency of the output waveform. How does the previous simulated frequency compare to the measured frequency? Explain and discrepancy in your notebook.

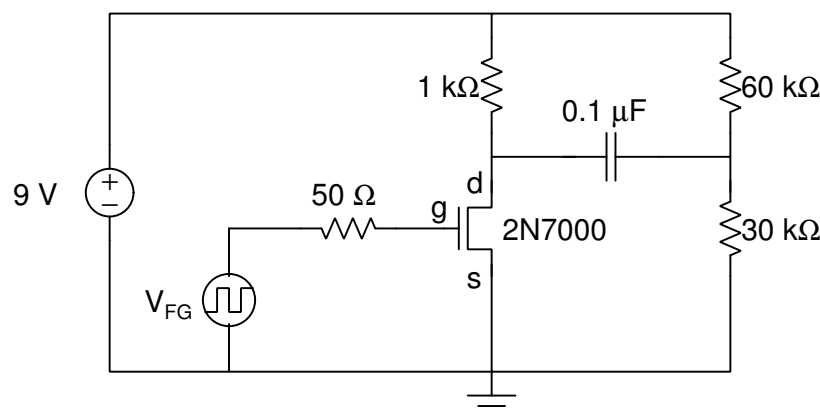


Figure 3: Multivibrator half-circuit.

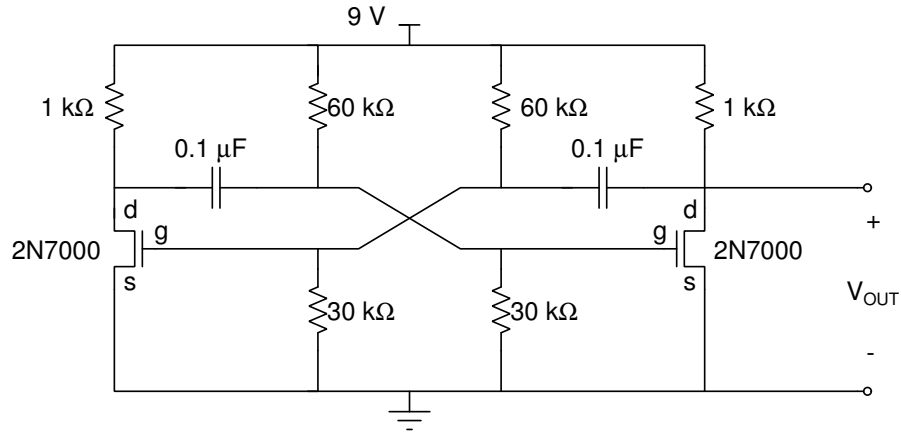


Figure 4: Astable multivibrator circuit.

6. In the Micro-Cap test circuit, change the turn-on voltage of the voltage controlled switch to match the measured turn-on voltage for the transistors.
7. Simulate the modified Micro-Cap test circuit. How does the simulated frequency now compare to the measured frequency? Explain any discrepancy in your notebook.
8. The multivibrator circuit will be used to drive the boost-circuit you built and tested in Lab 8. Modify the design of the multivibrator to match the best frequency and duty cycle determined in Lab 8. This is best accomplished by keeping the resistor values constant and adjusting the capacitance values  $C_1$  and  $C_2$  shown in Figure 5. The values of the capacitors determine the frequency while the ratio of the capacitors determine the duty cycle. Use hand-calculations, verified by Micro-Cap simulations, to determine the values of  $C_1$  and  $C_2$  so that:
  - (a) Output frequency matches the frequency found in Lab 8 needed to produce a 20 V output for your boost-circuit.
  - (b) Output duty cycle matches the duty cycle found in Lab 8 needed to produce a 20 V output for your boost-circuit.

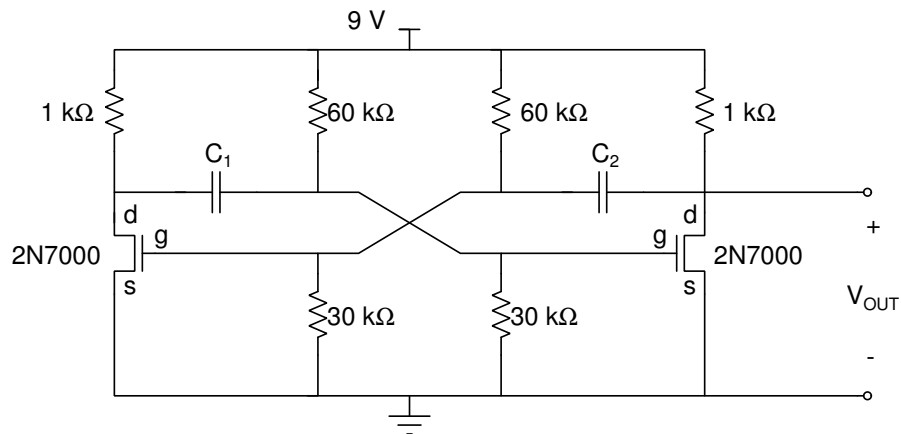


Figure 5: Astable multivibrator circuit.

Record the final capacitance values and include a photograph of the output waveform from the oscilloscope in your lab notebook. Create a reference for this information in the table of contents.

Do not disassemble the multivibrator circuit. In Lab 10 you will attach the multivibrator circuit to the boost circuit from Lab 8 and add a 2nd boost-circuit to increase the output voltage to 50 V.