Pre-Lab 1: Half-Wave Rectifier

• INTRODUCTION

Diodes are a critical part of DC power supplies. The half-wave rectifier is the simplest type of AC-to-DC converter. The overall goal of PreLab1 is to simulate some half-wave rectifier circuits that you will test during the lab session.

• GENERAL GUIDELINES

1) Each student must turn in his/her own Pre-Lab assignment (include both schematics and waveforms).
2) Students are allowed (even encouraged) to work together. However, you must turn in your own work! Turning in multiple printouts of the same schematic/waveforms (with different student names) will result in ZERO points.
3) You will be using the program Multisim for all simulations. The program is installed on all of the computers in N100, N102, and N106.

NOTE: There will be two lab exams during the term. Each lab exam will test each student’s ability to use Multisim and build/test a circuit.

• PART 1: HALF-WAVE RECTIFIER

TASK 1a: Simulate the half-wave rectifier shown below. Use the tutorial on the WEB site to get started.

- The voltage source is a sine wave generator (10V_{pp}, 60 Hz) in series with a 50 ohm resistor. This is a pretty good approximation of the Agilent 33220 function generators in N100.
- Note that 10 V_{pp} means peak-to-peak, so the sine wave amplitude is actually 5 V.
- The 1N4002 diode can be selected from the place menu by selecting: component | Diodes | Diode | 1N4004G.
- The resistor is 10 kohm.
- From the menu bar select: simulate | Analysis | Transient. Set the End Time to .05 s and the minimum number of points to 1000.
- After running the simulation a “Grapher” screen will pop up. Turn on the Grid. From the Cursor menu select show cursers and then select to the next Y MAX =>. After the cursor goes to the maximum point select Add Data Label at Cursor.
- Your simulated waveform should look like the graph shown below.
- Turn in both the schematic and waveform.

![Circuit schematic and simulated load voltage.](image)
**TASK 1b:** The half-wave rectifier output is obviously a terrible DC power supply. Smoothing capacitor to the rescue!

- Add a 1 uF electrolytic capacitor to the circuit, as shown below.
- Use a simulation end time of .05 s.
- Measure the maximum voltage of your waveform using the cursor menu.
- Measure the ripple voltage using the cursors.
- Estimate the ripple voltage using the formula from Lecture 1. You can use the measured max voltage for “V_p”. Compute the percentage error of this estimate with respect to your simulated “peak-to-peak” value.

**NOTE:** You should get an unrealistic result from the formula. This is why simulation is important! Explain why the calculated value is so far off.

- Turn in both the schematic and the waveform.

![Circuit schematic, data output adjustment, and simulated load voltage.](image)

**TASK 1c:** We can reduce the ripple voltage by increasing the capacitor value!

- Change the electrolytic capacitor value to 100 uF (single right click on the capacitor select properties and change value.
- Re-run your simulation using the same settings as before. Then change the start time to .5 s and the stop time to 5.5 s. Explain the differences between the two waveforms.
- Measure the maximum voltage and peak-to-peak voltage.
- Estimate the ripple voltage using the Lecture 1 formula. You can use the measured max voltage for “V_p”. Compute the percentage error of this estimate with respect to your simulated “peak-to-peak” value.

**NOTE:** Your ripple should be much smaller than in Task 1c.

- Turn in both the schematic and waveform.
• PART 2: AC VOLTAGE LIMITER

Task 2a: Simulate the AC voltage limiter shown below.

- The voltage source is a sine wave generator (10Vpp, 10 Hz) in series with a 50 ohm resistor.
- From the place menu select diodes | LED then RED_LED for one and GREEN_LED for the other.
- Run a Transient analysis selecting the correct start and end times.
- Measure the maximum and minimum values of your waveform using the cursors.
- Turn in both the schematic and waveform.
- Turn the toggle switch in the upper right corner of the Multisim screen and you should see the LEDs blink alternately. Pretty neat!!

![Fig. 4: Your AC voltage limiter simulation should look like this.](image)

(End of PreLab1)

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