

## 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<sub>pp</sub>, 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<sub>pp</sub> 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.

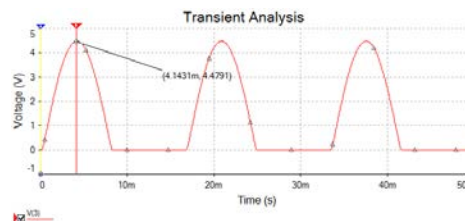
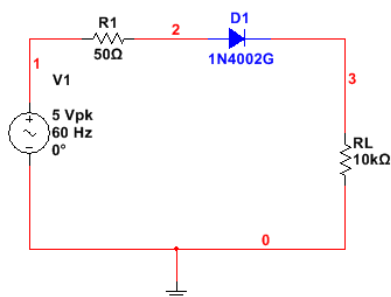


Figure 1: Circuit schematic and simulated load voltage.

**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.

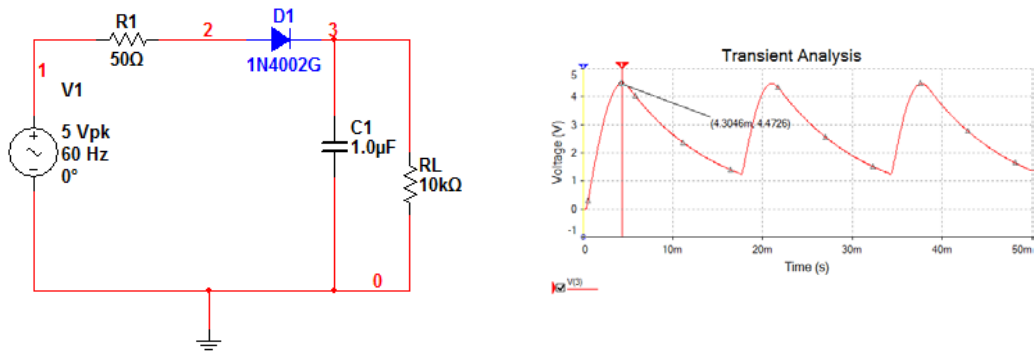


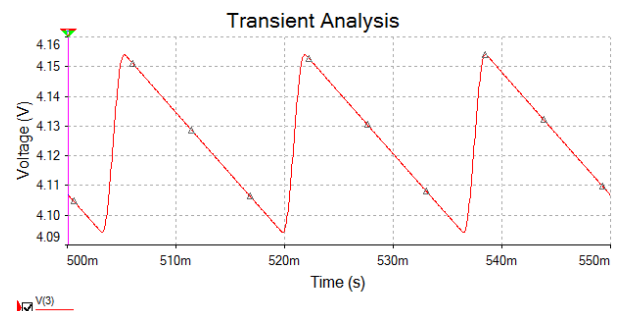
Figure 2: Circuit schematic, data output adjustment, and simulated load voltage.

**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.

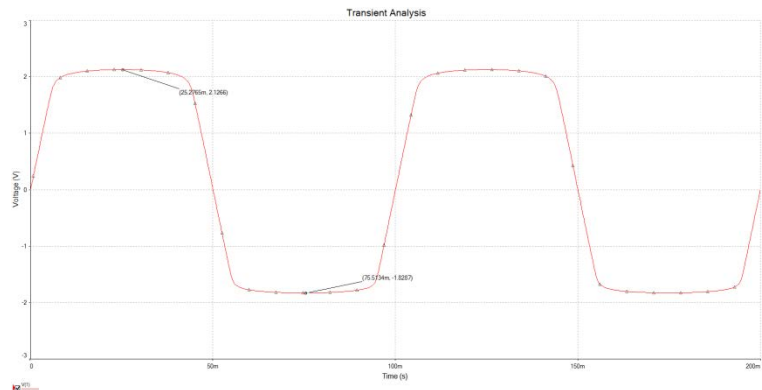
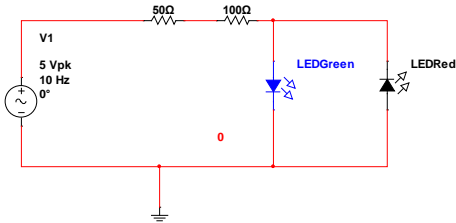
- Turn in both the schematic and waveform.



## • PART 2: AC VOLTAGE LIMITER

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

- The voltage source is a sine wave generator (10V<sub>pp</sub>, 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.

(End of PreLab1)

Spring 2015