ECE 3254 Laboratory
Diode Rectifier Circuits
Laboratory #5 Fall 2009
PRELAB (100 points total)

Name ________________________
Date: ________________
Bench: __________

Prelab assignment (to be completed before coming to Lab 5):

1. Read through the entire Lab 5 handout and Lab1 notes.

2. (10 points) Why is an isolation transformer required when using a Variac as a signal source? (hint: see Part I of the lab, and the Prelab notes)

3. (10 points) Why is a 10:1 isolation transformer required when using an oscilloscope to measure the output waveform of a bridge rectifier? (hint: see the Prelab notes)

4. (10 points) What does the "line trigger" do, and why will we use line triggering while measuring the output waveforms of our rectifier circuits supplied by the AC power mains? (hint: see Part I of the lab)

5. (10 points) Build the half wave rectifier circuit shown in Fig 5-1 in Pspice.
Select a D1N4002 for D1. Set R2 = 1kΩ and C1 = 1nF.
Add V1 as a sine source VSIN set for 10Vp at 60 Hz with no DC offset.
Place two voltage probes for measuring Vin (V1), and Vo (at R2).

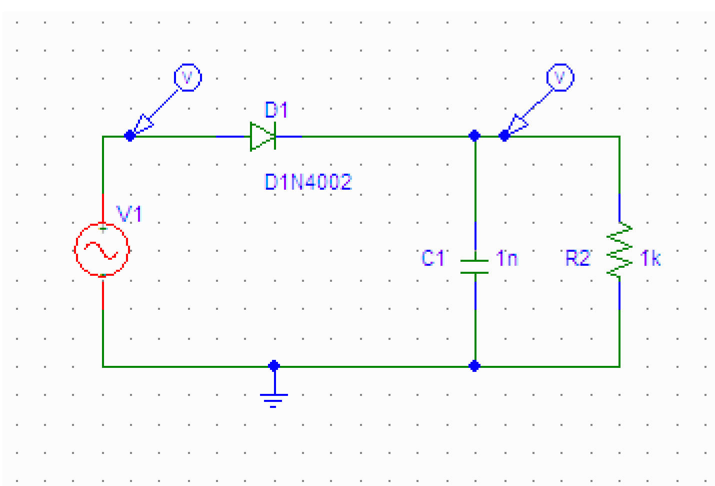

Figure 5-1

Use Pspice transient analysis to simulate the Vin(t) and V_o(t) waveforms from t = 0 to t = 50ms in 0.2ms steps. On the simulation results, use the cursors to find measure Vin_{max}, Vo_{min}, and Vo_{max}. Calculate $Vo_{pp} = Vo_{max} - Vo_{min}$ and V_D (the forward diode voltage drop = $Vin_{max} - Vo_{max}$).

Vin_{max} = ____________, Vo_{max} = ____________, Vpp = ____________, V_D = ______________

Enter these values in Part I-2 on the Data sheet.

Place a label on the simulation with your name and "Prelab 5 Half Wave", and print the simulation.

6. (25 points) Modify the Pspice model in question 5 by changing C1 to 10µF and replacing R2 with a variable resistor. Run a Parametric Sweep analysis for RL = 500Ω to 10500Ω in 2000Ω steps. Use the cursor to measure and mark Vo_{min} for RL = 500, 2500, and 10500 and Vo_{max} (note: Vo_{max} does not change much as RL varies, so measure and mark Vo_{max} for only one resistor value).
Calculate Vo_{pp} for three values of RL.

RL = 500Ω Vo_{min} = ______________, Vo_{max} = _______________ Vpp = ________________

RL = 2500Ω Vo_{min} = ______________, Vo_{max} = _______________ Vpp = ________________

RL = 10500Ω Vo_{min} = ______________, Vo_{max} = _______________ Vpp = ________________

Enter these results in Part I-3 on the Data sheet.

Edit the bottom right drawing information box to include our name, the date, and "Prelab 5 Half Wave". Save the schematic and then print it.

Place a label on the simulation with your name and "Prelab 5 Half Wave", and print the simulation. On the print, write the resistor value at each minimum voltage that has a simulation label, and write Vmax at the max voltage simulation label.

7. (25 points) Edit the half wave rectifier of question 6 to build the full wave bridge rectifier circuit shown in Fig 5-2.

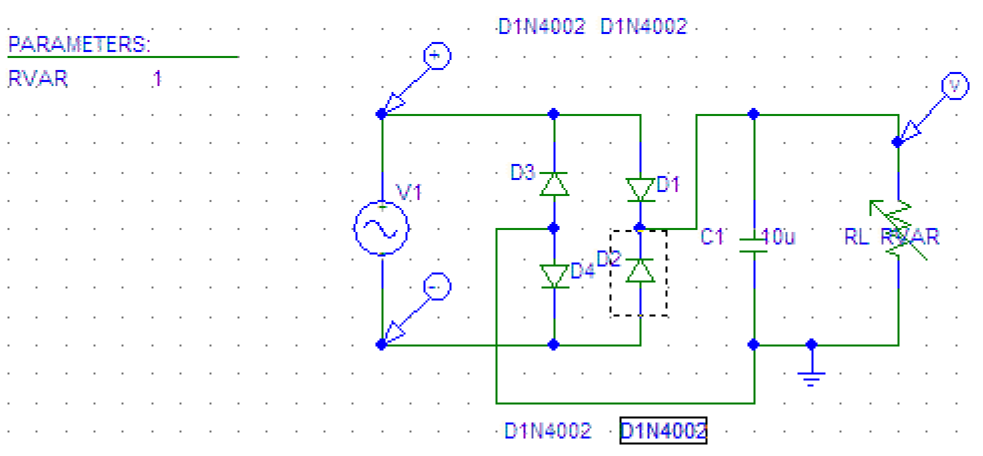

Figure 5-2
Note: You must use a differential voltage probe to measure V1 because V1 is not grounded.

Run the same parametric sweep that you did on question 6.
Use the cursor to measure and mark Vo_{min} for RL = 500, 2500, and 10500 and Vo_{max} (note: Vo_{max} does not change much as RL varies, so measure and mark Vo_{max} for only one resistor value).
Calculate $Vpp = Vo_{max} - Vo_{min}$ for three values of RL.

RL = 500Ω Vo_{min} = ______________, Vo_{max} = ________________ VVpp = _________________

RL = 2500Ω Vo_{min} = ______________, Vo_{max} = ________________ VVpp = _________________

RL = 10500Ω Vo_{min} = ______________, Vo_{max} = ________________ VVpp = _________________

Enter these results in Part II-3 on the Data sheet.

Edit the bottom right drawing information box to include our name, the date, and "Prelab 5 Full Wave". Save the schematic and then print it.

Place a label on the simulation with your name and "Prelab 5 Full Wave", and print the simulation. On the print, write the resistor value at each minimum voltage that has a simulation label, and write Vmax at the max voltage simulation label.

8. (5 points) Look at the Parametric sweep results for the full wave and half wave circuits. Compare Vo_{max}, Vo_{min}, and Vpp for the three resistor values. What can you say about the output voltage as RL decreases?

9. (5 points) Which rectifier circuit provides the best regulation (lowest ripple)? Why is this?

This page left blank for calculations

ECE 3254
Diode Rectifier Circuits
Laboratory #5
Last Revised: 09-25-2009

Part I: Half Wave Rectifier and Filter

1. Build the rectifier circuit of Figure 5-3 on the protoboard. D1 is a 1N4001, 1N4002, or 1N4003 rectifier. Use the decade resistor for RL and leave C1 out of the circuit.

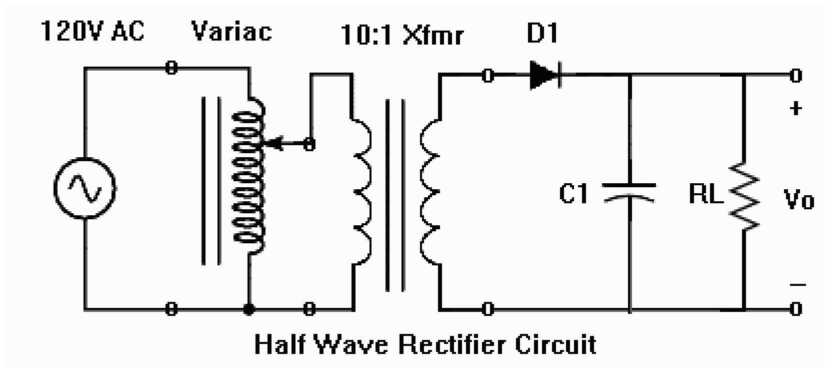

Figure 5-3

For Vin, use the Variac autotransformer and 10:1 isolation transformer for the input voltage source.
The Variac plugs into the 120V AC bench power outlet. The red isolation transformer plugs into the autotransformer output.

Note: The isolation 10:1 step-down transformer must be used with the Variac to eliminate the possibility of hazardous voltages in your circuit and to safely isolate the power line from you and your circuit.

Note: Set your load resistor to 10.5kΩ before connecting the transformer to the rectifier circuit.

With the load resistor set to 10.5kΩ (10,500Ω), use banana leads to connect the isolation transformer output to the rectifier AC input.

Connect the scope to the isolation transformer and adjust the autotransformer until scope measures isolation transformer output to be 20Vpp. When the voltage has been set, move the scope connection to R_L

2. **Set the scope trigger source to LINE** (using the Trigger EDGE button). Line triggering is used to synchronize the output waveforms to the 60Hz AC power line. Line triggering enables you to align and overlay the diode output waveforms for various load conditions by always beginning the trace at the AC power line 0V crossover. **Do not use the "autoscale" button** for any rectifier measurements.

   Set the Horizontal scale to 5ms/div, move the scope probe to R_L to **display the V_o waveform** on CH1 using DC input coupling, and measure the maximum, minimum, and ripple (peak-to-peak) load voltages. Calculate V_D. Record these values on the data sheet.

Use the computer to capture and save the DC coupled V_o waveform data
Filename=____________________.txt

3. Connect a 10µf filter capacitor (for C1) in parallel with R_L. Leave the Horizontal scale at 5ms/div for all measurements and Display the V_o waveform on CH1. For each value of R_L in the table below, measure the DC coupled minimum, maximum, RMS, and peak-to-peak voltages, and calculate the diode forward voltage drop ($V_D = Vin_{max} - Vmax$). As R_L changes, you will need to **adjust the Vertical scale and position** to keep the waveform on the screen and large enough for quick measure to accurately find the voltages. **DO NOT USE AUTOSCALE!** Leave the horizontal scale at 5ms/div for these measurements. Capture the DC coupled waveforms for R_L = 500Ω, 2.5kΩ, and 10.5kΩ. Record your measurements and calculations on the data sheet.

4. Use the buffer to overlay the 500Ω and 2.5KΩ waveforms and save the overlay.
______________.txt

   Overlay the 10.5kΩ/no capacitor halfwave waveform (from # 2) with the 10.5kΩ/10µf waveform obtained in the table above. ______________.txt

   Combine (overlay) the 500Ω/2.5KΩ overlay with the 10.5kΩ overlay and save this composite overlay (there should be 4 traces in this composite). _______________.txt

   Return to the main buffer and save the composite overlay as a jpeg file.

   ***Print one copy of the jpeg**, title the print, clearly identify the traces for each of the load conditions, write all names on the print, and attach the print to one of the lab reports.

   ***Answer the questions** on the data sheet.

Part II: Full Wave Bridge Rectifier and Filter

1. Build the rectifier circuit of Figure 5-3 on the protoboard. Use the decade resistor for RL and leave C1 out of the circuit.

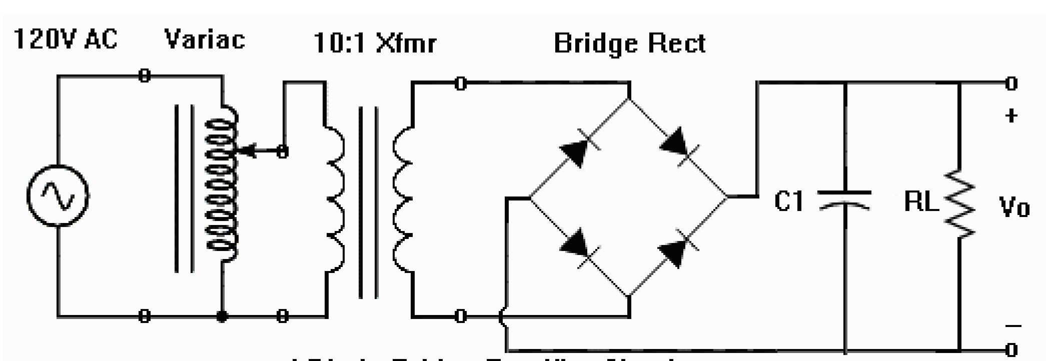

Figure 5-4

Use the same Variac/isolation transformer source that you used for the half wave rectifier.

With the load resistor set to 10.5kΩ (10,500Ω), use banana leads to connect the isolation transformer output to the rectifier AC input. Connect the scope to the isolation transformer and adjust the autotransformer until scope measures isolation transformer output to be 20Vpp. When the voltage has been set, move the scope connection to R_L

2. **Set the scope trigger source to LINE and the horizontal scale to 5ms/div**.

   Display the V_o waveform on CH1 using DC input coupling and measure the minimum, maximum, RMS, and peak-to-peak voltages. Calculate V_D. Record these values on the data sheet. Record these measurements on the data sheet.

   Use the computer to capture and save the DC coupled V_o waveform data
   Filename=____________________.txt

3. Connect a 10µf filter capacitor in parallel with R_L. Display the V_o waveform on CH1. For the values of R_L in the table below, measure the DC coupled maximum, minimum, and peak-to-peak voltages, and calculate the diode forward voltage drop ($V_D = Vin_{max} - Vmax$). Remember that there are two diodes conducting, so V_D will be half of the difference between Vmax and 10V. As R_L changes, you will need to adjust the Vertical scale and position to keep the waveform on the screen and large enough for quick measure to accurately find the voltages. DO NOT USE AUTOSCALE! Record the measurements and calculations on the data sheet.

   Capture the DC coupled waveforms for R_L = 500Ω, 2.5kΩ, and 10.5kΩ.

4. Use the buffer to overlay the 500Ω and 2.5KΩ waveforms and save the overlay.
   ______________.txt

   Overlay the 10.5kΩ/no capacitor fullwave waveform (from the previous page) with the 10.5kΩ/10µf waveform obtained in the table above. ____________.txt

   Overlay (combine) the 500Ω/2.5KΩ overlay and the 10.5kΩ overlay and save this composite overlay (there should be 4 traces in this composite). _______________.txt

   Return to the main buffer and save the composite overlay as a jpeg file.

   ***Print one copy of the jpeg,** title the print, identify the traces for each of the load conditions, write all partners names on the print, and attach the print to one of the lab reports.

   ***Answer the questions on the data sheet.**

5. **Before you leave:** Shut down Windows, return cables to racks, return parts to correct drawer bins, return adapters to container, turn off bench power, clear bench, and place seat under bench. **(Counts as 5 points of the Lab grade)**

ECE 3254 Lab 5 Data Sheet **Date**______________ **Bench**_________
(100 points total)
100 points total)
Names: ________________________ ______________________ ______________________
by first name: 2nd alphabetically – wiring 3rd alphabetically – Labview 1st alphabetically – data sheet

Part I: Half Wave Rectifier and Filter

2. *From the Prelab Pspice simulations:*

Vin_{max} = _____________, Vo_{max} = _____________, Vpp = ___________ V_D =_______________

Measured in the Lab:

Vin_{max} = _____________, Vo_{max} = _____________, Vpp = ___________ V_D =_______________

3. *From the Prelab Pspice simulations:*

R_L Ω	Vmin	Vmax	Vpp
500			
2.5k			
10.5k			

Measured in the Lab:

R_L Ω	Vmin	Vmax	Vpp	Vrms	Data filename
500					.txt
2.5k					.txt
10.5k					.txt
∞					do not capture

4. What changes do you see in V_{max}, V_{min}, V_{rms}, and the ripple (V_{pp}) as R_L changes?

What is responsible for these changes? (hint: see prelab notes)

How do the voltages compare to the values predicted by Pspice? What accounts for the difference?

Part II: Full Wave Bridge Rectifier and Filter

2. Measured in the Lab:

Vin_{max} = ____________, Vo_{max} = ____________, Vpp = __________ V_D =______________

3. *From the Prelab Pspice simulations:*

RL Ω	Vmin	Vmax	Vpp
500			
2.5k			
10.5k			

Measured in the Lab:

RL Ω	Vmin	Vmax	Vpp	Vrms	Data filename
500					.txt
2.5k					.txt
10.5k					.txt
∞					do not capture

4. What changes do you see in V_{max}, V_{min}, V_{rms}, and the ripple (V_{pp}) as R_L changes?

What is responsible for these changes? (hint: see prelab notes)

How do the voltages compare to the values predicted by Pspice? What accounts for the difference?

5. How do the V_o ripple voltage, V_{max}, V_{rms}, and V_{min} for the half wave rectifier compare to the results obtained for the same load resistor with a full wave rectifier?

6. Shut down Windows, return cables to racks, return parts to correct drawer bins, return adapters to container, turn off bench power, clear bench, and place seat under bench. (5)