CECS 311 - LAB 2
Power Supply Modeling and Construction
Transformer, Full-Wave Bridge Rectifier, Regulators

NAME: POSSIBLE POINTS: 10

COURSE DATE & TIME:

Although this lab will be done in groups of 2, each person must submit their own lab report and conduct all the simulations themselves. Only the measurements of the actual components and oscilloscope images may be shared.

This lab will create a fully functional Regulated 5v Power Supply. We will progress from modeling each of the individual components and entire design on LTSpice to prototyping this proof of concept on a breadboard.

LTSpice Modeling:

Step 1: In LTSpice add a voltage to imitate Mains Power. This is a 120Vrms 60Hz AC voltage. Also set the series resistance on the voltage source to 0.0001 ohms and set a label on the output called "Mains".

Take a screenshot of the waveform with a cursor placed at the peak voltage and also ensure that the screenshot includes the cursor window so that the peak voltage is clearly visible

-Include Screenshot Here-

Step 2: Now in the lab using the real transformer and the oscilloscope. Take a voltage measurement of your transformer you will be using to construct your power supply (ground clip on one of the outer AC terminal, and probe the other outer AC terminal). Include a picture of your oscilloscope screen that shows approximately 2 cycles. Also use the horizontal cursor to display the voltage and make sure the cursor and value (in the lower right corner) is readable.

Transformer Secondary Windings Peak Voltage: _____

Transformer Secondary Windings Peak-Peak Voltage: _____

We will assume that the Primary Windings actually have 120Vrms as this is a difficult and potentially dangerous measurement to make. No one in class should attempt to probe, touch, or interact in anyway with the mains 120Vrms power.

-Include Picture Here-

Now calculate the Turns Ratio (i.e. 5:1, 5.2:1 etc..) for the actual transformer you are using assuming a 120Vrms input to the Primary Windings: Show your work below

Turns Ratio:_____

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Step 3: In LTSpice create a transformer that has the same Turns Ratio that you calculated and attach to the Mains Power from step 1. Label the output from the Secondary Windings as "Secondary". Run your model again and take a measurement of the output from the secondary windings. You do not need a screenshot yet, just enter the values below.

Transformer Inductor Lp value in henrys:_____

Transformer Inductor Lp value in henrys:_____

LTSpice Modeled Transformer Secondary Windings Peak Voltage: _____

LTSpice Modeled Transformer Secondary Windings Peak-Peak Voltage: _____

What is the difference between the values from your actual transformer in Step 2 vs the modeled transformer step 3?

Peak Voltage Difference (actual - modeled): _____

Peak-Peak Voltage Difference (actual - modeled): _____

Now, do your best to adjust the LTSpice modeled transformer to behave the same as your actual transformer. This will require some trial and error.

New Transformer Inductor Lp value in henrys:_____

New Transformer Inductor Lp value in henrys:_____

New LTSpice Modeled Transformer Secondary Windings Peak Voltage: _____

New LTSpice Modeled Transformer Secondary Windings Peak-Peak Voltage: _____

Take a screenshot of the new adjusted transformer waveform with a cursor placed at the peak voltage and also ensure that the screenshot includes the cursor window so that the peak voltage is clearly visible.

-Include Screenshot Here-

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Step 4: In LTSpice, now contruct a Full-Wave Bridge Rectifier using 1N4001 Rectifier Diodes. Label the positive output from the rectifier as "Rect". Take a screenshot of the schematic and waveform. The waveform should show 5 cycles of "Mains" and "Rect" Take a differential voltage measurement of "Mains" and "Rect". This should show the voltage drop of the rectifier.

Peak Voltage of Mains Signal:_____

Peak Voltage of Rect Signal:_____

Calculated Voltage drop on the Rectifier:_____

Frequency of the output from Secondary Windings:_____

Frequency of the Rectified Voltage:_____

-Include Screenshot Here-

Step 5: Now construct the actual Full-Wave Bridge Rectifier on your breadboard. Attach the Transformer to the Rectifier. We would like to use the oscilloscope to see a waveform of the input and output of the rectifier, but due to a physical grounding problem with our oscilloscope probes we can not measure the input and the output of the rectifier at the same time. Use Ch1 to measure and take a screenshot of the Input. Then take another measurement and screenshot of Ch1 attached to the output of the rectifier. The output from the Rectifier is **Pulsating DC.**

Measured Frequency of Secondary Windings:_____

Measured Frequency of Rectifier:_____

Measured Peak-Peak Voltage of Secondary Windings:_____

Measured Peak-Peak Voltage of Rectifier:_____

Measured Peak Voltage of Secondary Windings:_____

Measured Peak Voltage of Rectifier:_____

-Include Picture 1 of the Oscilloscope Waveform for the Rectifier Input Here-

-Include Picture 2 of the Oscilloscope Waveform for the Rectifier Output Here-

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Step 6: Now we need to turn the Pulsating DC into something resembling DC i.e. Smoothed… In LTSpice, add a 2200uF Cap and 100 ohm Load Resistor. We sometimes call this capacitance "Bulk Capacitance" or a "Smoothing" Capacitor… Take a screenshot of the waveform showing the two signals, Rect and Secondary. Take a differential voltage measurement on the Rect signal, with the 2 cursors on the Min and Max voltage, this is Vripple - Ripple Voltage, make sure these measurements are visible in screenshot.

Measured Peak Voltage of Rect:_____

Measured Peak-Peak Vripple:_____

Calculate by hand and show all work and the equation for the theoretical approximate Vripple given the values we are using, make sure to use the Measured Peak Voltage of Rect:

Theoretical Vripple:_____

Difference of Theoretical Vripple vs Measured:_____

-Include Screenshot Here-

Step 7: **For this next step, call the instructor over. You must use a special resistor because of the large power being dissipated.** Now add the 2200uF Cap and a 100 ohm Load Resistor to the breadboard.

Calculate the power dissipated a 100 ohm Load and show the calculation:

Power Dissipated by RL, P_{RL}:_____

Connect the oscilloscope with 2 channels to measure both the output from the Secondary Windings and the Rectifier. Use the horizontal cursors on Rectified voltage to take a measurement on the Vripple. Take a picture that shows approximately 2 cycles of both the voltage on the Secondary Windings and the Rectified/Smoothed Voltage. The differential voltage indicating Vripple should be clearly displayed in the lower right hand corner using the horizontal cursors. This should approximately equal the values from LTSpice in Step 6**.**

Measured Peak Voltage of Rect:_____

Measured Peak-Peak Vripple:_____

Theoretical Vripple:_____ Modeled Vripple:_____ Measured Vripple:_____

-Include Picture Here-

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Step 8: In LTSpice, add the 7805 Regulator with appropriate filter caps and a 100ohm Load on the output. Label the output at "Vout". In the waveform, display Rect and Vout. Place the cursors on Vout and take a screenshot to demonstrate the regulated output voltage.

Measured Vout:_____

-Include Screenshot Here-

Step 9: On the actual circuit on your breadboard, attach the 7805 with the same filter caps from Step 8 and attach a 100ohm load.

Power Dissipated by RL, P_{RL}:_____

Your resistors should be ¼ Watt rated. Double the Power Dissipated that you calculated and select a number of resistors that when placed in parallel will equal 100ohms. In parallel the ¼ watt rating will be multiplied by the number of resistors in parallel, as long as you select a power rating that is double that of P_{RL}, you should have very safe power rating margins. **Call the instructor over to double check before powering it up.**

Connect your oscilloscope with Ch1 on Rect and Ch2 on Vout from the Regulator. Take a picture of the output with a horizontal cursor to show the regulated 5v on the output.

Measured Output Voltage from Regulator:_____

Measured Ripple on Output:_____

-Include Picture Here-