EE 40 PROJECT 1: AN AUDIO AMPLIFIER

Part 1: Power Supply

Prelab

1 Bridge Rectifier

In this lab we'll be using a circuit known as a bridge rectifier. This circuit is used to convert AC voltages to DC voltages. You may have noticed that we use a DC power supply in nearly every circuit we build in lab. However, the power coming out of a wall outlet in the US is 120 V_{rms}, 60 Hz AC. This means that nearly every electronic device incorporates a small AC to DC converter, and the bridge rectifier is one of the key pieces in this converter.

Figure 1 shows a typical bridge rectifier setup. A transformer is used to reduce the voltage and then the signal is fed to a bridge rectifier. Often, there is a large capacitor present on the output of the bridge rectifier.

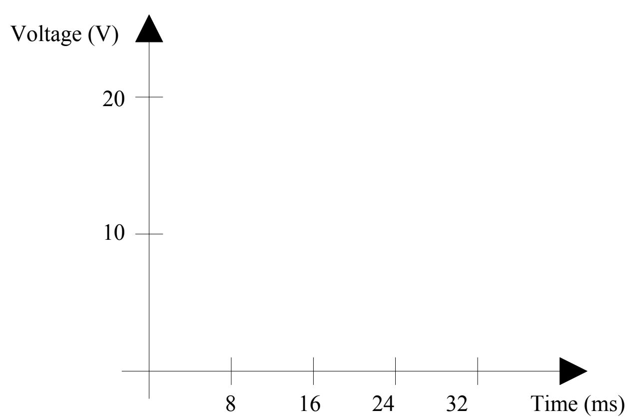
In this problem use the following assumptions:

- The wall outlet provides power in the form of a sinusoid. This sinusoid provides 120 V_{rms} at 60 Hz.
- The transformer has winding ratio 10:1.
- The diodes in the bridge rectifier can be approximated with the large signal model. Use $V_{th} = 0.7V$.

1.1 No Output Capacitor

First we'll assume that there is no output capacitor. Ignore C.

Sketch V_{out} as a function of t.



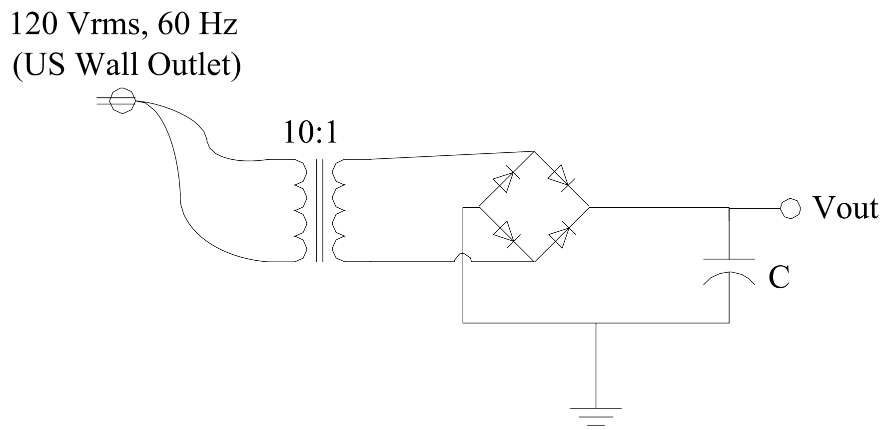
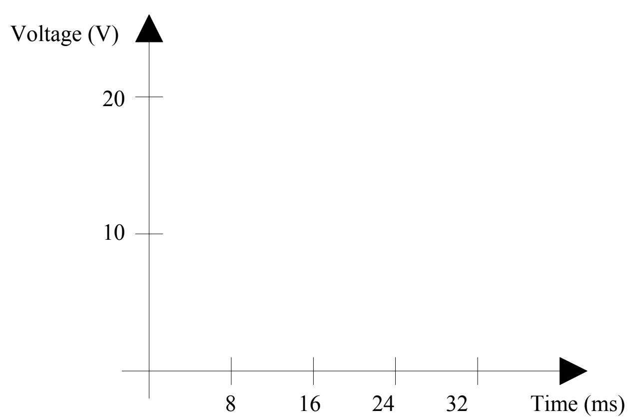


Figure 1: Bridge rectifier circuit.

What is the maximum voltage seen at V_{out} ?

1.2 With Output Capacitor

Now assume that there is a large output capacitor on the output of the bridge rectifier. Sketch V_{out} .



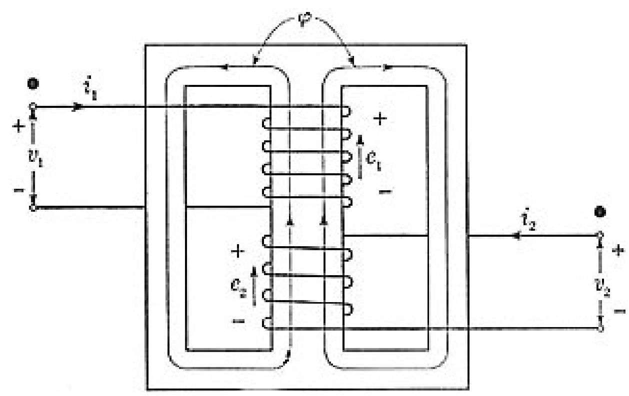


Figure 2: A typical transformer.

If we also place a load resistor in parallel with the output capacitor, how will the waveform change?

2 A Closer Look at the Transformer

A typical transformer design is shown in Figure 2. It consists of two pieces of wire would around a piece of iron. The wire on the left is known as the primary winding. The wire on the right is the secondary winding. We call the piece of iron the core.

Current i_1 entering the primary winding induces a magnetic field φ in the core. This magnetic field then in turn induces a voltage e_1 in the primary winding. Because of e_1, we are not short-circuiting the primary. The magnetic field also induces a voltage e_2 in the secondary. If we hook the secondary to a circuit, a voltage i_2 would be induced.

All wire in the real world has some non-zero resistance. In addition, the longer the wire, the higher the resistance will be. Assume that the resistance of the secondary is 5Ω. Also, assume that the turns' ratio is 10:1 and that the primary side is fed with 120 V_{rms}.

If we short the secondary side, how much current will flow through the secondary winding?

How much power will be dissipated in the secondary winding?

When a resistor absorbs energy, it heats up. What will likely happen to the secondary winding when we short it?

3 Building the Circuit

You will not have enough time to finish the audio amplifier unless you build the circuit outside of lab. Before you show up to the first lab, build the parts of the circuit that are listed below. Your pre-lab grade will be based significantly on completion of this section (not to mention, you probably will not finish the project if you do not build your circuit at home). Pay attention to the questions that are asked at the end of each section, as you will have to answer each of them during lab. Don't worry if your POT or AC transformer to breadboard jack does not stay in your breadboard; it may be necessary to solder wires to them.

- **Power Supply:** This section of the circuit converts the AC signal from the transformer into a clean, usable 5V DC supply. Follow the directions in sections 1 to 5 of the Part I lab guide to build the circuit. Do your best to limit this part of your circuit to the top third of your breadboard.

  Once you are done, the power supply section of your circuit should look like Figure 6 in the Part I guide.

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- **Audio Amplifier:** This section of the circuit drives the audio output jack and contains the volume control. Follow the directions in sections 1 to 4 of the Part II lab guide to build the circuit. Leave the 5V supply and male headphone jack unconnected, but make note of where you want to plug them in during lab. You will solder wires to the male headphone jack during lab. Do your best to limit this part of your circuit to the middle third of your breadboard.

  Once you are done, the audio amplifier section of your circuit should look like Figure 4 in the Part II guide.

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REVISION HISTORY

Name	Date	Note
David Lin	7/28/05	Revised Fall 2004 audio amplifier project for use with <12V supply and summer schedule.