The George Washington University
School of Engineering and Applied Science
Department of Electrical and Computer Engineering
ECE 20 - LAB
Experiment # 3b

Solid-State Diodes
Applications III

Components:

Kit Part #	***Spice Part Name***	***Part Description***	***Symbol Name*** ***(used in schematics throughout this lab manual)***
1N4002	D1N4002	Series Silicon Diode	D1
1N751A	D1N751	Zener Diode	VR1
MV5753	*NONE*	(GaAsP) Light Emitting Diode (LED)	DS1
LM 7805		Voltage Regulator IC	
1N751A	*XFRM_NONLIN*	$115V_{RMS}$ – $18V_{RMS}$ Center Tapped Transformer	TX1
Resistors	R	Value determined in prelab	RL
Capacitors	C	Value determined in prelab	C1

Table 1.1

Objectives:

- To design, build and test a Zener regulator circuit
- To design, build and test a 5 VDC regulated power supply
- To design a filter circuit
- To measure ripple voltage and obtain the ripple factor

Prelab: ***(Submit electronically prior to lab meeting,*** *also have a printed copy for yourself during lab)*

1. Read through lab, generate an equipment list.
2. Download and **Print** the specification sheet for the diodes: 1N751A, MV5753, the regulator circuit: 7805 *(see the lab website for links to spec sheet downloads)*

    a) From the spec sheet, populate the following table for each component:

Zener Diode:	V_Z, @ I_{Zt}	I_{Zt}	Zener Impedance	Max Regulator Current
1N751A				

Table 1.2a – Spec Sheet Values

LED	V_F (typical)	I_F
MV5753		

Table 1.2b – Spec Sheet Values

V. Regulator	V_F (typical)	I_F
LM7805		

Table 1.2c – Spec Sheet Values

3. Using the zener diode in your kit: 1N751A, with the spec sheet values you collected in table 1.2a, design a zener regulator circuit that has the specifications below. Simulate your circuit design using SPICE. Include your scanned hand calculations, complete schematic, with

output plots to ensure the regulator is putting out a constant 5.1 V in your prelab writeup. To aid you with the regulator design, read sections 3.4.1 - 3.4.2 use example 3.8 as a reference.

Zener Regulator Specifications:

- **Input:** 8.13 $V_{DC} \pm 1.87\ V_{DC}$
- **Output (unloaded):** 5.1 $V_{DC} \pm 5$ %
- **Output (loaded):** 5.1 $V_{DC} \pm 5$ %
- **Type of Load:** resistive, 300 Ohms

4. Cascade the center-tapped transformer, full wave rectifier (from lab 2), a filter capacitor, and the zener regulator (similar to the one designed in step 3) to create a basic AC-to-DC power supply with the following specifications.

   Power Supply Specifications:

   - **Line input voltage:** 115 V_{rms}
   - **Regulated output voltage:** 5.1 $V_{DC} \pm 5\%$
   - **Type of Load:** to be calculated using power dissipation parameter
   - **Power Dissipated by the Load:** 175 mW_{DC}
   - **Ripple:** minimum

-Figure 1.1 shows a block diagram of the circuits needed to cascade to create the AC-to-DC power supply. It is similar to figure 3.24 in the Sedra Textbook.
- Include your scanned hand calculations, complete schematic, with output plots of the output voltage at each block of the circuit schematic below. Be sure to place markers on your plots to make it clear your circuit is working.
-Note: The 175mW_{DC} requirement, may force you to change your Zener regulator calculations

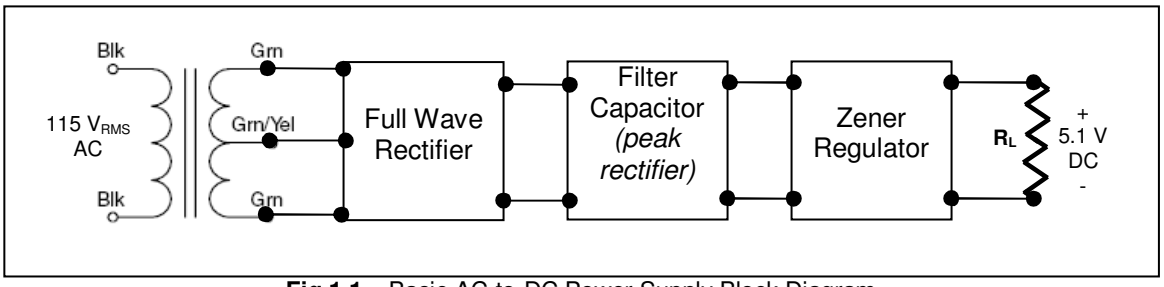

Fig 1.1 – Basic AC-to-DC Power Supply Block Diagram

Extra Credit *(good preparation for midterm project):*
-Add an LED (MV5753) to your AC-DC power supply from step 4, to indicate when the circuit has 5.1V across it. Show the necessary adjustment needed in your power calculations to include the LED.
-Note: Adding the LED may force you to change your Zener regulator calculations

Comments:
-Be prepared for possible prelab quiz on zener diode operation
-Look ahead to the midterm project and begin to see the similarities between this lab and the project. Prepare questions for your GTA regarding the project.

LAB:

CAUTION!
BE CAREFUL DURING THIS EXPERIMENT!
HAZARDOUS VOLTAGES WILL
BE PRESENT WHEN YOU PERFORM
YOUR MEASUREMENTS!

Part I – Zener Regulator:

a. Assemble the zener regulator circuit you designed in part 3 of the prelab.

b. Use the Keithley 175 to measure the DC output voltage to verify the correct operation of your design. Increase the DC input voltage and record the output voltage. Take enough readings to prove that your circuit is "regulating" the output voltage across the 300 ohm resistor. Record the values for the input and output voltage in a table.

c. Compute the load regulation value (Sedra example 3.8 page 170), show all calculations.

CAUTION!
BE CAREFUL DURING THIS EXPERIMENT!
HAZARDOUS VOLTAGES WILL
BE PRESENT WHEN YOU PERFORM
YOUR MEASUREMENTS!

Part II – 5 Volt AC-DC Power Supply

a. Assemble the AC-DC power supply you designed in part 4 of the prelab.

b. Verify the operation of your circuit using the Keithley 175 and an oscilloscope. Test it with and without the load, measure the ripple, and calculate the ripple factor for your circuit. Include plots showing the output voltage for each stage of your design. *NEVER measure the primary coil of your transformer with the oscilloscope, only measure the secondary coil's output voltage.*

Extra Credit

c. Adjust your AC-DC design to include the LED indicator light you calculated for in the prelab.

d. Your GTA will explain the operation of LM 7805 – Voltage Regulator IC. Once explained attempt to use this in place of your zener regulator in your AC-to-DC power supply. Verify the operation of you supply is the same (if not better) than with the zener regulator.

Part III - Analysis of Results

Explain the design considerations and characteristics of each of the circuits in this experiment: the Zener regulator and 5 V_{DC} regulator. Compare your calculations and spice results to your measurements.