THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

SCHOOL OF ENGINEERING AND APPLIED SCIENCE
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
ECE 2115: ENGINEERING ELECTRONICS LABORATORY

Experiment #4:
Solid State Diodes – Applications III

COMPONENTS

Type	*Value*	*Symbol Name*	*Multisim Part*	*Description*
Resistor	300Ω	R_1	Basic/Resistor	---
Resistor	--- Ω	R_L	Basic/Resistor	Determined in Prelab
Capacitor	--- F	C_1	Basic/Capacitor	Determined in Prelab
Transformer	166K18	T_1	Basic/Transformer/1P2S	$115V_{RMS}$–$18V_{RMS}$ C.T.
Diode	1N4002	D_1	Diodes/1N4002G	Series Silicon Diode
Diode	1N751A	D_2	Diodes/1N751A	Zener Diode
Diode	MV5753	D_3	---	GaAsP LED
Regulator	LM7805		Voltage_Regulator/LM7805CT	+5V DC Regulator

Table 1 – Component List

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

Part I – Generate Equipment List

1. Read through the lab manual and generate an equipment list.

Part II – Specification Sheet Values

1. **Download** and **print** the specification sheet for the 1N751A zener diode, MV5753 LED, and the LM7805 regulator IC.
(See the lab website for links to spec sheet downloads and ensure this part number matches your ECE 2115 parts kit list)
    a. From the spec sheet, populate the following table.

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

Table P.1 – Zener Diode Spec Sheet Values

LED	V_F *(typical)*	I_F
MV5753		

Table P.2 – LED Spec Sheet Values

Voltage Regulator	V_F *(typical)*	I_F
LM7805		

Table P.3 – Volage Regulator Spec Sheet Values

Part III – Zener Regulator

1. **Use** the zener diode in your kit (1N751A) and the spec sheet values you collected in **Table P.1** to **design** a **zener regulator circuit** that has the specifications below.

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

2. **Simulate** your circuit design using Multisim.
3. **Include** all calculations, the complete schematic, and output plots to ensure the regulator is putting out a constant 5.1V in your prelab writeup.

Note: *To aid you with the regulator design, read sections* ***4.4.1 - 4.4.2*** *and use* ***Example 4.7*** *as a reference.*

Part IV – 5V AC-DC Power Supply

1. **Cascade** the center-tapped transformer, full wave rectifier, a filter capacitor, and the zener regulator (similar to the one designed in **Part III**) to create a basic AC-to-DC power supply with the following specifications.

· **Line Input Voltage:** $115V_{RMS}$
· **Regulated Output Voltage:** $5.1V_{DC} \pm 5\%$
· **Type of Load:** To be calculated using power dissipation parameter
· **Power Dissipated by the Load:** $175mW_{DC}$
· **Ripple:** Minimum

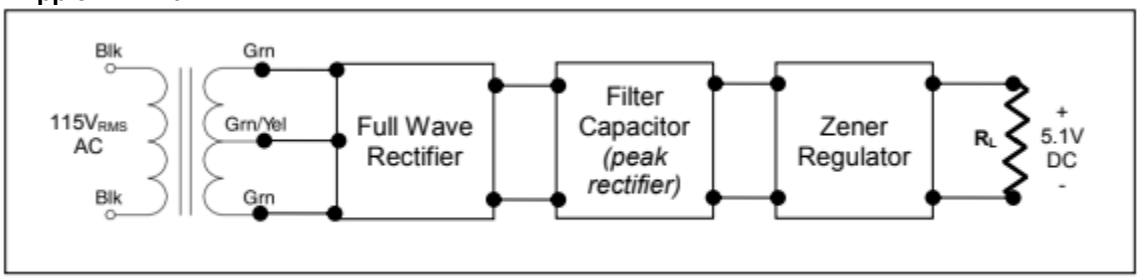

Figure P.1 – Basic AC-to-DC Power Supply Block Diagram

2. **Figure P.1** shows a block diagram of the necessary circuits cascaded to create a basic AC-to-DC power supply. It is similar to **Figure 4.20** in the Sedra textbook.

3. **Include** all calculations, the complete schematic, and 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 that your circuit is working.

Note: *The 175mW requirement may force you to change your Zener regulator calculations.*

4. **Extra Credit** ***(good preparation for midterm project):***

   a. **Add** a red **LED** (MV5753) to your AC-DC power supply 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:

1. Be prepared for a possible prelab quiz on zener diode operation.
2. 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 very careful during this experiment!**
❖ **Hazardous voltages will be present when you perform your measurements!** ❖ **The transformer in this lab has a primary voltage of roughly 120V_{RMS}.**
❖ **If not handled properly, injury can occur from your transformer.**

Part I – Zener Regulator

1. **Build** the zener regulator circuit you designed in **Part III** of the prelab.
2. **Use** the DMM to measure the DC output voltage to verify the correct operation of your design.
3. **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 300Ω resistor.
    a. **Record** the values for the input and output voltage in a table.
4. **Calculate** the load regulation value (**Sedra Example 4.7 page 192**), show all calculations.

Part II – 5V AC-DC Power Supply

1. **Build** the AC-DC power supply you designed in **Part IV** of the prelab.
2. **Verify** the operation of your circuit using the DMM 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.

Extra Credit

1. Adjust your AC-DC design to include the LED indicator light you calculated for in the prelab.
2. Your GTA will explain the operation of the **LM7805** – Voltage Regulator IC. Once explained, attempt to use this in place of your zener regulator in your AC-DC power supply. **Verify** that the operation of your supply is the same (if not better) than with the zener regulator.

POST-LAB ANALYSIS

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