

Thevenin & Norton Review

Air Washington Electronics ~ Introduction to Solid State Lab



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Revised: Friday, March 07, 2014

Thevenin & Norton Review

Overview

In this lab, students will review the concept of Thevenin and Norton circuits by detailing the processes and applying the processes to a complex resistive circuit. In addition, they will apply problem solving skills to solve the same complex resistive circuit.

Requirements

To meet all requirements for this lab, you must complete all activities, questions, critical thinking activities and questions, and observations and conclusions. Compile all results into an APA formatted lab report and submit on line.

Course Objectives

- Describe the basic steps to a systematic troubleshooting approach:
 - Verify the problem.
 - State the problem.
 - Develop appropriate hypothesis.
 - Test the hypothesis.
 - If correct, then continue with repair.
 - If not, reformulate the test hypothesis.
 - Correct the problem.
 - Test and align equipment. If unable to meet equipment specifications, repeat entire process.
 - Document corrective process.
 - Return equipment to service.
- Understand the loading effect of various types of test equipment.
- Understand the limitations of the various test equipment.

Module Objectives

- Calculate the equivalent resistance of a complex circuit.
- Describe in detail the process of finding a Thevenin circuit.
- Perform calculations necessary to find a Thevenin circuit.
- Describe in detail the process of finding a Norton circuit.
- Perform calculations necessary to find a Norton circuit.
- Analyze the relationship between a Thevenin and Norton circuit.

Activities

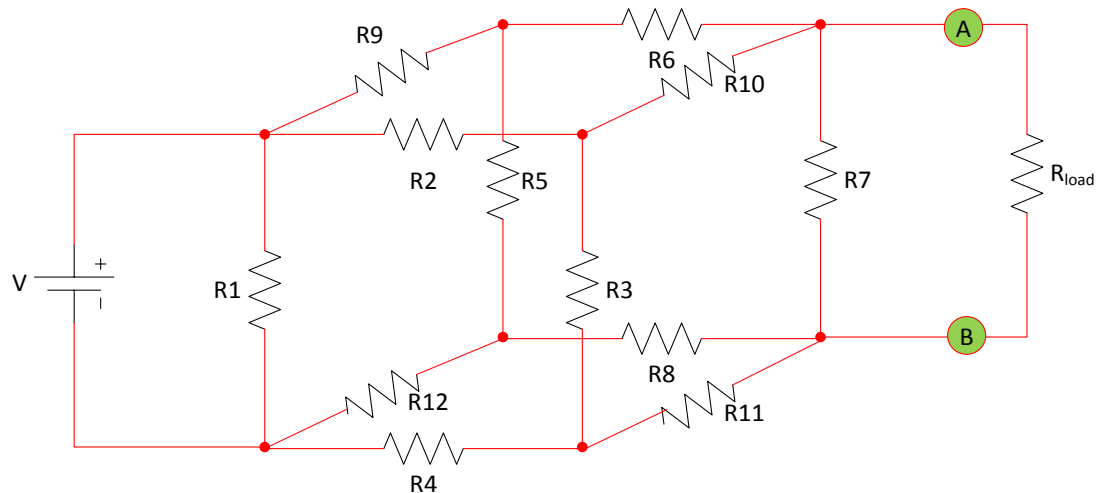
1. Thevenin Circuit
2. Norton Circuit

1: Thevenin Circuit

Components & Equipment Needed

- This experiment will be completed using Multisim only.

Schematic



Notes

- R_1 through R_{12} are of equal – choose a standard resistor value between $1\ \Omega$ and $100\ \text{k}\Omega$
- R_{Load} – choose any value
- V – choose a value between $5\ \text{V}$ and $100\ \text{V}$

Requirements

This assignment requires that you describe and execute the steps necessary to “Thevenize” the above circuit. Then you will need to describe and execute the steps necessary to then “Nortonize” the Thevenized circuit.

Required Elements

- The description of the steps should detail the procedure necessary to perform the actions. In your lab report, the description of the process, in paragraph form, would be included under the Methods section.
- The execution of the steps requires that you build and test the circuit and to then test and validate the Thevenin and Norton in Multisim. In Multisim, use a Current Source for the I_N .
- In your report, please include all Multisim schematics (original, Thevenin, Norton) and black box diagrams of the Thevenin and Norton circuits. Be aware that you will not be able to draw the circuit exactly as shown in Multisim.

Required data

The data that must be both calculated and collected through experimental procedures and presented in table form for this experiment are:

- V_{Th}
- R_{Th}
- I_N
- R_{EQ}

Questions

1. Describe the benefits of using a black box concept when designing or troubleshooting circuits.

2. Describe at least two reasons for using a Thevenin and/or Norton circuit

Diodes

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Diodes

Overview

In this lab, students will use a datasheet to investigate the operational parameters of a diode. They will use that information to perform calculations that can be used to solve simple diode circuits. In addition, the concepts of approximation (1st, 2nd, and 3rd) will be explored experimentally.

Requirements

To meet all requirements for this lab, you must complete all activities, questions, critical thinking activities and questions, and observations and conclusions. Compile all results into an APA formatted lab report and submit on line.

Course Objectives

1. Use data books to identify and select transistors for given application requirements.
2. Analyze, construct, and test small signal amplifier circuits.
3. Understand the loading effect of various types of test equipment.
4. Understand the limitations of the various test equipment.

Module Objectives

- Use data sheets to identify operating specifications.
- Use a DMM or VOM to test diode operation.
- Solve a simple diode circuit using a Thevenin circuit.
- Understand the differences between the 1st, 2nd, and 3rd approximations.
- Discuss the effect of polarity on diode biasing.
- Solve a diode bridge circuit.
- Describe the operation of alternating current in a diode bridge circuit.

Activities

1. Introduction to Diodes
2. Diode Biasing
3. Diode Bridge Circuit

1: Introduction to Diodes

Datasheets

A datasheet contains a wealth of information, from physical characteristics to operational characteristics. Being able to effectively read and use a datasheet is an important skill for a technician

to have. It is important to know how a component is supposed to work before one can troubleshoot and repair problems. Unfortunately, datasheets for each component in an electronic device are not included in the operational manual. Therefore, knowing where to find a datasheet is just as important as knowing how to use it.

If the vendor is known, it is as simple as contacting the vendor, usually via the Internet, and using the component's part number to look up the part. Given the small size of some components, being able to read the manufacturer's name is usually not a viable option. However, one can also search at any of the major electronics suppliers (Digi-Key, Jameco, Mouser, etc.) for the part. These vendors frequently have the datasheet available for download at their websites. It is also possible to do an Internet search of just the part number followed by the word, "datasheet."

Checking a Diode

A diode can be checked by using either a DMM or an analog meter such as a VOM. When using the DMM, the diode test selector is indicated with the schematic symbol for a diode. First, test the forward direction of the diode. This is done by connecting the positive lead to the anode of the diode and the negative lead to the cathode of the diode. The DMM will show the forward resistance, which should be relatively low. Next, reverse the leads and test the reverse direction of the diode. This should be a very high resistance, and many times will show as "OL" on the DMM.

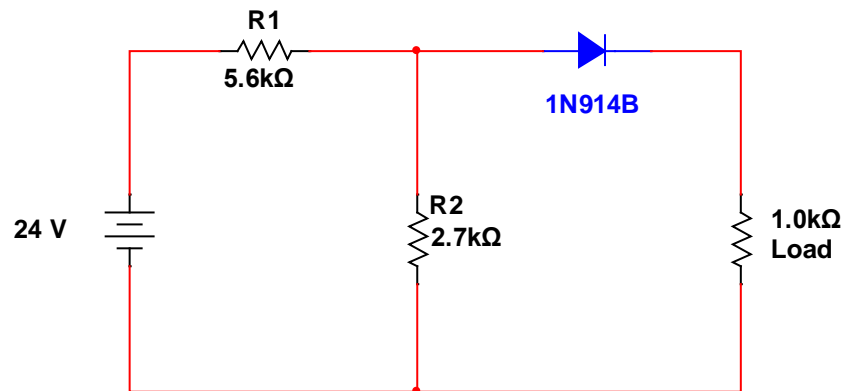
A DMM without the diode checking setting may not have the capability to adequately test a diode on just the Resistance setting. In this case, or if greater detail is desired, a VOM can be used to test a diode. The VOM Resistance setting needs to be set about mid-range (R x 1K). In this situation, the ratio between the resistance in the reverse direction and the resistance in the forward resistance is considered. It should be approximately 1000:1.

Diode Troubles	
Open	High Resistance in both forward and reverse directions
Short	Very low resistance in both forward and reverse directions
Leaky	A rather low resistance in the reverse direction

Components & Equipment Needed

- 1N914B-ND Diode (Manufacturer: Fairchild; Vendor: Digi-Key)
- Datasheet
- DC Power Supply
- Digital Multimeter (DMM)
- Resistors (1 each): 1k Ω , 2.7k Ω , 5.6k Ω

Schematic



Procedures

Step 1: Obtain the datasheet for the 1N914B-ND Diode.

Step 2: Using the datasheet, find the following information. Be aware that there may be multiple test conditions as well as minimum and maximum values. Include all data in your response.

- Breakdown Voltage
- Forward Voltage
- Max Forward Current (or Average Rectified Forward Current)
- Max Power Dissipation

Step 3: Using the performance characteristics graphs, calculate the bulk resistance (R_B):

$$R_B = \frac{V_2 - V_1}{I_2 - I_1}$$

- V_2 = the Forward Voltage at 500 mA
- V_1 = knee voltage
- I_2 = 500 mA
- I_1 = 0A

Step 4: Referring to the schematic shown above, solve the circuit, using the 1st, 2nd, and 3rd Approximations for the load voltage, the current at the load, and the power at the diode. Record in the table below.

Include the Thevenin circuit and Norton circuit drawings (clearly labeled) and all calculations in your lab report.

	1 st Approximation	2 nd Approximation	3 rd Approximation
I_L			
V_L			
P_D			

Step 5: Test the diode using the DMM and record the results (Good, Open, Short, Leaky). Replace if diode is Open, Short, or Leaky.

Step 6: Build the circuit as shown in the schematic. Measure V_L and I_L .

	Measured
I_L	
V_L	

Questions

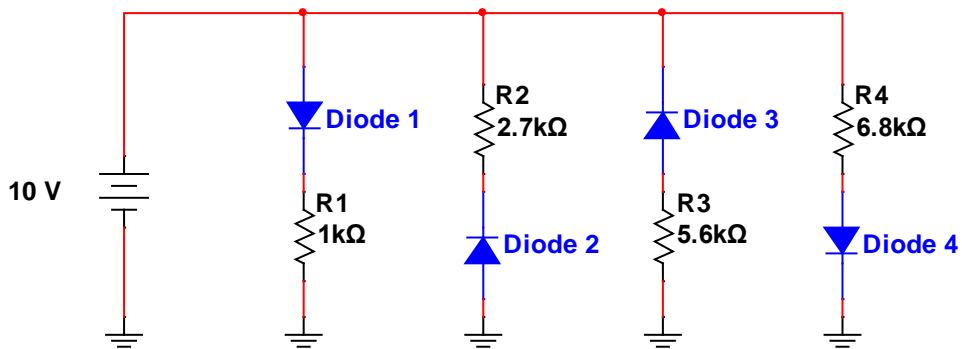
1. What is the percentage of difference between the measured values and the 1st Approximation?
2. What is the percentage of difference between the measured values and the 2nd Approximation?
3. What is the percentage of difference between the measured values and the 3rd Approximation?

2: Diode Biasing

Components & Equipment Needed

- (4) - 1N914B-ND Diodes
- DC Power Supply
- Digital Multimeter (DMM)
- Resistors (1 each): 1k Ω , 2.7k Ω , 5.6k Ω , 6.8k Ω

Schematic



Procedures

Step 1: Determine the state (on or off) of each diode in the schematic above.

	Diode 1	Diode 2	Diode 3	Diode 4
On (Normal)				
Off (Reversed)				

Step 2: Imagine the polarity of the power supply were reversed, determine the state (on or off) of each diode in the schematic above.

	Diode 1	Diode 2	Diode 3	Diode 4
On (Normal)				
Off (Reversed)				

Step 3: Calculate the voltage and current at each resistor using the 1st, 2nd, and 3rd Approximations.

	1 st Approximation	2 nd Approximation	3 rd Approximation
V_{R1}			
I_{R1}			
V_{R2}			
I_{R2}			
V_{R3}			
I_{R3}			
V_{R4}			
I_{R4}			

Step 4: Using Multisim, build the circuit as shown in the schematic. Take voltage and current measurements for each resistor. Record your results in the table below.

Step 5: Test each diode using a DMM and replace if necessary.

Step 6: Build the circuit on a breadboard. Take voltage and current measurements for each resistor. Record your results in the table below.

	Multisim Measurements	Breadboard Measurements
V_{R1}		
I_{R1}		
V_{R2}		
I_{R2}		
V_{R3}		
I_{R3}		
V_{R4}		
I_{R4}		

Questions

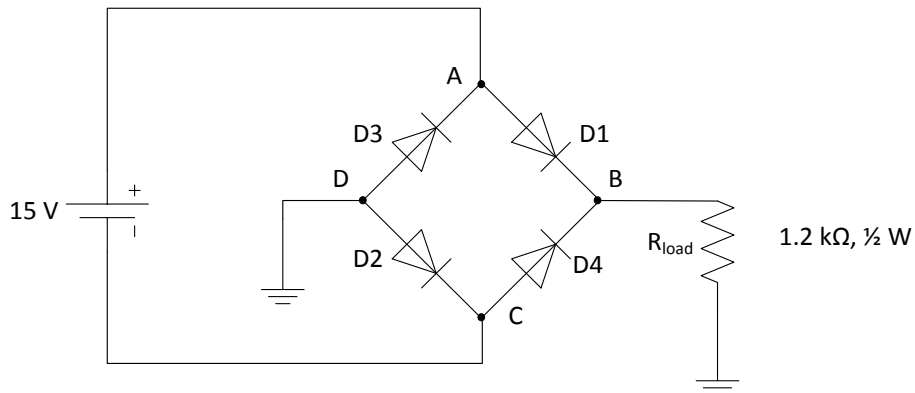
4. With which approximation do the Multisim measurements agree? Why?
5. With which approximation do the Breadboard measurements agree? Why?

3: Diode Bridge Circuit

Components & Equipment Needed

- (4) - 1N914B-ND Diodes
- DC Power Supply
- Digital Multimeter (DMM)
- 1.2 k Ω , ½ W Resistor

Schematic



Procedures

Step 1: Determine the state (on or off) of each diode in the schematic above.

	Diode 1	Diode 2	Diode 3	Diode 4
On (Normal)				
Off (Reversed)				

Step 2: Imagine the polarity of the power supply were reversed, determine the state (on or off) of each diode in the schematic above.

	Diode 1	Diode 2	Diode 3	Diode 4
On (Normal)				
Off (Reversed)				

Step 3: Calculate the voltage and current at each node between the diodes and at the load.

	1 st Approximation	2 nd Approximation	3 rd Approximation
V_A			
I_A			
V_B			
I_B			
V_C			
I_C			
V_D			
I_D			
V_L			
I_L			

- Step 4:** Using Multisim, build the circuit as shown in the schematic. Take voltage and current measurements for each resistor. Be aware that due to limitations within Multisim, your circuit will not look exactly like the schematic. Record your results in the table below.
- Step 5:** Test each diode using a DMM and replace if necessary.
- Step 6:** Build the circuit on a breadboard. Take voltage and current measurements at each node and the load. Record your results in the table below.

	Multisim Measurements	Breadboard Measurements
V_A		
I_A		
V_B		
I_B		
V_C		
I_C		
V_D		
I_D		
V_L		
I_L		

Critical Thinking

Given your knowledge of alternating current, describe, in detail, the behavior of the diode bridge, including each separate diode, during a full sine wave cycle.

Diode Logic

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Diode Logic

Overview

In this lab, students will use MultiSim and a breadboard to build Logic AND & OR gates to investigate the operational parameters of a diode in a logic circuit. They will use that information to perform calculations that can be used to solve simple diode circuits. In addition, the concepts of approximation (1st, 2nd, and 3rd) will be explored experimentally.

Requirements

To meet all requirements for this lab, you must complete all activities, questions, critical thinking activities and questions, and observations and conclusions. Compile all results into an APA formatted lab report and submit on line.

Course Objectives

1. Use data sheets to identify and select diodes and resistors for given application requirements.
2. Analyze, construct, and test logic circuits.
3. Understand the transient effects of various types of diodes.
4. Understand the limitations of the various different configurations.

Module Objectives

- Use data sheets to identify operating specifications.
- Use a DMM or VOM to test diode operation.
- Solve simple diode logic circuits.
- State the differences between the 1st, 2nd, and 3rd approximations.
- Discuss the effect of polarity on diode biasing in logic circuit development.
- Solve diode logic circuit.
- Describe the operation of multiple logic gates in series.

Activities

1. Diode Logic (DL) Gates.
2. Build an AND Gate.
3. Build an OR Gate.
4. Build a series logic gate.

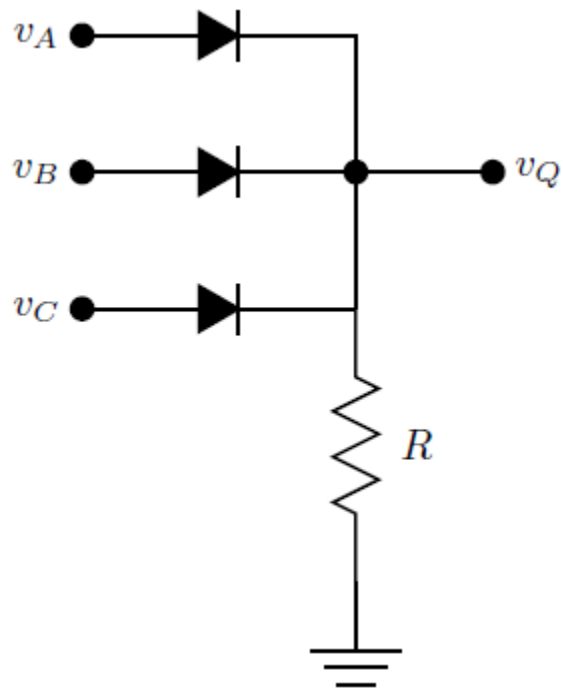
1: Diode Logic (DL) Gates.

DL Logic: The OR gate & AND Gates

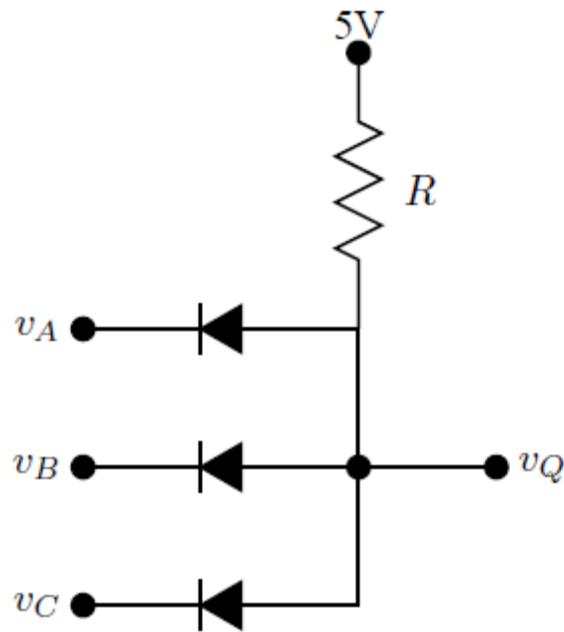
Components & Equipment Needed

- 1N914B-ND Diodes (Manufacturer: Fairchild; Vendor: Digi-Key)
- Datasheet
- DC Power Supply
- Digital Multimeter (DMM)
- Oscilloscope
- Resistors (as per diagrams): TBD

Diagrams:



A: DL OR Gate



B: DL AND Gate

Procedures

- Step 1:** Obtain the datasheet for the 1N914B-ND Diode.
- Step 2:** Using the datasheet and diagrams, build the above circuits in Multisim. Use switches to signify a high or low input to the gates. Use LEDs to demonstrate high or low for outputs.
- Step 3:** Create and verify the truth table for each gate.
- Step 4:** Create the output values for each output based on each particular state using the 1st, 2nd, and 3rd Approximations
- Step 5:** Build both gates on a breadboard and verify the outputs in regards to all approximations.

Questions

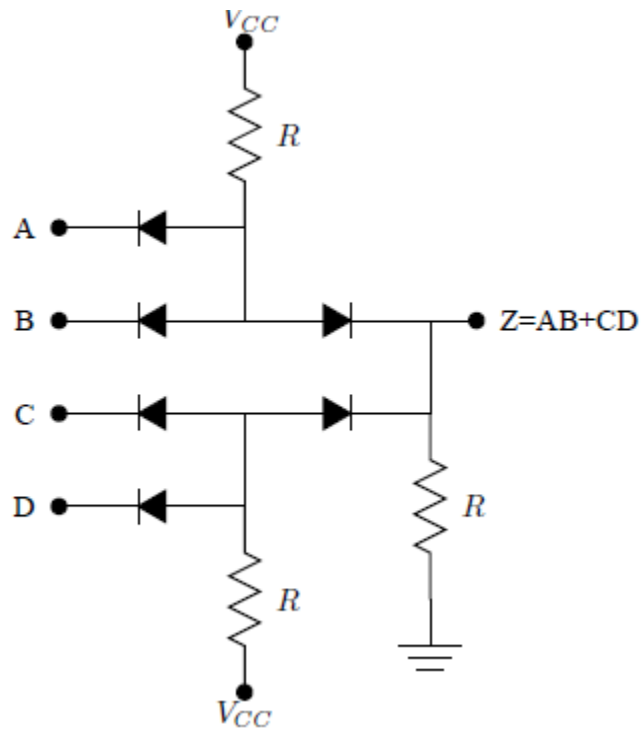
1. What is the percentage of difference between the measured values and the 1st Approximation?
2. What is the percentage of difference between the measured values and the 2nd Approximation?
3. What is the percentage of difference between the measured values and the 3rd Approximation?

2: Cascading DL Logic

Components & Equipment Needed

- 1N914B-ND Diodes (Manufacturer: Fairchild; Vendor: Digi-Key)
- Datasheet
- DC Power Supply
- Digital Multimeter (DMM)
- Oscilloscope
- Resistors (as per diagrams): TBD

Diagram



C: Cascading DL Logic

Procedures

- Step 1:** Using the datasheet and diagrams, build the above circuits in Multisim. Use switches to signify a high or low input to the gates. Use LEDs to demonstrate high or low for outputs.
- Step 2:** Create and verify the truth table for each gate.
- Step 3:** Create the output values for each output based on each particular state using the 1st, 2nd, and 3rd Approximations
- Step 4:** Build both gates on a breadboard and verify the outputs in regards to all approximations.

Questions

4. What is the percentage of difference between the measured values and the 1st Approximation?
5. What is the percentage of difference between the measured values and the 2nd Approximation?
6. What is the percentage of difference between the measured values and the 3rd Approximation?

Critical Thinking

Given your knowledge of alternating current, solid state circuitry, and logic gates, describe the behavior of the DL cascading logic gate; include all observations and conclusions concerning the design

Wave Shaping with Diodes

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Wave Shaping with Diodes

Overview

In this set of labs, students will explore the use of diodes for shaping sine waves through the use of rectifiers, clippers, and clampers.

Requirements

To meet all requirements for this lab, you must complete all activities, questions, critical thinking activities and questions, and observations and conclusions. Compile all results into an APA formatted lab report and submit on line.

Course Objectives

- Use data books to identify and select transistors for given application requirements.
- Analyze amplifier frequency response determining parameters such as upper and lower cutoff frequencies and amplifier bandwidth.
- Analyze, construct, and test small signal amplifier circuits.
- Understand the loading effect of various types of test equipment.
- Understand the limitations of the various test equipment.

Module Objectives

- Build half-wave rectifiers.
- Construct conventional full-wave and bridge rectifiers.
- Discuss advantages and disadvantages of the types of full-wave rectifiers.
- Build simple capacitor filters.
- Select components for the design of LC Choke filters based on X_L and X_C specifications
- Design and build a diode clipper circuit to meet specified needs.
- Design and build a diode clamper circuit to meet specified needs.

Activities

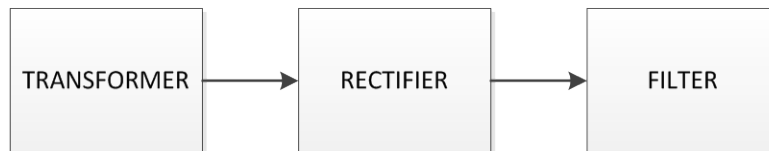
1. Shaping
2. Clipping
3. Clamping

Components & Equipment Needed (for all activities)

- 12.6 V Transformer
- Small Signal Diodes (1N914B)
- $R_L = 1k\Omega$ and to be determined (TBD)
- Capacitors (47 μ F, 470 μ F, TBD)
- Inductor (TBD)

1: Basic Wave Shaping

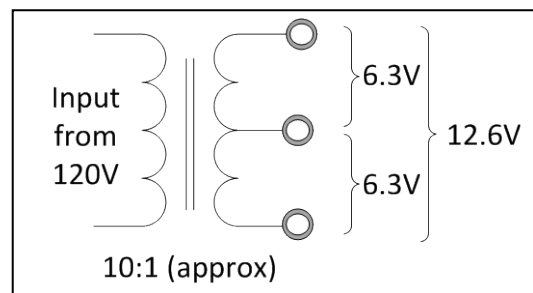
Functional Diagram



Transformers

Using a Transformer

The transformers available in the lab have been mounted so that there are easy to use outputs, including a center-tap. As shown below, 12.6 V is available if the two outer jacks are used. If center tap is used with either the top or the bottom jacks, one-half of that is available or approximately 6.3 V.



Transformer Safety

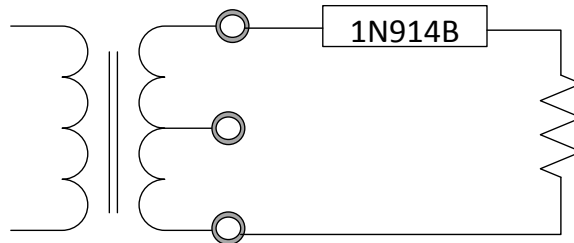
Because transformers are connected directly to 120 V, there is some risk involved. It is important to observe safety protocols while using the transformers for experiments.

1. Connect the wall plug only when the transformer is needed, and unplug when measurements have been taken.
2. Never leave a “live” transformer unattended.
3. These transformers are set to blow a fuse at a relatively low threshold on purpose. **USE ONLY 1 AMP FUSES.** DO NOT replace the fuse with a higher rated one. If fuses are blowing, there is a possibility that the circuit has been connected incorrectly.

Rectifiers

Half-Wave Rectifiers

Schematic



Procedure

- Step 1:** For a **positive half-wave rectifier**, calculate the peak output voltage, the dc output voltage, and the ripple frequency.
- Step 2:** Using the diagram, build a positive half-wave rectifier.
- Step 3:** Measure and record all values in the table below.
- Step 4:** Draw 2 complete cycles of the waveform. Label peak voltages and dc average voltage.
- Step 5:** Repeat Steps 1 - 4, but as for a **negative half-wave rectifier**.

Positive Half-Wave Rectifier

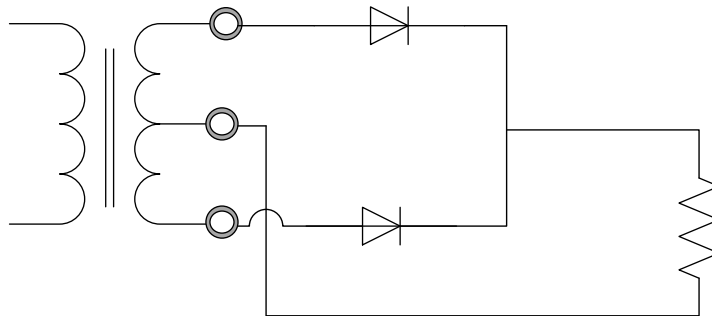
	Calculated	Measured	% Difference
V_{rms} (Secondary)	12.6 V		
$V_{out(peak)}$			
$V_{out(DC)}$			
f_{ripple}			

Negative Half-Wave Rectifier

	Calculated	Measured	% Difference
V_{rms} (Secondary)	12.6 V		
$V_{out(peak)}$			
$V_{out(DC)}$			
f_{ripple}			

Conventional Full-Wave Rectifier

Schematic



Procedure

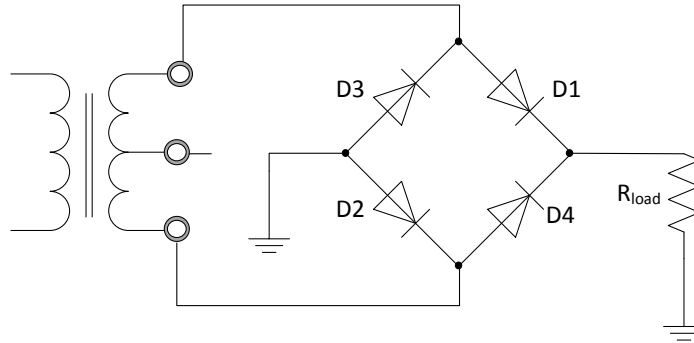
- Step 1:** For the **conventional full-wave rectifier**, calculate the peak output voltage, the dc output voltage, and the ripple frequency.
- Step 2:** Using the diagram, build a conventional full-wave rectifier.
- Step 3:** Measure and record all values in the table below.
- Step 4:** Draw 2 complete cycles of the waveform. Label peak voltages and dc average voltage.

Conventional Full-Wave Rectifier

	Calculated	Measured	% Difference
V_{rms} (Secondary)	12.6 V		
$V_{out(peak)}$			
$V_{out(DC)}$			
f_{ripple}			

Bridge Rectifier

Schematic



Procedure

- Step 1:** For the **bridge rectifier**, calculate the peak output voltage, the dc output voltage, and the ripple frequency.
- Step 2:** Using the diagram, build a bridge rectifier.
- Step 3:** Measure and record all values in the table below.
- Step 4:** Draw 2 complete cycles of the waveform. Label peak voltages and dc average voltage.

Bridge Rectifier

	Calculated	Measured	% Difference
V_{rms} (Secondary)	12.6 V		
V_{out(peak)}			
V_{out} (DC)			
f_{ripple}			

Questions

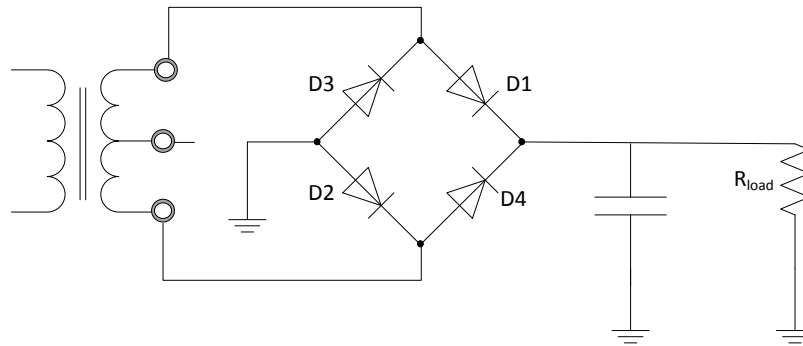
1. What is a disadvantage of a conventional full-wave rectifier?

2. What is the advantage of a bridge rectifier over a conventional full-wave rectifier?

Filters

Capacitor Filter

Schematic



Procedure

- Step 1:** For the **capacitor filter**, calculate the peak output voltage, the dc output voltage, the dc output current, the ripple frequency and the peak to peak ripple with $R_L = 1k\Omega$ and $C = 47\mu F$.
- Step 2:** Using the diagram and the specifications above, build a capacitor filter.
- Step 3:** Measure and record all values in the table below.
- Step 4:** Draw 2 complete cycles of the waveform. Label peak voltages and dc average voltage.
- Step 5:** Repeat Steps 1 – 4, but as for a capacitor filter with $R_L = 1k\Omega$ and $C = 470\mu F$.

Capacitor Filter (C=47 uF)

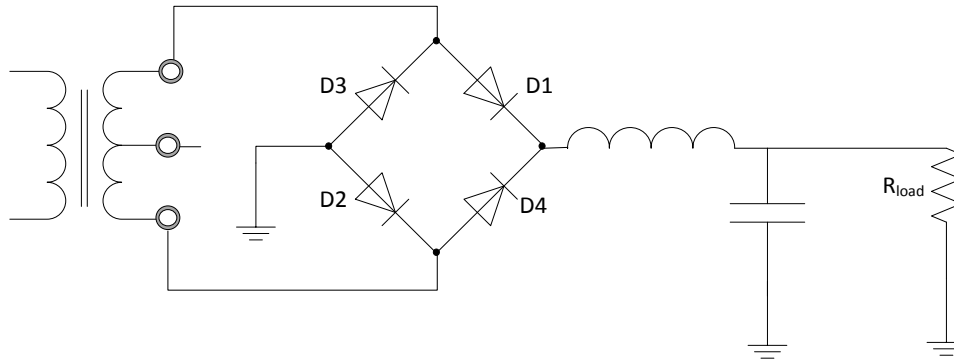
	Calculated	Measured	% Difference
V_{rms} (Secondary)	12.6 V		
$V_{out(peak)}$			
V_{out} (DC)			
f_{ripple}			
$V_{ripple(pp)}$			

Capacitor Filter (C=470 uF)

	Calculated	Measured	% Difference
V_{rms} (Secondary)	12.6 V		
$V_{out(peak)}$			
V_{out} (DC)			
f_{ripple}			
$V_{ripple(pp)}$			

LC Choke Filter

Schematic



Procedure



Choose the correct values L, C, and R_L based on $X_L = 10k\Omega$ and $X_C = 100\Omega$

- Step 1:** For the **capacitor filter**, calculate the peak output voltage, the dc output voltage, the dc output current, the ripple frequency and the peak to peak ripple using the specifications above.
- Step 2:** Using the diagram and the specifications above, build the capacitor filter.
- Step 3:** Measure and record all values in the table below.
- Step 4:** Draw 2 complete cycles of the waveform. Label peak voltages and dc average voltage.

LC Choke Filter

	Calculated	Measured	% Difference
V_{rms} (Secondary)	12.6 V		
$V_{out(peak)}$			
$V_{out(DC)}$			
f_{ripple}			
$V_{ripple(pp)}$			

2: Clipping

Functional Diagram



Procedure

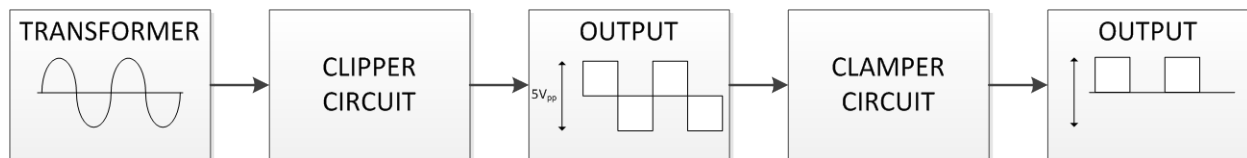
Using the diagram above, design and build a diode **clipper** circuit which outputs a **5V_{pp} square wave**.

Requirements

In addition to the schematic of your design, please include a labeled drawing of 3 complete cycles of the output of this circuit in your lab report.

3: Clamping

Functional Diagram



Procedure

Using the diagram above, design and build a diode **clammer** circuit which will **clamp low to zero (0)**.

Requirements

In addition to the schematic of your design, please include a labeled drawing of 3 complete cycles of the output of this circuit in your lab report

Special Diodes

Air Washington Electronics ~ Introduction to Solid State Lab



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Special Diodes

Overview

In this lab, students are introduced to special diodes, particularly zener diodes and light emitting diodes (LED). Using zener diodes, students will construct a variety of circuits allowing them to draw their own conclusions concerning their operational properties.

Requirements

To meet all requirements for this lab, you must complete all activities, questions, critical thinking activities and questions, and observations and conclusions. Compile all results into an APA formatted lab report and submit on line.

Course Objectives

1. Construct simple stabilizing circuits using Zener diodes.
2. Use data books to identify and select transistors for given application requirements.
3. Understand the loading effect of various types of test equipment.
4. Understand the limitations of the various test equipment.

Module Objectives

- Use a data sheet to determine minimum, typical, and maximum operational parameters.
- Use the data from data sheets to make calculations.
- Design a zener voltage regulator based on given specifications and data sheet specifications.
- Understand the operational parameters of a light emitting diode.

Activities

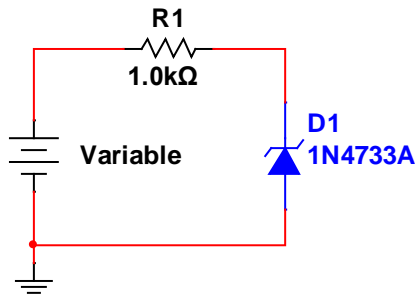
1. Zeners
2. Zener Clipper
3. Zener Regulator
4. Zener Critical Thinking
5. LEDs

1: Zeners

Components & Equipment Needed

- Variable DC Power Supply
- 1.0 k Ω Resistor
- 1N4733 Zener Diode

Schematic



Procedures

Step 1: Calculate V_{out} and current in this circuit based on 5, 10, 15, and 20 V at both the 1st and 2nd Approximation

1 st Approximation				
	5 V	10 V	15 V	20 V
V_{out}				
I_s				
2nd Approximation				
	5 V	10 V	15 V	20 V
V_{out}				
I_s				

Step 2: Build the circuit as shown in the schematic. Measure V_{out} and current based on 5, 10, 15, and 20 V.

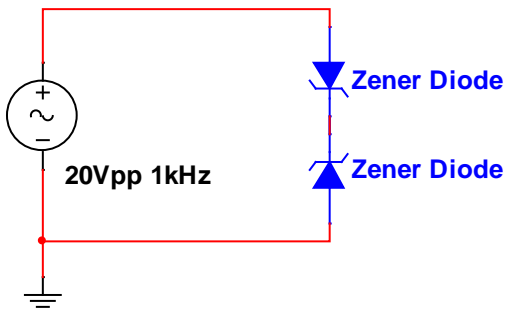
Measured				
	5 V	10 V	15 V	20 V
V_{out}				
I_s				

2: Zener Clipper

Components & Equipment Needed

- Function Generator
- Zener Diodes (2 each of: 1N4731, 1N4733, 1N4735, 1N4739, 1N4742)

Schematic



Procedures

Step 1: Identify the zeners being used and record their typical V_z value where indicated. Use two of the same zener to build the circuit. The circuit will be built five (5) times, each time using a different pair of zeners.

Datasheet		Measurements		Observations
Diode	V_z (Typ.)	V_{pk} (pos)	V_{pk} (neg)	Description of Wave
1N4731				
1N4733				
1N4735				
1N4739				
1N4742				

Questions

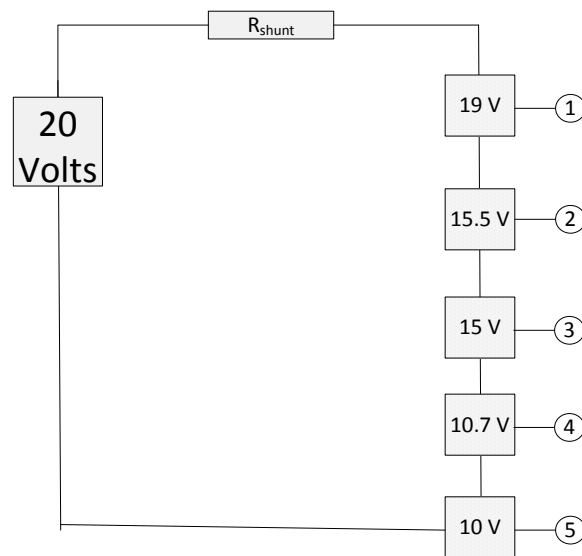
1. For each zener, briefly explain why the output wave appears as it does.

3: Zener Voltage Regulator

Components & Equipment Needed

- DC Power Supply
- Zener Diodes (choice of 1 or more of the following: 1N4731, 1N4732, 1N4733, 1N4734, 1N4735, 1N4739, 1N4742, 1N4744, 1N5240)
- 1kΩ Resistor

Functional Diagram



Procedures

Step 1: In Multisim, design a zener voltage regulator using the specifications for input (20 V) and output shown in the diagram above. $R_{shunt} = 1 \text{ k}\Omega$.

Step 2: Breadboard and test your diagram. Record measurements below.

Output	Voltage	Output	Voltage
Output 1		Output 3	
Output 2		Output 4	
		Output 5	

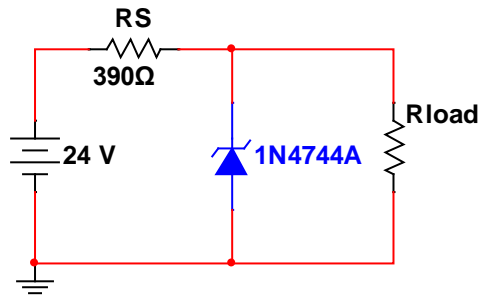
Step 3: Describe and discuss any differences between the Multisim and Breadboarded circuits.

4: Zener Diode Critical Thinking

Components & Equipment Needed

- DC Power Supply
- Resistors: 390 Ω
- Potentiometer
- 1N4744 Zener Diode

Schematic



Procedure

Step 1: Based on the circuit above and using the data sheet as a guide, calculate the load resistance for minimum, typical, and maximum zener operation.

	R_{Load}	V_{out}	I_s	I_L	I_Z
Minimum					
Typical					
Maximum					

Step 2: Breadboard the circuit to represent the load resistance values calculated above. Measure and record the measurements as shown in the table below. You may need to use a potentiometer to approximate the calculated load resistance.

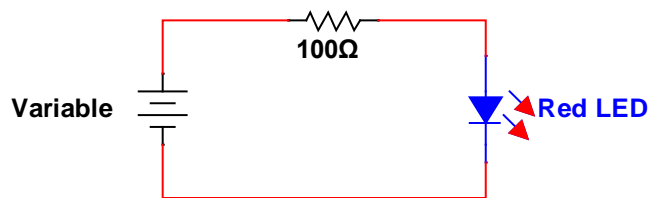
	R_{Load}	V_{out}	I_s	I_L	I_Z
Minimum					
Typical					
Maximum					

5: Light Emitting Diodes

Components & Equipment Needed

- DC Power Supply
- 100 Ω resistor
- Red LED, Green LED

Schematic



Procedure

Step 1: Starting with the red LED, build the circuit above. Use an ammeter in series with the circuit to help with adjusting the variable power supply to the required current settings. Take voltage measurements across the LED for each current setting shown in the table below.

Step 2: Switch to the green LED and repeat Step 1.

Current	V _{Red}	V _{Yellow}
10 mA		
20 mA		
30 mA		
40 mA		