



HASAN KALYONCU UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

**ELECTRONIC CIRCUIT
LABORATORY MANUEL**

Contents

1. USING OSCILLOSCOPE AND FUNCTION GENERATOR
2. INTRODUCTION TO ELECTRONIC CIRCUIT LABORATORY
3. DIODES CHARACTERISTICS AND APPLICATIONS
4. DIODES APPLICATIONS, HALF-WAVE RECTIFIERS
5. BRIDGE RECTIFIERS
6. FILTER CAPACITOR
7. ZENER DIODES CHARACTERISTICS AND APPLICATIONS
8. FIXED BIAS FOR BJT
9. VOLTAGE DIVIDER BIAS FOR BJT

Using oscilloscope and Function Generator

Objective:

To familiarize with the use Oscilloscope and Function generator for Measurement and Testing purposes.

Equipments and Components:

- Oscilloscope
- Function Generator

Theory:

- Oscilloscope is used for voltage measurement. Unlike a voltmeter, an oscilloscope does not display a single number. An oscilloscope displays signals - voltages that are functions of time. Oscilloscopes can measure signal parameters - like frequency, peak-to-peak voltages, RMS values of signals
- A function generator generates defined signals for test roles. These are sinusoidal signals, triangles, square wave signals and even random signals.

Measuring:

- Connect the probe of oscilloscope to voltage measuring point.
- Be sure that, the two grounds connected together and selected in the active channel
- Press the auto scale button to see the graph, or use manual setting (Change the value of horizontal and vertical setting)

Generator:

- Set the frequency of signal generator output to 5 kHz.
- Set the amplitude of signal generator output voltage to 3 V_{peak-to-peak}.

Procedure:

- Generate the Square wave for 2 kHz, 3 volt_{peak to peak} and measure the frequency utilizing from screen.
- Generate the Sine wave for 0.05 kHz, 2.5 volt_{peak to peak} and measure the frequency utilizing from screen.
- Generate the Triangular wave for 1500 Hz, 3 volt_{peak to peak} and measure the frequency utilizing from screen.

Introduction to Electronic circuit laboratory

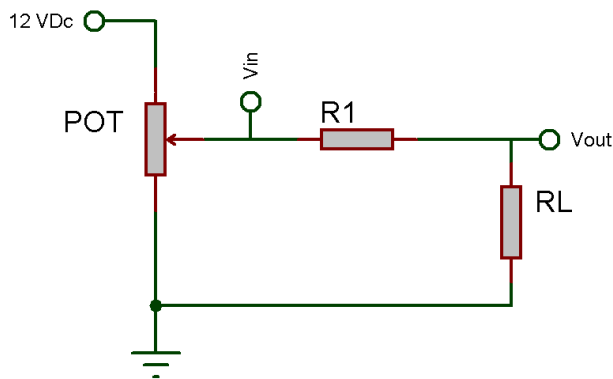
Objective:

- Introduction to the equipment and components used in Electronics Laboratory.

Equipments and Components:

- Analog Multi meter
- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator
- Variable resistor – 10 Kohm

Theory:



*E : 12 Volt Dc
POT : 10 K Ohm
R1: 1k ohm*

Figure 1.1

Experiment:

- Set up the circuits that have been shown figure1.1 on the breadboard. And measure and fill the table below according to current and voltage values for each resistor value.

V_{in}	10V	7V	5V	2500 mV	700 mV	500 mV	400mV	100mV
I_L (mA)								
V(V)								

Conclusion:

- Explain the function of pot.

Diodes Characteristics and Applications

Objective:

Equipments and Components:

- Analog Multi meter
- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator

Discussion:

The purpose of this experience is to become familiar with diode and its reaction to bias. You have learned the theory that a diode conducts in only one direction, and this experience is to support that theory.

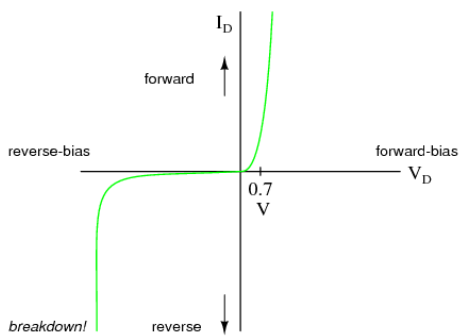


Figure 1

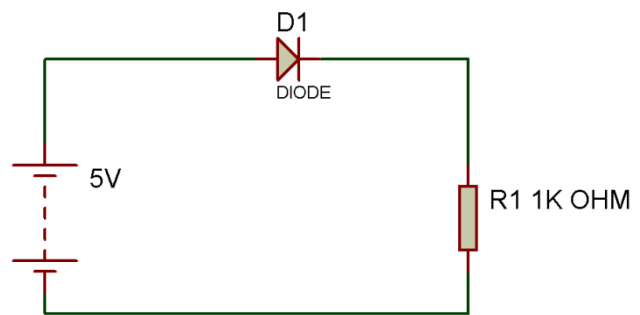


Figure 2

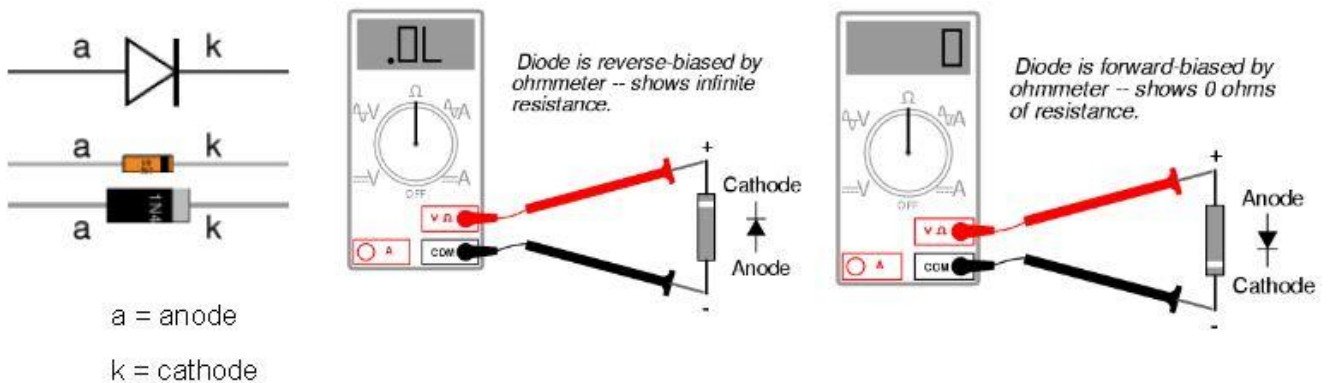


Figure 3

Circuit:

The schematic for this experience is shown in figure 2. Figure 2 shows a method of placing the components on the board for the experience.

1. Test Diodes as shown in figure 3
2. Place components into the board as shown in figure 2.
3. Apply the power to the circuit as shown in previous lab.
4. Measure voltage drop across each of the components (V_D =Voltage drop across diode)

	Value	UNIT
V _D		
V _R		

5. Knowing the voltage drop across the resistor, calculate the current flowing in the circuit.

$$I_T = V_R / R_L$$

$$I_T = \underline{\hspace{2cm}} / \underline{\hspace{2cm}} =$$

6. Turn of the power applied to the circuit. Now exchange the leads going to the power supply. Put the diode lead to ground and resistor lead to +5V.
 7. Apply power to the circuit and measure the voltage drops across the components.

	Value	UNIT
V _D		
V _R		

8. Calculate the current flowing in the circuit.

$$I_T = V_R / R_L$$

$$I_T = \underline{\hspace{2cm}} / \underline{\hspace{2cm}} =$$

9. Is there any difference between this current and the current calculated in step 4, above? Why?

10. Write a conclusion about biasing of diode.

Diodes Applications, Half-wave Rectifiers

Objective:

Equipments and Components:

- Analog Multi meter
- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator

Discussion:

This experiment will allow you to become familiar with the half-wave power supply. This was a primary power source for many years in the early days of electronics.

All electronics devices run from DC power sources. The major thing we must accomplish is to change the ac from the power line to something we can use for powering our equipment. In this experiment, you will change the input voltage 12.5 V AC , 60 Hz to a different level that allows operation of the electronic devices.

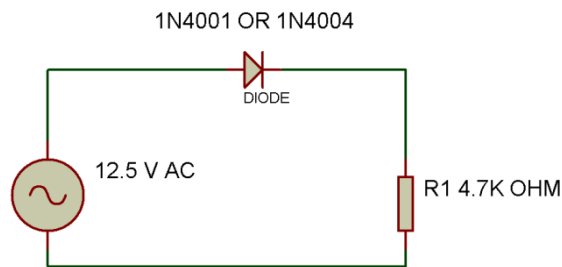


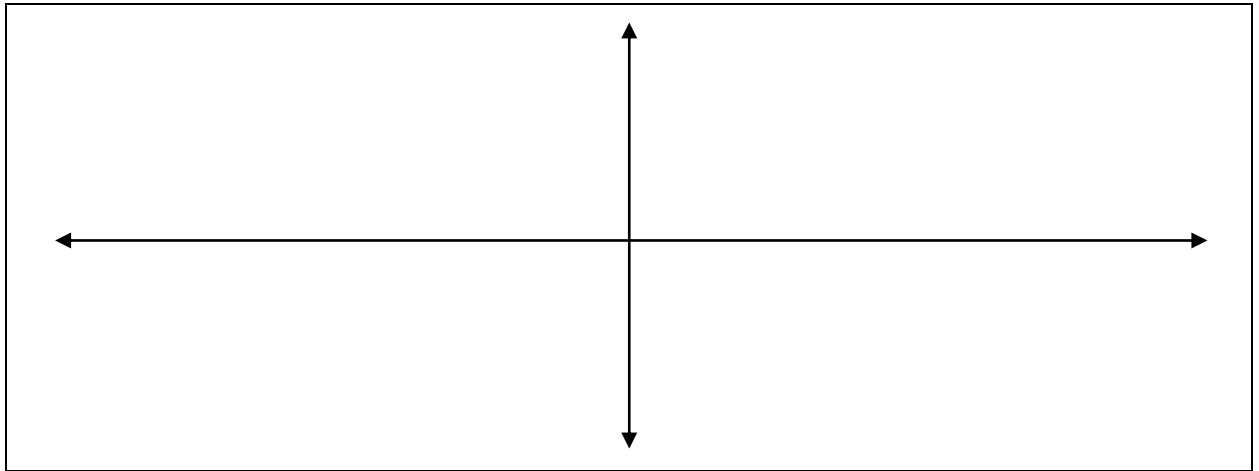
Figure 3

Circuit:

Figure 3 is the schematic for the circuit to be set up on board. Set the components into the board by tracing the current flow.

1. Place the components into the board following the procedure from previous works.
2. Apply power on board.

- Place the oscilloscope leads across the resistors. Be sure the ground connection is attached to black or return lead from the power source. Draw the wave form as sees on oscilloscope.



- Calculate the voltage output.

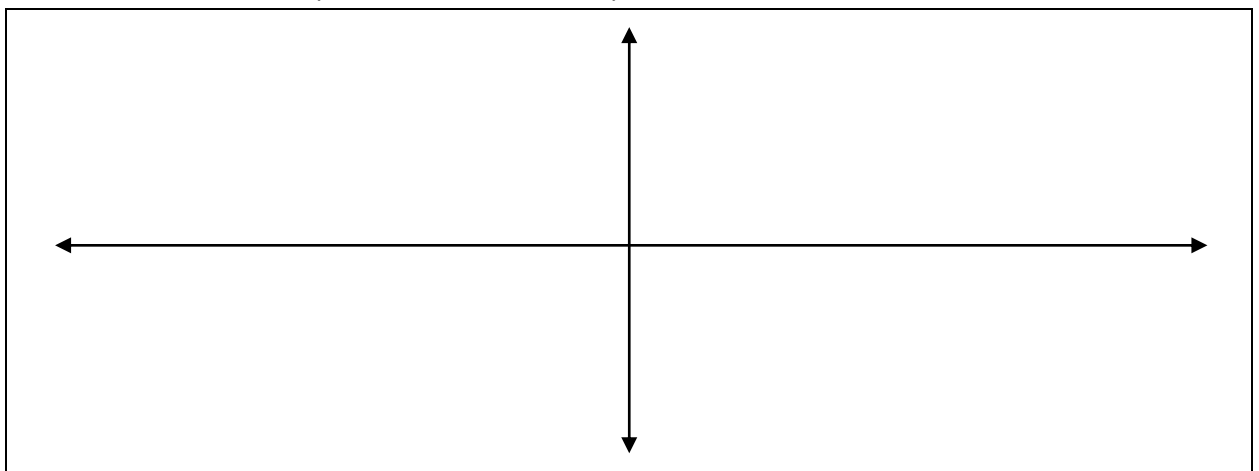
$$V_{\text{out}} = V_{\text{pk}} \times 0.318$$

$$V_{\text{out}} = \underline{\hspace{2cm}} \times 0.318 =$$

- Measure the DC voltage.

$$\underline{\hspace{2cm}} \text{ V}$$

- Turn of the power and reverse the diode. Apply power again and measure the waveform across the diode with the oscilloscope. Draw the wave form produced.



- What is the frequency of this waveform. $\underline{\hspace{2cm}}$
- Compare the waveforms produced in step 3 and 6 what are the differences? Why do the differences exist?

- Write a conclusion about diode effect on AC signal.

Objective:

Equipments and Components:

- Analog Multi meter
- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator

Discussion:

The purpose of this experiment is to look at the differences between this circuit and the half-wave and full-wave rectifier circuit. The bridge rectifier system is the most popular and gives the highest voltage output of the three systems. The important thing is to understand what happens to the output when one of the legs of the bridge opens, and to remember this for future reference.

Circuit:

1. Set up the circuit on the breadboard from schematic figure 4.

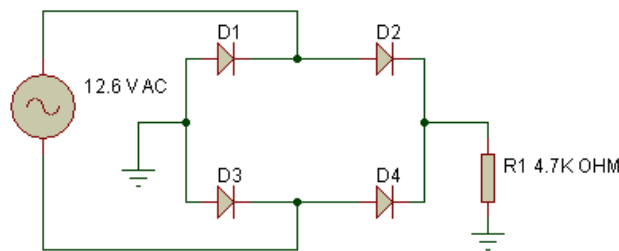


Figure4

2. Measure the ac voltage applied to the input of the rectifier system.

$$V_{AC} = \underline{\hspace{2cm}}$$

3. Measure the DC voltage across the resistor.

$$V_{dc} = \underline{\hspace{2cm}}$$

4. Calculate the peak voltage of the input.

$$V_{pk} = \underline{\hspace{2cm}}$$

5. Multiply this peak input voltage times 0.636.

$$V_{pk} \times 0.636 = V_{avg}$$

$$\underline{\hspace{2cm}} \times 0.636 = \underline{\hspace{2cm}}$$

6. What is the difference between the answers to steps 4 and 5? Why?

Difference $\underline{\hspace{2cm}}$

7. Apply the oscilloscope across the output resistor.
8. While watching the display, disconnect one of the diodes.
9. What was the result as shown on the display
10. Write a conclusion about working principles of bridge rectifiers.

Objective:**Equipments and Components:**

- Analog Multi meter
- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator

Discussion:

In this experiment a half-wave rectifier system will be used because the results are more dramatic and easier to observe. The purpose of this experiment is to observe the results of changing a load on the power source.

Circuit:

1. Place the components into breadboard according to schematic figure 5.

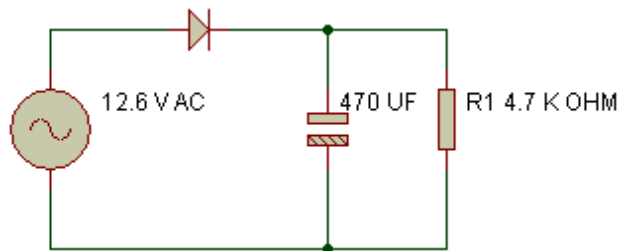


Figure 5

2. Apply power to the circuit and measure the voltage across the capacitor using a Multimeter. Be sure the switch is in the DC voltage position.

$$V_{DC} = \underline{\hspace{2cm}}$$

3. Place the oscilloscope leads across the capacitor and measure the DC voltage on the oscilloscope.

$$V_{DC} = \underline{\hspace{2cm}}$$

4. Change the oscilloscope to measure ac rather than DC. Turn down the volts per cm until the ripple is visible. The ripple is visible. This ripple voltage measures.

$$V_{p-p} = \underline{\hspace{2cm}}$$

5. Pull out the 4.7 k Ohm resistor being used for the load. Measure the ac ripple across the capacitor. This measures

$$V_{p-p} = \underline{\hspace{2cm}}$$

6. Change the volts per cm reading to a higher voltage range, and measure the DC voltage across the capacitor.

$$V_{DC} = \underline{\hspace{2cm}}$$

7. Compare this reading in step 6 with the reading taken in step 2. Is there any change? Why?

8. Place the 1 k ohm resistor across the capacitor as the load.
9. Measure the DC voltage across the capacitor.

$$V_{DC} = \underline{\hspace{10em}}$$

10. The voltage measured in step 9 can now be compared with the voltages measured in step 2 and 6. What do these three reading tell you, as the observer?

11. Change the oscilloscope readings to ac. Measure the amplitude of the ripple.

$$V_{ripple} = \underline{\hspace{10em}}$$

12. The ripple voltage measured in step 11 can now be compared with the reading taken in step 4. How do they -compare?

13. These different reading of ripple output and DC output will tell you what occurs when the load changes. What does it tell you?

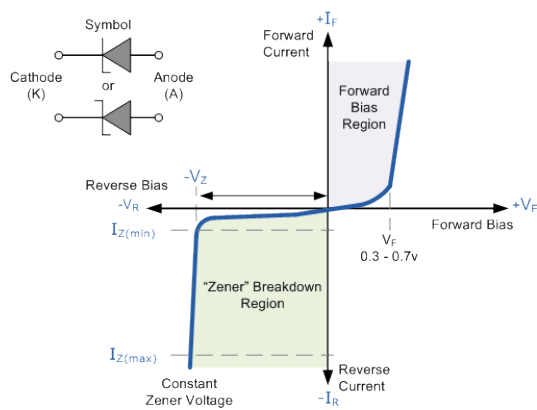
Zener Diodes Characteristics and Applications

Objective:

Equipments and Components:

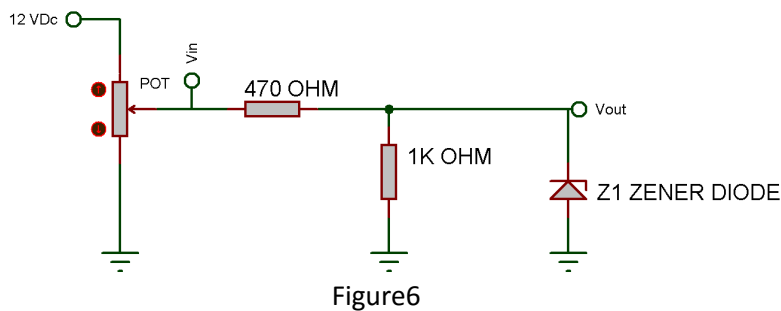
- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator

Discussion:



Circuit:

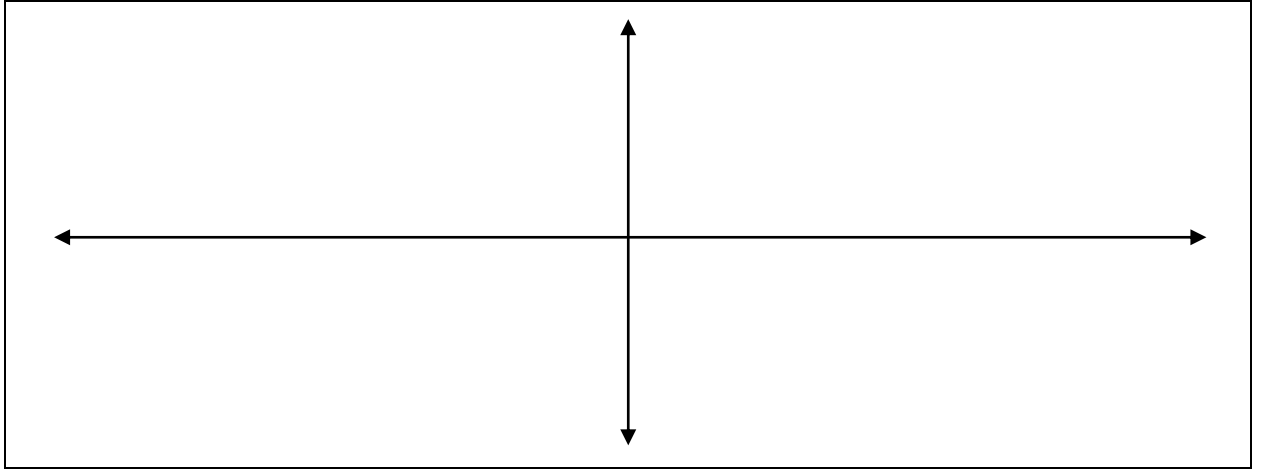
1. Place the components into breadboard according to schematic figure 6.



POT: 5k or 10K
Z1 : 3V9 Zener diode

2. Read 10 voltage data from V_{in} port and V_{out} port.
3. Draw Voltage –sample graphic on the same graph.

4. Write a conclusion that explains the function of zener diode.



Objective:

Equipments and Components:

- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator

Discussion:

The purpose of this experience is to become familiar with the fixed method of biasing and the calculation for further experimentation. This experiment will allow us to become more familiar with the transistor.

Circuit:

1. Set the components into the board according to the schematic shown in figure 7.

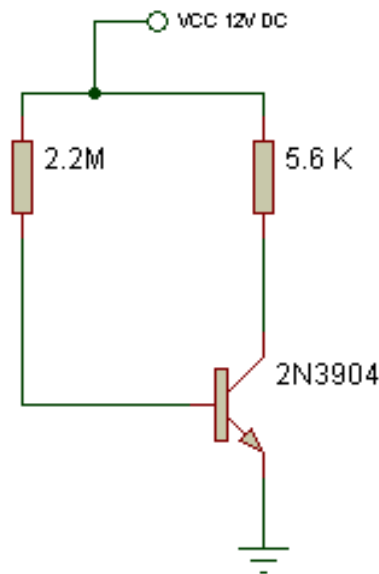


Figure 7

2. Measure the voltages at base and collector.

$$V_B = \underline{\hspace{2cm}}$$

$$V_C = \underline{\hspace{2cm}}$$

3. Calculate the base and collector currents.

$$I_B = (V_{CC} - V_B) / R_B =$$

$$I_C = V_{RC} / R_C =$$

4. Calculate the β for the transistor.

$$\beta = I_C / I_B =$$

5. Disconnect one end of the base resistor. Measure the collector voltage.

$$V_C = \underline{\hspace{4cm}}$$

6. What does the value of V_C tell you?

7. Reconnect the base resistor, and disconnect one end of the collector resistor. Measure V_C .

$$V_C = \underline{\hspace{4cm}}$$

8. Write a conclusion about the working principle of BJT.

Voltage Divider Bias For BJT

Objective:

Equipments and Components:

- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator

Discussion:

This experience will allow the student to become more familiar with “H” bias and the paths for direct-current flow through the transistor.

Circuit:

1. Set up the circuit of figure 8.
2. Calculate the voltages V_E , V_B and V_C

$V_E =$ _____
 $V_B =$ _____
 $V_C =$ _____

3. Measure the voltages V_E , V_B and V_C

$V_E =$ _____
 $V_B =$ _____
 $V_C =$ _____

4. How do these reading differ and Why?

5. Pull out one end of the 10-k ohm resistor. Measure the voltages V_E , V_B and V_C

$V_E =$ _____
 $V_B =$ _____
 $V_C =$ _____

6. This represents an open R_B . What are the results?

7. Replace thee end of the 10 K ohm resistor that you pulled from the board. Pull out one end of the 2.2k ohm resistor. Measure V_E , V_B and V_C

$V_E =$ _____
 $V_B =$ _____
 $V_C =$ _____

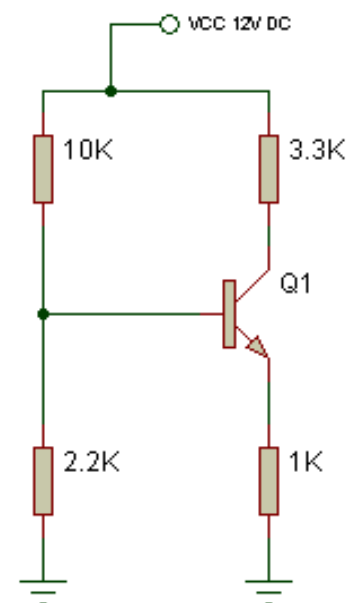


Figure 8

8. This represents an open R_S . What are the results?

9. Replace the end of 2.2 k ohm resistor into the board. Pull out one end of 3.3 k ohm resistor and measure V_E , V_B and V_C .

$V_E =$ _____

$V_B =$ _____

$V_C =$ _____

10. This represents an open collector resistor. What are the results?

Noninverting Amplifier - OP-AMP

Objective:

Equipments and Components:

- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator

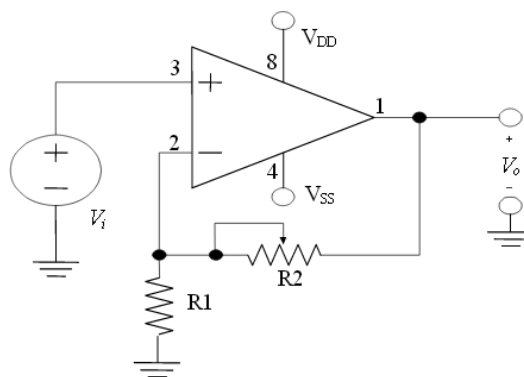
Discussion:

In this lab, we are going to study operational amplifiers and circuits with op-amps. The op-amp chip that we are going to use is LM741. The configuration of the chip is shown below.

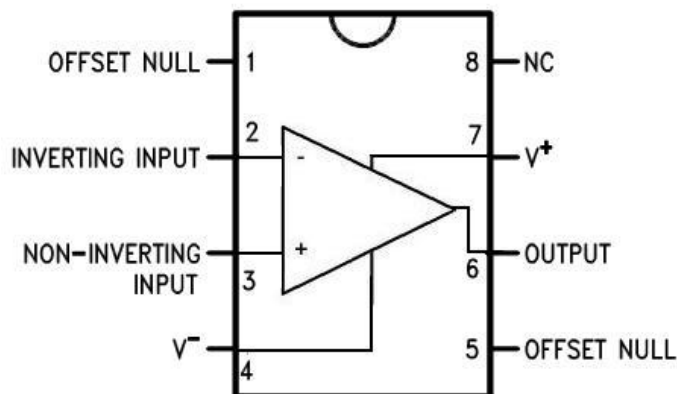
Circuit:

a) DC Measurements

Build up the noninverting amplifier as shown in Fig 1. Use +12V channel and -12V channel of the DC power supply for the VDD and VSS, the +12V should be set up to +6V and -12V channel should be set up to -4V. Use 6V channel of the DC power supply for V_{in} , and measure both input and output using oscilloscope. R1 is 5k and R2 is 5k. Change V_{in} from -2V to 3V to verify the proper amplification range of DC inputs.



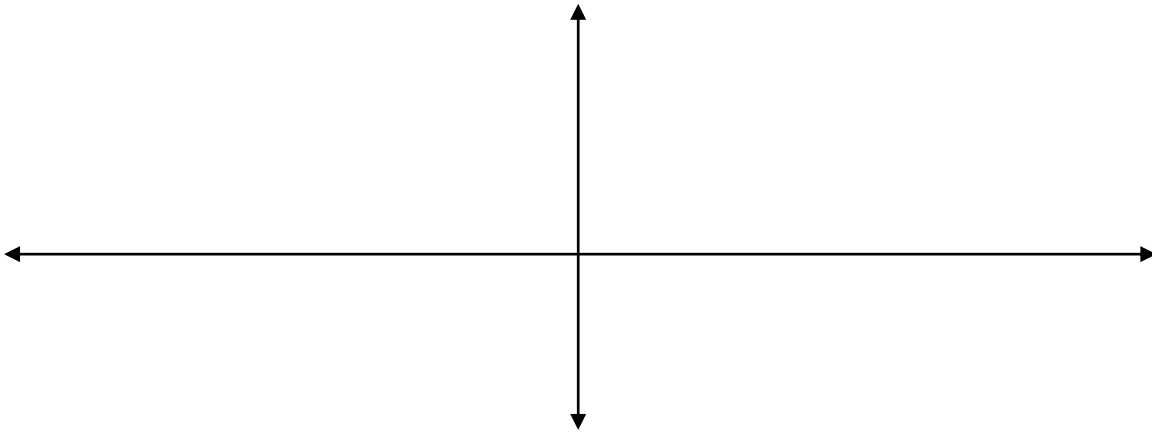
LM741 Pinout Diagram



b) AC Measurement

Now, set the input signal to a 1 kHz, 0.5 VPP, 0 VDC offset (on the function generator display) Sine wave from the function generator. Use a 10k Ω potentiometer as R2. Adjust R2 to see the gain change. Can you get a gain less than unity by turning R2? Why?

Turn the potentiometer R2 until the gain is 2 and then adjust the Vpp and DC offset to the input signal. Observe the input and output waveforms as you vary the DC offset for large Vpp (say 2.5V)



Experiment: 11

Differentiator - Integrator

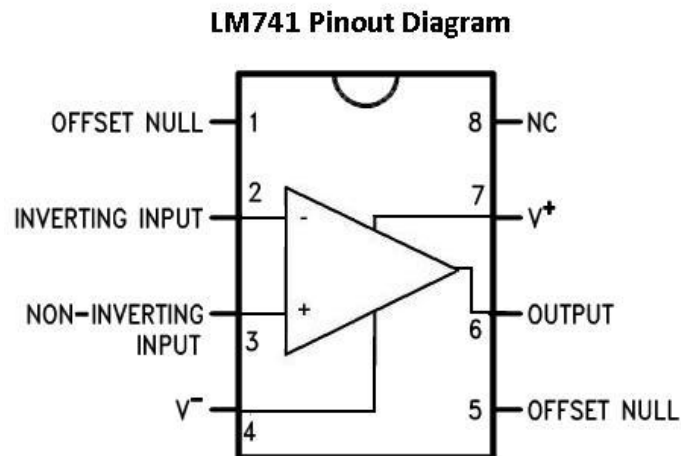
Objective:

Equipments and Components:

- Digital Multi meter
- Oscilloscope
- Voltage Generator
- Signal Generator

Discussion:

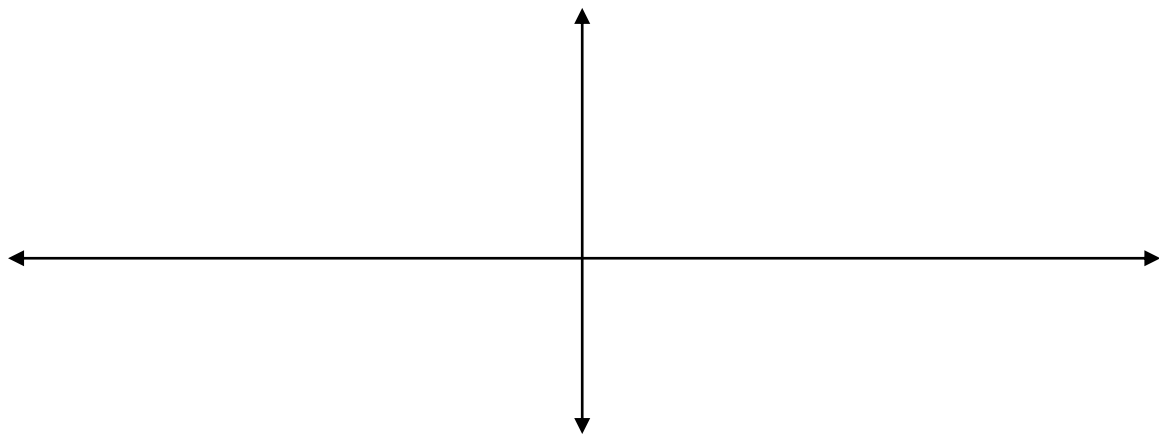
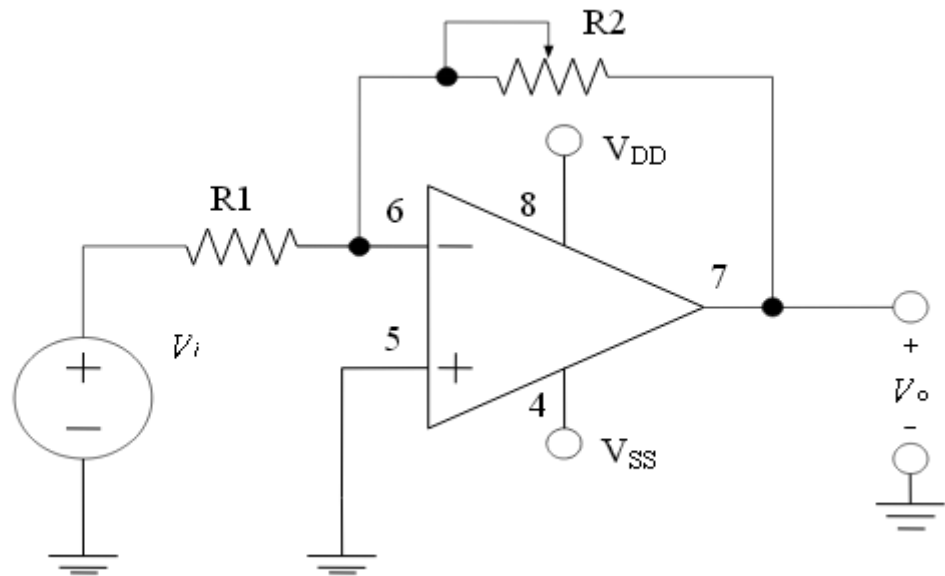
In this lab, we are going to study operational amplifiers and circuits with op-amps. The op-amp chip that we are going to use is LM741. The configuration of the chip is shown below.



Circuit:

a) Differentiator

Build the inverting amplifier but put 0.1 μF capacitor instead of R_1 as shown in Fig 4. Use $R_2=5\text{k}$ Input a 500 Hz 500 mVpp triangle wave. Zoom into the waveform to measure time constant RC . Add DC offset to the input signal, is there any change on the output signal? Why? What happens when the input is a triangle wave?



b) Integrator

Put a 0.1 uF capacitor instead of R2 in a new inverting amplifier (Fig 3) and measure the time constant. Use a 60 Hz, 500mVPP square wave as input. After getting the waveforms and triggering correct, measure time constant RC. Now change the function generator back to a sine wave input, sweep frequency from 1Hz to 100kHz and observe the change of the gain with frequency.

