Helwan university
Faculty of engineering
Electronics and Communication Department

Academic year : 1^{st} First term:2022/2023

Electronics devices lab

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Experiment 1

Diode characteristic

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Objective

- To calculate, compare, draw, and measure the characteristics of a silicon and germanium diode.
- To study the series and parallel configurations of a silicon and germanium diodes.

Tools and Equipment Required

DMM (Digital Multi Meter)

DC Power Supply

1 kΩ	× 1
1 MΩ	× 1
Silicon Diode	× 1
Germanium Diode	× 1

Procedures

PART 1. Diode Test

a) Diode testing Scale

The diode-testing scale of a DMM can be used to determine the operating condition of a diode. With one polarity, the DMM should provide "offset voltage" of the diode, while the reverse connection should result is an "OL" response to support the open-circuit approximation.

Using the connections shown in **Fig1.2,** the constant-current source of about 2 mA internal to the meter will forward bias the junction, and a voltage about 0.7 V (700mV) will be obtained for silicon and 0.3 V (300mV) for germanium. If the leads are reserved, an OL indication will be obtained.

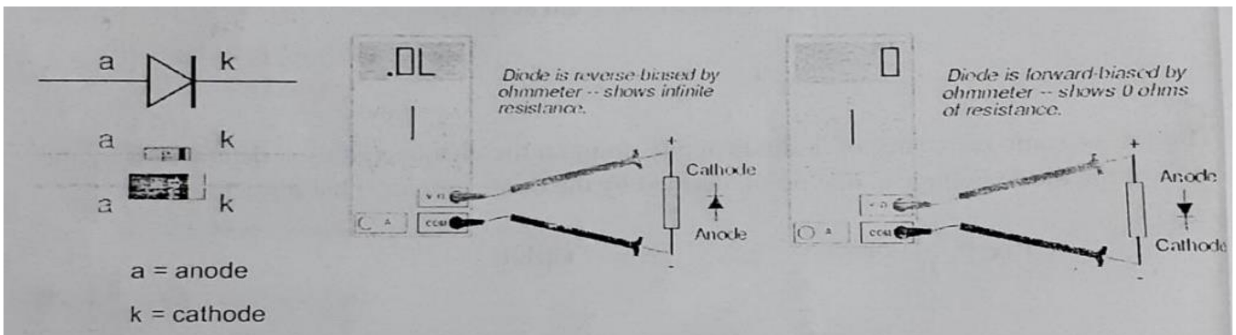

Figure 1.2 diode testing

If a low reading (less than 1 V) is obtained in both directions, the junction is shorted. If an OL indication is obtained in both direction, junction is open. Perform the tests of table 1.1 for silicon and germanium diodes.

Table 1.1

Test	Si	Ge
Forward		
Reverse		

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Part 2. Forward-bias Diode Characteristics

In this part of the experiment we will obtain sufficient data to plot the forward-bias characteristics of the silicon and germanium diodes on **Fig 1.4**

a) Construct the network of fig 1.3 with the supply (E) set at 0 V . record the measured value of the resistor.

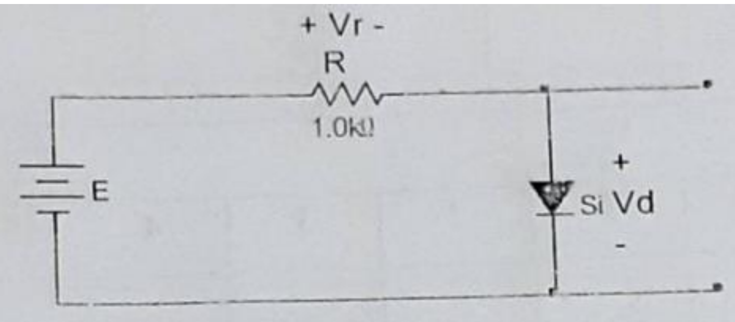

Figure 1.3

b) Increase the supply voltage E until V_R **(not E)** reads 0.1 V. Then measure V_D and insert its voltage in Table1.3**. Calculate** the value of the corresponding current I_D using the equation shown in Table 1.3

TABLE 1.3

V_D versus I_D for silicon diode

V_R (V)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
V_D (V)								
$I_D = \frac{v_R}{R_{meas}}$(mA)								

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V_R (V)	0.9	1	2	3	4	5	6	7	10
V_D (V)									
$I_D = \frac{v_R}{R_{meas}}$(mA)									

c) Replace the silicon diode by a germanium diode and complete table1.4

d) TABLE 1.3

e) V_D versus I_D for germanium diode

V_R (V)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
V_D (V)								
$I_D = \frac{v_R}{R_{meas}}$(mA)								

V_R (V)	0.9	1	2	3	4	5	6	7	10
V_D (V)									
$I_D = \frac{v_R}{R_{meas}}$(mA)									

d) On **fig 1.4**, plot I_D versus V_D for the silicon and germanium diodes. Complete the curves by extending the lower region of each curve to the intersection of axis at $\boldsymbol{I_D} = 0$ mA and $\boldsymbol{V_D} = 0\ V$. lable each curve and clearly indicate data points.

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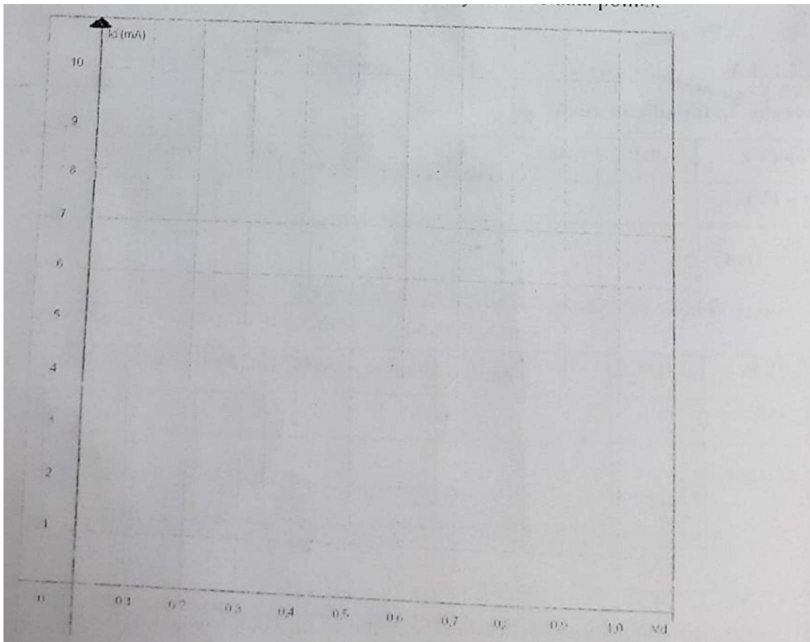

Figure 1.4

Part 3. Reverse Bias

a) In fig.1.5 a reverse-bias condition has been estabiished. Since the reverse saturation will be relatively small. a large resistance of 1 MΩ is required if the voltage across R is to be of measureable amplitude. Construct the circuit of fig.1.5 and record the measured value of R on the diagram.

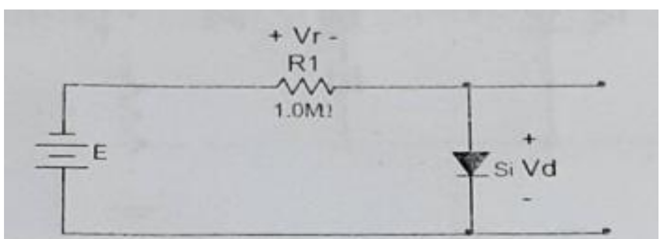

Figure 1.5

b) Measure the voltage V_R. Calculate the reverse saturation current from

$\boldsymbol{I_s = V_R / (R_{meas} // R_m)}$. The internal resistance $\boldsymbol{R_m}$ of the DMM is included because of the large mangnitude of the resistance R. your instructer will provide the internals resistance of DMM for your calculations. If unavailable, use a typical value of 10 MΩ.

R_m = ___________
V_R =____________
I_s =____________

c) Repeat Part3(b) for the germanium diode.

V_R =_____________
I_s =_____________

d) Determine the DC resistance levels for the silicon diodes using the equation

$$R_m = \frac{V_D}{I_D} = \frac{V_D}{I_S} = \frac{E - V_B}{I_S}$$

$R_{DC}\ (calculated)\ (Si) =$ _____________

$R_{DC}\ (calculated)\ (Si) =$ _____________

Part 4. Forward-bias Series Diodes

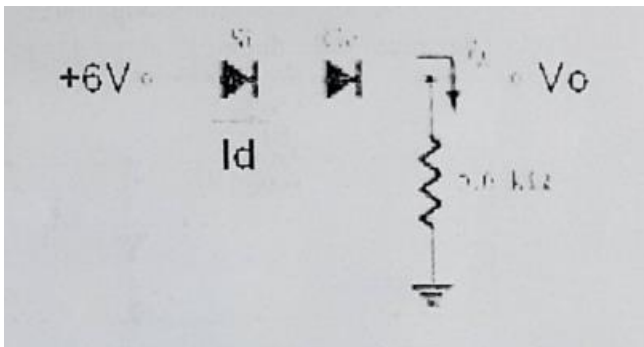

Figure 1.6: Series diode configuration

Determine the current Id. V_0 , I_R for the network of Fig. 1.6.

V_0 = ……….. , I_d =………… , and I_R = …………

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Part 5. Series Si-Si Diode Configuration

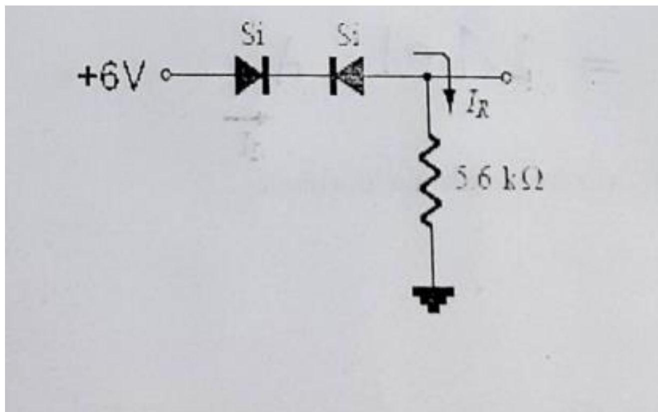

Figure 1.7: Series Si-Si diode configuration

Determine the current I_D , V_{D2} , V_0 for the network of Fig. 1.7.

V_{D2} = ………… , I_d =…………. , and V_0 = ………….

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Experiment 2

Half-Wave and Full Rectification

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Objective

To calculate, compare, draw, and measure the DC output voltages of half-wave and full-wave rectifier circuits.

Tools and Equipment Required

DMM (**D**igital **M**ulti **M**eter)

DC Power Supply

Function Generator

Oscilloscope

2.2 MΩ $\times 3$

Silicon Diode $\times 4$

Procedures

PART 1. Threshold Voltage

Choose one of the four silicon diodes and determine the threshold voltage, V_T, using the diode-checking capability of the DMM.

V_T = ____________

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Part 2. Half-Wave Rectification

a) Construct the circuit of Fig.2.2 using the chosen diode of Part 1. Record the measured value of the resistance R. set the function generator to 1000 Hz, $\mathbf{8}\ \boldsymbol{V_{p-p}}$ sinusoidal voltage using the oscilloscope.

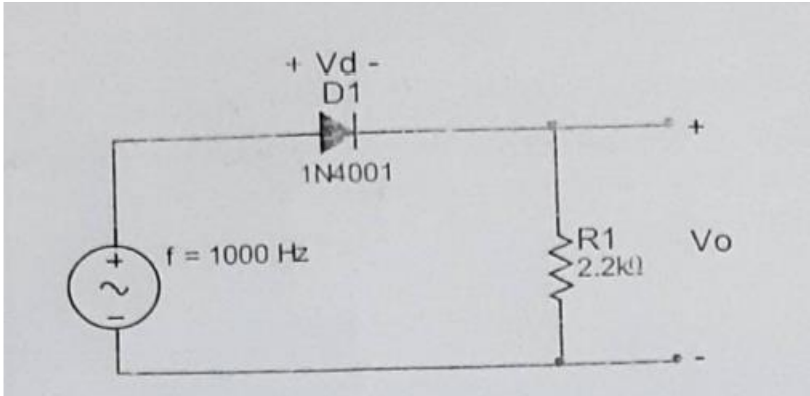

Figure 2.2 half –wave rectifier

b) The sinusoidal input of fig.2.2 has been plotted on the screen of fig.2.3.

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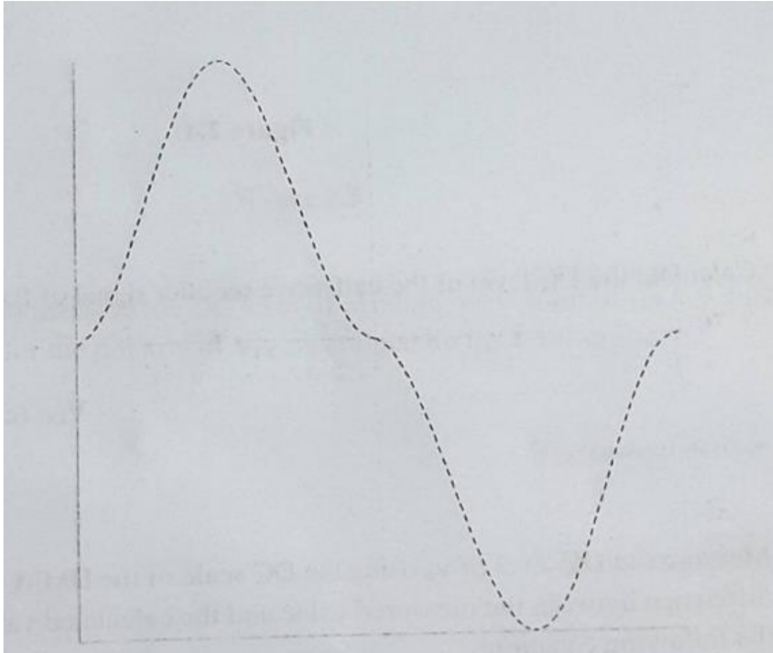

Figure 2.3

c) Using the threshold voltage $\boldsymbol{V_T}$ of Part 1, determine the theoretical output voltage $\boldsymbol{v_O}$ for the circuit of fig.2.2 and sketch the waveform on fig.2.3 for one full cycle using the same sensitivities employed in Part 2(b). Indicate maximum and minimum values.

d) Using the oscilloscope with the DC position, obtain the voltage $\boldsymbol{v_O}$ and sketch the waveform on fig.2.4. Before viewing $\boldsymbol{v_O}$ be sure to set the $\boldsymbol{v_O = 0\ V}$ line using the GND position of the coupling switch.

Part 5. Full-Wave Rectification

a) Construct the full-wave bridge rectifier of fig.2.12. Be sure that the diodes are inserted correctly and that grounding is as shown.

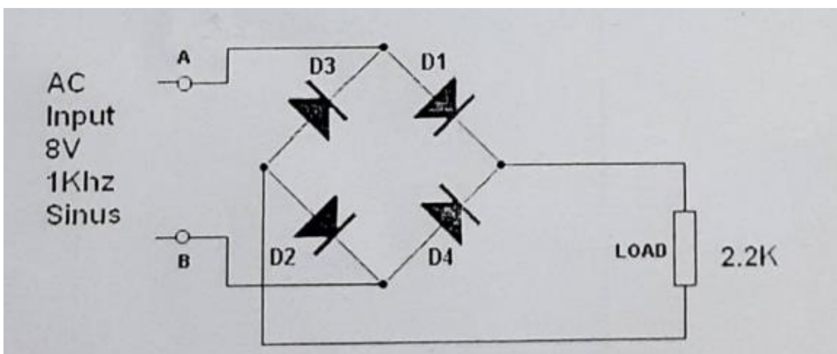

Figure 2.13

$V_{rms}(measured) =$ ____________

b) Using the V_T of Part 1 for each diode, sketch the expected output waveform v_O on fig.2.14.

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Experiment 3

Clipping and Clamping Circuits

Objective:

To calculate, compare, draw, and measure the output voltages of clipping and clamping circuits.

Tools and equipments required:

- DMM (digital multi meter)
- DC power supply
- Function generator
- Oscilloscope
- 1 uF x1
- 2.2 $K\Omega$ x1
- 1 $K\Omega$ x1
- Germanium diode x1
- Silicon diode x1

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Procedures

Part one: clipping circuit

a) Record the measured value of resistance value of R and construct the circuit of fig 3.1. note that the input voltage is 8 V_{P-P} square wave at frequency of 1000 hz. (here E=1.5V DC supply)

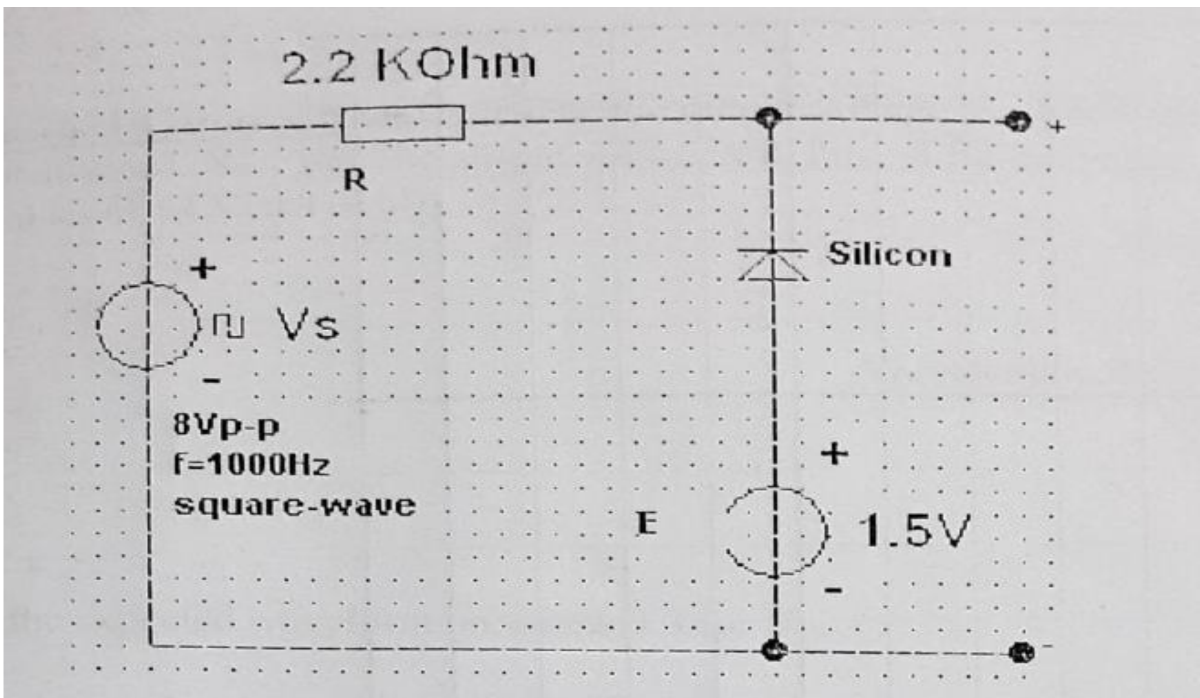

Figure 3.1

b) Using the measured values of V_T E, and R , calculate the output voltage .

$V_O(calculated)$=

c) Sketch the expected waveform for V_O .

d) Reverse the DC supply E and calculate the output voltage.

$V_O(calculated)$=

e) Sketch the expected waveform for V_O.

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Part two: clamping circuit

Construct the circuit of fig 4.1 and change the input signal to 8 V_{P-P} square wave at frequency of 1 KHz.

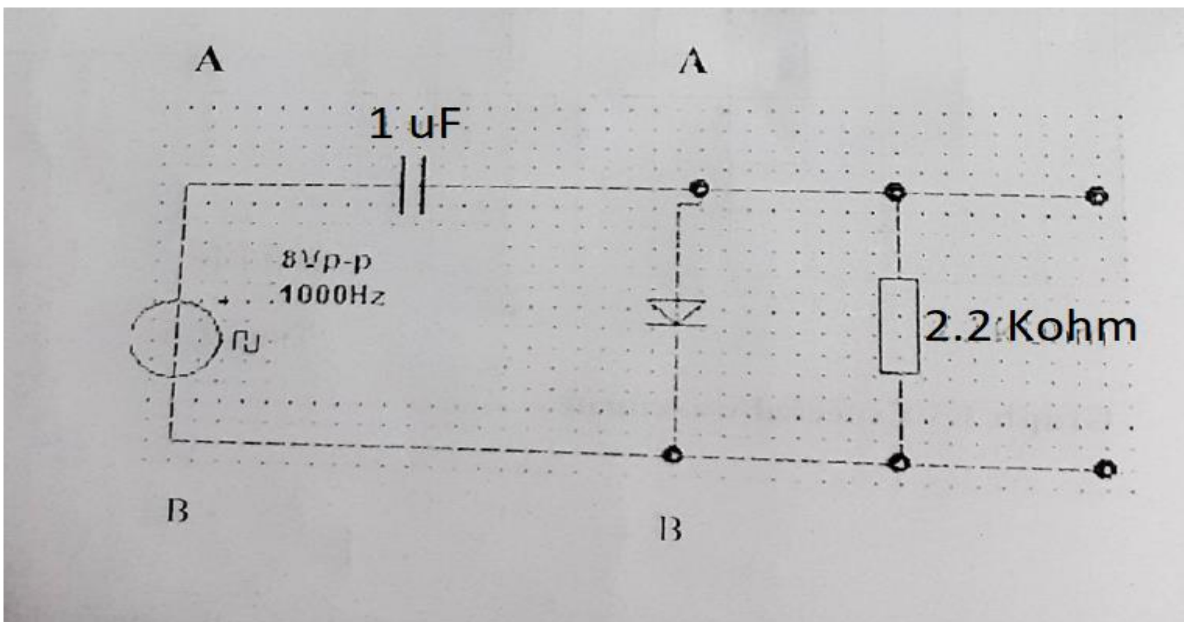

Figure 4.1.

a) Sketch the observed waveform from oscilloscope

b) Reverse the diode and sketch the observed waveform again.

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Experiment 4

Light-Emitting and Zener Diodes

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Objective:

To calculate, draw, and measure the currents and voltages of light-emitting diode (LEDs) and Zener Diodes.

Tools and equipments required:

- DMM (digital multi meter)
- DC power supply
- Function generator
- Oscilloscope
- 1 uF x1
- 220 Ω x1
- 100 Ω or 120 Ω x1
- Germanium diode x1
- Silicon diode x1

Procedures

Part 1: Diode characteristics

a) Record the measured value of resistor R and construct the circuit in fig.4.1. Initially, set the supply voltage to 0V.

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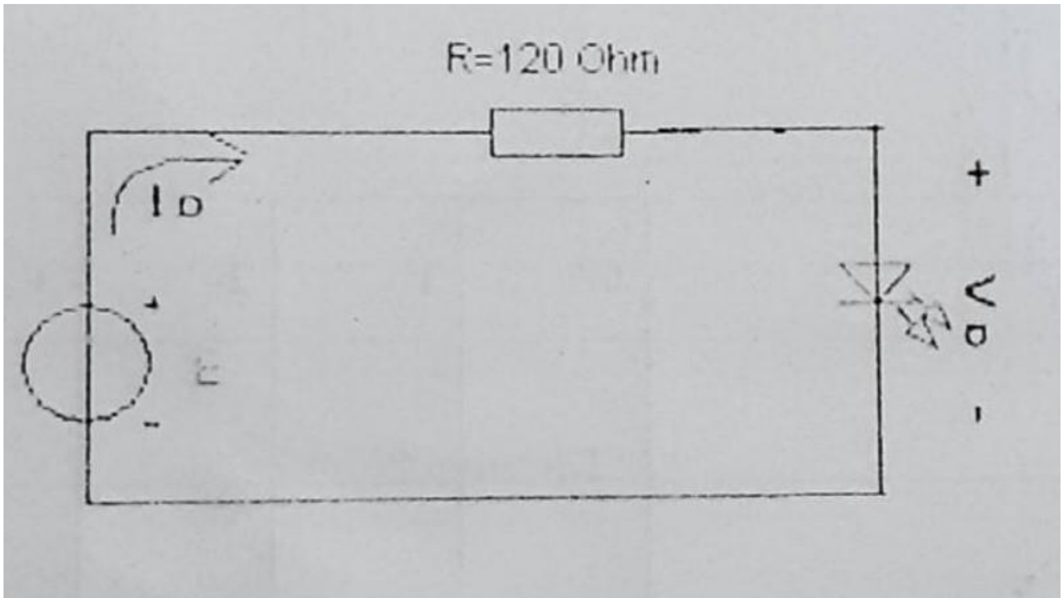

Figure 4.1

R(measured)= ______________________

b) Increase the supply voltage E until “first light” is noticed. Record the V_D and V_R using DMM. Calculate I_D using $I_D = V_R / R$.

c) Continue to increase the supply voltage E until “good brightness” is first established.
DO NOT OVERLOAD the circuit. Record the V_D and V_R using DMM. Calculate I_D using $I_D = V_R / R$.

d) Set DC supply E to corresponding values on the table 4.1 and measure the values V_D and V_R and calculate the current I_D and fill the table.

Table 4.1

E(V)	0	1	2	3	4	5
V_D(V)						
V_R(V)						
$I_D = V_R/R$ (mA)						

e) Using the table 4.1 sketch the curve I_D vs. V_D on the graph fig.4.2. Point the I_D and V_D of “good brightness” from the part 1.(c) and draw a vertical line from the intersection point . Area on right of lines is “good brightness”.

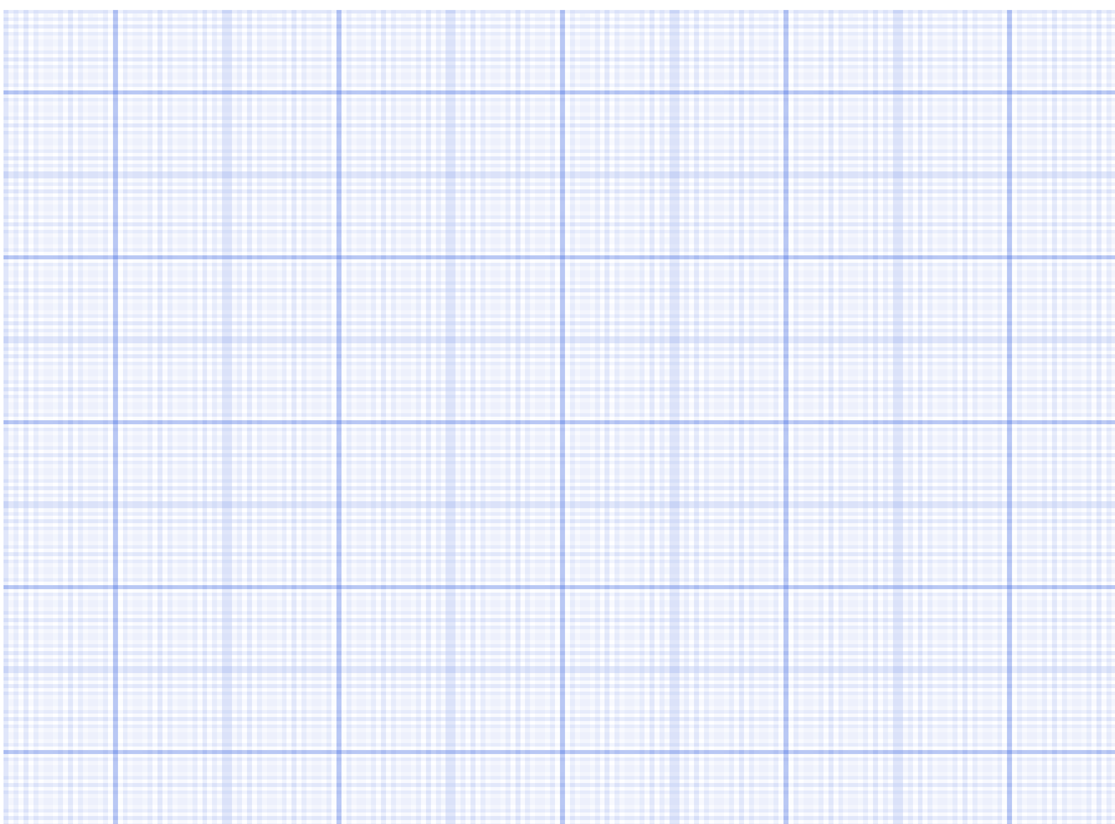

Figure 4.2

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f) Record the measured value of resistance and construct the circuit of fig.4.3. be sure that both diodes are connected properly.

R(measured)= ________________

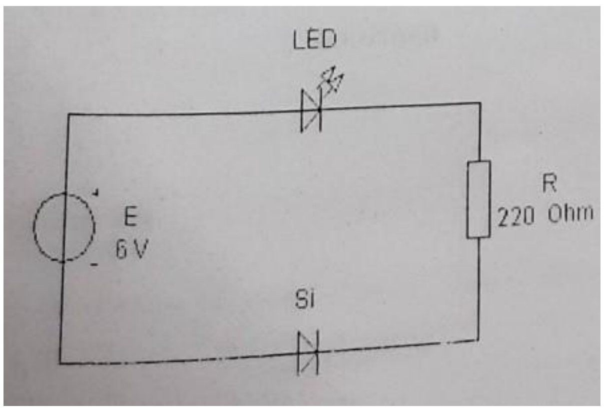

Figure 4.3

g) Do you expect the LED to burn brightly? Why? What if the silicon diode is reversed?

h) Energize the circuit for both conditions of silicon diode. (as shown in fig.4.3 and reversed). If the LED is "on" with "good brightness", measure V_D and V_R and calculate I_D. Compare with the area "good brightness" on graph of fig.4.2.

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Part 2: Zener Diode Characteristics:

a) Record the measured value of resistance R. Construct the circuit of fig.4.4. Initially set DC supply to 0V.

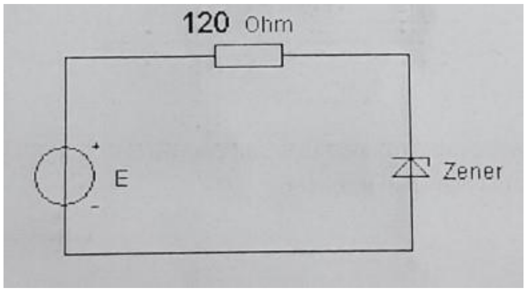

Figure 4.4

R(measured)= ___________________________

b) Set the DC supply E to the values on table 4.2 and measure both V_Z and V_R. Calculate the Zener current I_Z in mA.

Table 4.2

E(V)	0	1	2	3	4	5	6	7	8
V_Z(V)									
V_R(V)									
$I_Z = V_R/R$ (mA)									

c) Since the Zener region is I the third quadrant of a complete diode characteristic curve, place a minus sign in front of each I_Z and V_Z value. Plot the curve I_Z vs. V_Z

Figure 4.5

d) For the measurable current I_Z in the linear region, what is the average value of V_Z? Estimate the average resistance of Zener diode in the linear region using ravg $=\Delta V_Z/\Delta I_Z$. Choose an interval for ΔV_Z at least 2V.

V_Z(approximated) = ____________________

R_Z(calculated) = ______________________

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Experiment 5

A bipolar junction transistor (BJT)

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Objectives:

1- To determine transistor type (npn, pnp),terminal and material.
2- Measure and graph the collector characteristics curves for a bipolar junction transistor.
3- Use the characteristic curves to determine the β_{DC} of the transistor at a given point.

Tools and equipments required:

- DMM (digital multi meter)
- DC power supply
- Function generator
- Oscilloscope
- 5 KΩ pot. x1
- 100 MΩ pot. x1
- 1 $K\Omega$ x1
- 220 $K\Omega$ x1
- 2N2222 x2

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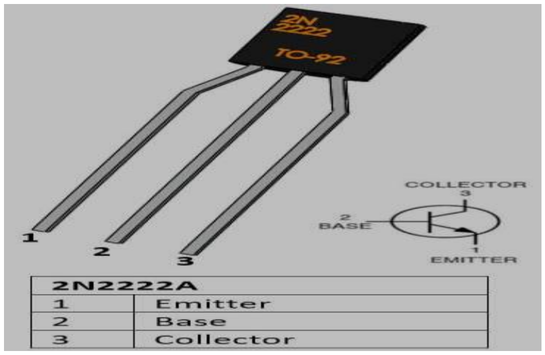
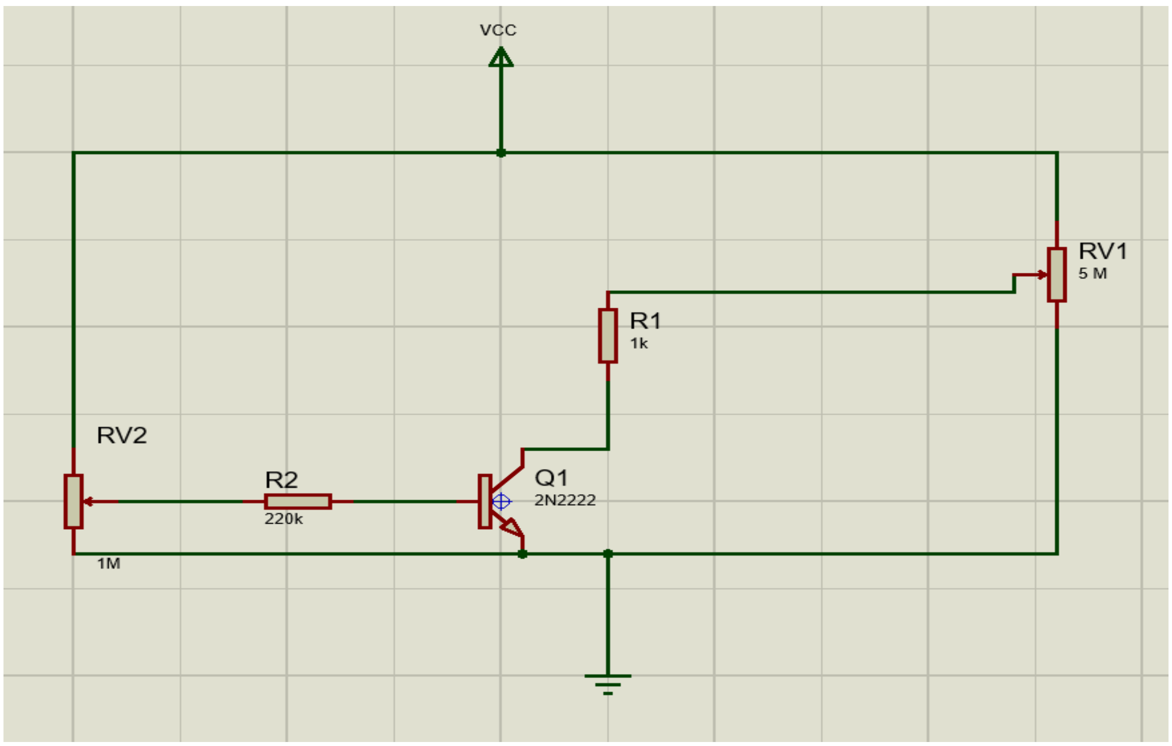


Procedures

Part one:



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f) 1. Connect the 2N222 (NPN) as shown in Fig. 1., Let VCC = 15V.

g) Set the voltage V_{RB}= 2.2 V BY varying 1MΩ Potentiometer. this set make I_B= V_{RB} /RB =10 μA .

h) Then set v_{CE} =2 V by 5 kΩ potentiometer and record V_{RC} , V_{BE}

i) Varying 5kΩ to increase v_{CE} from 2 v to valueQ in the table

j) For each value of v_{CE} measure and record V_{RC} , V_{BE} use mv scale for V_{BE}

k) Repeat part (b) through (f) for all values of V_{RB}

l) Use all data of the table to plot I_C verses v_{CE} for various value of I_B

V_{RB}=	I_B=	V_{CE}=	V_{RC}=	I_C=	V_{BC}=	I_E=	α=	B=
2.2	10	2						
2.2	10	4						
2.2	10	6						
2.2	10	8						
6.6	30	2						
6.6	30	4						
6.6	30	6						
6.6	30	8						
9.9	45	2						
9.9	45	4						
9.9	45	6						
9.9	45	8						