FIRST COURSE

1-Characteristics of *diode (Forward bias)*

2- Characteristics of *diode (Reverse bias)*

3- Light emitting diode (LED)

4- Zener Diode *(Forward bias)*

5- Zener Diode *(Reverse bias)*

6-Half and full wave rectifier

7-Voltage doublers

8- Common Emitter Circuit

9- Logic Circuits

Experiment One

Characteristics of *diode*

The purpose of the experiment:-

Study of the properties of diode by drawing current – voltage curve.

Devices used:-

Diode 100 Ω resistance, Voltmeter (from zero to 30 volt), Ameter (from zero to 50 μA and from zero to 100 mA),Power supply and connecting wires.

Theory

Semiconductors are materials whose electrical properties lie between Conductors and Insulators. Ex : Silicon and Germanium.Semiconductors are classified in to P-type and N-type semiconductor P-type: A P-type material is one in which holes are majority carriers i.e. they are positively charged materials N-type: A N-type material is one in which electrons are majority charge carriers i.e. they are negatively charged materials. The appearance of negative ions and positive in both regions (P), (N) and respectively will not be able these ions from moving to the area other because of their link bonds covalent with other atoms and collected at the boundary between the two regions consisting binaries polarity of negative ions and positive. That there binary Pole means that the electrons and the gap from the pack Plug have cut movement and the increasing number of these couples become the region on both sides of the boundary-free shipments moving therefore called this region layer depletion (depletion - layer) and characterized by that irresistible high compared with other

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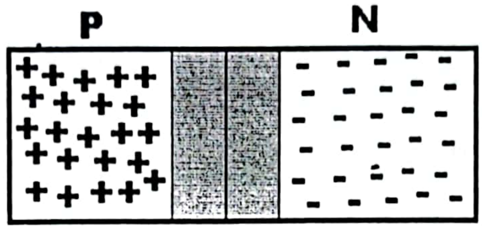
parts of the regions (P and N) as show in figure(1) .In addition, the appearance of their opposite distance charge will lead to make a difference voltage. This voltage is known voltage barrier and be worth up to (0.3 V) for Germanium and (0.6 V) for Silicon.



Figure(1) depletion - layer

Diodes

Electronic devices created by bringing together a p-type and n-type region within the same semiconductor lattice. Used for rectifiers, LED etc.**Diodes** it is represented by the following symbol as show in figure (2), where the arrow indicates the direction of positive current flow.

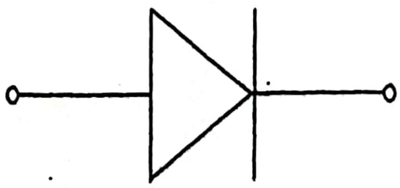


Figure (2) Diodes

Forward Bias and Reverse Bias:-

Forward Bias : Connect positive of the Diode to positive of supply…negative of Diode to negative of supply as show in figure (3 a).

Reverse Bias: Connect positive of the Diode to negative of supply…negative of diode to positive of supply as show in figure (3 b).

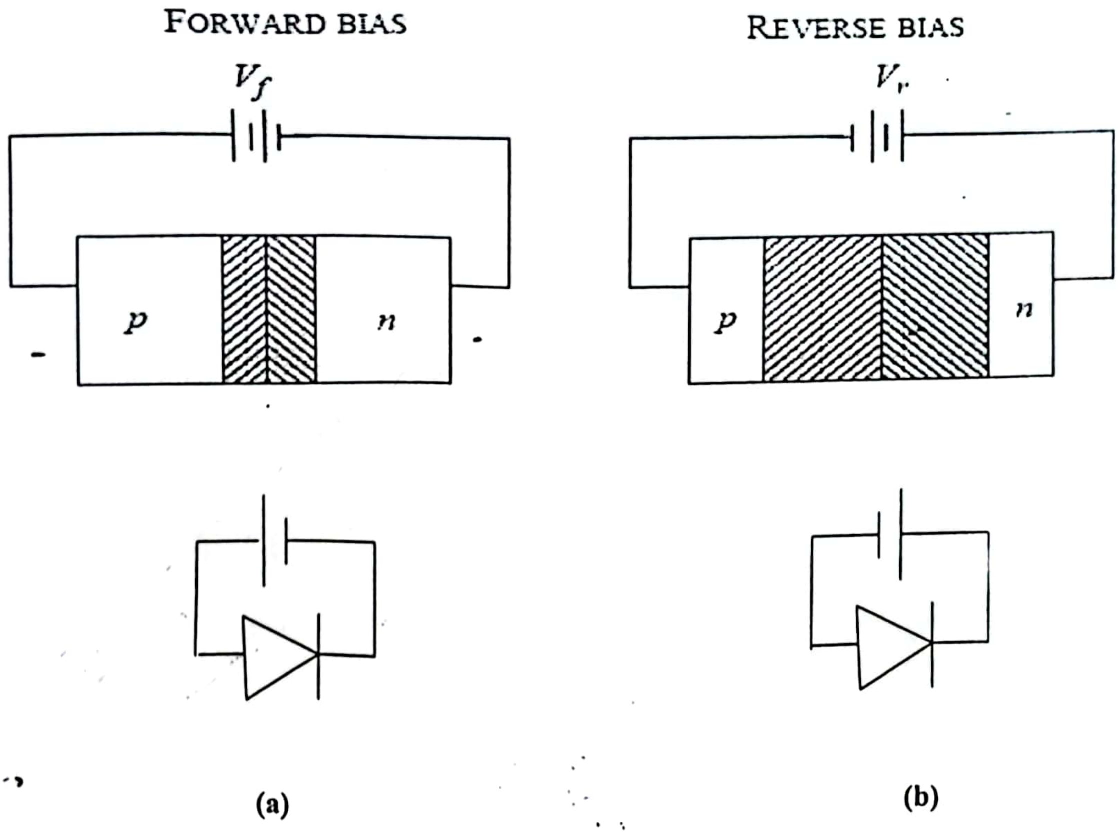


Figure (3) a)Forward Bias b) Reverse Bias

Characteristics of Diode:-

- Diode always conducts in one direction.
- Diodes always conduct current when "Forward Biased" (Zero resistance)
- Diodes do not conduct when Reverse Biased

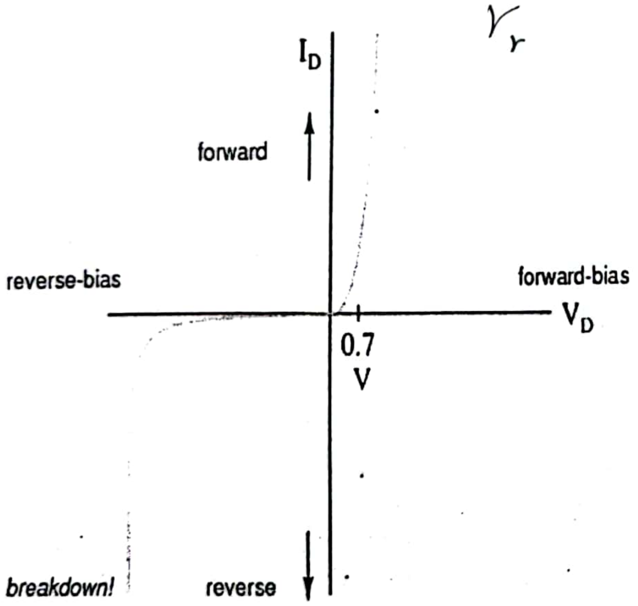
(Infinite resistance)

Current–voltage characteristic

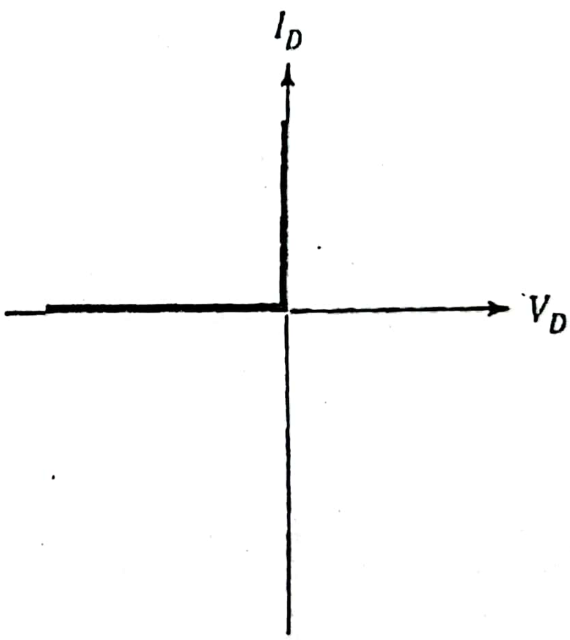
Diode resistance is defined as the ratio between voltage- current, and is obtained by drawing a tangent curve as show in figure (4 a).

The resistant of the diode in the case of **Forward Bias** very small and is denoted by (r_f) and ranging between (30- 500)Ω, in the case of **Reverse Bias** reistance has very high value and denoted by (r_r) and could be exceeding the 2MΩ.

a) Practical Diode



b) Ideal diode



Figure(4)_Current–voltage curve

Procedure :-

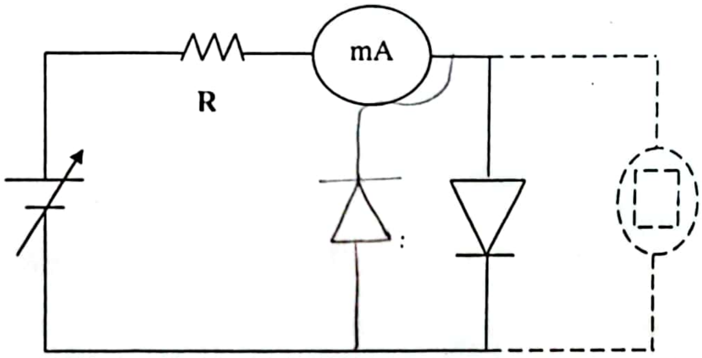
1-Use silicon diode No4007

2-Connect the circuit as shown in figurer (5).

3- Increase the voltage 0.1 V each time up to 0.8 V (Forward Biased) and read the current each time.

4- Increase the voltage 1 V each time up to 8 V and read the current in case (Reverse Biased).

5-Draw the current –voltage characteristics of silicon diode.



Figure(5)

V(volt)	A(mA)
0.1	
0.2	
0.3	

Discussions:-

1-Explain how each of the following occur:-

a- depletion Layer

b- voltage barrier

2- What is the difference between the voltage barrier and the barrier voltage ?

3- What is the value of voltages when the current start to pass through? What does this mean for a material diode?

4-Why the resistance of PN are concentrated in the depletion layer?

Experiment Two

Light emitting diode (LED)

The purpose of the experiment:-

Identify the Characteristics of Light emitting diode and how to use it in emitting light.

Devices used:-.-

Power supply 5 volt, variable resistors, milli ameter,light diode and connecting wires.

Theory

The difference between the junction diode and light emitting diode:

1-Junction diode consists of semiconducting material from element Clique fourth Si and Ge while the light emitting diode consists of semiconductor materials composite from element Clique third and fifth GaAs, GaP, GaAsP .

2- Junction diode emits energizes in the form of heat, while LED emits energizes in the form of light .

Physical principle for the work (LED)

LED works in the case of Forward Bias when the electron transit from conduction band to valance band.It means any electron transit from a higher energy level to lower energy level is release energy in the form of light.While in the case of reverse bias the PN has high resistance and the current is weak and therefore does not emit light.

Light emitted a different frequency and different wavelength so light emitted in different colors because it depends on the energy gap Eg confined between conduction band and valance band .

Procedure :-

After making sure to connect the circuit as show in figure (1) supply the circuit with d.c voltage 4.5 volt from the power supply,observe 4.5 volt on the voltmeter connected in parallel with continuous source then separate voltmeter.

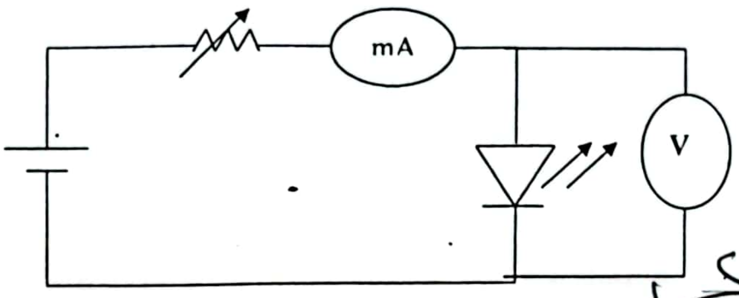


Figure (1)

Then we apply the following table ,Which shows the relationship between the resistance and the current:

R(Ω)	I (mA)
200	
400	
600	
800	
1K	
4K	
8K	

Put the terminal of positive continuous source and milli ameter on both sides of the resistance (200 Ω) observe glow LED, then put the terminal of positive continuous source and milli ameter on both sides of the resistance (400Ω) observe glow LED less than it was in the first case (why).

Thus we continue to experience with (800Ω,1KΩ ,4KΩ , 8KΩ) with observe change glow LED decrease gradually with the reading of the current .Then draw a curved graph as shown in Figure (2).

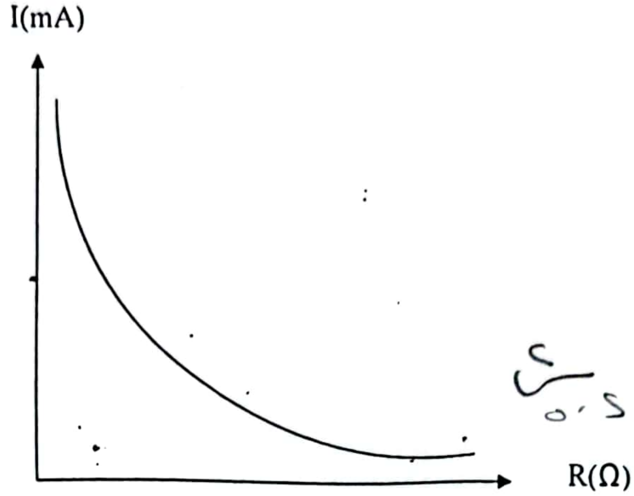


Figure (2)

<u>Discussions:-</u>

1- Define light emitting diode (LED) and then compare between Junction diode and light emitting diode?

2-The colour of (LED) depend on what?

3-Why the glow of (LED) gradually decreases when the resistance increase ?

Experiment Three

Zener Diode

The purpose of the experiment:-

Features characteristics of zener diode and how to used it in voltage regulation.

Devices used:-

zener diode, continuous source, Ameter (from zero to 50 μA and from zero to 100 mA), Voltmeter, resistance and connecting wires.

Theory

We have seen in experiment one when supply reverse bias voltage on both sides of the diode working to increase depletion layer width as well as to accelerate the minority charge carriers and create a small current called the reverse current. Supply reverse bias voltage on PN junction will work on providing minority carriers energy and increase at a certain point will gives more energy, making it able to release the valence electrons of other atoms when colliding, in this way we will get much number of free electrons doubles number too quickly leading to the so-called electric breakdown as show in figure (1).In addition of electric breakdown exist collapse of another kind called the breakdown of the Zener Zener breakdown occurs in diodes that contain a high concentration of impurities so that the depletion layer be very thin result of getting high electric field ($E = V/d$) where d is the width of the depletion layer, V is the voltage .The value of E around 300,000

V/cm.This high field has ability to pull more valance electrons from their atoms produce current which what is called zener breakdown.

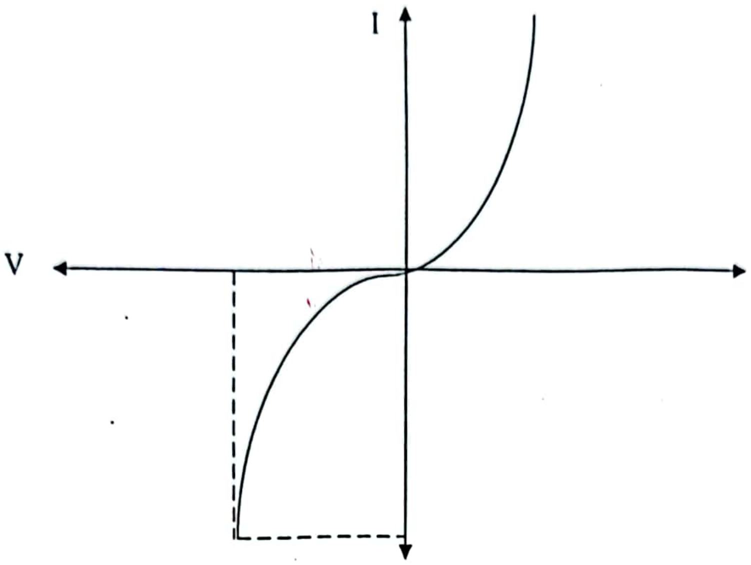


Figure (1)- (I-V) characteristic of Zener diode

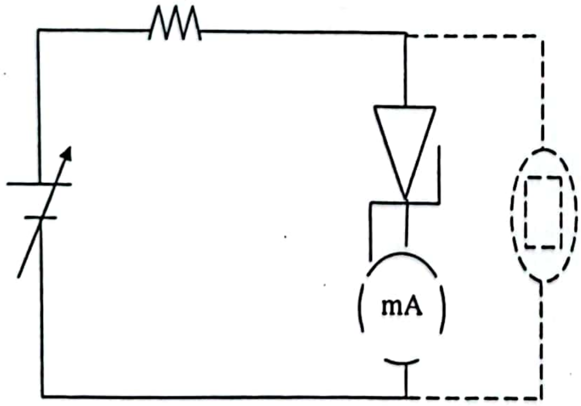
Procedure :-

1- Connect the circuit as shown in figurer (2).

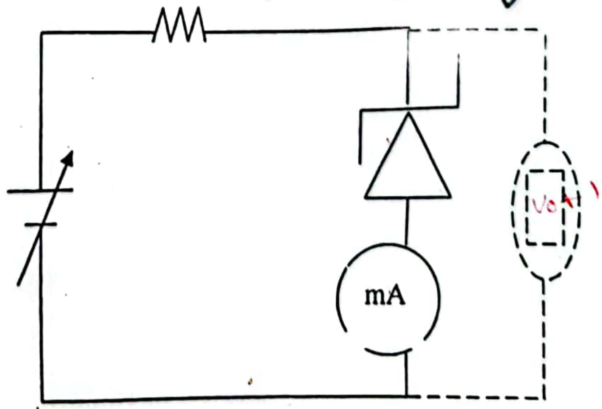
2- Measure I_z as a function of the voltage as show in table (1).

3-Reverse the connection of Zener diode as show in figure (3) then measured I_z as a function of the voltage as show in table (2).

4-Draw a relationship between the I_z and V in both directions as show in figure (1).



Figure(2)



Figure(3)

V volt	I(mA)
0.1	
0.2	
0.3	
0.4	
0.5	
0.6	
0.7	
0.8	
0.9	

Table (1)

V_{in}	I(mA)	V_o
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

Table (2)

Discussions:-

1- Compare between crystalline diode and Zener diode in terms of their characteristics and uses?

2- What is a Zener breakdown? What is the difference between zener breakdown and avalanche breakdown?

3-What is the meant by voltage regulator? Explain in detail?

4- What is the value of voltages at which the Zener diode began to conduct?

5- What is the most important part of the curve (I - V) use to regulate the voltage?

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مالت فيزياء / الكترونيك (عملي)

Half-Wave Rectifier

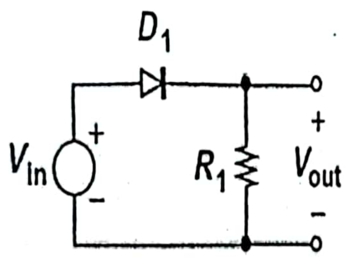
التجربة الرابعة

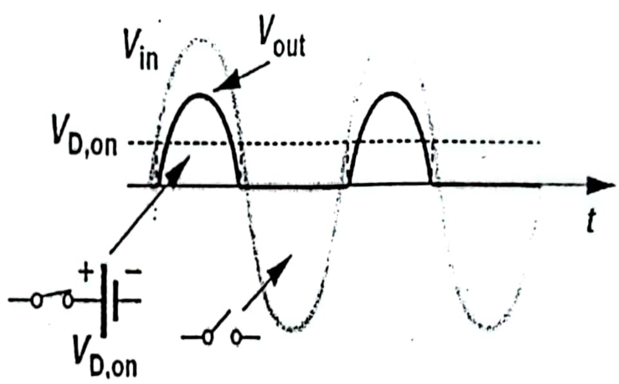
The process of removing one half the input signal to establish a dc level is aptly called half wave rectification.

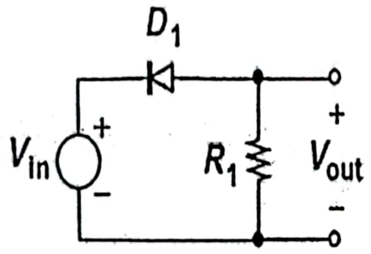
Since a diode p-n junction conducts in one direction but not in the reverse direction, diodes can be used to convert ac voltages into dc

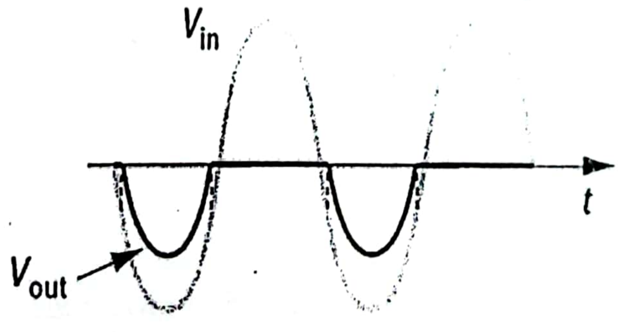
Theory :

In positive half cycle, D1 diode is forward biased and conducts. Thus the output voltage is same as the input voltage. . In the negative half cycle, D1 is reverse biased, and therefore output voltage is zero .









During the negative half cycle of the input voltage the polarity is Change ~~of the secondary voltage gets reversed~~. As a result, the diode is reverse biased Practically no current flows through the circuit and almost no voltage is developed across the resistor. All input voltage appears across the diode itself .

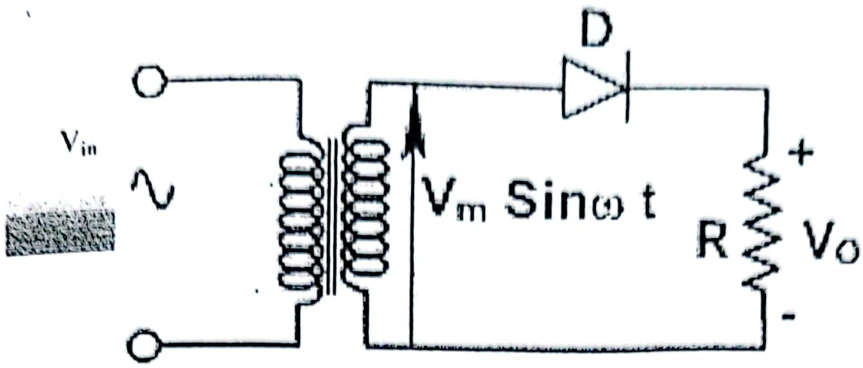


Figure1: experimental setup

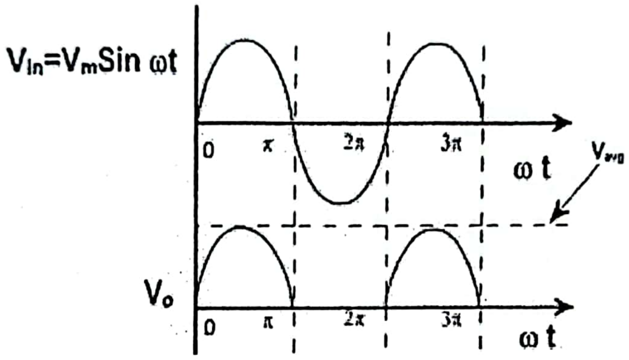


Figure2: Input and output signals

Questions

1- Define the ripple factor

2- Calculate the input and output power of half wave rectifier

3- Can you design power supply using half wave rectifier circuit? Explain

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Hence we conclude that when the input voltage is going through its positive half cycle, output voltage is almost the same as the input voltage and during the negative half cycle no voltage is available across the load.

Average value of the output voltage, V_{av} same as , V_{dc} is given by

$$V_{av} = V_{dc} = \frac{1}{2\pi}\left[\int_0^{\pi} V_m \sin \omega t \, d(\omega t) + \int_{\pi}^{2\pi} 0 . d(\omega t)\right] \text{-----(1)}$$

$$f = \frac{1}{T}$$

$$\omega = 2\pi f$$

$$V_{dc} = \frac{V_m}{\pi} = 0.318 V_m$$

$$I_{dc} = \frac{V_{dc}}{R} = \frac{0.318 V_m}{R}$$

$V_{rms} = Vm/2$ (2)

Procedure

1- Connect the circuit as shown in figure 1.
2- Draw the input and the output signal .from the oscilloscopeas shown in figure 2
3- Measure V_{av} ,V_{rms} ,fin , fout experimentally
4- calculate V_{av} ,V_{rms} ,fin , fout, γ theoretically
5- compare the results experimentally from theoretically

Full wave Rectifier

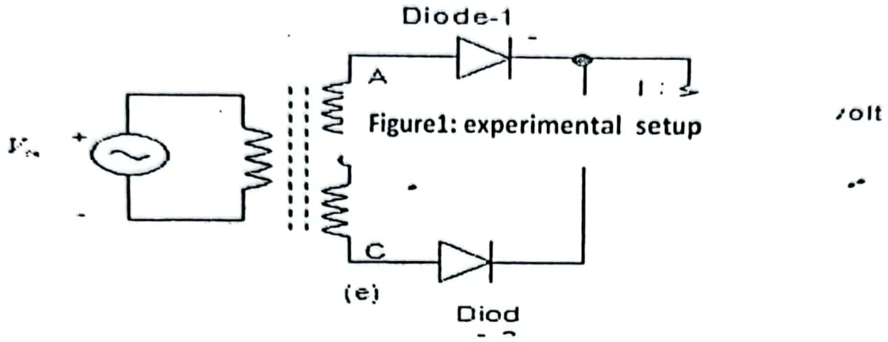
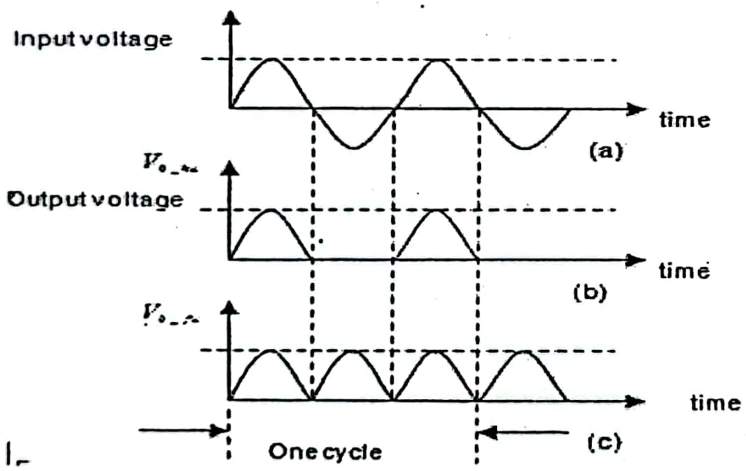


Figure1: experimental setup



$$V_{rms} = \sqrt{\frac{1}{\pi}\int_0^{\pi} (V_m \sin \omega t)^2 \; d\omega t} = \frac{V_m}{\sqrt{2}}$$

$$I_{dc} = \frac{2V_m}{\pi R}$$

Vdc=2Vm/Π

$$I_{rms} = \frac{V_m}{\sqrt{2}\, R}$$

Experiment Five

Voltage Doublers

The purpose of the experiment

How to use the diode to duplicate the input voltage.

Instruments

Diodes, two capacitors (0.1,40µf) a.c power supply, resistance 10kΩ,oscilloscope.

Theory

We use in this experiment Voltage doubler circuit to get voltage which is two times of the input voltage as in figure (1).

Procedure

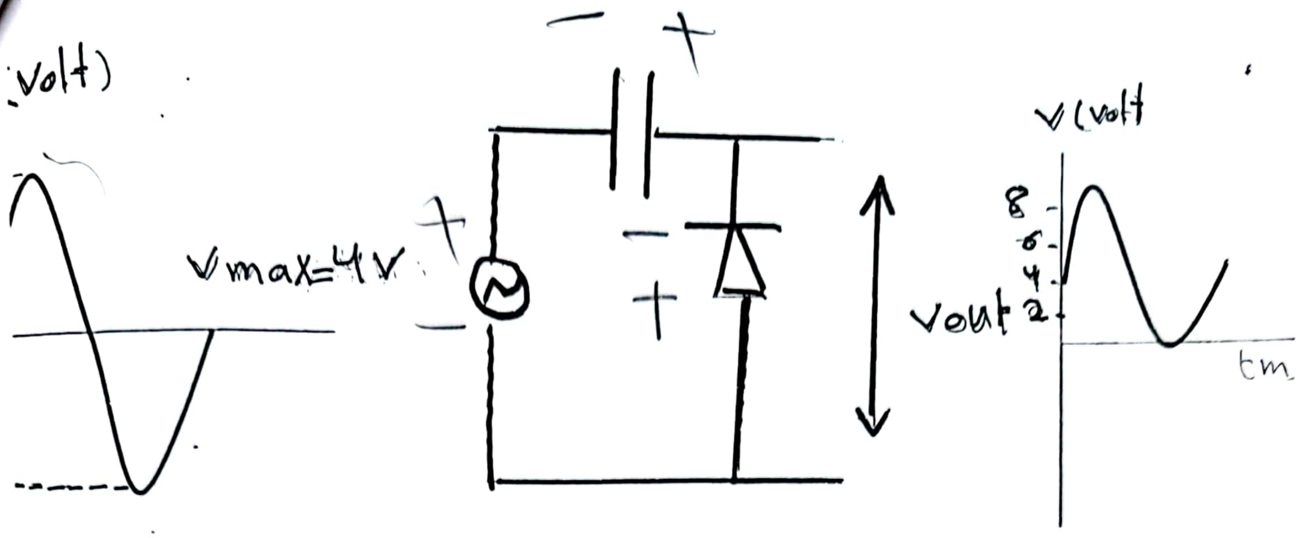
Connect the circuit as in figure (2a) and draw the waveform for the input and the output.

Teory Voltage doubler

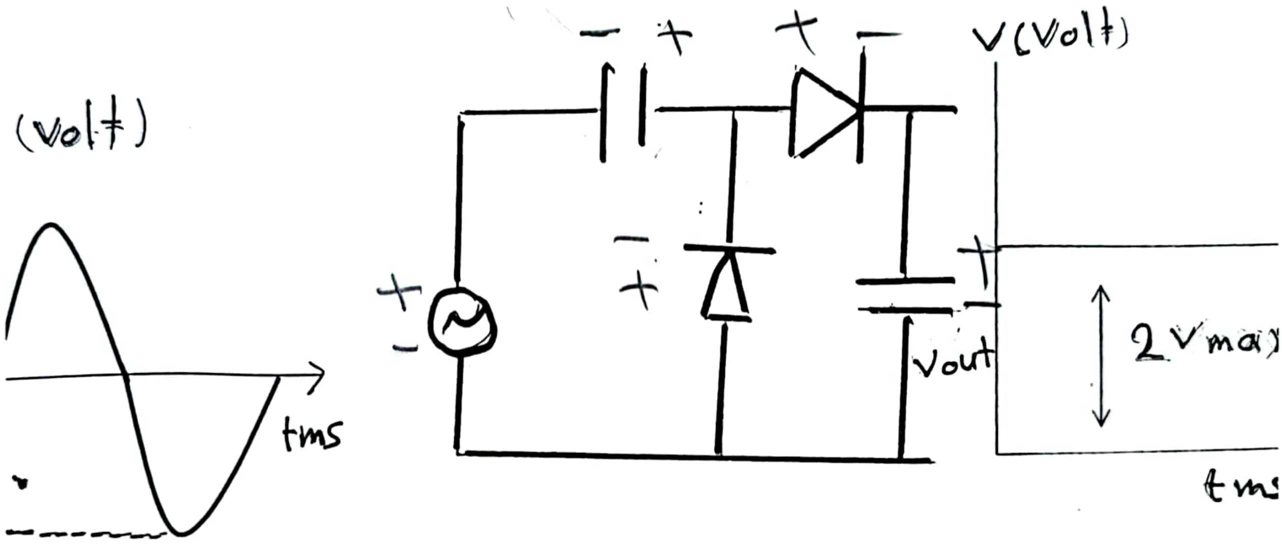
A voltage doubler is an electronic circuit which charges capacitors from the input voltage and switches these charges in such a way that, in the ideal case, exactly twice the voltage is produced at the output as at its input.

The simplest of these circuits are a form of rectifier which take an AC voltage as input and outputs a doubled DC voltage. The switching elements are simple diodes and they are driven to switch state merely by the alternating voltage of the input. DC-to-DC voltage doublers cannot switch in this way and require a driving circuit to control the switching. They frequently also require a switching element that can be controlled directly, such as a transistor, rather than relying on the voltage across the switch as in the simple AC-to-DC case.

Voltage doublers are a variety of voltage multiplier circuit. Many, but not all, voltage doubler circuits can be viewed as a single stage of a higher order multiplier: cascading identical stages together achieves a greater voltage multip



Fig(1) clamping circuit



Fig(2)voltage double

Experiment Six

Common Emitter Circuit

The purpose of the experiment:-

Identify a transistor circuit with a common emitter and drawing features.

Devices uses:-

NPN transistor ,two D.c power supply (0 - 15 volts),two resistance,two Voltmeter and two ameter for d.c current (0 - 30) mA (0 - 50) μA.

Theory

Curves the input and output characteristics

Construction of the transistor:

The name of this device stems from the nature of the work of this device when linked in electric circuits as the first part of this word (trans) refers to property owned by this device in the signal transmit from the input circuit with small resistance to the output circuit with high resistance without reduce and amplifier, while the second part of this word (istor) describing the device as a hard element of the family of resistance.

Transistor consists mainly of a semiconductor crystal is composed of three regions, respectively (the emitter, base, collector) as show in figure (1b). The impurity of base material different than that of the emitter and collector material that why the transistor could be either PNP or NPN. It becomes possible to represent the transistor as two crystal diode connect either face to face or back to back as show in figure (1a). Therefore, the transistor characteristics very similar to that of crystalline diode characteristics.Usually the base is thin layer compared with the emitter and collector.Also the base as small doping compared with high dopping emitter while collector has doping between base and emitter.Figure (1b) show electrical symbol of PNP and NPN transistors are observed arrow with the emitter. Indicates the direction of the arrow to the direction of motion of electrons, where graduation electrons usually from the negative pole and moving toward the positive pole. So the direction of the arrow to the outside refers to the emitter that negative and therefore the transistor is type NPN either entering stock it refers to the emitter that positive and therefore the transistor is of type PNP.

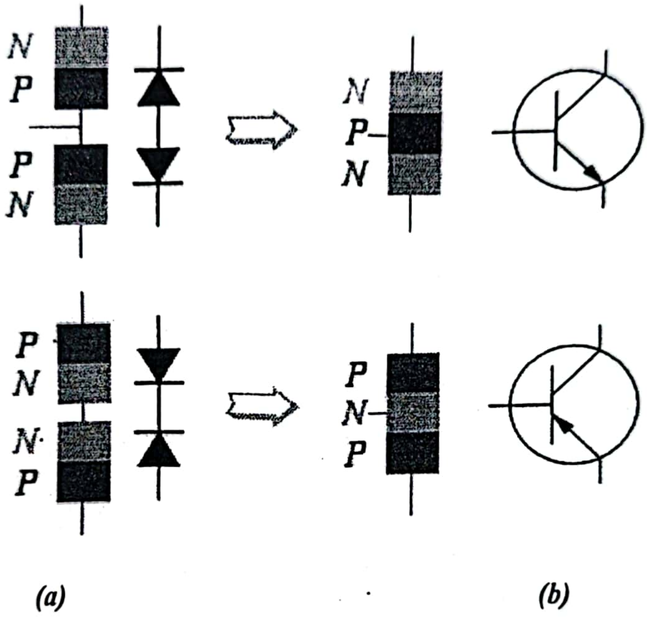


Figure (1)

At the moment apply forward bias voltage(V_{BE}) do not move electrons from the emitter to the base so as to increase the value of (V_{BE}) and become higher than the value of the voltage barrier when it begins electrons spread from the emitter to the base consisting current emitter (I_E) and because the base is thin layer and light doped therefore more than (95%) of the electrons coming from the emitter toward base will arrive to the collector producing collector current (I_C). Some of these electrons recombine with the base holes produce current called a base current

(I_B).As show in figure (2) this connect is considered the famous since it is the most useful type became it give high current and voltage gain.The emitter is common between base and collector .

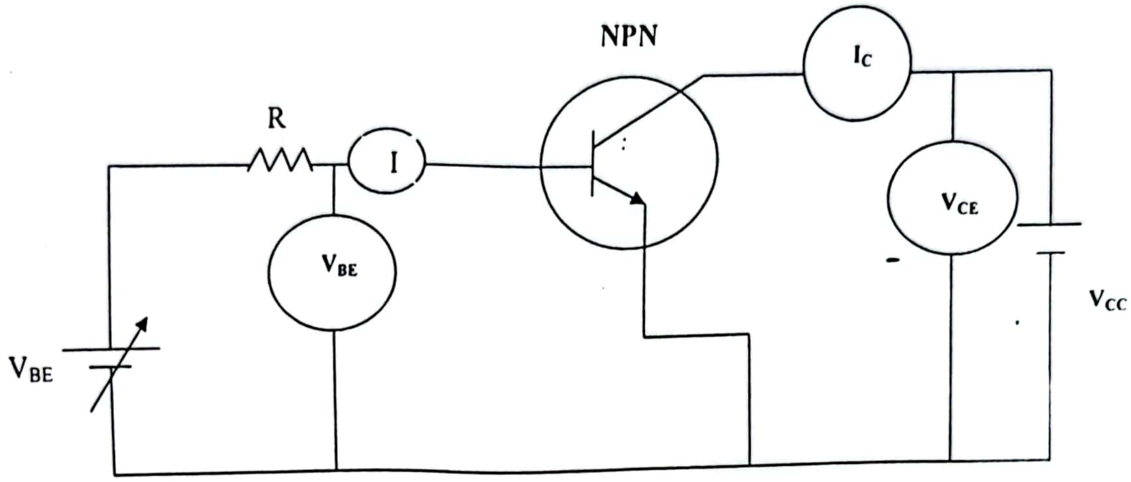


Figure (2)

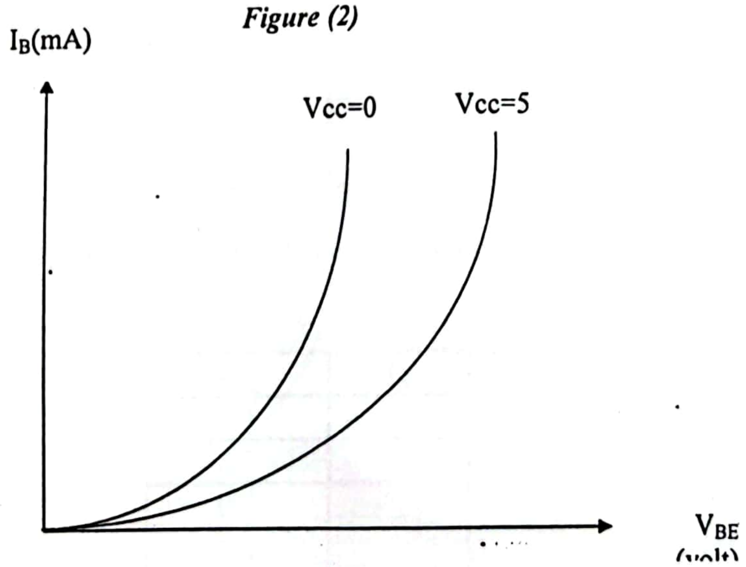


Figure (3)

a- Inputs characteristics:

The input characteristics represent a relationship between the input current I_B and the input voltage V_{BE} when the output voltage V_{CC} constant figure (3) show this relationship.

Procedure :-

1- Connect the circuit as show in figure (2) Note that all source voltages at zero, resistance value (10 KΩ).

2-Fixed (V_{CE} &V_{CC}) at zero and then register I_B value for each change in (V_{BE}) as show in the table below.

$V_{CE=0}$

V_{BE}	I_B
0.1	
0.2	
0.3	
0.4	
0.5	
0.6	
0.7	
0.8	

3- Repeat step (2), but the value of V_{CE} = 5 volts as show in the table below.

V_{BE}	I_B
0.1	
0.2	
0.3	
0.4	
0.5	
0.6	
0.7	
0.8	

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4-Draw a relationship between the I_B and V_{BE} when the V_{CE} is constant as show in figure (3).

a- Outputs characteristics:

The outputs characteristics represents the relationship between the current output I_C and output voltage V_{CE} at constant value from the input current I_B as shown in figure (4).

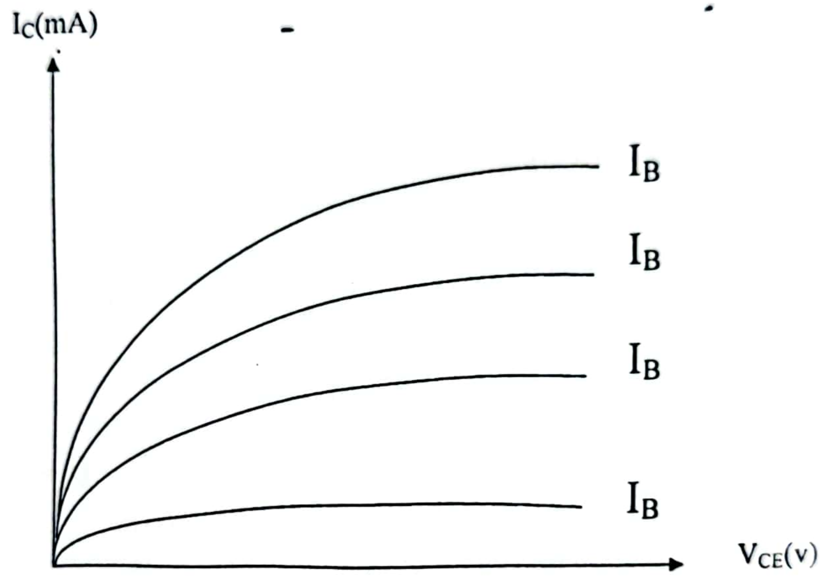

Figure (4)

Procedure :-

1- Connect the circuit as show in figure (2) Note that all source voltages at zero.

2- Take $I_B = 0$ and placing VBE = zero. Change emitter and collector voltage V_{CE} (V_{CC}) and then record the value of I_C corresponding to each change for V_{CE}.

3- Repeat step (2) but with other values for I_B when V_{BE} change for I_B = 10 and I_B = 20 and I_B = 30 .... etc. See table (1).

4- Draw curves between I_C and V_{CE} for each value I_B See Figure (4).

5- Draw a relationship between the I_C and I_B then calculate amplification factor β See figure (5).

V_{CE}	I_B=0mA	I_B=10mA	I_B=20mA	I_B=30mA	I_B=40mA
	Ic=mA	Ic=mA	Ic=mA	Ic=mA	Ic=mA
1					
2					
3					
4					
5					
6					
7					
8					

Table (1)

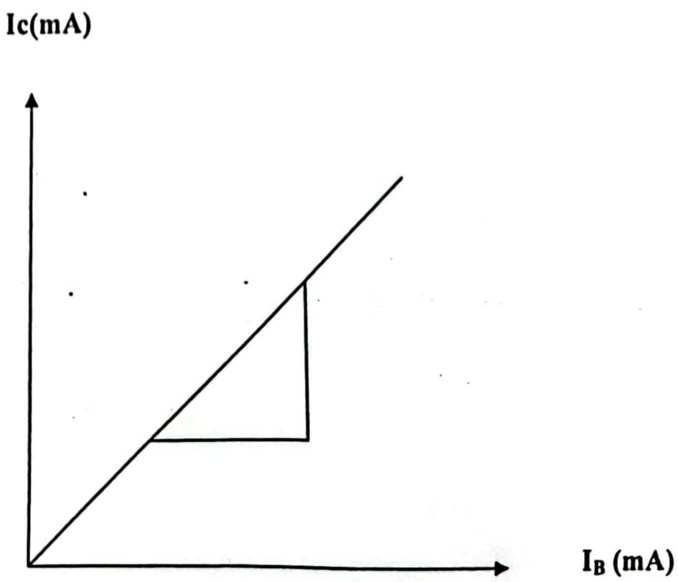

Figure (5)

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Discussions:-

1- Why transistor is used instead of triode in electric circuit?

2- What do you mean equation $I_C / I_B = B$?

3-Why the output current IC in a mA while the unit of the input current (IB) μA?

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Experiment seven

Logic Circuits

The purpose of the experiment:-

Identify the characteristics and truth tables practically for following logic circuits.

1-AND gate

2-OR gate

3-NOTgate

Devices used:-

Two diode, resistance, continuous source d.c and Voltmeter.

Theory

Modern electronic computers consist of large groups of simple circuits called (logic circuits) and many of them are collected from small circuits called Integrated Circuits.The computers ability to resolve issues lies in their ability to make decisions in their work and at every step. Computers circuit capable of comparison and make decision are the so-called logic circuits.

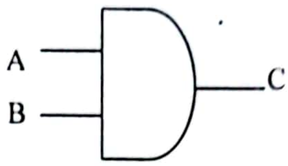
These circuits characterize by its output voltage are either (5 volt) high or zero (Low) and so can be considered for this binary property for the output voltage of these circuits. There are many logic circuits will be explain the nature of their composition and how they work:

a-AND gate

Its an electrical circuit has two inputs or more and only one output and the output of the gate either high or low depending on the type of gate used as well as depending on the type of input voltage of the gate. The gate (AND) is the circuit that has high output voltage when all inputs voltage are high. That the output voltage is low if one of the input voltage is low. See the truth table as shown in figure (1- a). Figure (1-b) shows the symbol for this gate, figure (1-c) refers to the electronic circuit to represent the (AND) gate.

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

Figure (1-a) truth table



C=A.B

Figure (1-b) symbol

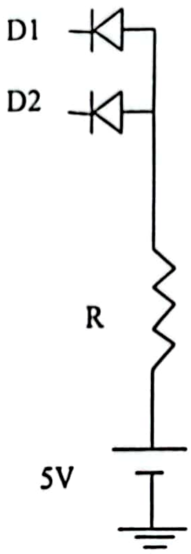


Figure (1-c) electronic circuit

b-OR gate

Output voltage is high for this gate if any input voltage high and output voltage is low only in the case that all input voltage is low. Look truth table in figure (2- a), figure (2-b) shows the symbol for this gate, figure (2-c) refers to the electronic circuit to represent the (AND) gate.

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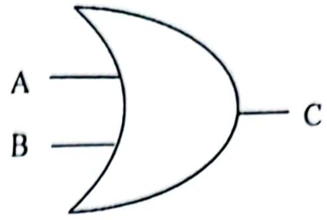
A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

Figure (2-a) truth table



C=A+B

Figure (2-b) symbol

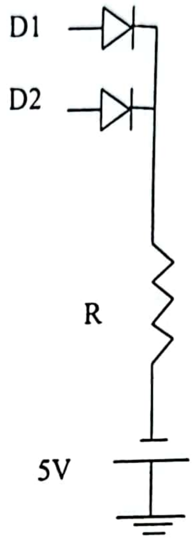


Figure (2-c) electronic circuit

C-NOT gate

To understand the work of this gate through look the truth table (3- a) where we note that the work of this gate is to reverse the input voltages and can be expressed mathematically:

Vin =A but Vout=$\overline{A}$

See the truth table in figure (3- a).Figure (3-b) shows the symbol for this gate.

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A	B
0	1
1	0

Figure (3-a) truth table

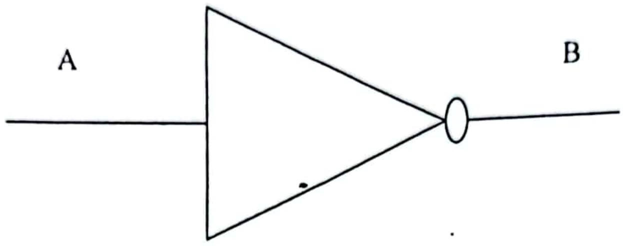


Figure (3-b) symbol

<u>Procedure</u> :-

a- AND gate

1-Connect the circuit as show in figure (1-c).

2- Put V_A and V_B=0 and then measure V_C.

3- Put V_A=5 volt , V_B=0 and then measure V_C.

4- Put V_A=0, V_B=5 volt and then measure V_C.

5- Put V_A=5 volt , V_B=5 volt and then measure V_C.

6- Regist the results similar to the truth table (1-a).

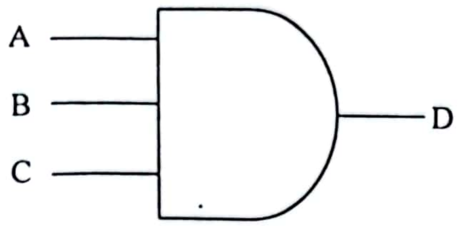
b- OR gate

1- Connect the circuit as show in figure (2-c).

2- Repeat steps (2,3,4,5) above.

Discussions:-

1-Write the truth table for each of the following circuits?



2-Explain the work of each of the following circuits (AND gate) (OR gate) (NOT gate)?

3-Write equation of output voltages (Vout) for each of the following circuits AND gate, OR gate, NOT gate?

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