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P.M.B 168 EKEREMOR

ELECTRONICS 1
PRACTICAL MANUAL

COURSE CODE: EEC 124

PARTMENT OF ELECTRICAL ELECTRONICS ENGINEERING TECHNOLOGY.

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Experiment 1:

P-N JUNCITON SEMICONDUCTOR DIODE CHARACTERISTICS

Objectives:

(a) To study the effects of forward and reverse biasing on both the silicon and germanium junction diodes.

(b)To plot the static characteristics of silicon and germanium junction diodes from experimental results.

(c)To determine d.c and dynamic resistances of p-n junction diode.

INTRODUCTORY INFORMATION

Static Characteristics

The current-voltage relationship of the p-n junction diode is represented analytically by Equation (1) and graphically by Fig.1

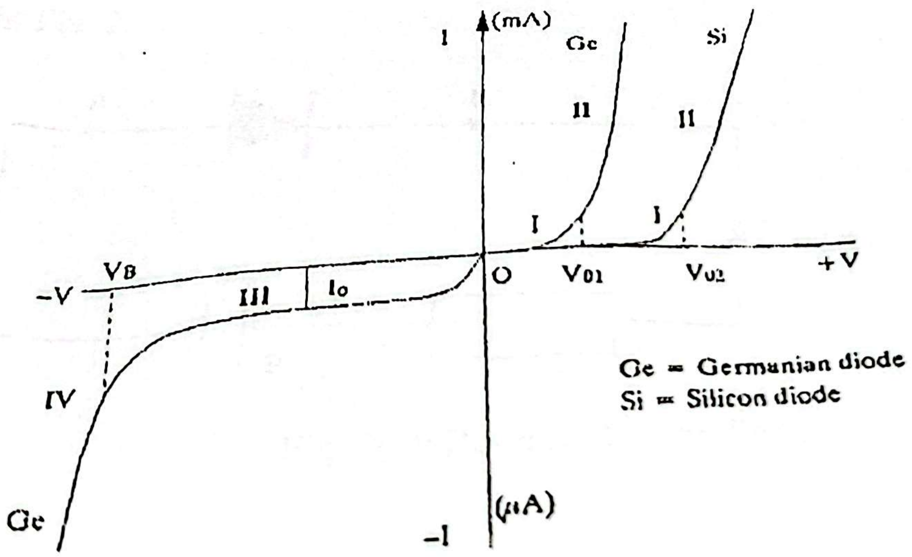


Fig. 1: Static Characteristics of p-n junction diode

The equation is given by: I = Io expeV - 1

[illegible]

[illegible] charge on the electron (Coulombs)
Boltzmann's constant [illegible]
Junction temperature (usually taken as room temperature) Kelvin)

...s experiment, we shall observe how V relates to I practically. Will the result ... the exponential relationship between V and I? We are yet to see!

... shows typical static characteristic curves for silicon and germanium pn ... diodes. It is a plot of diode current I versus applied voltage V across the ... both forward and reverse-biased voltages.

... is said to be forward-biased if the positive terminal of a d.c e.m.f source, ...nected to the anode (A) of the diode and the negative terminal to its ... (k). If we have the same d.c source E connected to the diode with its ... interchanged, then we have a reverse-biased diode. These connections ... in Fig. 2.

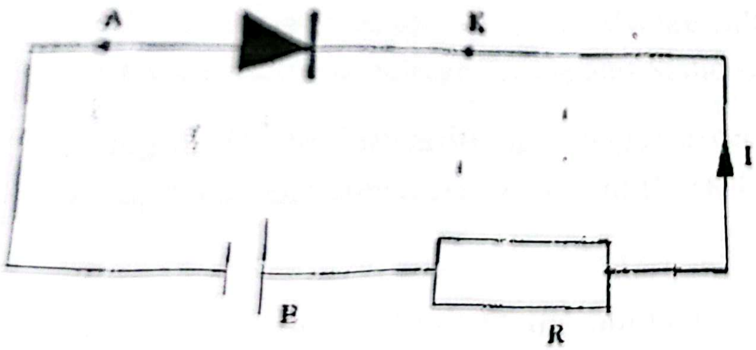


Fig. 2(a): Reverse -biased diode

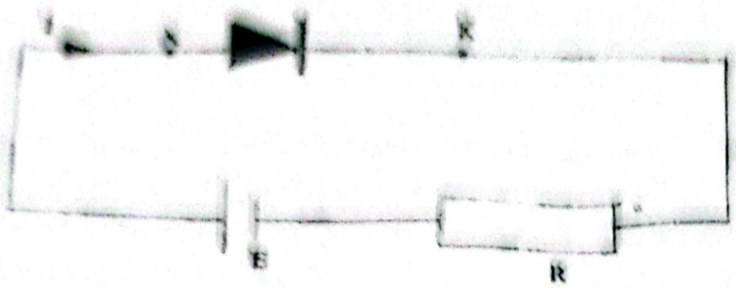


Fig. 2(b): Forward -biased diode

N.B. Resistor R is included in the circuit for current limiting purpose (so that excessive current does not flow in the diode).

The static characteristic curve shown in Fig. 1 can be divided into four regions, namely: I, II, III and IV.For any diode, regions I and II together constitute what is known as the forward-biased range. Regions III and IV together constitute the reverse-biased range.

In region I, very low current flows in the diode for small applied voltages (V) less than V_{01}. (V_{01}=0.3 Volts for Ge diode) and V_{02} (V_{02} = 0.7 Volts for Si diode). V_{01} and V_{02} are called the turn-on or offset for forward-biased voltage for Ge and Si diodes respectively.

In region II, the forward-bias voltages exceed the turn-on values of V_{01} and V_{02}, and considerable current flows in the diodes.

Caution: There is a limit to the amount of current which can flow safely through a diode. Beyond this limit, the diode will overheat and an be destroyed! Therefore, TAKE CARE!

this experiment, we shall therefore observe very carefully the rent flow as the applied voltage exceeds the turn-on voltage V_{01} or as the case may be.

gion III, reverse-bias voltages up to the breakdown voltage VB, producing a fairly constant saturation current Io. Have a look at

Fig. 1 once again. Io is in the order of micro-amperes for Ge diode and nano-amperes (1nA = 0.001μA) for Si diode at a fixed room temperature (25°C).

In region IV, when a critical value of reverse-bias voltage VB is exceeded a relatively large reverse current flows.In this experiment, we shall be able to determine Io and VB for our didoes after plotting our own graph similar to Fig. 1

14.3 MATERIALS REQUIRED

14.3.1 Components

* Potentometer Linear 2KΩ
* Resistor. 100Ω. 2W
* Silicon diode. IN 4148 or equivalent
* Germanium diode IN34A

N.B. A point-contact germanium diode like OA 90 is not suitable because it is not a plane p-n junction diode.

14.3.2 Equipment

* 0.5V voltmeter, d.c
* 0-50V voltmeter d,c
* 0-10mA ammeter, d.c
* 0-100A ammeter, d.c
* Stabilized Power supply unit 0-60V

JRE

A) **Forward Biasing**

) Set up the circuit shown in Fig. 5 for the silicon diode and switch on the power supply set at 5V.

Turn the potentiometer R1 gradually so that the applied voltage, V (measured by the 0-5V voltmeter) varies gradually in steps of 0.1V, starting from zero volt and stopping at a maximum of 0.8V. Measure the corresponding current I for each value of applied voltage, and record your readings as shown in Table 1 below.

(iii) Repeat steps (i) and (ii) for the germanium diode, except that the maximum applied voltage should not exceed 0.5V. Record your results as shown also in Table 1.

(iv) Switch off the power supply

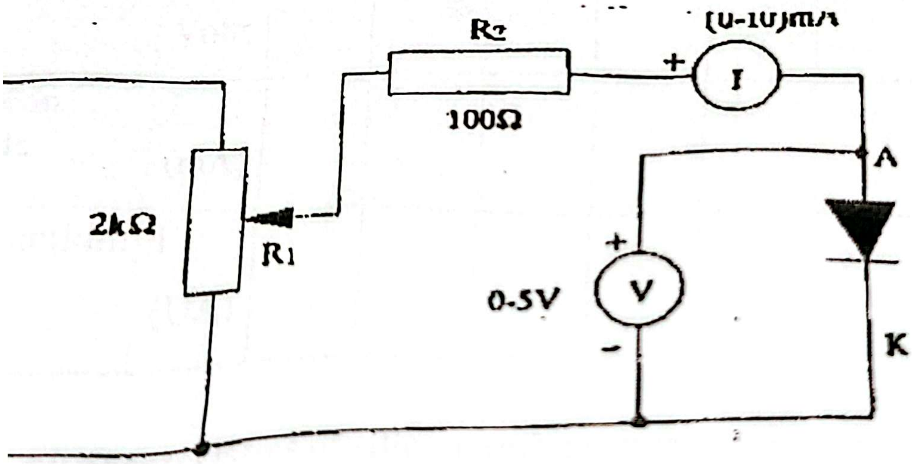
(B)Reverse biasing

(v) Set up the circuit shown in Fig. 6 for the silicon diode.

(vi) Switch on the power supply and set it to read 50V.

(vii) Measure the current (using the 0-100mA ammeter) as you gradually turn the potentiometer R1 to produce varying reverse applied voltage in steps of -2V, starting from zero volt to – 10 volts and subsequently in steps of -5V up to -30V, as shown in Table 2.

(viii) Repeat steps (v) to (vii) for the germanium diode.



. Forward-biasing mode of the diode

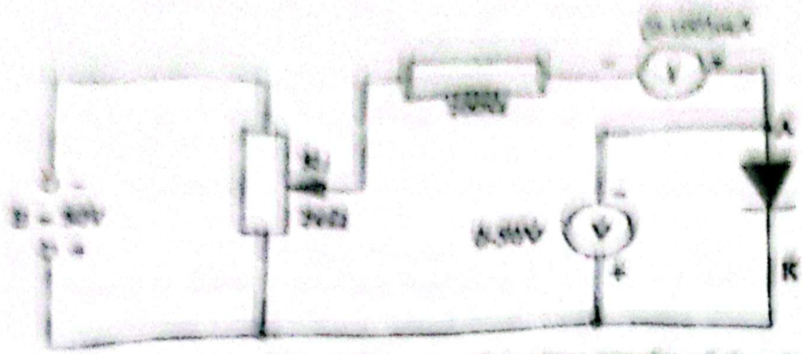


Fig. 6 Reverse-biasing mode of the diode

N.B. Only negtive voltages and currents are implied in this step. The change in connection to the terminals of the micro-ammeter and voltmeter make the readings appear positive (see Table 2).

T ANALYSIS

Forward characteristics of silicon and germanium diodes.

Type	V, Volts	0	0.1	0.2	0.3	0.4	0.5	0.5	0.7	0.8
Silicon liode	I (mA)									
ermanium ode	I (UA)									

erse characteristics of silicon and germanium diodes.

e	V, Volts	0	-2	-4	-6	-8	-10	-15	-20	-25	-30
n	I (nA)										

Germanium diode	I (UA)										

1. Record your results as shown in Table 1 and 2 above.
2. Plot separately the graphs of current (I) versus voltage (V) for the silicon and germanium diodes for both conditions using the results in Table 1 and Table 2.
3. Determine and record the turn-on voltages. V_{01} and V_{02} for the silicon and germanium diodes respectively for the forward-bias condition from the graphs obtained in step 2.

4. Determine and record the saturation current (Io) and breakdown voltage V_B for both silicon and germanium diodes, (for the reverse-biased condition) from the graphs obtained in step 2.

5. For the silicon diode in forward-bias condition, determine the dc and dynamic resistances when (i) V = 0.5 volts and (ii) V = 0.7 volt.

6. Repeat step 5 for the germanium diode when (i) V = 0.2 volt and (ii) V = 0.4 volt.

7. For the germanium diode, under reverse-bias condition determine the reverse dc resistance when (i) V = -5V and (ii) V = -20V

14.6 QUESTIONS

(a) Do the static characteristic curves plotted in step 2 resemble in shape those shown in Fig. 1? Explain briefly the differences, if any.

(b) What difference do you notice in values between the dynamic resistances for a germanium diode under forward-bias and reverse-bias conditions?

Hint: In answering this question you may use your results in steps 6 and 7

(c) DO the turn-on voltages determined for silicon and germanium diode in step 3 agree with the expected results? Explain the differences, if any.

periment 2:

Determination of the time Constant of a Capacitor

OBJECTIVES

1. To determine the charging and discharging pattern of a capacitor.
2. To determine the current and voltage between its plates.
3. To determine the charging and discharging curves of a capacitor

ATERIALS REQUIRED

Variable d.c power supply

1 no 100 kΩ resistor

1 no 0.001 microfarad capacitor

1 no SPST switch

2 no multimeters

TRODUCTORY INFORMATION

In Fig. 1 capacitor which has no charge can be charged by connecting it to a source of constant voltage, V_0. The current flowing to the capacitor and the potential between its plates can be measured by the meters.

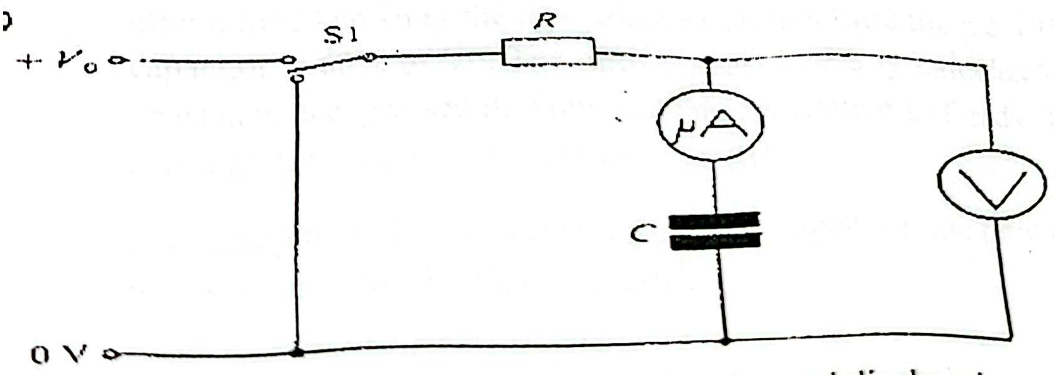


Fig.1. Circuit diagram for charging and discharging a capacitor.

When the switch is first closed the voltage at one end of R_1 is Vo. The other end is at 0v. The current through the resistor is I=Vo/R.

Current flows to the capacitor and a p.d begins to develop between its plates. As soon as this starts to happen the p.d across the resistor begins to fall. The current flowing to the capacitor becomes less and less. The current is decreasing, as the rate of charging decreases. The p.d between the plates of the capacitor rises less and less rapidly. Fig. 2 shows how the p.d varies with time. At the beginning, the curve rises steeply, for the maximum current is flowing into the capacitor. Towards the end, when the p.d has risen almost as high as Vo, the charging current is very small. The curve is almost horizontal.

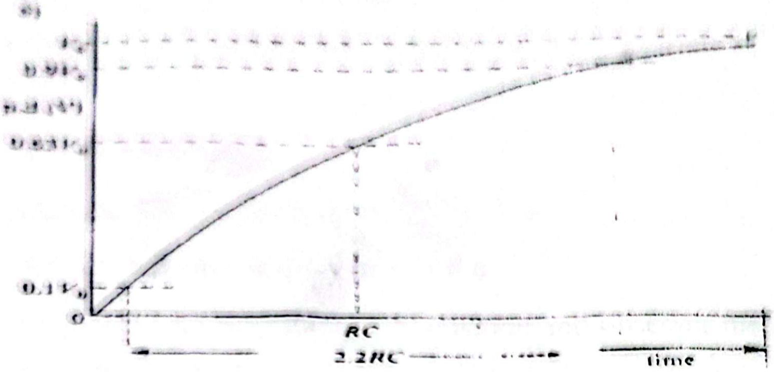


Fig. 2.Charging a capacitor graph of p.d with time.

This curve has a special shape that can be described by a mathematical formula, but the mathematics is difficult. However, we can locate two points on the curve very easily. The first is the starting point, when the p.d is zero and time is zero. The second point occurs after a time known as the time constant. At this time the p.d across the capacitor is 63% of Vo. The time constant is easily calculated. If the resistance is expressed in ohms and the capacitance in farads, the time constant, t, in seconds is given by: $t = RC$

For example, with a 100kΩ and a 0.001μF capacitor, the time constant is as shown in fig. 3 below as 2.2RC.

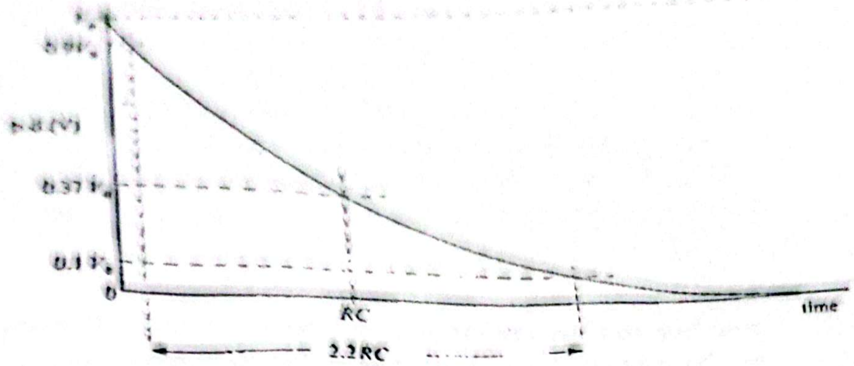


Fig. 3. Graph of p.d against time for a discharging capacitor

9.4 PROCEDURE

1. Connect the circuit as shown in fig. 1
2. Adjust the power supply to a 9v d.c
3. Switch the S1 position to ON position and observer the current and voltage reading.
4. Repeat the same in 3 above but with the switch to "off "position.

9.5 QUESTIONS

1. Calculate the value of "t" given the formula t = RC

2. Plot the graphs of the charging and discharging pattern of the capacitor.

3. Replace the [illegible] resistor with a [illegible] resistor and plot the graphs of the charging and discharging pattern of the capacitor.

iment 3:

R DIODE CHARACTERISTICS

CTIVE

To determine the characteristics of a zener diode

DUCTORY INFORMATION

teristics of a Zener Diode

A zener diode is one of the existing two-terminal devices having a single p-n junction. In a zenerdidoe the p-type material and the n-type material are heavily doped. This heavy doping, if properly controlled during manufacture results in a pre-determined reverse breakdown voltage, called the zener voltage, Vz. Zener diodes have been designed to deliver zener voltages from 1 to several hundred volts.

The symbol of a zener diode is shown in Fig.1 and a typical graph of its current versus voltage characteristics (i.e.zener diode characteristics) is shown in Fig. 2. The symbol may or may not be shown with the circle.

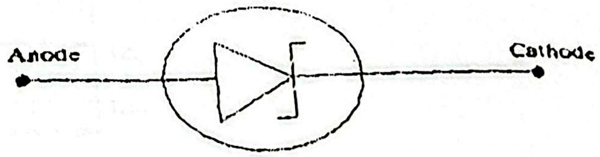


Fig. 1: Symbol of a Zener diode

The zener diode characteristic curve has three distinct regions: namely: regions I, II and III. Region I show the forward characteristic curve and is obtained when the zener diode is forward-biased. Knowledge of the forward characteristic is of little interest to us because the zener diode is most often used in electronic circuits only under the reverse-biased condition.

Regions II and III together represents the reverse characteristic. Region II alone covers the leakage current portion and it extends from the origin to the knee of the curve. Region III extends from approximately the knee to and beyond the Imax level, as shown in Fig. 2. Region III is commonly known as the 'zener breakdown region'.

In region II, the leakage current Io referred to earlier is not constant in value. Conventionally the value of the leakage current Io is normally specified by giving its value at a point about 80% of the zener voltage, vz (i.e 0.8 Vz). When the reverse voltage on the didoe is increased from zero, an avalanche takes palce at the knee of the curve, and the current increases rapidly with only a very small change in voltage. An external resistance Rs (see Fig. 3) is normally required in practice to limit this current to the maximum permissible value denoted by Iz,max. The zener voltage Vz is that voltage which exists across the terminals of the diode when the currnet I_{ZT} is approximately equal to the mid-point of its linear range, as shown in Fig. 2. In this experiment we shall bias the zener diode in both the forward and reverse directions, obtain readings and plot the zener diode characteristic curve discussed so far.

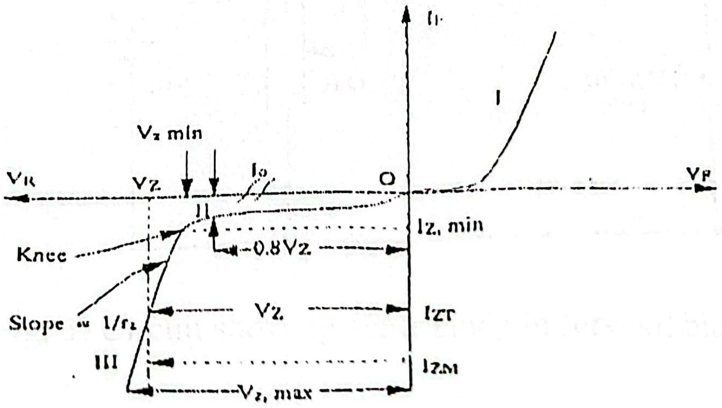


Fig. 2.Zener diode characteristic curve

MATERIALS REQUIRED

Components

- (Linear) Potentiometer. 2 kilo ohms
- Resistor 470Ω (2W rated)
- Zener diode. BZY 488. 6.8V. 500mW at 25°C.

N.B. Any other zener diode of different breakdown voltage V_z may also be used.

12.3.2 **Equipment**

* Power supply, d.c., variable.
* Electronic voltmeter.
* 0.10v, dc voltmeter
* 0-5, mA meter, d.c
* 0-10, mA meter, d.c.
* 0-30, mA meter, d.c (2Nos)
* 0-50, mA meter d.c
* Connection Leads or wires.

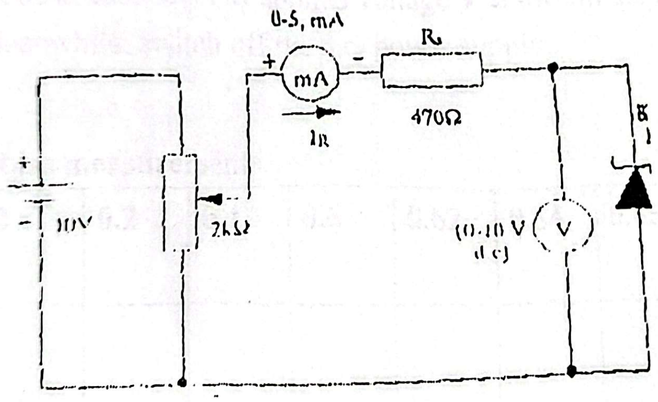


Fig. 3: Circuit showing zener diode in forward biasing condition.

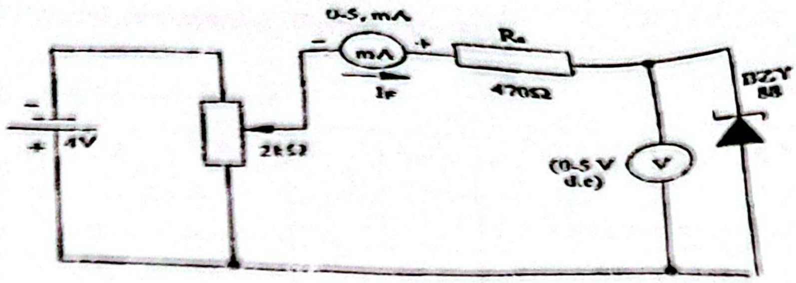
OCEDURE

(A) **Forward bias**

(i) Connect the circuit of Fig. 12.3, keeping the power supply at 4v and the range of the voltmeter at 5v, max.

(ii) Measure and record in Table 12.1, the forward current IF in the diode at each level of applied voltage VF shown in the table.

(iii) Switch off the d.c power supply.



4: Circuit showing zener diode in reverse-biasing condition.

se bias

(iv) Connect the circuit of Fig.12.4, keeping the power supply and those of the miliammetre, compared with the connection of Fig. 12.3.

(v) Measure and record in Table 12.2, the reverse current IR in the diode at each level of applied voltage V shown in the table.

(vi) Meanwhile, switch off the d.c. power supply

T ANALYSIS

e 1: Forward-bias measurements

V_f (Volts)	0	0.2	0.4	0.6	0.62	0.64	0.65	0.66	0.67
I_f (mA)									
R_{dc} ohms									

N.B. Forward resistance, $R_F = \frac{V_F}{I_F}$ (ohms)

able 2: Reverse-bias measurements

V_F (Volts)	1	2	3	4	5	6	6.5	6.6	6.7	6.8	6.9
I_R (mA)											
R, ohms											

N.B. Reverse resistance of the zener diode, $V_R = \frac{V_R}{I_R}$(ohms)

1. Using the results in Table 1, sketch the forward volt-ampere characteristic curve.

2. Using the results in table 1, sketch the reverse volt-ampere characteristic curve.

3. Determine from the reverse characteristic curve obtained in step 2 above the approximate values of the following parameters: I_O, V_{Zmin}, I_{ZM} and I_{ZT}.

QUESTIONS

(a) Do the forward and reverse characteristic curves obtained in steps 1 and 2 agree with the sketch shown in Fig. 2? If not, explain any difference(s)?

(b) Explain the reason for the changing values of R_F and R_Z obtained from Table 1 and Table 2 respectively.

(c) What portion of a zener – diode characteristic is most useful for voltage regulator applications? Why?

(d) Given that the power and voltage ratings of the zener diode BZY 88 are P= 500mW and V_Z = 6.8V respectively, determine the maximum permissible current through the diode.

Experiment 4:

ZENER DIODE AS A VOLTAGE REGULATOR

OBJECTIVE

To investigate how the zener diode is used as a voltage regulator.

INTRODUCTORY INFORMATION

The application of the zener diode as a voltage regulator is our concern in this experiment. In a voltage regulator, the voltage across the load, V_L is kept at a constant value over a range of varying load currents I_L. Fig.1 shows a voltage regulator circuit using a Zener diode. In this circuit, the zener diode is in the reverse-biased mode.

In Fig. 1, the voltage across the load is the fixed voltage $V_L = V_Z$ because the Zener diode is connected in parallel with the load, R_L.

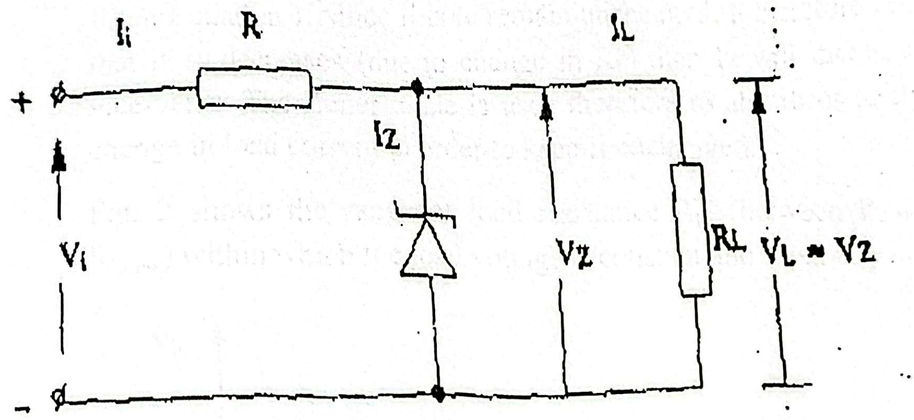


Fig. 1: Voltage regulator circuit using a Zener diode

In this circuit the input current I, is the sum of Iz and I_L,

i.e $I_i = I_z + I_L$ ....(1)

and the input voltage is related to the load voltage, Vz by tl expression

$V_i = I_iR + V_z$ ....(2)

There are two situations to consider under any of which the circuit in Fig. 1 operates as a voltage regulator:

(i) **When Vi is fixed and R_L varies and**

(ii) **When Vi varies and R_l is fixed.**

Fixed Vi, Variable R_L

Here, we expect that if R_L varies over a range of valuos (between R_{Lmiin} and R_{Lmax}) then I_L will also consequently vary over a range of values (between I_{Lmax} and I_{Lmin}) without changing Ii and ensuring at the same time that V_L =Vz (i.e without causing the load voltage to change).

It should be noted from Equation 1 that Ii = I_{Lmax}, when I_x = 0. Similarly, I_{Lmin} = Ii – Izmax., where Iz_{max} is the maximum permissible current through the zenerdidoe.

From Equation 1, since Ii is to remain unchanged, it therefore follows that if I_L decreases (due to change in R_L) then Iz will increase and vice-versa. The Zener diode is used therefore to absorb or to supply change in load current in order to keep Ii unchanged.

Fig. 2 shows the range of load resistance R_L, (between R_{Lmin} and R_{Lmax}) within which the load voltage is constant and fixed at Vz.

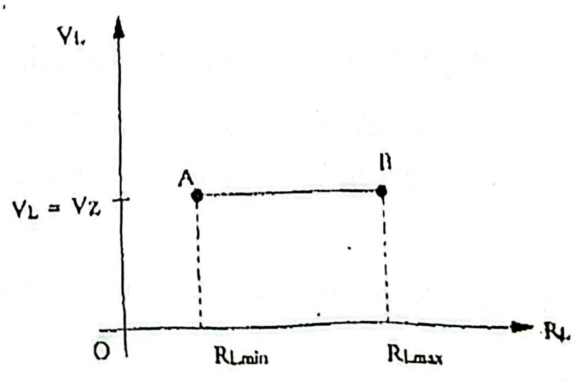


Fig. 10.2 Range of load resistances. R_L

Fixed R_L, Variable Vi

In this case since RL is fixed, therefore IL is fixed, only Vi varies. From equation 11.2 we see that an increase in Vi causes I_i to rise since

Vz remains unchanged. The Zener diode absorbs the rise in Ii. Likewise, a decrease in Vi causes Ii to decrease. The Zener diode current, Iz decreases by the amount that I_i decreases to maintain the load current I_L at a fixed value.

In this case (from Equation 1) Iimin - I_L, and Iimax $= I_l$ + Izmax Fig. 10.3 shows the range of values of Vi that will maintain V_l = Vz.

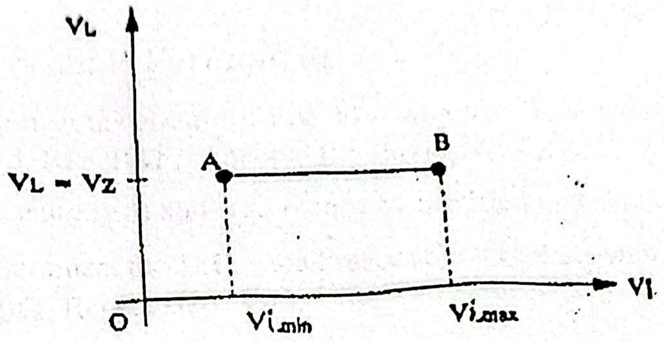


Fig. 10.3. Range of values V_i

As before, we can write the following expressions without proofs:

$$V_{i.min} = \frac{(R + R_L)Vz}{R_L}$$

This is the condition at point X in Fig 10.3.

Also, $V_{imax} = I_{imax}$ R + VzThis is the condition at point Y in Fig. 10.3.

In this experiment we shall examine alos the range of Vi that maintains V_L = Vz

10.3 MATERIAL REQUIRED

- Linear potentiometer. 2kΩ
- Resistor. 1 kΩ (1w). (2Nos)

- Resistor, 100Ω (2w)
- Zener diode BZY 88, 6.8V, 500mW at 25°C or any other type, preferably with Vz< 10v.
  - Power supply, dc, variable unit.
  - Electronic voltmeter:(0-10)V dc voltmeter
  - (0-20)mA (dc) meter
  - (0-30) mA (dc) meters (2 Nos)

PROCEDURE

(A) *Fixed V_i Variable R_L*

(i) Connect the circuit of Fig. 11.4 with Vi = 20V fixed and load, Rl = 1kΩ connected (by linking A to X).

(ii) Measure Iz, Il and VL, record as specified in Table 10.1.

(iii) Disconnect the 1kΩ - load resistor and replace with RL = 470Ω. Repeat step (ii)

(iv) Disconnect the 470Ω - load resistor and replace with RL = 100Ω. Repeat step (ii).

NB: Use (0-50) mA meter to measure IL in this case.

(v) Meanwhile, switch off the dc power supply. Do not disconnect the whole circuit of Fig. 10.4. Replace only the (0-50) mA mete with the (0-10) mA meter.

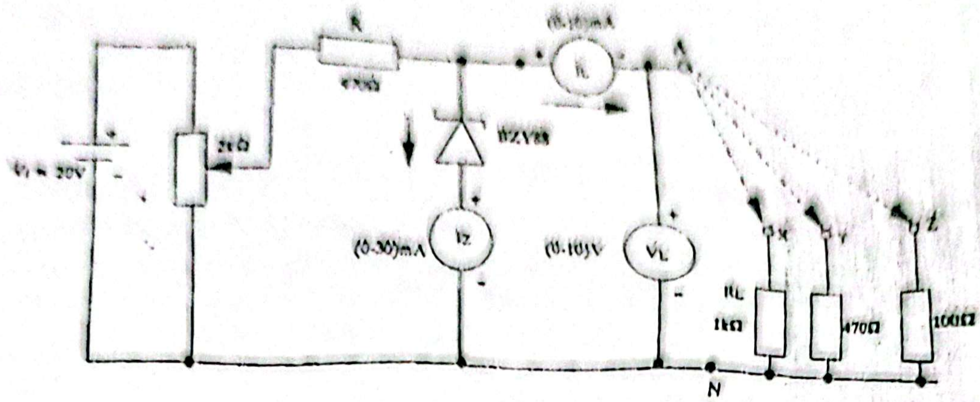


Fig. 10.4: Voltage regulator circuit using zener diode.

(B) Fixed R_L Variable Vi

(i) Connect the same circuit shown in Fig. 11.4 with $R_L = 1k\Omega$

(ii) set the dc power supply initially to Vi = 10v.

(iii) Measure and record Iz, I_L and Vz as specified in Table 11.2

(iv) Slowly increase Vi in steps of 1V until Vi = 20v, and repeat step (iii).

Result

Table 1: Zener diode regulator with different loads. Fixed Vi = 20v variable R_L.

	$R_L = 1k\Omega$	$R_L = 470\Omega$	$R_L = 100\Omega$
I_L, mA			
Iz, mA			
Ii = (IL + Iz)mA			
V_L (Volts)			

Vz(Volts)	6.8	6.8	6.8
Vi (Volts)	20	20	20

N.B. If the Zener diode BZY 88 is not used in this experiment, then write down the voltage rating of the zener diode you used (instead of the 6.8V).

Table 2: Zener – regulator with Vi variable, fixed R_L = 1kΩ, variable V_i.

Vi(Volts	10	11	12	1	14	15	16	17	18	19	20
Iz, mA											
IL, mA											
VL, (Volts)											
Vz, (Volts)	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.[illegible]

10.5QUESTIONS

(a) Using Equation 3, determine the minimum value of load resistance R_L, min suitable for this experiment if Vi = 20V, Vz = 6.8v and R = 470Ω.

(b) How would you use your result in (i) to justify why Vi = 6.8v when the 100Ω - load was used (as recorded in Table 10.1)?

(c) Determine from Table 2 the range of values of Vi for which V_L differs from Vz by 0.1v.

(d) (ii) Determine from Table 2 the least in the value of Vi when V_L begins to be equal to V_Z. Regard this value of Vi as Vi,min (as illustrated in Fig. 3)? If yes, why?

(iii) Is it possible to determine Vi,max in this experiment? If not, why?

(e) Given that the manufacturer's specification of the Zener diode (BZY 88) used in this experiment are as follows: P = 500mW and Vx = 6.8V, determine the maximum permissible current through the diode.

Experiment 5:

STATIC CHARACTERISTICS OF A NPN TRANSISTOR IN COMMONEMITTER CONFIGURATION

OBJECTIVE

To investigate the output, input and current gain static characteristics of a NPN transistor in common-emitter (CE) configuration.

5.1INTRODUCTORY INFORMATION

Every bipolar junction transistor (NPN or PNP type).ahs a base (B), an emitter (E) and a collector (C) as its electrodes. However, when the NPN transistor is connected such that the emitter is common to both the base-emitter input side and the collector-emitter output side, as shown in Fig. 5.1 then the transistor is said to be in common-emitter configuration.

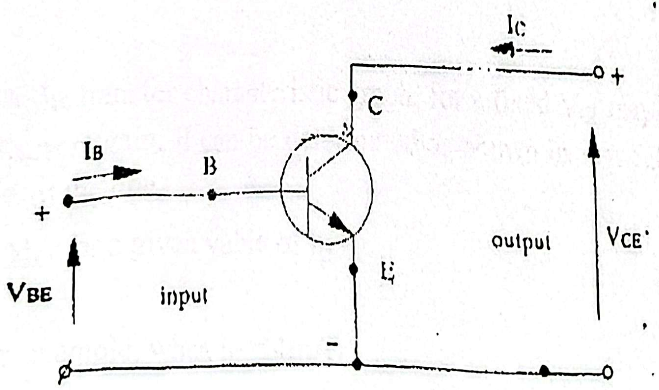


Fig. 5.1: Symbol of an NPN transistor in CE configuration

As expected of all bipolar junction transistor circuits in CE configuration the (base-emitter) side is forward-biased and the output (collector-emitter) side is reverse-biased. In particular for the NPN transistor in common-emitter connection (in the active region) the base-emitter junction is forward-biased. while the collector junction is reverse biased as shown in Fig. 5.2.

For the transistor in common-emitter configuration, we note that output (collector) characteristics are plots of the output current (I_C) versus output voltage (VCE) for a range of fixed values of input current (IB) as shown in Fig. 5.3(a).

i.e $I_C = f_1(V_{CE})$. for constant values of I_B

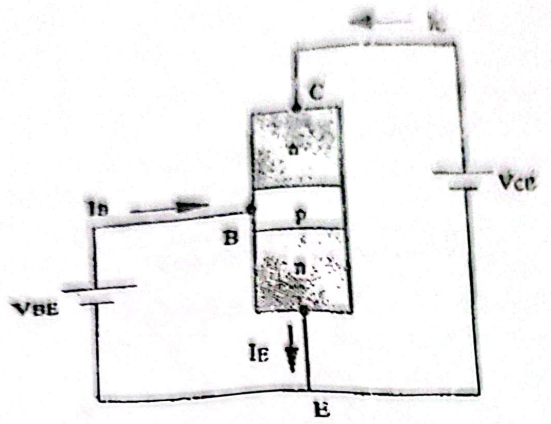


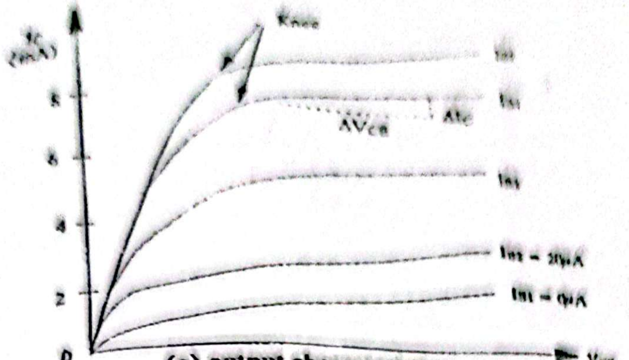
Fig. 5.2: Notation of an NPN transistor in CE

From the transfer characteristic graph, for a fixed V_{CE} (say, $V_{CE} = 4V$) the current gain, β can be determined as shown in Fig. 5.3(c). as the slope of the line,

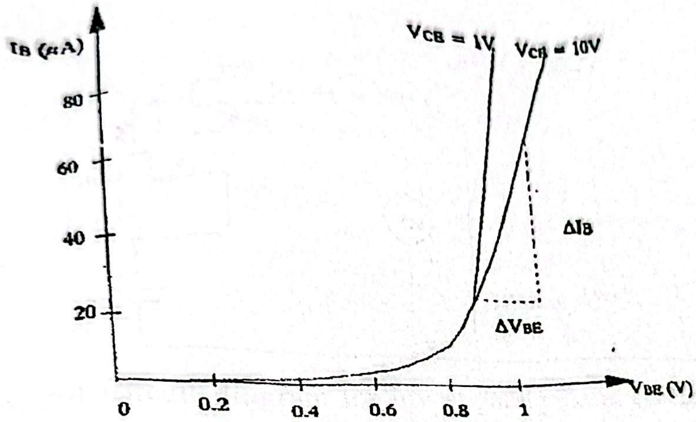
$\beta = \frac{\Delta I_C}{\Delta IB}$ for a given value of I_C

(for example, when $I_C = 4mA$)

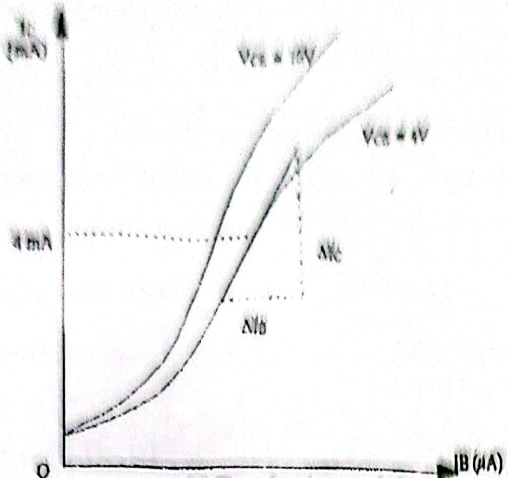
$\beta = \frac{\Delta I_C}{\Delta I_B}$ for a given value of V_C
(for example, when I_C = [illegible] mA)



(a) output characteristics



(b) input characteristics



(c) Transfer characteristics

Fig.. 13.3: Characteristic curves of an NPN transistor in the CE configuration:

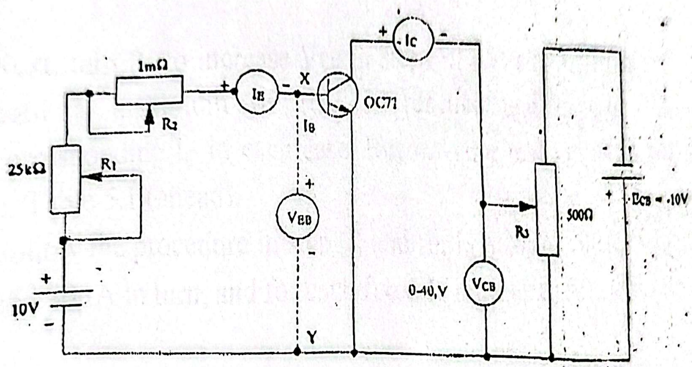


Fig. 5.4 Circuit diagram for investigating static characteristics of an NPN transistor in CE

In this experiment, we shall obtain readings that will enable us plot the output, input and transfer characteristic curves, the types shown in, Fig. 5.3, and determine there from output impedance, input impedance and current gain of a transistor in CE configuration.

It should be noted that if a PNP transistor were used the battery polarities would be reverse.

MATERIALS REQUIRED

- Power supply unit, d.c variable, 0-100, UA. meter (d.c)
- 0-30, mA meter (d.c)
- 0-30, V voltmeter d.c
- 0-5v, dcc voltmeter
- Connection leads

13.4 PROCEDURE

13.4.1 Output Characteristics

(i) Connect the circuit of Fig. 5.4, and turn R_1 and R_2 appropriately to set I_B = 0 0μA

initially.

(ii) Next, turn R_3 to increase Vce in steps of 1V, starting from OV until a maximum of 10V is reached and measure the corresponding I_C in each case. Record your readings as shown in Table 5.1 (ahead).

(iii) Follow the procedure in step (i) and set I_B = 20μA, 40μA, 60μA and 80μA in turn, and for each fixed I_B repeat step (ii).

Transfer characteristics

(iv) Using the same circuit connection of Fig. 5.4, set and keep V_{CE} = 2V initially.

(v) Vary IB continuously in steps of 20μA, after starting from 0μA until a maximum of 80μA is reached and measure the corresponding I_C in mA). Record your readings as shown in Table 5.2.

(vi) Next, set V_{CE} = 8V and repeat step (v).

Input Characteristics

N.B. Briefly have a look at Fig. 5.3(b) to remind you that we wouldn't need to measure

I_c (but V_{CE}) in the next stage of our experiment.

(vii) Disconnect the I_C measuring meter from the circuit of Fig. 5.4, and link up the gap by using aa connection lead. Connect a 0-5, V dc voltmeter between terminals X and Y to measure (V_{BE}).

(viii) Set V_{CE} = 1V initially

(ix) Turn R_1 and R_2 carefully to vary V_{BE} in steps o 0.1V starting from 0V until a maximum of 0.7V (or 1V, if possible) is reached and measure the corresponding value of IB. record your measurements as shown in Table 5.3

(x)Next, set V_{CE} = 10V and repeat step (ix)

RESULT ANALYSIS

Table 1: Measurement on output characteristics.

I_B, (μA)	0	20	40	60	80
V_{CE}, (V)					
0					
1					
1					
2					
…					
…					
10					

Table 2: Measurements on Transfer characteristics

	I_B, µA	0	20	40	60	80
V_{CE} = 2V	IC, mA					
V_{CE} = 10V						

Table 3: Measurements on input characteristics

	V_{BE}, V	0	0.1	…	…	0.7	80
V_{CE} = 1V	I_B, µA						
V_{CE} = 10V	I_B, µA						

Result Analysis

1. Using the results in table 1, plot the output characteristic curves.
2. Using the results in Table .2, plot the transfer characteristics curves
3. Using the results in Table 3, plot the input characteristic curves
4. Determine the output impedance Ro of the transistor in CE for I_B = 20µA and I_B = 80µA, using your plot in step 1 (N.B. see Fig. 5.3(a) for a hint on how to determine Ro)
5. Using your plot in step 2, determine the current gain for V = 1V, when I_C =

5mA

6. Use your plot in step 3 to determine the input impedance R_i for $V_{CE} = 2V$, when

$I_B = 20\mu A$.

QUESTIONS

) Do your characteristic curves in steps 1 – 3 agree with the sketches shown in Fig. 5.3? Explain briefly the differences you notice, if any.

) Explain briefly how the transistor characteristic curve in Fig. 5.3(c) could be obtained by using the output characteristic curves of Fig. 13.3(a) for a fixed value of Vce.

Compute the value of β from one end of the curve to the other?

Explain briefly what change(s) you would expect in the circuit of Fig. 5.4 if a PNP transistor were used?

Using the characteristic cuves in steps 1 and 3, find the value of Ic corresponding to

$V_{BE} = +600mv$ and $V_{CE} = +5V$.