

Practical No.4: Check performance of Zener diode

I Practical Significance

In industries, Zener diode is widely used as voltage references and as shunt regulators to regulate the voltage across circuits. Zener diodes are also used in over voltage protection circuits and switching applications. Zener diode is suitable for surge suppression circuits, for device protection, for clipping, clamping circuits and especially as peak clippers.

II Industry / Employer Expected Outcome

This practical is expected to develop the following skill: 'Use electronics components and circuits in electrical equipment'.

III Course Level Learning Outcome

Use relevant diode in different electronic circuits.

IV Laboratory Learning Outcome

Check the performance of Zener diode in forward and reverse biasing.

V Relevant Affective Domain related Outcomes

Handle components and equipment carefully.

VI Minimum Theoretical Background

Zener diode is formed by combining highly doped P and N semiconductor materials. It works on the principle of Zener breakdown and is normally operated in reverse breakdown region. In reverse breakdown region, high current flow through the diode leading to high power dissipation.

The Zener breakdown occurs when the electric field across the junction produced due to the reverse voltage is sufficiently high, this breaks covalent bonds. Thus, large numbers of carriers are generated which causes a more current to flow. This mechanism is called as Zener breakdown. After Zener breakdown the reverse current increases sharply. Zener resistance of a Zener diode is a ratio of reverse Zener voltage to the reverse Zener current.

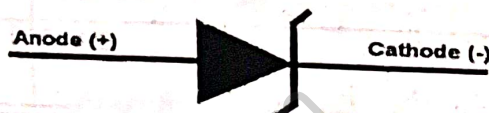


Figure 4.1: Symbol of Zener diode

VII Practical setup in Laboratory

(a) Sample

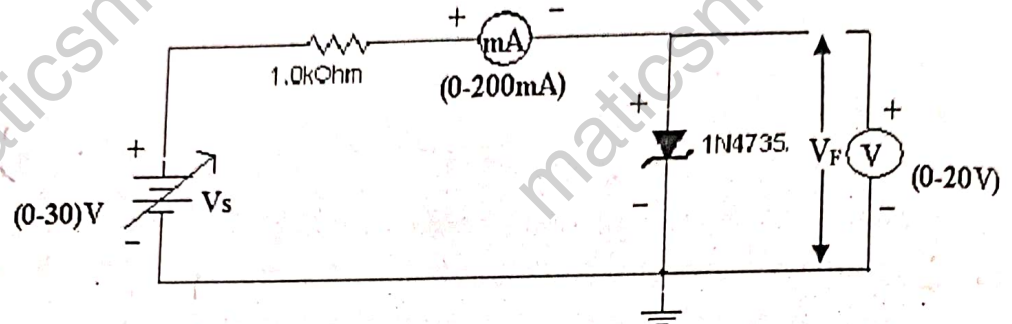


Figure 4.2: Zener diode in forward bias

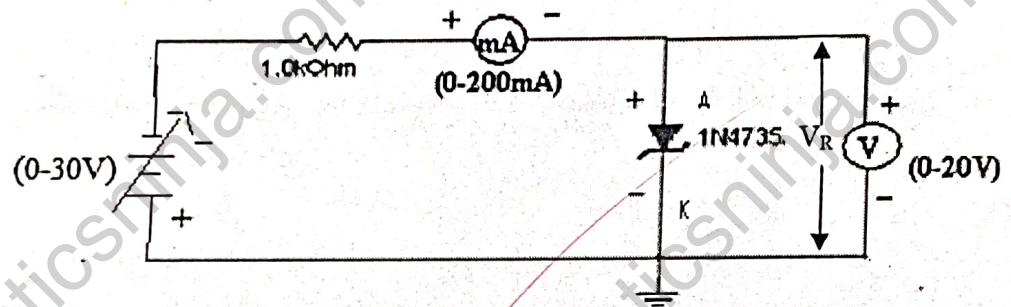
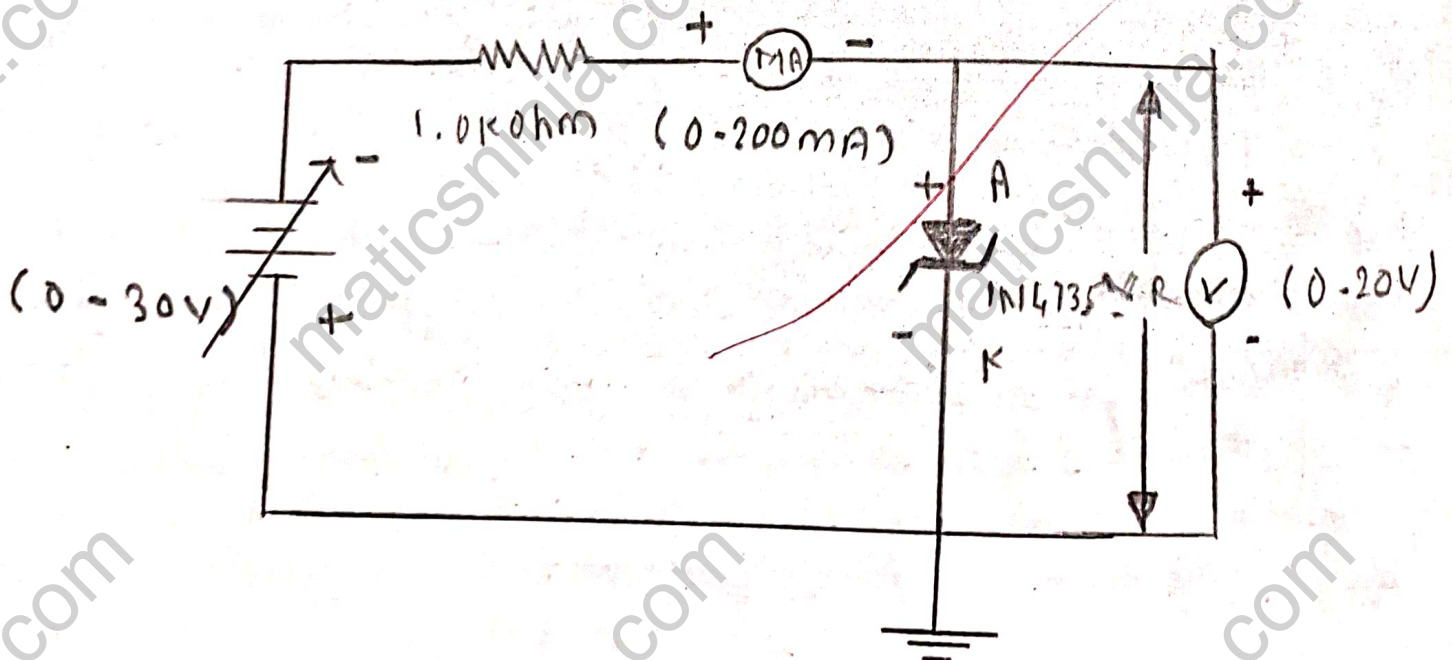
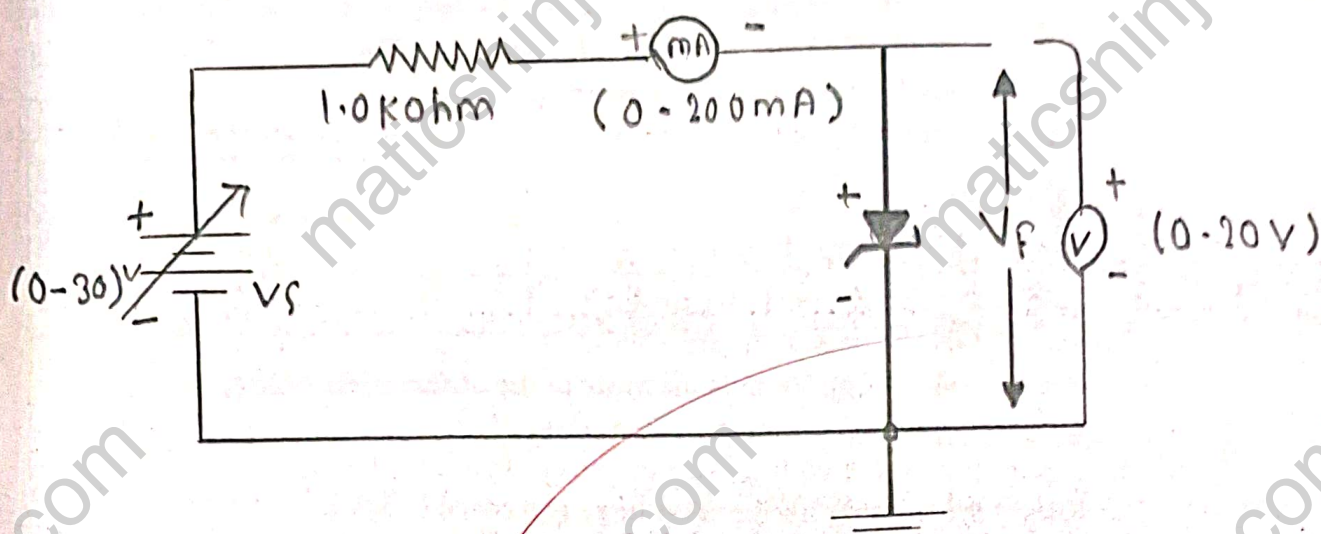


Figure 4.3: Zener diode in reverse bias

(b) Actual Circuit Diagram used in Laboratory



(c) Actual Experimental set up used in Laboratory



VIII Required Resources/apparatus/equipment with specifications

Sr. No	Instruments/Components	Specification	Quantity
1.	Multimeter	3 ½ -digit display with AC and DC voltage measurement and Current measurement facility and Diode testing facility.	1
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1
3.	DC Voltmeter	0-20 V	1
4.	DC Ammeter	0 - 200 mA	1
5.	Bread board	5.5CM X 17CM	1
6.	Diode	1N4735 (or any another equivalent diode)	1
7.	Resistor	1K Ω (0.5watts/0.25watts)	1
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

IX Precautions to be followed

1. Do not switch ON the power supply unless you have checked circuit connections as in figure 4.2
2. While doing the practical do not exceed the input voltage of the diode beyond the rated voltage of diode as given in datasheet. This may lead to damaging of the diode. Connect the circuit as in figure 4.2
3. Connect voltmeter and ammeter with correct polarities as shown in the circuit diagram

X Procedure

1. Connect the circuit as in figure 4.2
2. Switch ON the power supply.
3. Record the voltage V_F and current I_F in the observation table
4. Increase the input voltage in step of 0.1 V
5. Again, record the voltage V_F and current I_F in the table 1.
6. Repeat steps 4 to 5 till input voltage is reached to 1 V.
7. Plot the graph for the forward bias characteristics of diode by taking V_F on X-axis and I_F on Y-axis.
8. Connect the circuit as shown in figure 4.3
9. Vary input voltage gradually in steps of 1V up to 12V.
10. Record the corresponding readings of V_R and I_R in the observation table 2.
11. Plot the graph for the reverse bias characteristics of Zener diode by taking V_R on X-axis and I_R on Y-axis.

XI Observation TableTable 1: Measurement of V_F and I_F

Sr. No.	V_F (volts)	I_F (mA)
1.	0	0.0
2.	0.1	0.00000014
3.	0.2	0.00000028
4.	0.3	0.000526
5.	0.4	0.000578
6.	0.5	0.000278
7.	0.6	0.028
8.	0.7	0.871223
9.	0.8	13.0871
10.	0.9	1.698

Table 2: Measurement of V_R and I_R

Sr. No.	V_R (volts)	I_R (mA)
1.	0	0
2.	1	-0.0001
3.	2	-0.000201
4.	3	-0.000301
5.	4	-0.000400
6.	5	-0.00067
7.	6	-8.784
8.	7	-19
9.	8	-28
10.	9	-38

Calculations:

$$R_Z = V_F / I_F$$

$$0.5 / 0.49 = 1.020 \text{ m ohm}$$

$$R_Z = V_R / I_R$$

$$.2060 / 6 = 3.43 \text{ m ohm}$$

XII Results

1. Zener breakdown voltage = 5 volt
2. Forward resistance of zener diode = ... 1.020 m ohm

XIII Interpretation of results

In this practical we intercept the observation of zener breakdown voltage and forward resistance

XIV Conclusions and Recommendation

In this practical we conclude that the forward resistance of zener diode and observe the principal

XV Practical related Questions of zener diode.

1. Determine maximum and minimum value of Zener current if value of series resistance is 1K, load resistance is 2K and input varies from 10V to 30V. Zener voltage is 5 V.
2. Is it possible to operate normal PN junction diode in breakdown region? Justify your answer Give reason.

3. State the effect on voltage across zener diode and current flowing through it, when reverse voltage across it is more than breakdown voltage.
4. Identify the portion of Zener diode characteristics suitable for voltage regulation applications.

[Space for answers]

② - - - - ?

→ Normal P-N Junction diodes are not designed to operate in reverse breakdown region. Normal P-N Junction is not operated in breakdown region for longer duration as the excess current will permanently destroy the diode.

③ - - - - ?

→ When the zener diodes reverse breakdown voltage is reached the current flow will be very high (a short) effectively clamping the voltage across the diode to the breakdown voltage zener diode.

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→ The important portion is the reverse breakdown voltage which ensures that the voltage across that the diode.

XVI References / Suggestions for further Reading

1. <https://www.youtube.com/watch?v=itzPT3UCII>
2. <https://www.youtube.com/watch?v=XhQqtdTIRus>
3. <https://www.youtube.com/watch?v=mtjnStAF8Yg>