LAB ASSIGNMENT – 6

(Hardware Experiment-1)

Course: Basic Electrical and Electronics Engineering

Course Code: EEE1001

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Slot: L-19+L-20

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Submission Date: 16.10.2018

Ex. No.:5 Date: 16/10/2018

Line and Load Regulation using zener diode

Aim Design a voltage regulating circuit using Zener Diode & verify its characteristics for line & load regulations.

Apparatus Required

S. No.	Name of the apparatus	Range / Type	Quantity
1	Zener diode	-	1 No.
2	RPS	0 – 30 V	1 No.
3	Ammeter	0 – 10 A	2 No.
4	Voltmeter	0 – 30 V	2 No.
5	Resistor	330 Ω	1 No.
6	Resistor	1 kΩ	1 No.
7	Breadboard	-	1 No.
8	Wires	-	Few

Theory

Zener diodes are generally used in the reverse bias mode. You have seen already in one of your previous experiments that the zener diode has a region of almost a constant voltage in its reverse bias characteristics, regardless of the current flowing through the diode. This voltage across the diode (zener Voltage, V_z) remains nearly constant even with large changes in current through the diode caused by variations in the supply voltage or load. This ability to control itself can be used to great effect to regulate or stabilize a voltage source against *supply* or *load* variations. The zener diode maintains a constant output voltage until the diode current falls below the minimum Iz value in the reverse breakdown region, which means the supply voltage, Vs, must be much greater than V_z for a successful breakdown operation. When no load resistance, R_L, is connected to the circuit, no load current ($I_L = 0$), is drawn and all the circuit current passes through the zener diode which dissipates its maximum power. So, a suitable current limiting resistor, (Rs) is always used in series to limit the zener current to less than its maximum rating under this "no-load" condition.

From the previous experiments on rectifiers, you know that the d.c. output voltage from the half or full-wave rectifiers contains ripples superimposed on the d.c. voltage and that the average output voltage changes with load. As shown in the circuit diagram, a more stable reference voltage can be produced by connecting a simple zener regulator circuit across the output of the rectifier. The breakdown condition of the zener can be confirmed by calculating the Thevenin voltage, V_{TH}, facing the diode is given as:

$$V_{TH} = \frac{R_L}{R_S + R_L} V_S$$

This is the voltage that exists when the zener is disconnected from the circuit. Thus, V_{TH} has to be greater than the zener voltage to facilitate breakdown. Now, under this breakdown condition, irrespective of the load resistance value, the current through the current limiting resistor, Is, is given by

$$I_S = \frac{V_S - V_Z}{R_S}$$

The output voltage across the load resistor, V_L, is ideally equal to the zener voltage and the load current, I_L, can be calculated using Ohm's law:

$$V_L = V_Z \text{ and } I_L = \frac{V_L}{R_L}$$

Thus the zener current, Iz, is

$$I_Z = I_S - I_L.$$

Now that you have constructed a basic power supply, its quality depends on its load and line regulation characteristics as defined below.

Load Regulation: It indicates how much the load voltage varies when the load current changes. Quantitatively, it is defined as:

$$\textit{Load regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100\%$$

where V_{NL} = load voltage with no load current ($I_L = 0$) and V_{FL} = load voltage with full load current. The smaller the regulation, the better is the power supply.

Line Regulation: It indicates how much the load voltage varies when the input line voltage changes. Quantitatively, it is defined as:

$$\textit{Line regulation} = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

where V_{HL} = load voltage with high input line voltage, and V_{LL} = load voltage with low input line voltage. As with load regulation, the smaller the regulation, the better is the power supply.

Procedure:

1. Use the full-wave rectifier circuit configured in your previous lab (with capacitor filter minus the load). Connect the primary of a variable transformer to a.c. mains and the secondary as the a.c. source for the rectifier circuit. This will facilitate to change the magnitude of input voltage to rectifier by choosing different secondary terminals. You can use only those secondary terminals whose voltage is much more than the zener breakdown voltage you are using.
2. Complete the rest part of the circuit as shown in the circuit diagram. Note down all the values of the components being used including the zener breakdown voltage.
3. Keeping input voltage suitably fixed, use different values of R_L and measure both the output d.c. voltage and current using multimeter (in d.c. mode). Measure input unregulated d.c. voltage across capacitor. Calculate V_{TH} before each measurement and ensure that the zener is operating in breakdown region.
4. Similarly, keeping R_L fixed, vary the input voltage and measure again the output d.c. voltage, current and input unregulated d.c. voltage across capacitor. Calculate V_{TH} before each measurement.
5. Tabulate all your data and calculate percentage regulation in each case.

Observations:

Specifications of zener diode: Breakdown voltage = 5.68 V

Rs = 330 Ω

Circuit Diagram

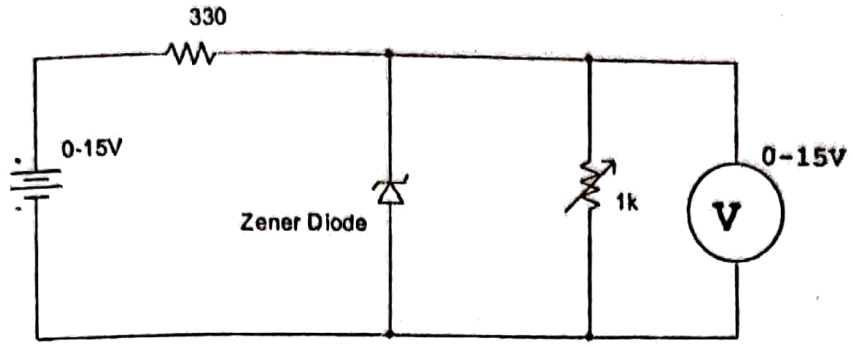

Table (i) Line Regulation: Load Resistor = 1000 Ω

Sl.No	Input DC Voltage (Vi) in Volts	Output DC Voltage (V_L) in Volts
1	4	2.97
2	6	4.40
3	8	5.59
4	10	5.68 → Breakdown voltage.
5	12	5.69

Table (ii) Load Regulation: Input d.c. voltage = 10 V

Sl.No	Load Resistance in ohms	Output DC Voltage (V_L) in Volts
1	4700	5.68
2	10000	5.68
3		
4		
5		

Result:

The breakdown voltage obtained from line regulation is equal to the output DC voltage obtained from load regulation; i.e 5.68V

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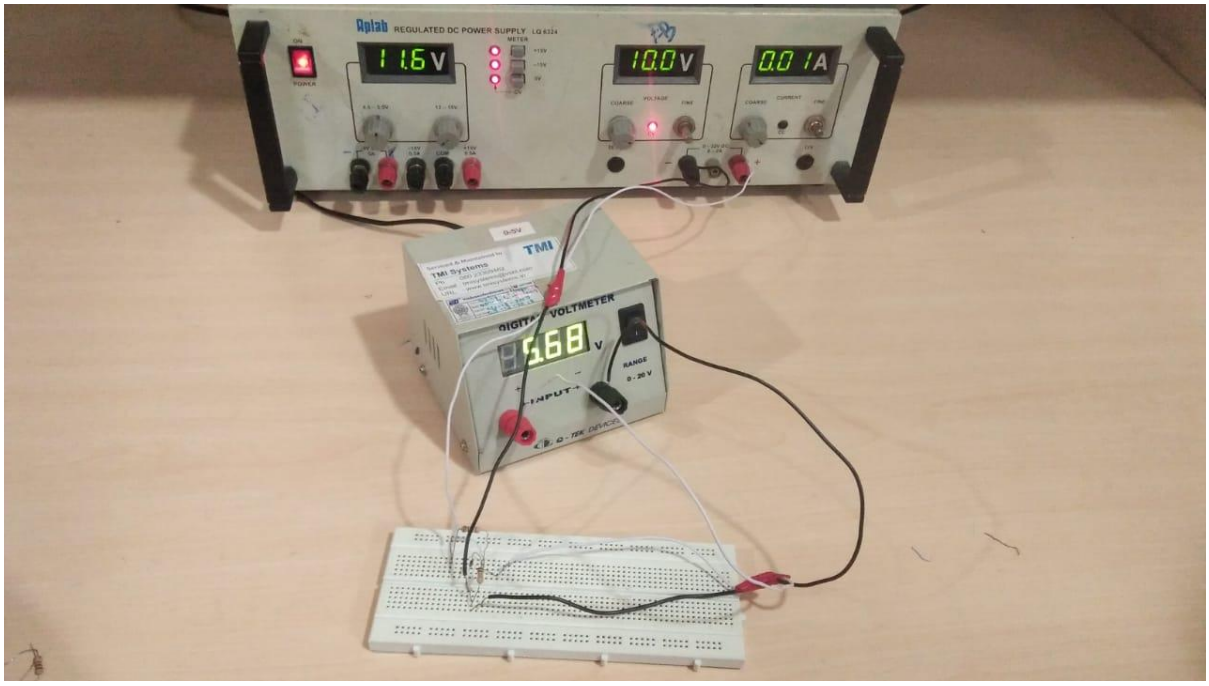
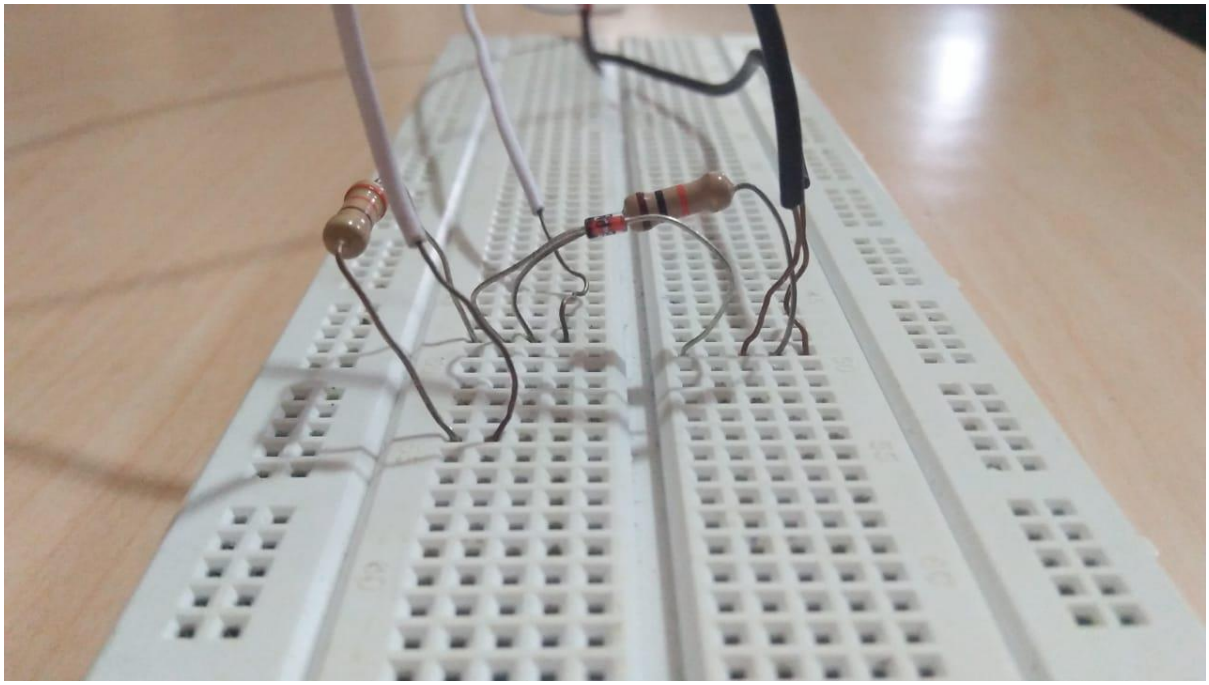
Breakdown Voltage:



Connections: