Ex. No.:8 Date:16-10-2020

Line and Load Regulation using Zener diode

Aim :

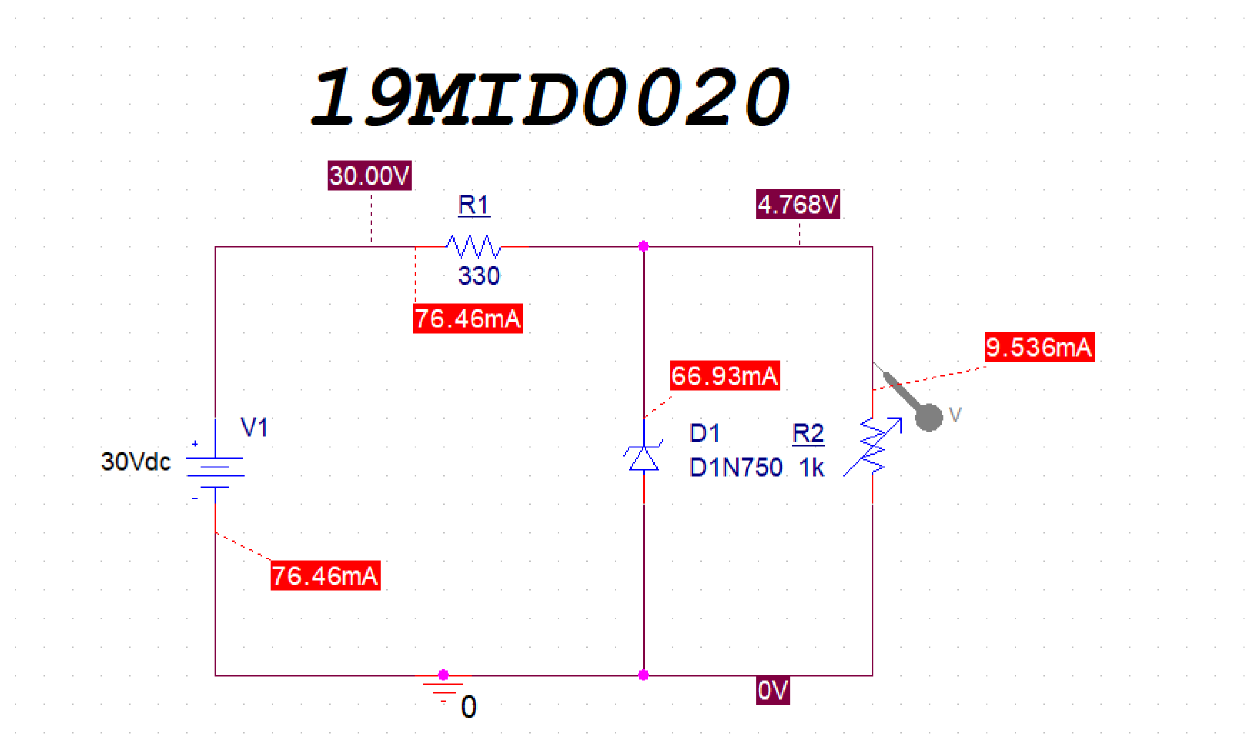
To understand the application of Zener voltage in the area of Voltage regulation using OrCAD Pspice software.

Apparatus/Tool required:

ORCAD / Capture CIS --> **Analog Library – R,**
Source Library – Vdc, Idc &
Diode Library - Zener diode D1N750
Ground (GND) – 0 (zero)

Simulation Settings: **Analysis Type - Bias Point**

Circuit Diagram (indicative)



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 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:

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

Thus the zener current, I_Z, 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.

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

$$Line\ Regulation = \frac{\Delta V_o}{\Delta V_{IN}} \times 100$$

where $\Delta V_o = V_{L-high} - V_{L-low}$ = difference in the high and low output voltage, and

ΔV_{IN} = difference in the high and low input voltage

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

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

where V_{NL} = load voltage with no load current ($I_L = 0$) or a very high value of load resistance (1K or above) and

V_{FL} = load voltage with full load current or a very low value of load resistance.

The smaller the regulation, the better is the power supply.

Procedure:

1. 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.
2. Keeping R_L fixed, vary the input voltage and measure again the output d.c. voltage, current and input d.c. voltage. (Will be need for line regulation)
3. Keeping input voltage suitably fixed, use different values of R_L and measure both the output d.c. voltage and current.
4. Tabulate all your data and ***calculate percentage regulation in each case.***

Observations:

Specifications of zener diode: Breakdown voltage = 4.610V

R_S = 330Ω

Table (i) Line Regulation: Load Resistor = 1KΩ

Sl.No	Input DC Voltage (V_{IN}) in Volts	Output DC Voltage (V_L) in Volts
1	3	1.807
2	6	3.592
3	9	4.610
4	12	4.677
5	15	4.705
6	18	4.723
7	21	4.737
8	24	4.749
9	27	4.759
10	30	4.768

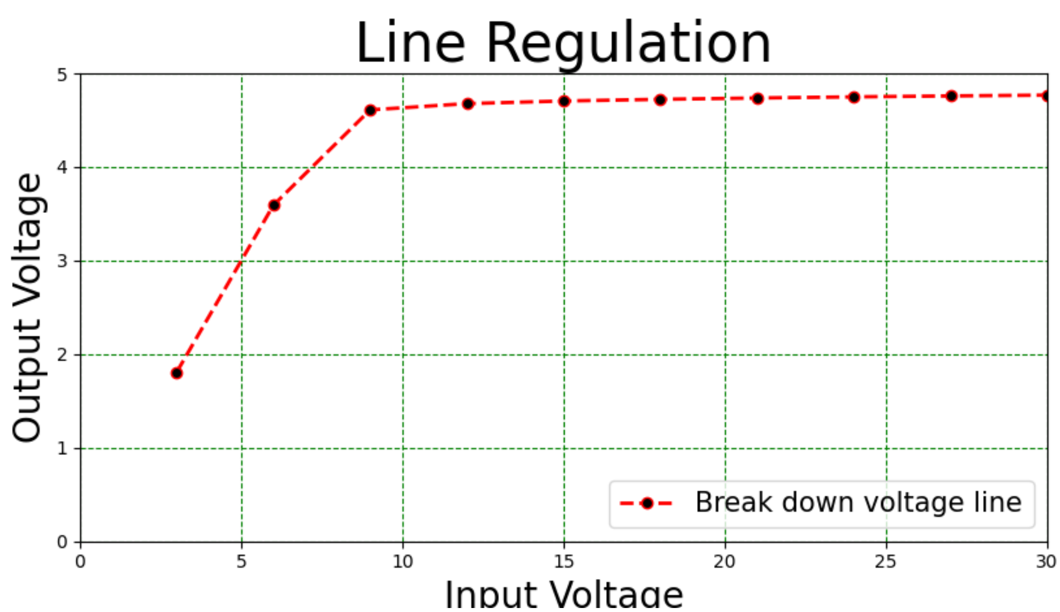
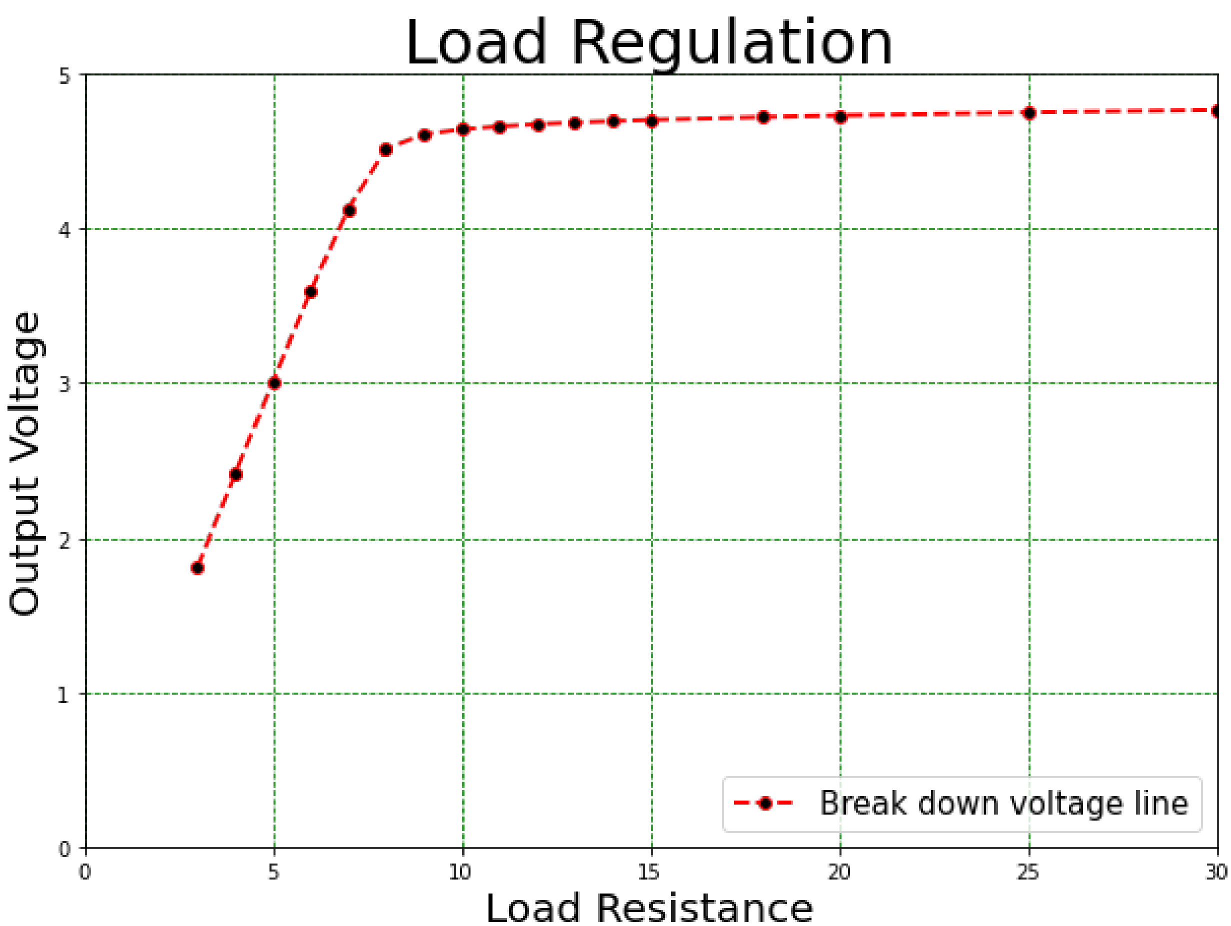


Table (ii) Load Regulation: Input DC voltage =10V

Sl.No	Load Resistance in ohms	Output DC Voltage (V_L) in Volts
1	10	149.3 mv
2	30	434.8 mv
3	50	704.2 mv
4	100	1.316
5	200	2.325
6	500	4.228
7	800	4.620
8	1K	4.643
9	2K	4.671
10	3K	4.677



Manual Calculation:

1) Line Regulation

$\Delta V_o \Rightarrow V_{L-high} - V_{L-low}$

$\Delta V_o \Rightarrow 4.768 - 1.807$

$\Delta V_o \Rightarrow 2.961$

$\Delta V_{in} \Rightarrow 30-3$

$\Delta V_{in} \Rightarrow 27$

$$\text{Line regulation} \Rightarrow \frac{\Delta V_o}{\Delta V_{in}} * 100$$

$$\Rightarrow \frac{2.961}{27} * 100$$

$\boxed{\text{Line regulation} \Rightarrow 10.9667 \%}$

ii) Load Regulation :

$V_{NL} \Rightarrow \cancel{3000} \; 4.688\ V$

$V_{FL} \Rightarrow 4.228\ V$

$$\text{Load regulation} \Rightarrow \frac{V_{NL} - V_{FL}}{V_{FL}} * 100$$

$$\Rightarrow \frac{4.688 - 4.228}{4.228} * 100$$

$\boxed{\text{Load regulation} \Rightarrow 10.879}$

Result:

The Voltage regulation application of Zener diode is understood and proved using OrCAD Pspice Software.

Conclusion:

The **Zener diode**, with its accurate and specific reverse **breakdown voltage**, allows for a simple, inexpensive **voltage** regulator. Combined with the right resistor, fine control over both the **voltage** and the supply current can be attained.

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