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**REG.NO.: 21BAI1660**

**BRANCH: BTECH - CSE AND SPEC IN AI/ML – VITCHENNAI**

**BECE101P\_SLOT-L5+L6\_EXPERIMENT – 06**

**FACULTY: PROF. SASITHRADEVI MA'AM**

### **Line Regulation and Load Regulation of Zener Diode**

**AIM: To study and understand the line voltage regulation and the load voltage regulation (no load and full load voltage regulations) of the Zener diode.**

**SOFTWARE REQUIRED: LT-Spice**

**Apparatus required:** Zener diode, resistor, batteries, wires and grounding.

#### **THEORY:**

##### Zener Diode

A Zener Diode, also known as a breakdown diode, is a heavily doped semiconductor device that is designed to operate in the reverse direction. A Zener diode operates just like a normal diode when it is **forward-biased**. However, when connected in reverse biased mode, a small leakage current flows through the diode. As the reverse voltage increases to the predetermined breakdown voltage ( $V_z$ ), current starts flowing through the diode.

##### Working

This diode has a thin depletion layer. So, during the reverse bias also, the electrons flow through the depletion layer and hence current flows through the diode. A Zener diode works just like a regular diode in forward bias. When the voltage across the terminals of a Zener diode is reversed and the potential reaches the Zener Voltage (knee voltage), the junction breaks down and the current flows in the reverse direction. This effect is known as the Zener Effect.

##### Line regulation of Zener diode

If the output voltage is regulated by varying the input voltage  $V_i$ , keeping the load resistance  $R_L$  constant, then the regulation is called the Line regulation.

Since  $R_L$  is constant, then load current  $I_L$  also remains same. Now, input current  $I_i$  varies due to variation of input voltage  $V_i$ . Then we can see that any change of input current is balanced by Zener current. Again, Zener voltage is almost independent of Zener voltage then output remains same at  $V_z$ .

**Note:** To use Zener diode as a voltage regulator it is necessary to have Zener voltage ( $V_z$ ) less than the equivalent input voltage. Also, the Zener current should not exceed the maximum rating.

### Load Regulation of Zener diode

If the output voltage is regulated by varying the load resistance  $R_L$ , keeping the input power supply voltage ( $V_i$ ) constant, then the regulation is called the Load regulation.

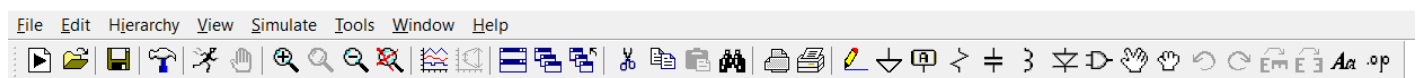
Since  $R_L$  is varying, then load current ( $I_L$ ) also varying. Again, the input current  $I_i$  is constant as the input voltage  $V_i$  is not varying. Then we observe that Zener current balances any change of load current. If Load current increases, Zener current decreases and vice-versa. Since, output voltage  $V_z$  is independent of Zener current then output still remains constant at  $V_z$ .

This is first done without any load resistance, then done for some load resistances. It is load regulation with no load of Zener diode.

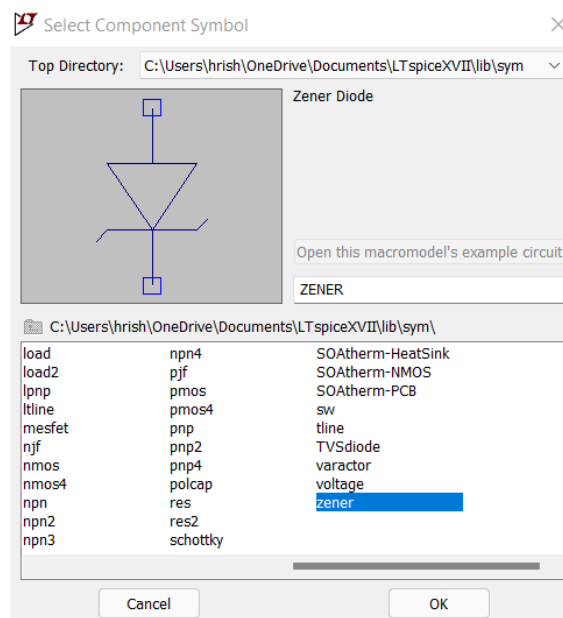
### **PROCEDURE:**

#### **STEPS**

- Go to LT-spice and open new schematic.
- Write name and reg.no. in the text button on the toolbar.
- Using Voltage source, resistor, Zener diode, wires and grounding draw the circuits as shown in the circuit diagrams (later shown) using tool bar and component library.

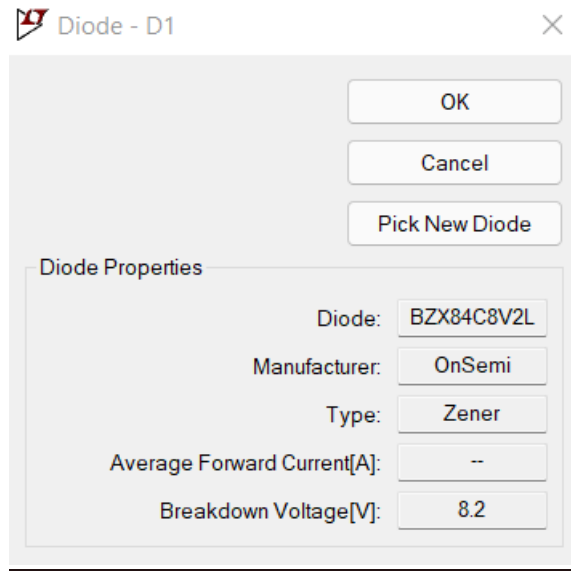


- For Zener diode click on component button on the toolbar and search Zener.



- After drawing the circuits for line regulation and load regulation (no load and full load), we give values  $R_s=100$  ohms and  $R_L=1000$  ohms and battery voltage  $=0V$  and select a pre-set diode from the “pick a new diode” section by right clicking the Zener diode in the line regulation circuit. Then in load regulation full load give values  $R_1=220$  ohms  $V_1=24V$   $R_2(\text{load}) = \{R_1\}$  and select the diode as shown in the circuit by right clicking and “pick a new diode” section. For no load just disconnect the wire connecting the load resistance  $R_2$ .

### Line regulation Zener diode



Diode - D1

OK

Cancel

Pick New Diode

Diode Properties

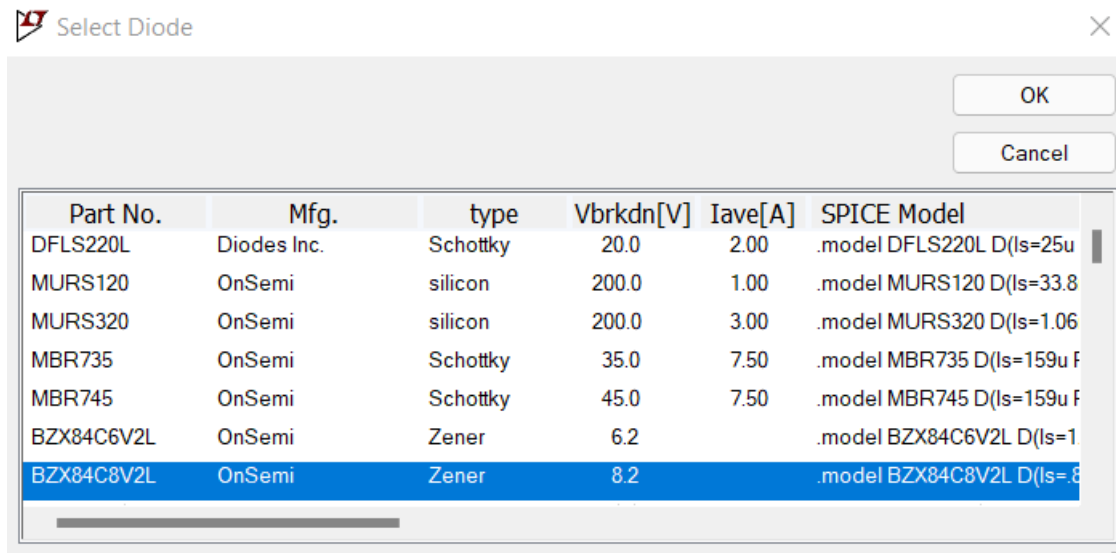
Diode: BZX84C8V2L

Manufacturer: OnSemi

Type: Zener

Average Forward Current[A]: --

Breakdown Voltage[V]: 8.2



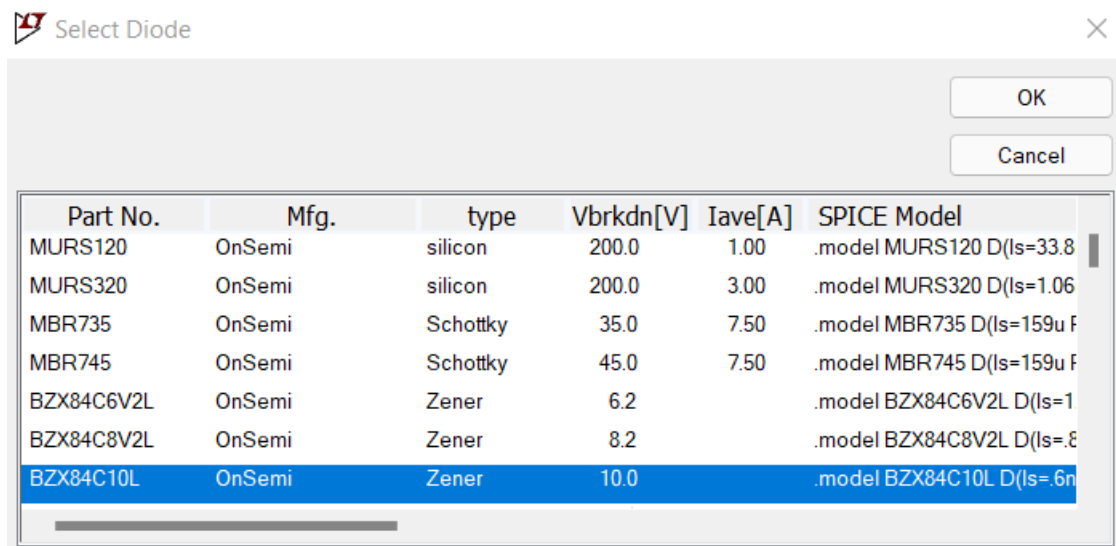
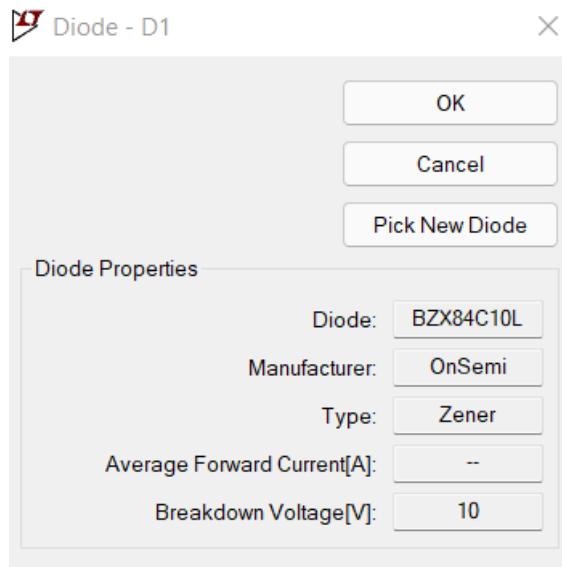
Select Diode

OK

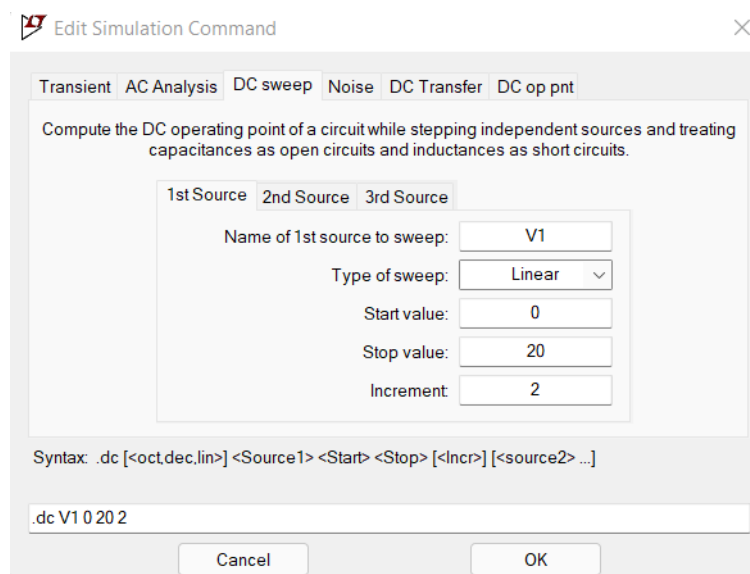
Cancel

Part No.	Mfg.	type	Vbrkdn[V]	Iave[A]	SPICE Model
DFLS220L	Diodes Inc.	Schottky	20.0	2.00	.model DFLS220L D(Is=25u
MURS120	OnSemi	silicon	200.0	1.00	.model MURS120 D(Is=33.8
MURS320	OnSemi	silicon	200.0	3.00	.model MURS320 D(Is=1.06
MBR735	OnSemi	Schottky	35.0	7.50	.model MBR735 D(Is=159u F
MBR745	OnSemi	Schottky	45.0	7.50	.model MBR745 D(Is=159u F
BZX84C6V2L	OnSemi	Zener	6.2		.model BZX84C6V2L D(Is=1
BZX84C8V2L	OnSemi	Zener	8.2		.model BZX84C8V2L D(Is=.8

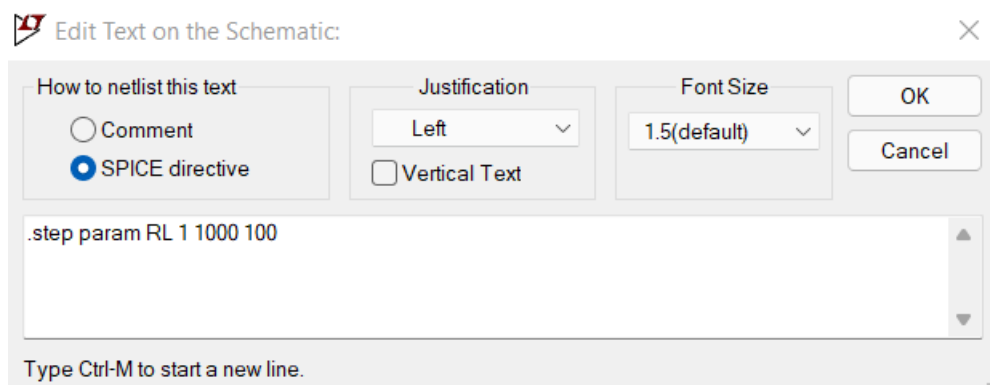
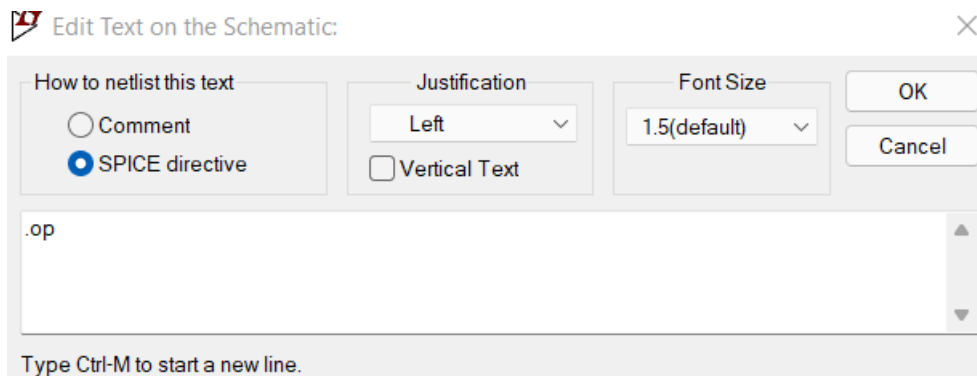
## Load regulation Zener diode



- Now for line regulation, go under simulate and edit simulation command. Give the settings of running the circuit as shown.



- Click on the run symbol or click on run under simulate menu.
- Keep the prongs on the point above the diode to measure the line regulation of the Zener diode.
- Now, we to use 2 cursors on the graph and mark, measure and observe the point where the slopes change largely on the 2 points on the graph.
- Now, for load regulation first doing for no load. Where, the resistance is not connected to the circuit. We go under simulate and click run or click the run symbol.
- We can observe a flat constant voltage being displayed on the graph.
- Now, for full load under simulate we go under spice directive and give .op first and then we go under spice directive once again and type .step param RL 1 1000 100.

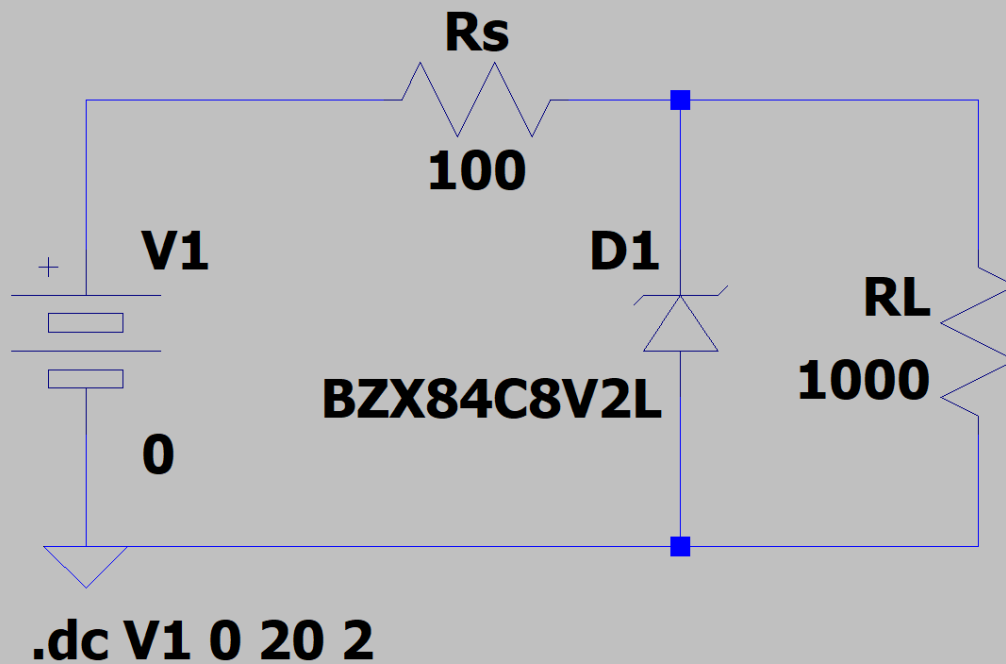


- Now, we click the run symbol the run button under simulate.
- Then, we use 1 cursor on the graph and plot the point where slope changes from positive to close to 0.

## CIRCUIT DIAGRAMS:

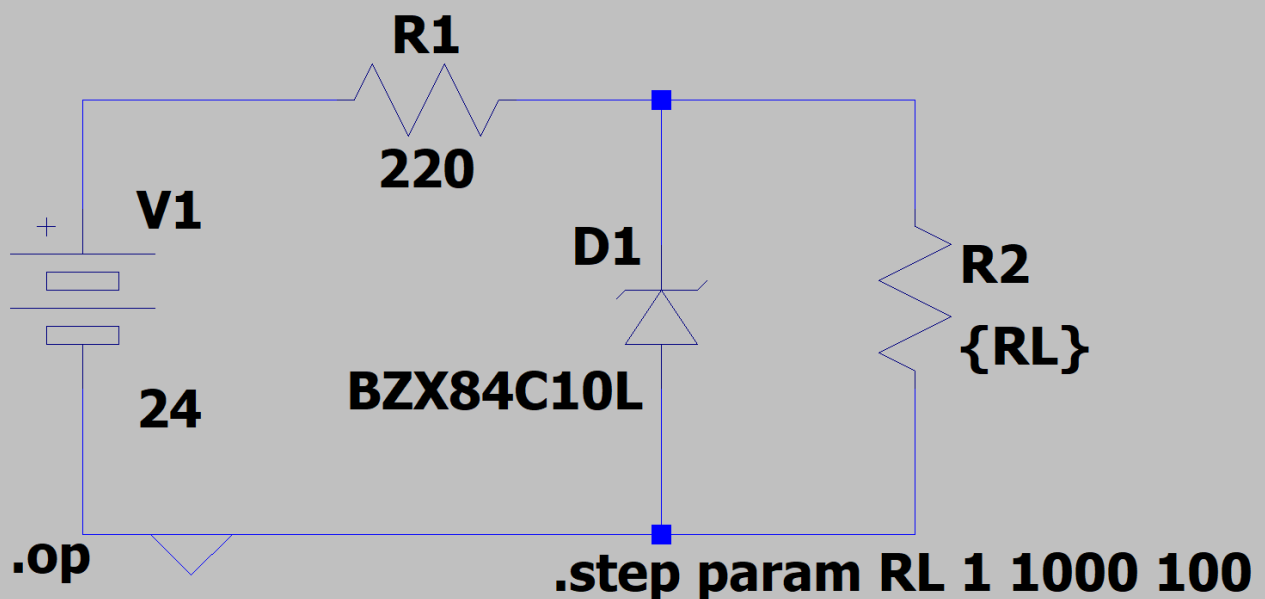
### Line regulation of Zener diode

#### Line Regulation of Zener diode - 21BAI1660 HRISHIKESH G KULKARNI



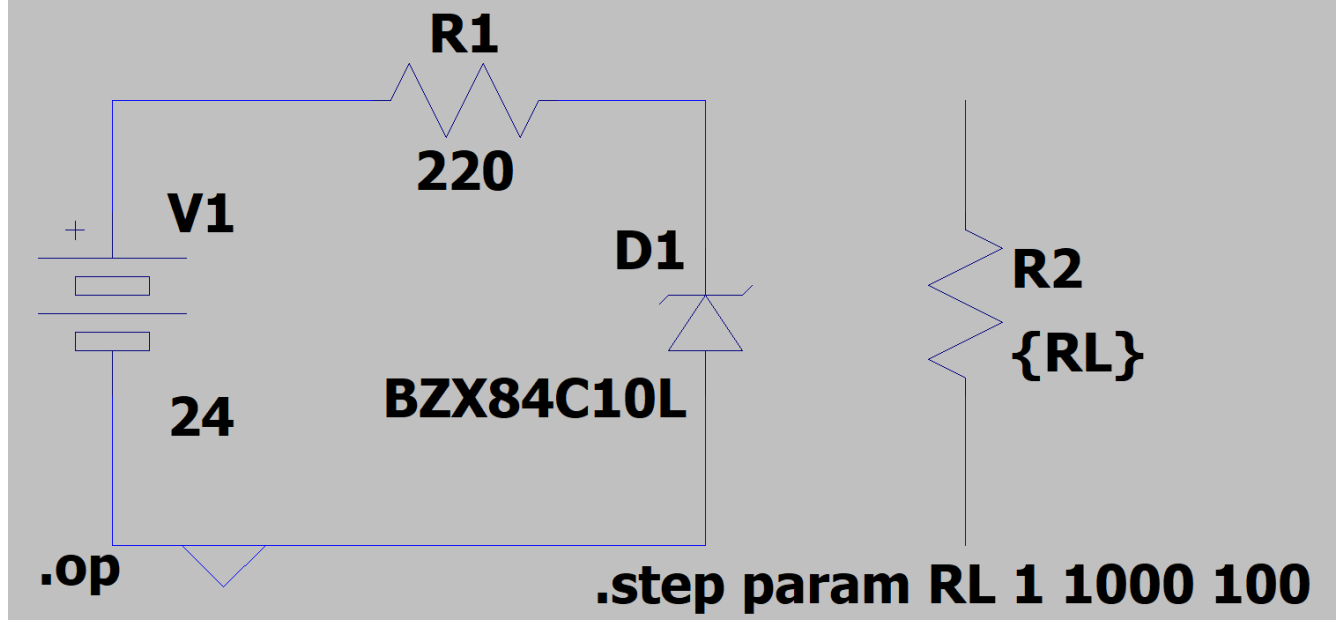
### Load regulation of Zener diode with full load

#### Load Regulation of Zener Diode with Full load 21BAI1660 - HRISHIKESH G KULKARNI



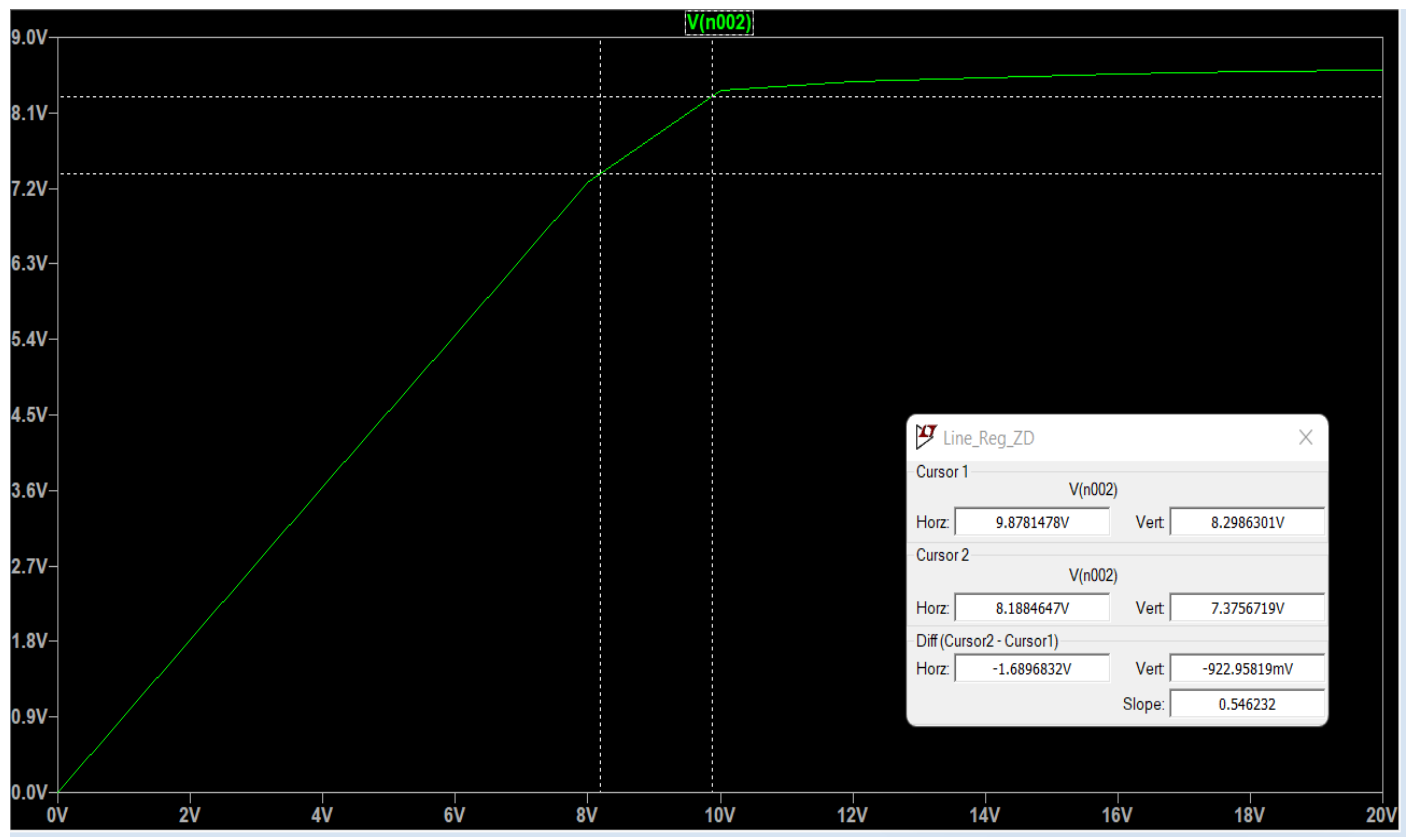
## Load regulation of Zener diode with no load

### Load Regulation of Zener Diode with Full load 21BAI1660 - HRISHIKESH G KULKARNI

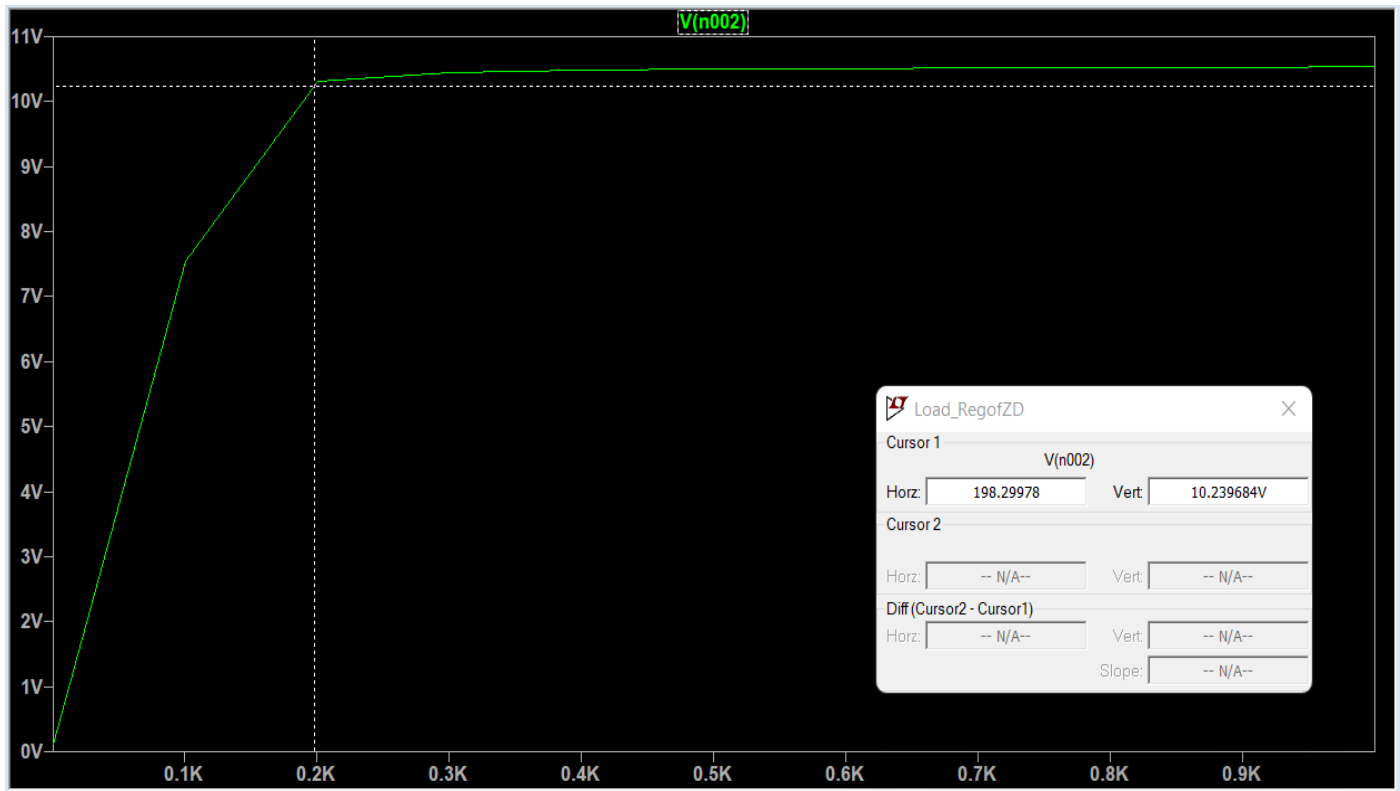


## OUTPUT:

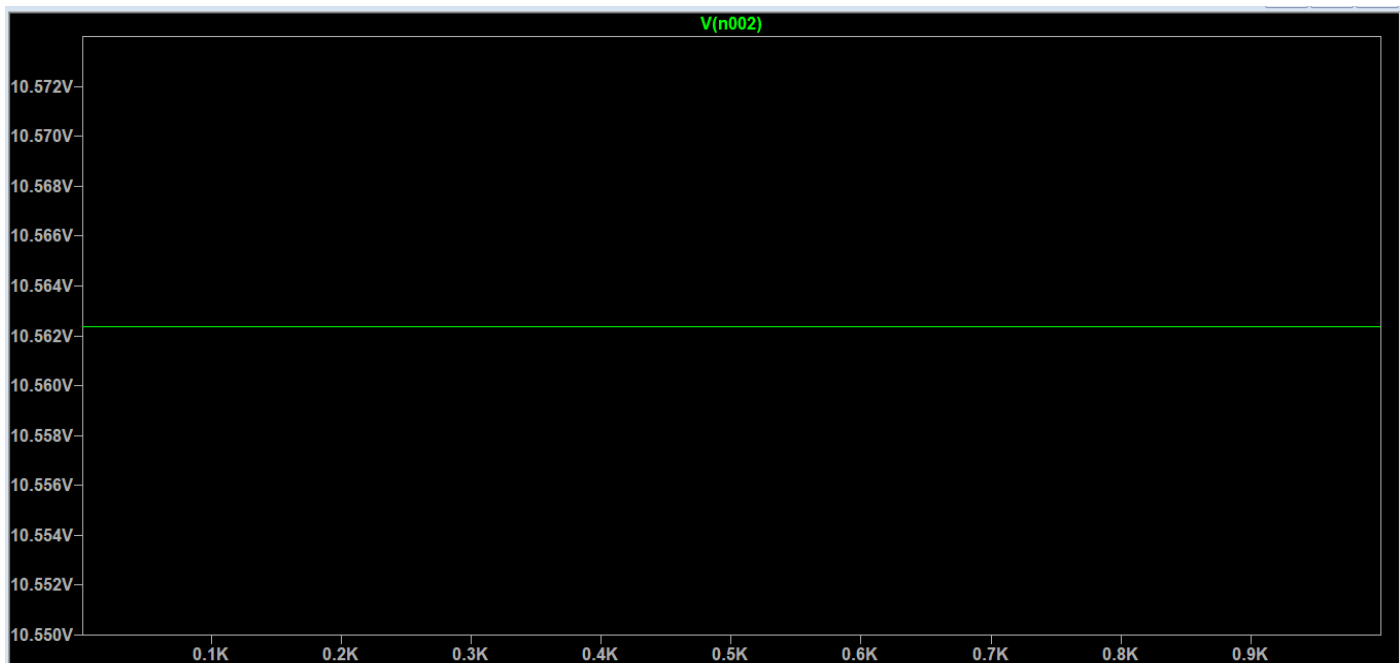
### Line voltage regulation of Zener Diode



## Load Voltage regulation – full load



## Load voltage regulation – No load



## Result and Inference:

We studied the line and load voltage regulation of the Zener diode from the simulation. We understood how a Zener diode functions and its regulation in this experiment.

---THE END---



