Experiment-03

CSE251

Electronic Devices and Circuits Lab.

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CSE251

Experiement - 3

Title: Study of Zener Diode and Its Application in Voltage Regulation.

Theory: The diodes we have studied before do not operate in the breakdown region because this may damage them. A Zener diode is different it is a silicon diode that the manufacturer has optimized for operation in the breakdown region. It is used to build voltage regulator circuits that hold the load voltage almost constant despite large change in line voltage and load resistance. The zener diode may have a breakdown voltage from about 2 to 200V. These diodes can operate in any of the

three regions: forward, leakage and breakdown.

- Model Approximations:
- First approximation: When the voltage across the zener diode $V \geq V_Z$ the diode is ON, and it is represented by a battery with constant voltage of V_Z; otherwise the diode is OFF and it is represented by an open circuit.
- Second approximation: The Zener diode is modeled with a battery of voltage V_{Z0} in series with resistance r_Z; called the zener resistance, to account for the slight increase in the zener voltage V_Z with the zener current I_Z.
- Voltage regulation: Voltage regulation is a measure of performance of voltage regulator circuits. It is classified as two types:

1. Line Regulation.
2. Load Regulation.

⊞ Line Regulation: Line regulation is the variation in the output or the load voltage (V_L) for one volt variation in the input voltage (V_i) expressed mathematically as $\Delta V_L / \Delta V_i$ (mV/V)

⊞ Load Regulation: Load regulation is the variation in the output or the load voltage (V_L) for one mA variation in the load current (I_L), expressed mathematically as $\Delta V_L / \Delta I_L$ (mV/mA)

⊞ Equipments:

1. Zener Diode (5 volt) X1
2. Resistance (220Ω, 470Ω, 1.0kΩ)
3. POT 10kΩ
4. DC Power Supply
5. Digital Multimeter
6. Breadboard.
7. Chords and wire.

Calculation :

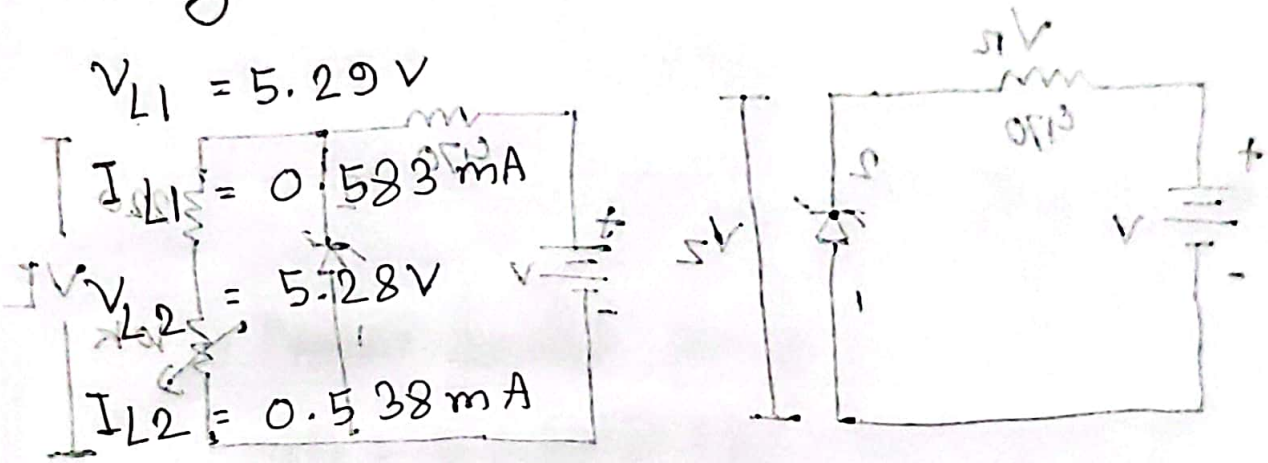
⊛ Picking two data from table 2.

$V_{L1} = 5.29\,V$

$I_{L1} = 0.583\,mA$

$V_{L2} = 5.28\,V$

$I_{L2} = 0.538\,mA$



load regulation, $\Delta V_L / \Delta I_L$

$$= \frac{(5.29 - 5.28) \times 1000}{(0.583 + 0.538)}$$

$= 8.921\ (mV/mA)$

⊛ Picking any two data from table 3.

$V_{L1} = 5.29$			
$V_{P1} = 10$	01	1.5 C.8	8.01

$V_{L2} = 5.28$

$V_2 = 9$

Line regulation, $\Delta V_L / \Delta V = 10\ (mV/V)$

Circuit Diagram:

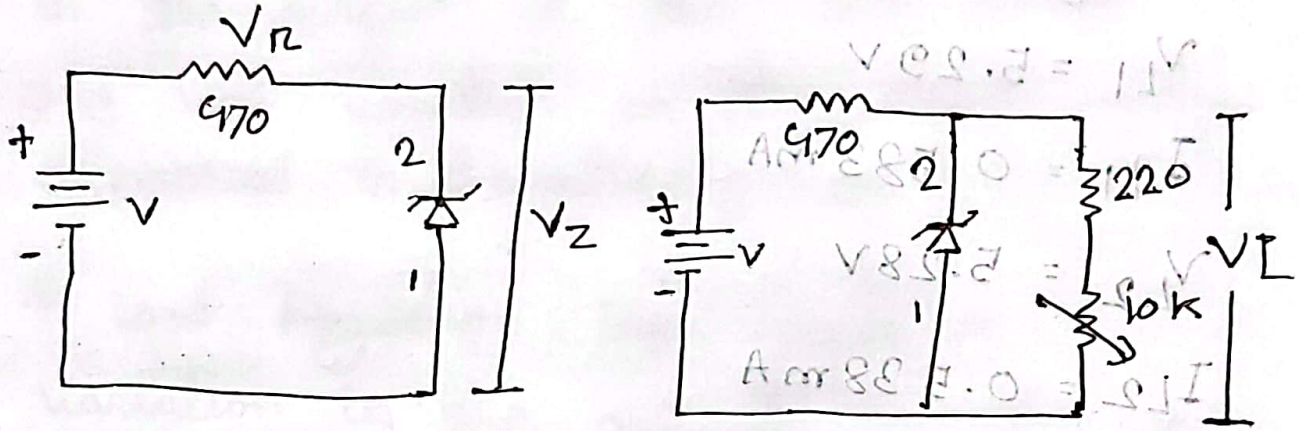


Table 4.

Load Regulation (mV/mA)		Line Regulation (mV/V)	
From Experiment (graph)	Theoretical Calculation	From Experiment (graph)	Theoretical Calculation
16.8	8.921	10	10V

0.252 kΩ

Tab-1

V	V_R	V_z	$I_z = \frac{V_R}{R}$
0	0	0	0
1	0	0.967	0
2	0	1.961	0
3	0	2.996	0
4	0	3.95	0
4.9	125mV	4.79	0.268
5	158.2mV	4.82	0.3402
5.1	208mV	4.89	0.447
5.2	233.5mV	4.93	0.502
5.3	288.3mV	4.98	0.62
5.4	334 mV	5.02	0.718
5.5	0.423V	5.07	0.909
6	0.818V	5.18	1.759
7	1.715V	5.24	3.688
8	2.67 V	5.26	5.741
9	3.696	5.28	7.948
10	4.69	5.29	10.086

Tab-2

V_{220}	V_L	$I_L = \frac{V_{220}}{R_{220}}$
115.8mV	5.28V	0.538mA
131.7mV	5.29V	0.612mA
147.3mV	5.29V	0.583
162.9mV	5.29V	0.646
176.4mV	5.29V	0.7 mA
194.1mV	5.29V	0.770mA
207.5mV	5.28V	0.8234mA
232.8mV	5.28V	0.923mA
256.6mV	5.28V	1.015
281.9mV	5.28V	1.115
315.2mV	5.28	1.25
0.414V	5.28	1.643
0.552V	5.28	2.191
0.778V	5.27	3.087
2.1V	5.01	8.33
~~3.136V~~	~~3.183~~	
2.53V	4.39	10.036
3.058V	3.244	12.135
3.134	3.183	12.436
2.633	4.00	~~10.448mA~~ 10.448mA

Tab-3

V	V_L
0	
0	0 V
1	0.945
2	1.90
3	2.73
4	3.7
4.9	4.57
5	4.66
5.1	4.72
5.2	4.79
5.3	4.86
5.4	4.91
5.5	4.96
6	5.13
7	5.23
8	5.26
9	5.28
10	5.29

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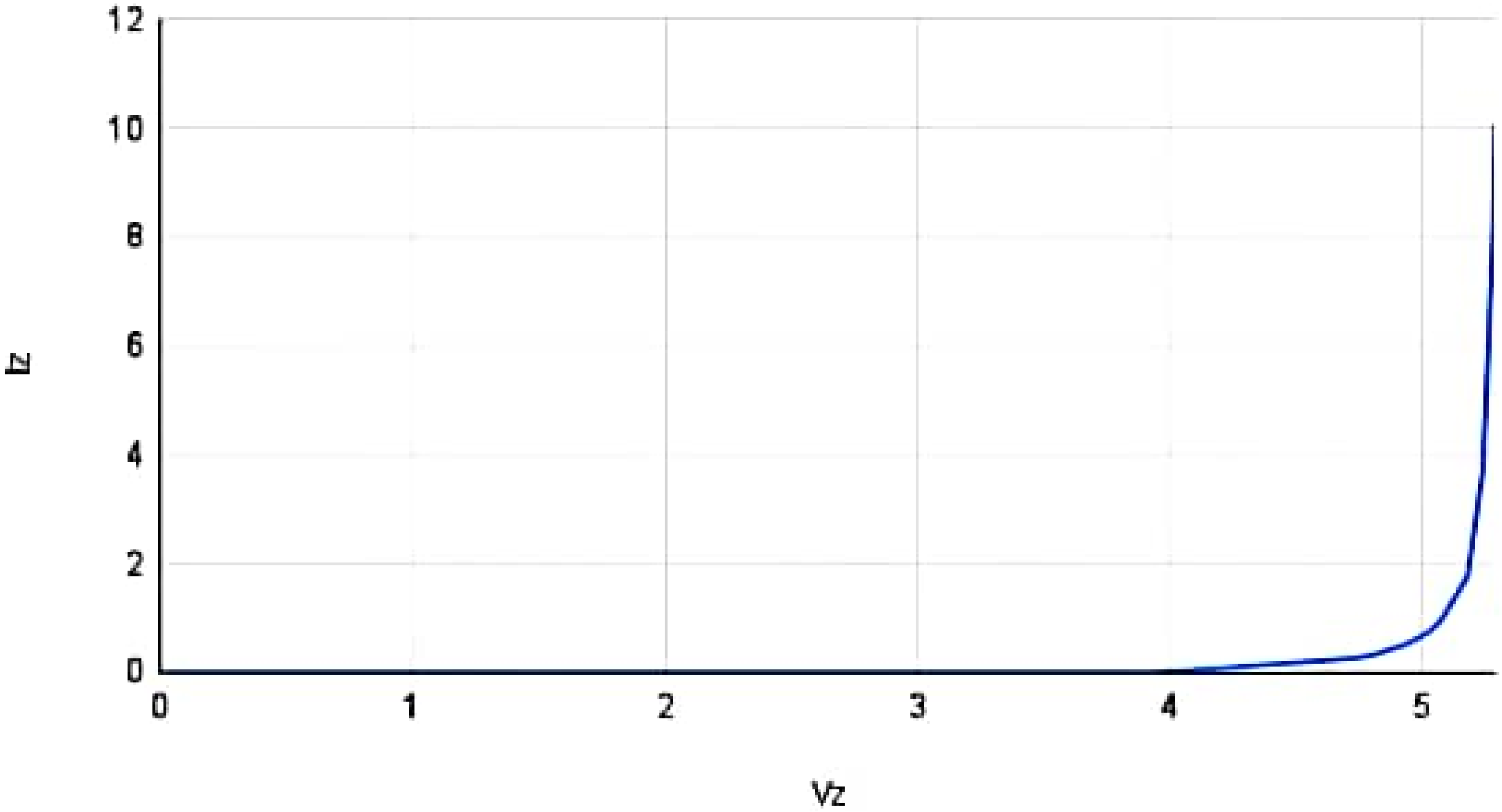
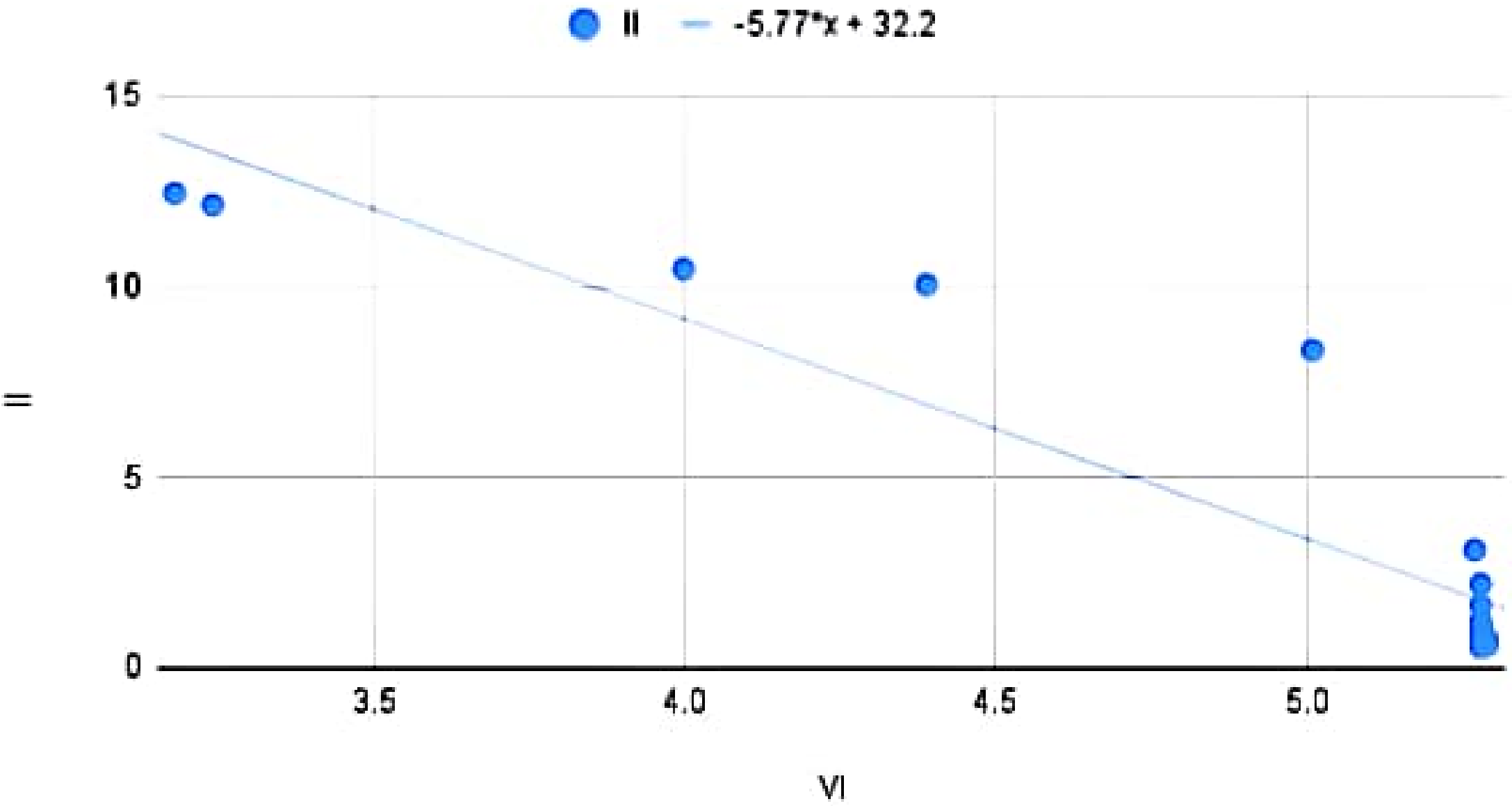
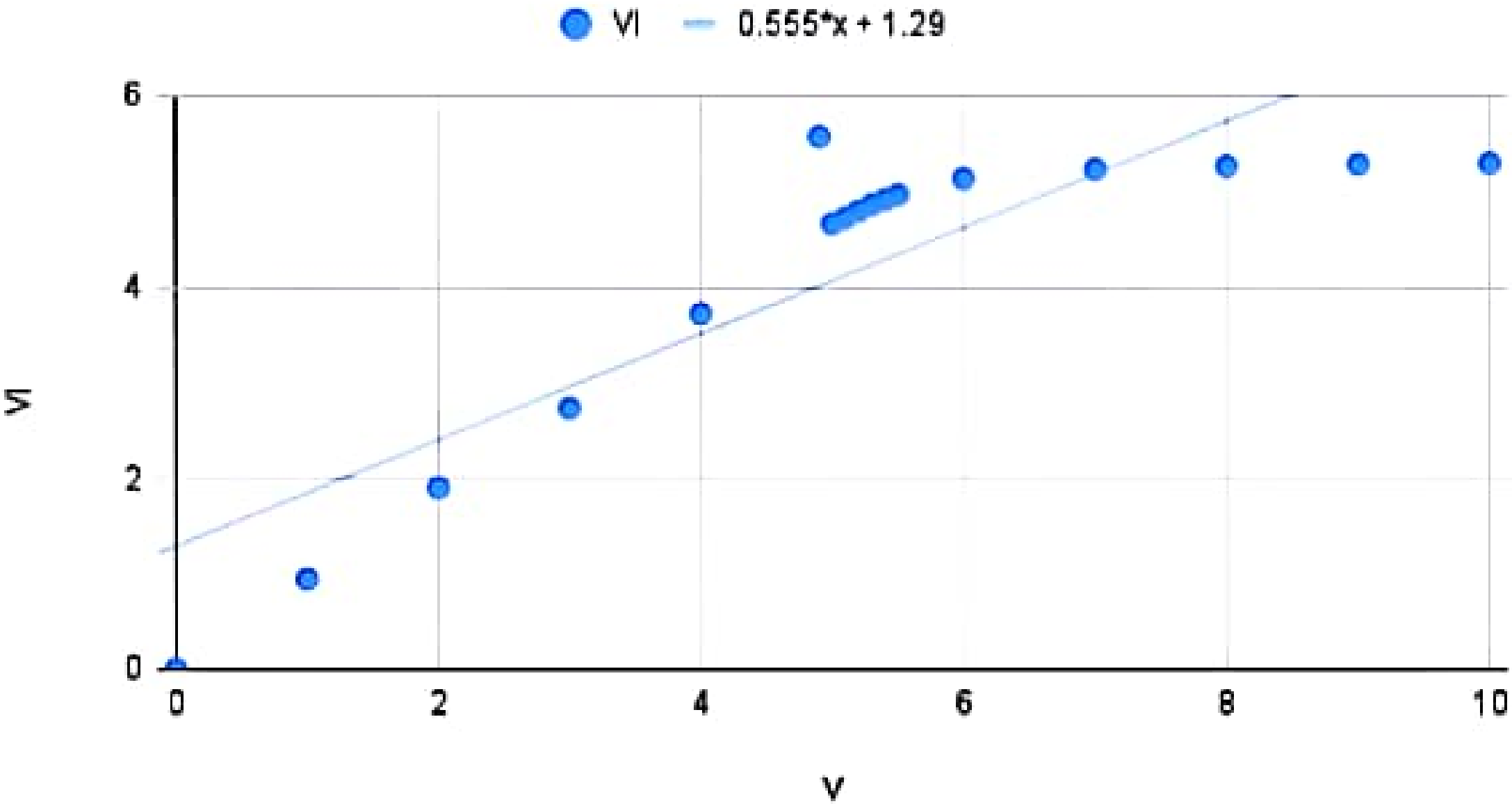
Iz vs. Vz



II vs. VI



VI vs. V

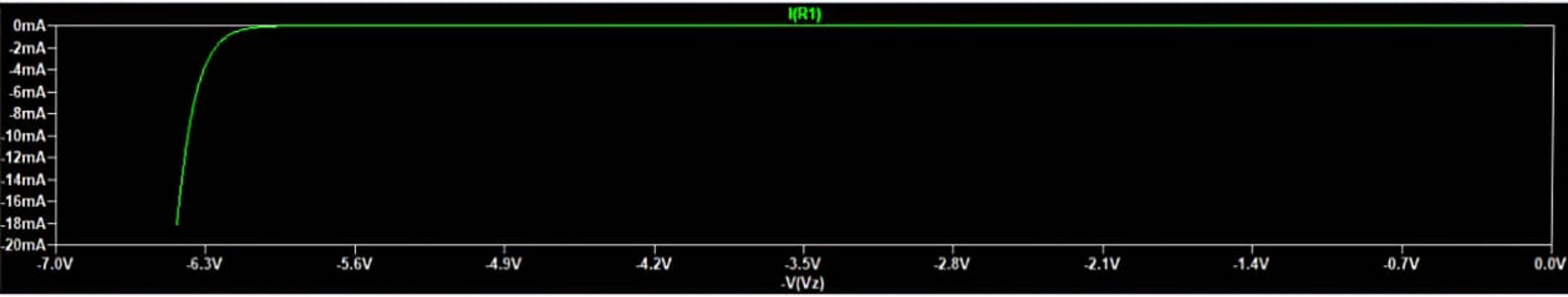


LTspice XVII - Draft1

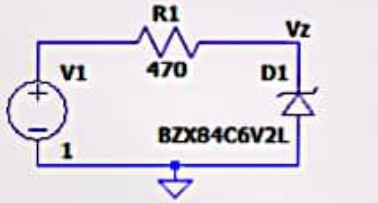
File View Plot Settings Simulation Tools Window Help

Draft1 Draft1

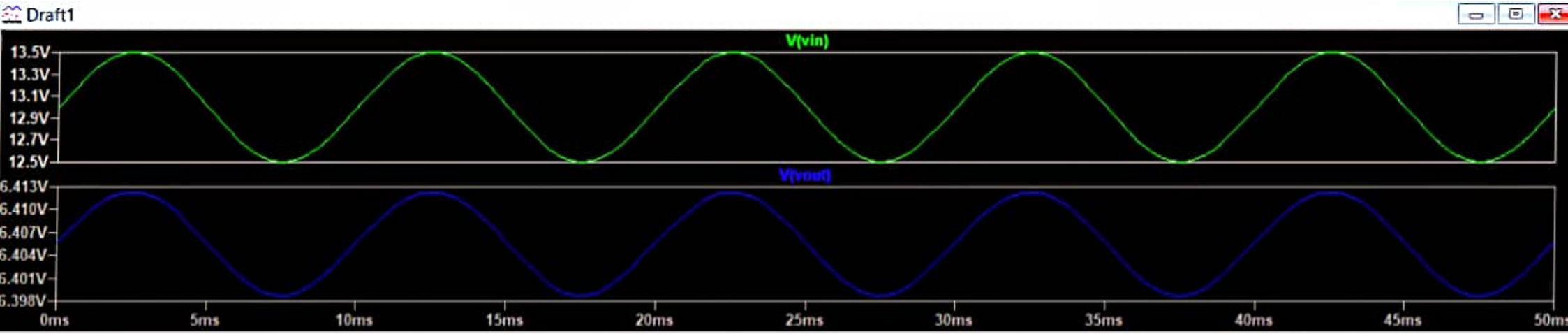
Draft1

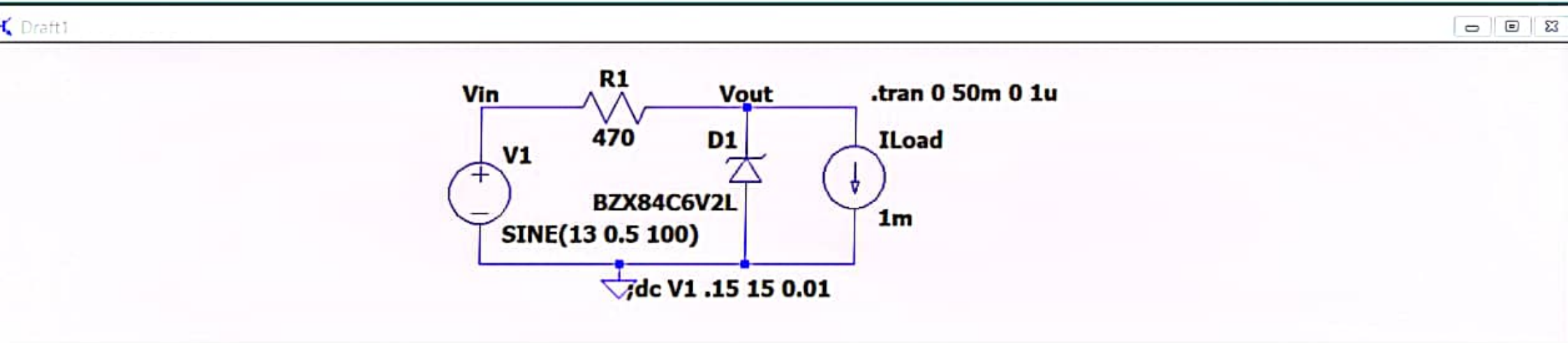


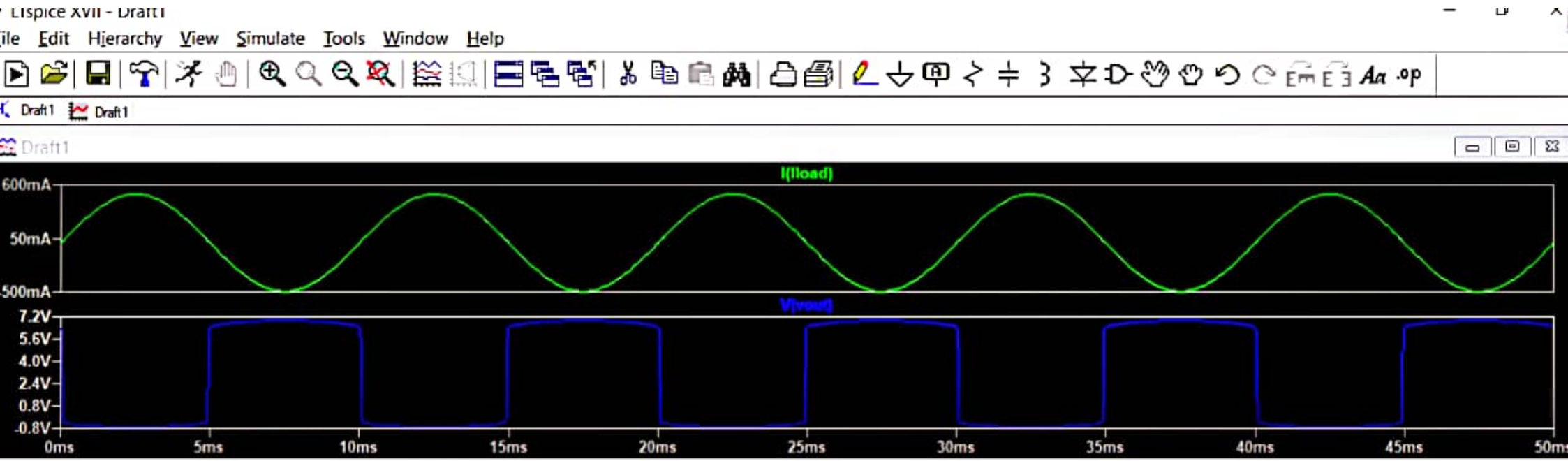
Draft1

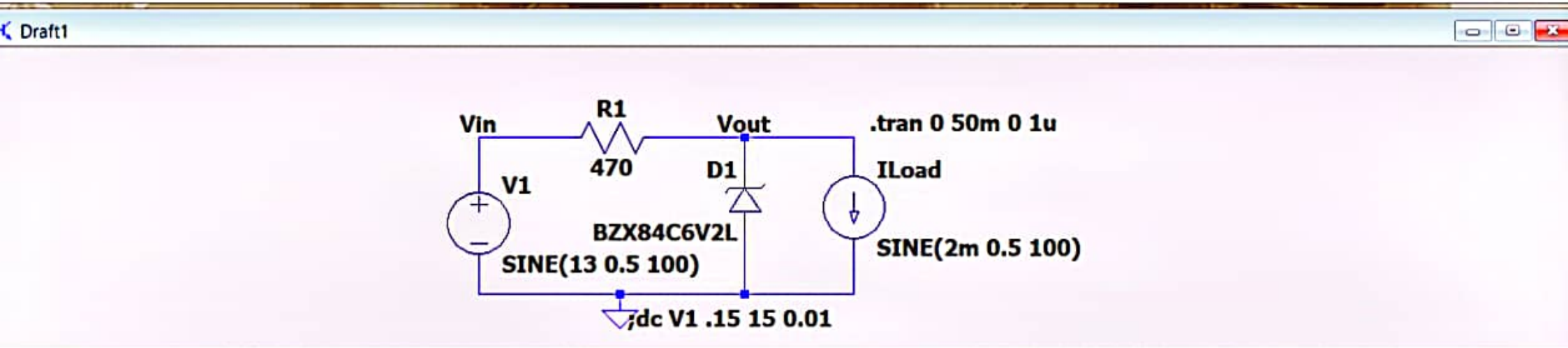


.dc V1 .15 15 0.01


Draft1
V(vin)
13.5V
13.3V
13.1V
12.9V
12.7V
12.5V
V(vout)
6.413V
6.410V
6.407V
6.404V
6.401V
6.398V
0ms
5ms
10ms
15ms
20ms
25ms
30ms
35ms
40ms
45ms
50ms


Draft1
Vin
R1
470
Vout
D1
BZX84C6V2L
V1
SINE(13 0.5 100)
ILoad
1m
.tran 0 50m 0 1u
;dc V1 .15 15 0.01


LTspice XVII - Draft1
File Edit Hierarchy View Simulate Tools Window Help
Draft1
Draft1
I(Iload)
600mA
50mA
-500mA
V(vout)
7.2V
5.6V
4.0V
2.4V
0.8V
-0.8V
0ms
5ms
10ms
15ms
20ms
25ms
30ms
35ms
40ms
45ms
50ms


Draft1
Vin
R1
470
Vout
D1
BZX84C6V2L
V1
SINE(13 0.5 100)
ILoad
SINE(2m 0.5 100)
.tran 0 50m 0 1u
;dc V1 .15 15 0.01