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Aim: To study the load regulation and line Regulation characteristics of Zener diode.

Apparatus:
1. Zener diode
2. Resistor
3. Rehostat
4. Voltmeter
5. Ammeter
6. DC Source
7. Bread board

Theory: A Zener diode functions as an ordinary diode when it is forward biased. It is a specially designed device to operate in the reverse bias. When it is in the reverse breakdown region, the Zener voltage V_z remains almost constant irrespective of the current I_z through it. A series resistor R_s is used to limit the Zener current below its maximum current rating. The current through R_s is given given by the expression $I_s = I_z + I_L$, where I_L is the current through the load resistor R_L. The value of R_s must be properly selected to fulfill the following condition requirements.

When the input voltage, V_i increases I_L remains the same, I_s and I_z increases. Similarly if input voltage decreases, I_L remains the same, I_s and I_z decreases. But if I_z falls lower than the

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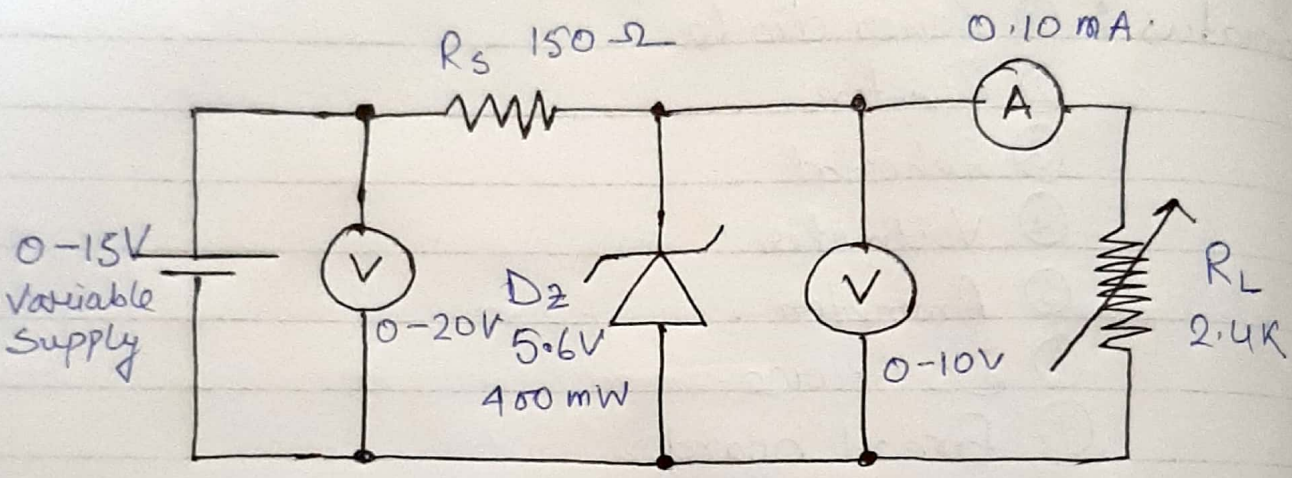
Circuit Diagram:



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minimum zener current through enough to keep the zener in the breakdown region, the regulation will cease and output voltage decreases. A lower input voltage can cause the regulator fail to regulate. The series resistance should be selected between R_{smax} and R_{smin} which are given by the expression.

$$R_{smin} = [V_{imax} - V_z] / I_{zmax}$$

$$R_{smax} = [V_{imin} - V_z] / [I_{zmin} + I_L]$$

To Calculate percentage load regulation, mark V_{NL} and V_{FL} on Y-axis on the load regulation graph. V_{NL} is the output voltage in the absence of load resistor and V_{FL} is the output voltage corresponing to rated I_L (here, 5mA). Calculate the percentage load regulation V_R as per the equation,

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

Calculation:-

Assume, $V_o = 5.6V$, $I_{max} = 5mA$ input voltage is in the range 8-14 V.

Select 5.6V zener [$P_o = 400mW$, $V_z = 5.6V$, $r_d = 8\Omega$ at $I_z = 10mA$]

Use 2.4K rheostat as load resistance load current can be varied from 2.4 mA and upwards.

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$I_{Zmax} = \frac{P_{max}}{V_Z} = \frac{0.4}{5.6} = 71.42\ mA.$

$I_{Zmin} = 10\%\ of\ I_{ZMax} = 0.1 \times 71.42 = 7.142\ mA.$

$R_{Smax} > R_S > R_{Smin}$

$R_{Smax} = [V_{imin} - V_Z] / [I_{Zmin} + I_{LMax}]$

$= \frac{(8 - 5.6)V}{(7.142 + 5)mA} = 197.6\ \Omega$

$R_{Smin} = [V_{imax} - V_Z] / I_{Zmax}$

$= \frac{(14 - 5.6)V}{71.42\ mA} = 117.6\ \Omega.$

Select $R_S = 150\ \Omega$.

Power Rating of R_S :-

Max current through $R_S = I_m$

$= [V_{imin} - V_Z] / R_S$

$= \frac{14 - 5.6\ V}{150\ \Omega}$

$= 56\ mA.$

Power rating of $R_S = I_m^2 \times R_S$

$= 0.4704\ W >>$

Select 150 ohms 0.5 W resistor.

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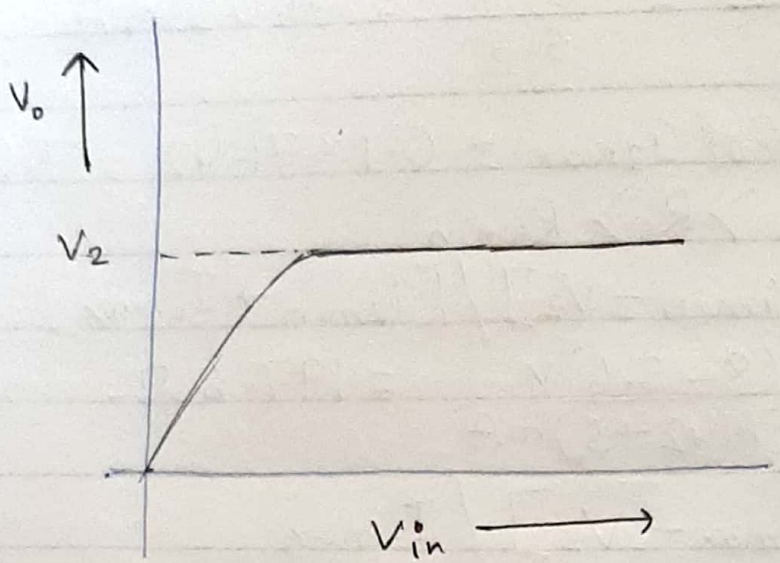
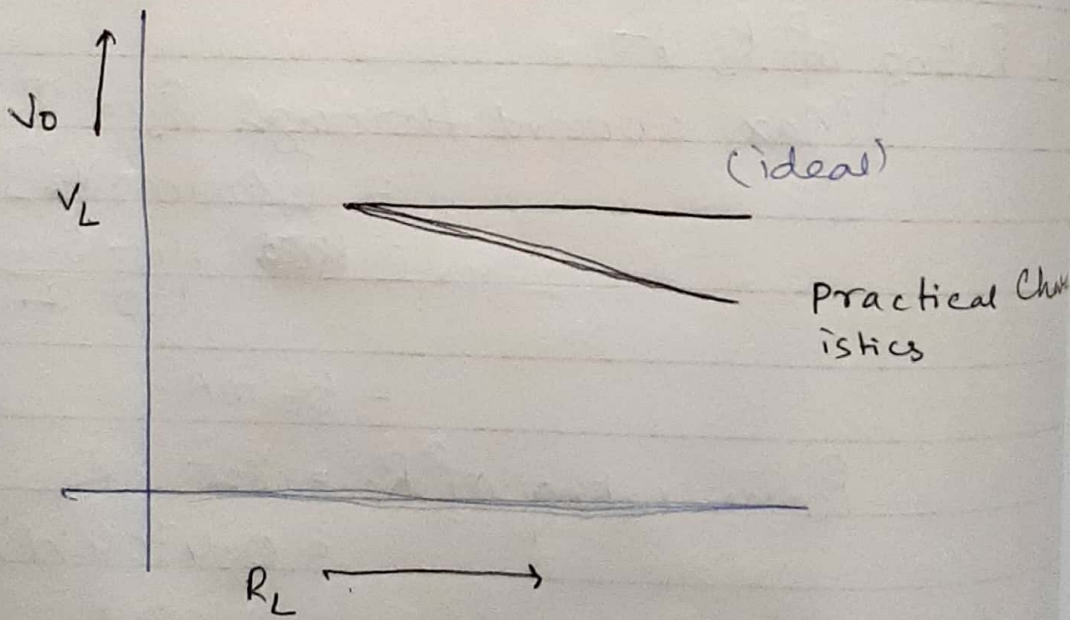


Output voltage vs. input voltage for Line Regulation.



Output voltage vs input voltage for Load regulation.

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Linear Regulation :

Keeping load current constant at $I_L = 5mA$, The input voltage is 8 to 14 V and corresponding observation are made.

V_{in}	V_o
8	5.60
10	5.60
12	5.60
14	5.60

Load Regulation :

Keeping input voltage at 10V, the load current is varied from 0 to 5 mA and observations are made. For taking reading corresponding to no load ($I_L = 0$), the loading rehostat,

R_L	I_L mA	V_o (Volt).
1250	4.48	5.60
1028	5.45	5.60
856	6.54	5.60
703	7.97	5.60
		5.60.

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Pre Cautions: ① All the connections should be proper, neat and clean.

② Polarity of devices should be checked.

③ Power should be turned off while construction of a circuit is in progress.

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