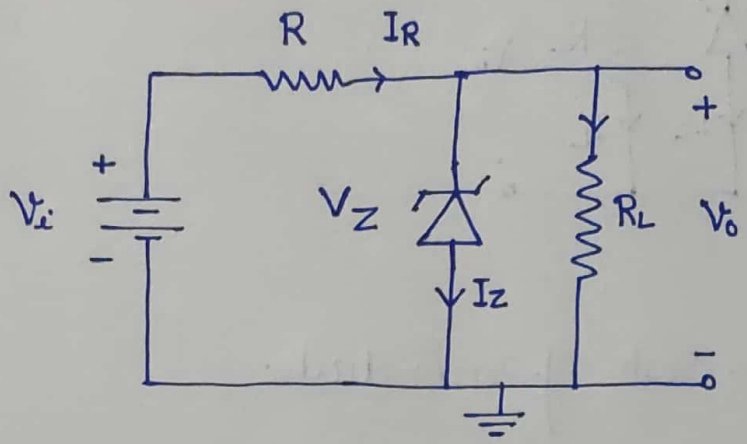
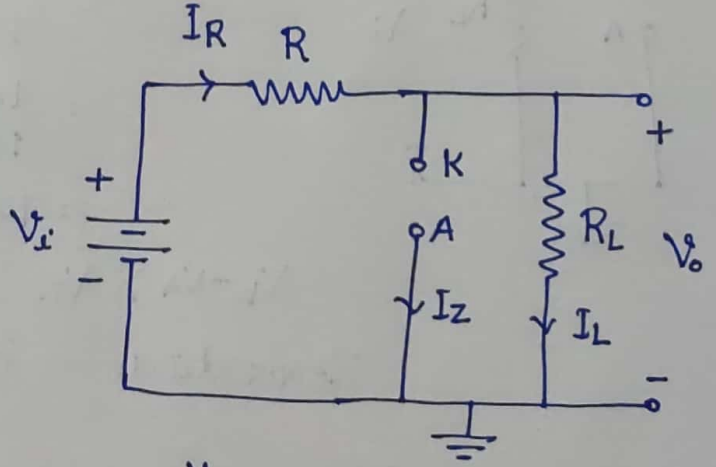
Q.1: For the circuit shown in figure, determine I_R, I_Z, I_L, V_o and P_Z. Given that $V_i = 16\,V$, $R = 1\,K\Omega$, $V_Z = 10\,V$, $P_{ZM} = 30\,mW$, and $R_L = 1.2\,K\Omega$.



Sol: **Step 1:** Determine the state of Zenor diode



$$I_R = \frac{V_i}{R+R_L} = \frac{16}{1+1.2}\ mA$$

$$= \frac{16\times10^{-3}}{2.2}\ \frac{mA}{A}$$

$$= 7.27\ mA$$

$I_Z = 0$; $I_L = I_R$

$P_Z = V_Z \cdot I_Z = 0\ W$

$V_o = I_R \cdot R_L = I_L R_L = 8.72\ V$

$V_K - V_A = V_o$

$$= \frac{V_i R_L}{R+R_L}$$

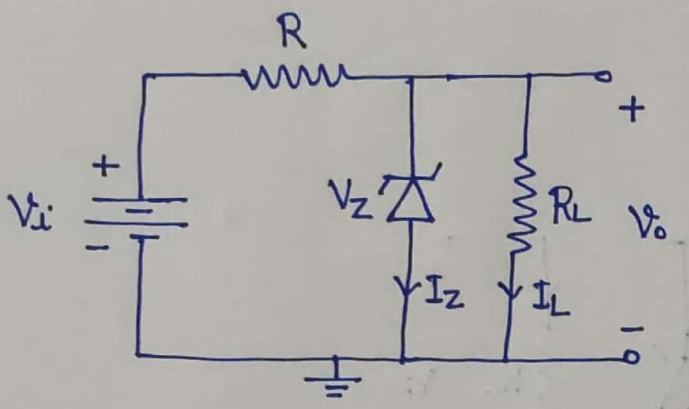
$$= \frac{16\times1.2\times10^{+3}}{2.2\times10^{3}}$$

$$= \frac{8\times1.2}{1.1} = \frac{12\times8}{11}$$

$V_K - V_A = < 10\ V$

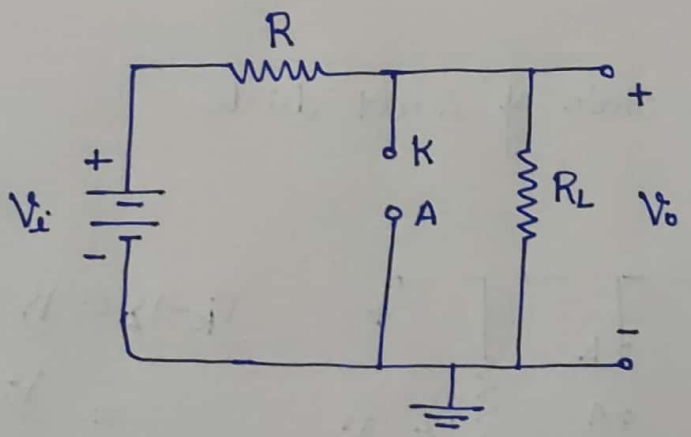
Zenor diode is in 'OFF' state.

Q.2: For the circuit shown in Figure, determine I_R, I_Z, I_L, V_o, and P_Z. Given that $V_i = 16V$, $R = 1\,K\Omega$, $V_Z = 10V$, $P_{ZM} = 30\,mW$, and $R_L = 3K\Omega$.



Sol:

Step 1: Determine the state of Zenor diode.

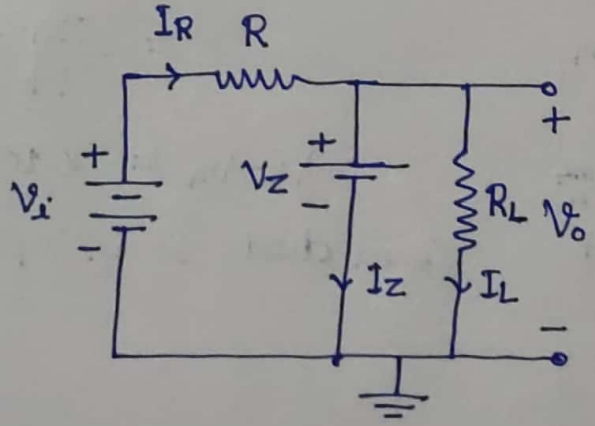


$$V_K - V_A = V_o$$
$$= \frac{V_i R_L}{R + R_L}$$
$$= \frac{16 \times 3}{1+3}$$
$$= 12V$$

$V_K - V_A > V_Z$

Zenor diode is 'ON'

Step 2:



$$I_R = \frac{V_i - V_Z}{R}$$
$$= \frac{16-10}{1} = 6\,mA$$

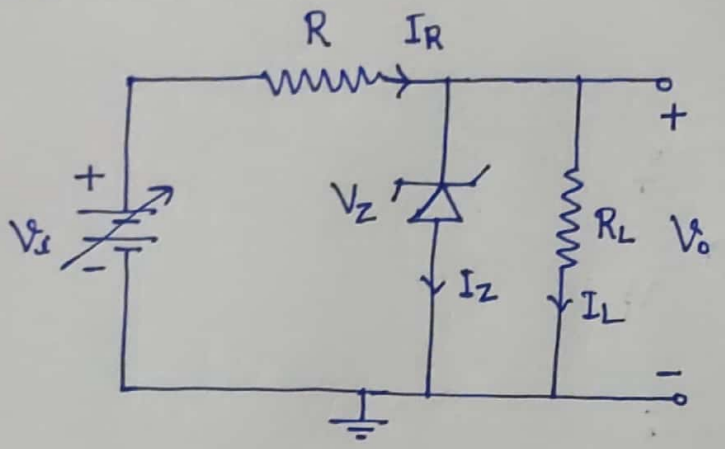
$$I_L = \frac{V_Z}{R_L} = \frac{10}{3}\,mA$$

$$I_Z = 6 - \frac{10}{3} = \frac{8}{3}\,mA$$

$$P_Z = V_Z I_Z = 10 \cdot \frac{8}{3} = \frac{80}{3}\,V$$

$$V_o = I_L \cdot R_L = \frac{10}{3} \times 3 = 10V$$

Q3: Determine the range of V_i which maintains the Zenoor diode in 'ON' state. Given that $R = 220\Omega$, $R_L = 1.2K\Omega$, $V_Z = 20V$, $I_{ZM} = 60mA$.



Sol:

$$\{V_i\}_{min.} = V_Z\left(1+\frac{R}{R_L}\right) = 20\times\left(1+\frac{220}{1200}\right)$$

$$= 20\times\left(1+\frac{11}{60}\right) = 23.67V$$

For $\{V_i\}_{max.}$

$$\{V_i\}_{max.} = V_Z + R\cdot I_{ZM} + RI_L$$

$$= V_Z + R(I_{ZM} + I_L)$$

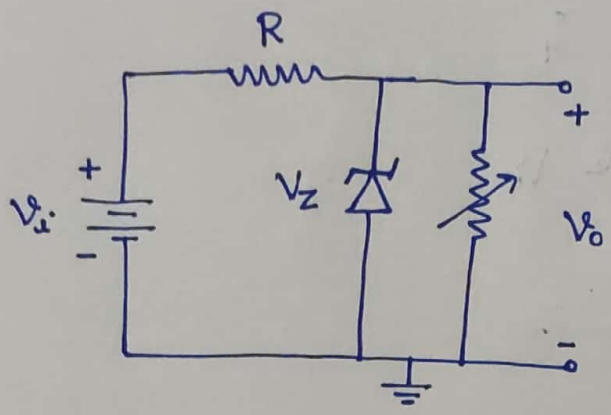
$$= 20 + 220\times\left(60+\frac{20}{1.2}\right)\times10^{-3}$$

$$= 20 + 0.22\times 76.67$$

$$= 36.87V$$

Range of $V_i \Rightarrow [\{V_i\}_{min.}, \{V_i\}_{max.}] \equiv [23.67, 36.87]$

Q. 4: Determine the range of R_L which maintains the Zener diode in 'ON' state. Given that $V_i = 50V$, $R = 1K\Omega$, $V_Z = 10V$, and $I_{ZM} = 32mA$.



Sol:-

$$\{R_L\}_{min.} = \frac{RV_Z}{V_i - V_Z} = \frac{1000 \times 10}{50-10}$$

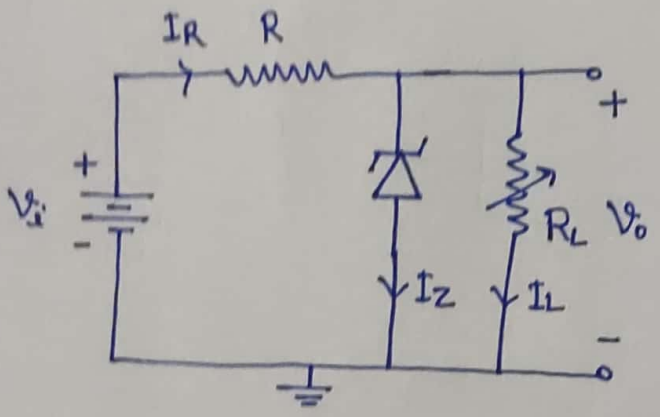
$$= 250\,\Omega$$

$$\{R_L\}_{max.} = \frac{V_Z}{\{I\}_{min.}} = \frac{10}{40-32} = \frac{10}{8} \times 10^3 = 1250\,\Omega$$

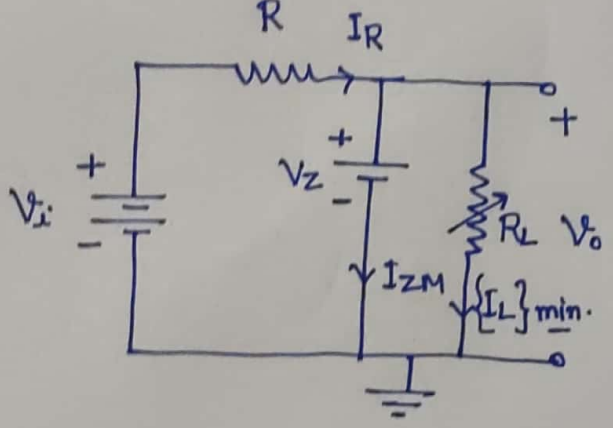
Range of $R_L = [\{R_L\}_{min}, \{R_L\}_{max.}]$

$$= [250, 1250]$$

Q.5: Determine the value of R_L that will establish maximum power condition for the Zener diode. Given that $V_i = 20V$, $R = 220\Omega$, $V_Z = 10V$, $P_{ZM} = 400\,mW$.



Sol:



~~$I_R = I_{ZM} + I_L$~~

~~$I_{max.}$~~ $\{I_L\}_{min.} = I_R - I_{ZM}$

$= \frac{V_i - V_Z}{R} - 40$

$= \frac{(20-10)\times 10^3}{220} - 40$

$= \frac{10 \times 10^3}{220} - 40$

$= \frac{1000}{22} - 40$

$= 45.45 - 40$

$= 5.45\,mA$

$\{R_L\}_{max.} = \frac{V_Z}{\{I_L\}_{min}} = \frac{10 \times 10^3}{5.45}$

$= 1834.86\Omega$