1)

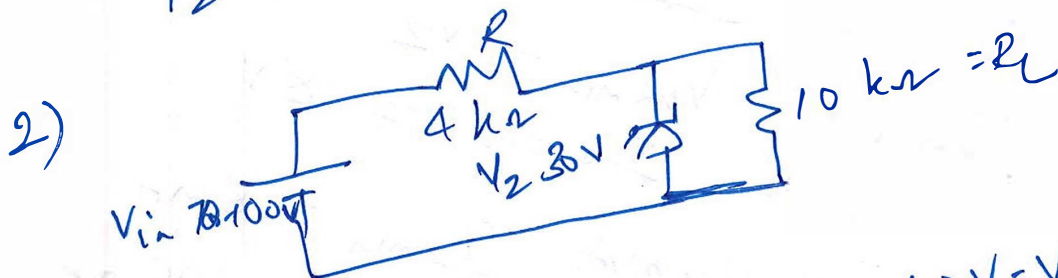$$V_L = \frac{40 \times 100}{50 + 100} = 26.67 \, V > V_Z.$$

Then $\underline{V_L = 20V}$

$$I_L = \frac{V_L}{R_L} = \frac{20}{100} = 0.2 \, A$$

$$V_R = V_{ih} - V_z = 40 - 20 = 20V$$

$$I_R = \frac{V_R}{R} = \frac{20}{50} = 0.4 \, A$$

$$I_z = I_R - I_L = 0.4 - 0.2 = \underline{0.2 \, A}$$

$$P_z = V_z I_z = 20 \times 0.2 = \underline{4w}$$

2)

i) $V_z = 30 \, V.$

So $V_R = 70 - 30 = 40V = V_{Rmin}$

$$V_R = 100 - 30 = 70 \, V = V_{Rmax}$$

$$I_{R \, min} = \frac{40}{4k\Omega} = 10 \, mA$$

$$I_{R\ max} = \frac{V_{Rmax}}{R} = \frac{70}{4k} = \underline{17.5\ mA}$$

$$I_L = \frac{V_L}{R_L} = \frac{30}{10k} = 3\ mA$$

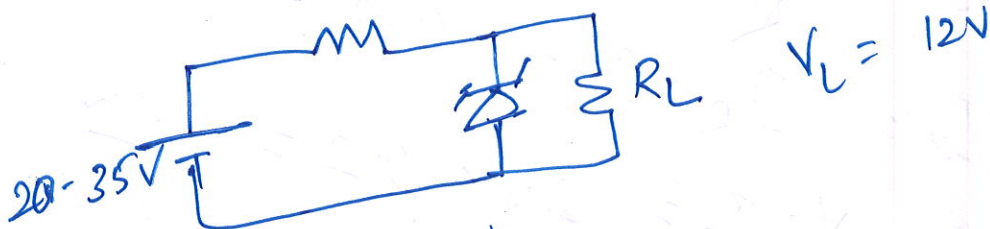$$I_{zmin} = I_{R\ min} - I_L = 10-3 = \underline{7mA}$$

$$I_{zmax} = I_{Rmax} - I_L = 17.5-3 = \underline{14.5mA}$$

$$P_{zmin} = V_z \cdot I_{zmin} = 210\ mW$$

$$P_{zmax} = V_z \cdot I_{zmax} = 30 \times 14.5\ mA$$
$$= \underline{435\ mW}$$

3)

$20-35V$ R_L $V_L = 12V$

$$V_z = V_L = \underline{12V}$$

$$V_{Rmin} = V_{in\ min} - V_z$$
$$= 20-12 = 8V$$

$$I_{Lmin} = 100\ mA \qquad I_{zmin} = 8\ mA$$
$$I_{Rmin} = I_{Lmin} + I_{zmin} = 108\ mA$$

$$R_L = \frac{V_L}{I_L} = \frac{12}{100\ mA} = 120\,\Omega$$

$$R = \frac{V_R}{I_R} = \frac{8V}{108mA} = 74\,\Omega$$

4) The minimum input voltage is when $I_z = 0$.

$$I_L = \frac{30}{2k} = 15\,mA$$

$I = I_L + I_z \Rightarrow I_{min} = 15\,mA$

$V_{in,min} = V_z + IR = 30 + 15 \times 10^{-3} \times 200$

$= 30 + 3 = 33\,V$

input is maximum when I_z is maximum.

$$I_{max} = I_L + I_z = 15 + 25 = 40\,mA$$

$V_{in,max} = 30 + I_{max} R$

$= 30 + 40 \times 10^{-3} \times 200$

$= 38\,V$

5) $V_z = 12\,V$

$$R = \frac{V_{in} - V_o}{I}$$

$I = I_{L,max} + I_{2,min} = 200\,mA$

$$R = \frac{16 - 12}{200 \times 10^{-3}} = 20\,\Omega$$

$P_{ZM} = V_z \cdot I_{ZM} = 2.4\,W$